Photo courtesy of Chelan PUD

April 2020
Rocky Reach Hydroelectric Project FERC License No. 2145

Annual Report Calendar Year 2019 Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan

Prepared for Federal Energy Regulatory Commission

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TABLE OF CONTENTS

TABLES

APPENDICES

ABBREVIATIONS

BiOp	Biological Opinion
BY	brood year
CCFEG	Cascade Columbia Fisheries Enhancement Group
CCNRD	Chelan County Natural Resources Department
CCT	Colville Confederated Tribes
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
EA	environmental assessment
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
GSHP	General Salmon Habitat Program
GSI	gonadosomatic index
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
IRTAG	Integrated Recovery Technical Advisory Group
kcfs	thousand cubic feet per second
M&E	monitoring and evaluation
MSRF	Methow Salmon Recovery Foundation
NMFS	National Marine Fisheries Service
NNI	No Net Impact
NOAA	National Oceanic and Atmospheric Administration
OLAFT	off-ladder adult fish trap
ONA	Okanagan Nation Alliance
PIT	passive integrated transponder
Plan Species	species addressed in the HCP
PNI	proportionate natural influence
PRCC	Priest Rapids Coordinating Committee
RI	Rock Island
RR	Rocky Reach
RRJFBS	Rocky Reach Juvenile Fish Bypass System
RRS	relative reproductive success
SOA	statement of agreement
SRFB	Salmon Recovery Funding Board
TU	Trout Unlimited
UCR	upper Columbia River
UCSRB	Upper Columbia Salmon Recovery Board

USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
W	Wells Plan Species Account
WDFW	Washington Department of Fish and Wildlife
WNFH	Winthrop National Fish Hatchery
YN	Yakama Nation

1 Introduction

On June 21, 2004, the Federal Energy Regulatory Commission (FERC) approved an Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for the Rocky Reach Hydroelectric Project (Rocky Reach – FERC License No. 2145) on the Columbia River in Washington State, operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The HCP provides a comprehensive and long-term adaptive management plan for meeting a No Net Impact (NNI) goal for species addressed in the plan (Plan Species) and their habitat. This document fulfills Article 10 of Appendix B and Section 9.8 of Appendix E of the FERC License issued on February 19, 2009[1], and Section 4.8 of the HCP, which requires annual reporting of progress toward achieving the NNI goal. Responsibilities toward achieving the NNI goal are described in Section 3 of the HCP, and in a 10-year Comprehensive Report assessing overall status of NNI (HCP Coordinating Committees 2013),[2] as well as successive 10-year intervals, in common understandings based upon completed studies, including those conducted as research and development for NNI progress or those not considered valid due to extenuating circumstances (Section 5.2.3 of the HCP).

The signatories of the Mid-Columbia HCPs (HCPs for the Wells, Rocky Reach, and Rock Island hydroelectric projects) meet as combined Coordinating Committees, Hatchery Committees, and Tributary Committees to expedite the process of overseeing and guiding HCP implementation. Minutes from the 2019 monthly meetings are compiled in Appendix A (HCP Coordinating Committees), Appendix B (HCP Hatchery Committees), and Appendix C (HCP Tributary Committees). In 2019, the HCP Policy Committees convened to discuss a potential impending dispute resolution from the HCP Tributary Committees, as further described in Section 3.2 and Appendix D. Appendix E lists members of the Rocky Reach HCP Committees. The Rocky Reach HCP Coordinating Committee oversaw the preparation of this 16th Annual Report, which covers the period from January 1 to December 31, 2019. (The 1st through 15th Annual Reports covered the periods January 1 to December 31, 2004, through 2018, respectively.)

[1] 126 FERC, paragraph 61,138 (2009)

[2] Public Utility District No. 1 of Chelan County – Natural Resources Department, 2013 Rock Island and Rocky Reach Anadromous Fish Agreements and Habitat Conservation Plans 2013 Comprehensive Progress Report. February 2013.

2 Progress Toward Meeting No Net Impact

The Rocky Reach HCP requires preparation of an Annual Report that describes progress toward achieving the performance standard of NNI for each Plan Species. The NNI standard consists of two components: 1) 91% combined adult and juvenile project survival, as achieved by project-improvement measures implemented within the geographic area of the project; and 2) up to 9% compensation for unavoidable project mortality provided through hatchery and tributary programs, with up to 7% compensation provided through hatchery programs and 2% through tributary programs (Section 3.1 of the HCP).

In 2019, Chelan PUD has met or exceeded all requirements for NNI under the Rocky Reach HCP for spring migrant HCP Plan Species (spring Chinook salmon [*Oncorhynchus tshawytscha*], steelhead [*O. mykiss*], sockeye salmon [*O. nerka*], and coho salmon [*O. kisutch*]). Project survival standards have been exceeded for steelhead, yearling Chinook salmon, sockeye salmon, and coho salmon; all of which are currently designated Phase III (Standards Achieved). For subyearling summer/fall Chinook salmon (a summer migrant and non-Endangered Species Act [ESA]-listed Plan Species), considerable life-history variability and limited technology constrain the ability to meaningfully estimate project survival (see Section 2.1.1). As a result, subyearling summer Chinook salmon are designated as Phase III (Additional Juvenile Studies[3]) and will continue to be compensated through the Tributary Conservation and Hatchery Compensation Plans at levels consistent with the guidance provided in the HCP. As established in Section 3.1 of the HCP, the inability to estimate survival due to limitations of technology shall not be construed as a success or a failure to achieve NNI.

Recalculated NNI production levels for all Plan Species were agreed on in 2011 within the HCP Hatchery Committees, and implementation began with the 2014 release year and will continue for the next 10 years (release years 2014 through 2023). Additionally, Chelan PUD funded the Tributary Conservation Plan's Plan Species Account at the level established in the HCP ($229,800 in 1998 dollars; see Section 2.3; Table 1).

Table 1
Rocky Reach Habitat Conservation Plan No Net Impact Progress for Plan Species (2019)

HCP Plan Species (ESA Status)	Survival Standard Met	Hatchery Compensation Provided	Tributary Conservation Plan Funded	NNI
Spring Chinook Salmon Yearlings (ESA-listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes
Steelhead (ESA-listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes

[3] The current phase designation will be re-evaluated in 2029.

HCP Plan Species (ESA Status)	Survival Standard Met	Hatchery Compensation Provided	Tributary Conservation Plan Funded	NNI
Sockeye (Not Listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes
Summer/Fall Chinook Salmon (Not Listed)	Phase III (Additional Studies)	Yes	Yes	Yes – NNI compensation provided, but additional studies required
Coho Salmon (Not Listed)	Phase III (Standards Achieved)	Yes	Yes	Yes

Throughout 2019, the HCP Coordinating, Hatchery, and Tributary Committees reached agreement on numerous issues during meetings in support of achieving the NNI goals, all of which were documented in the meeting minutes or were described in stand-alone statements of agreement (SOAs). In 2019, the HCP Policy Committees also convened to discuss the potential need for a dispute resolution that arose in the HCP Tributary Committees, which resulted in developing guidance to the HCP Coordinating, Hatchery, and Tributary Committees but no formal HCP Agreements or Decisions (see Section 3.2 and Appendix D). All agreements reached among the HCP committees along with approvals for funding of habitat projects by the Rocky Reach HCP Tributary Committee, are summarized in Table 2 and discussed in the remainder of this report.

Table 2
Summary of 2019 Agreements and Decisions for Rocky Reach Habitat Conservation Plan

Date	Agreement	HCP Committee	Reference
January 14, 2019	Approved the Northern Pikeminnow Report after no disapprovals were received prior to the 30-day review deadline on January 14, 2019	Coordinating	Appendix A and Appendix M
February 13, 2019	Agreed to add analysis of linkage disequilibrium to the Hatchery M&E Plan (update to the 2017 Plan). *(Note: NMFS abstained during the January 16, 2019 meeting but approved via email on February 13.)*	Hatchery	Appendix B

Date	Agreement	HCP Committee	Reference
February 13, 2019	Agreed to the following items regarding joint meetings with the Rocky Reach and Rock Island HCP Hatchery Committees and PRCC Hatchery Sub-Committee: • Combine meeting attendance into one forum • Issue one meeting agenda (including estimated duration for discussion items) and one set of meeting minutes • Develop similar protocols for documentation and distribution of materials in emails, pending agreement to final distribution lists • Develop joint meeting protocols *(Note: NMFS abstained during the January 16, 2019 meeting but approved via email on February 13.)*	Hatchery	Appendix B
February 26, 2019	Approved the 2018 RRJFBS Report	Coordinating	Appendix A and Appendix K
March 14, 2019	Approved a General Salmon Habitat Program proposal from YN titled: *Stormy Project Area "A" Stream and Floodplain Enhancement Project*	Tributary	Appendix C
March 18, 2019	Approved the 2018 Rocky Reach HCP Annual Report after no disapprovals were received prior to the 30-day review period deadline on March 18, 2019	Coordinating	Appendix A
March 22, 2019	Approved the 2019 Broodstock Collection Protocols.	Hatchery	Appendix B and Appendix O
March 26, 2019	Approved the 2019 Rock Island and Rocky Reach HCP Action Plan *(Note: USFWS approved the plan via email on March 18, and the CCT approved the plan via a phone call to Kristi Geris on March 25, 2019)*	Coordinating	Appendix A and Appendix H
March 26, 2019	Approved the 2019 Rock Island and Rocky Reach Fish Spill Plan, as revised *(Note: USFWS approved the plan via email on March 18, and the CCT approved the plan via a phone call to Kristi Geris on March 25, 2019)*	Coordinating	Appendix A and Appendix J
March 26, 2019	Approved the 2019 RRJFBS Operations Plan, as revised *(Note: USFWS approved the plan via email on March 18, and the CCT approved the plan via a phone call to Kristi Geris on March 25, 2019)*	Coordinating	Appendix A and Appendix I
March 26, 2019	Agreed to add Emi Kondo (NMFS) to select HCP Hatchery Committees email distribution lists	Coordinating	Appendix A
April 11, 2019	Approved the updated Section 5 of the Policies and Procedures for Funding Projects document	Tributary	Appendix C
April 17, 2019	Agreed to review the current broodstock collection protocols in September and October to identify changes needed in the next Protocols and determine who will make the revisions. Topics that deserve further discussion and/or SOAs will be identified on a case-by-case basis.	Hatchery	Appendix B

Date	Agreement	HCP Committee	Reference
April 17, 2019	Agreed to distribute draft meeting materials only to a primary distribution list that includes representatives, alternates and select participants. Final materials will be sent to a broader/secondary distribution list.	Hatchery	Appendix B
May 15, 2019	Approved the revised meeting protocols and distribution lists.	Hatchery	Appendix B
May 15, 2019	Agreed not to re-activate the expired Conflict of Interest Policy SOA.	Hatchery	Appendix B
May 29, 2019	Approved the updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists, contingent on USFWS approval of the lists *(Note: USFWS approved the lists via email on May 29, 2019)*	Coordinating	Appendix A
August 27, 2019	Agreed to Chelan PUD's request to begin the 2019/2020 ladder maintenance outage at Rocky Reach Dam 2.5 weeks earlier than usual to allow more time to complete required work, contingent on approval by the YN. Rather than beginning work during the first week in January (per usual), maintenance work will begin on December 16, 2019 *(Note: the YN agreed to Chelan PUD's request via email on September 3, 2019)*	Coordinating	Appendix A
September 16, 2019	Approved the *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2018 Annual Report* after no disapprovals were received prior to the 30-day review period deadline.	Hatchery	Appendix B and Appendix S
September 18, 2019	Approved the *Relative Reproductive Success Study Extension Memorandum*.	Hatchery	Appendix B and Appendix W
September 18, 2019	Approved the *Broodstock Collection Protocols Development Timeline SOA*.	Hatchery	Appendix B and Appendix G
September 18, 2019	Approved Chelan PUD's *2020 Draft Monitoring and Evaluation Implementation Plan*.	Hatchery	Appendix B and Appendix Q
September 18, 2019	Agreed to describe the alternative method of equivalence testing in the narrative in the genetic monitoring objectives of the PUDs' Monitoring and Evaluation Plan (M&E Plan).	Hatchery	Appendix B
September 26, 2019	Approved the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years*, as revised *(Note: USFWS approved the revised SOA via email on September 26, 2019)*	Coordinating	Appendix A and Appendix F

Date	Agreement	HCP Committee	Reference
October 16, 2019	Agreed to allow scientists to report the carcass survey data at the historic reach scale for comparison to past results, and also to report the data at a scale that is appropriate for each reach and population to discern distribution trends.	Hatchery	Appendix B
November 19, 2019	Approved the 2018 Northern Pikeminnow Report *(Note: WDFW approved the draft report via email on November 12, 2019)*	Coordinating	Appendix A and Appendix N
December 17, 2019	Approved the SOA, *Updated Flow Duration Curves for the Rocky Reach Project for Establishing Representative Flow Conditions*	Coordinating	Appendix A and Appendix F
December 17, 2019	Approved the 2019 Rock Island and Rocky Reach Fish Spill Report	Coordinating	Appendix A and Appendix L

The following sections summarize the achievements, actions, and activities taken in 2019 specific to project survival and dam operations, hatchery compensation, and funding of tributary habitat protection and restoration projects.

2.1 Project Survival and Dam Operations

2.1.1 Status of Phase Designations for Current Plan Species

A major feature of the Rocky Reach HCP is what is termed a "phased implementation plan" to achieve the survival standards. This approach includes three phases (Phase I, II, and III), and consists of conducting survival studies over multiple years and evaluating the achievement of survival standards, which is needed to proceed to the next phase. Progress through each phase has been described at length in previous HCP Annual Reports submitted to FERC.

Current phase designations for all Rocky Reach HCP Plan Species are summarized in Table 3.

Table 3
Current Phase Designations for Rocky Reach Habitat Conservation Plan

Plan Species	Project Survival (%)	Phase Designation	SOA Date
UCR Steelhead	94.77[1]	Phase III (Standards Achieved)	January 25, 2013
Okanogan River Sockeye Salmon	92.58[1]	Phase III (Standards Achieved)	January 25, 2013
UCR Yearling Chinook Salmon	92.28[1]	Phase III (Standards Achieved)	August 30, 2011

Plan Species	Project Survival (%)	Phase Designation	SOA Date
UCR Subyearling Summer/Fall Chinook Salmon	To Be Determined	Phase III (Additional Juvenile Studies)	September 26, 2019
Coho Salmon	92.94[2]	Phase III (Standards Achieved)	March 30, 2017

Notes:

1. Combined adult and juvenile survival achieved (HCP standard is 91%)
2. Juvenile project survival achieved using surrogacy analysis of direct-measured yearling Chinook salmon acoustic tag passage survival

Since 2013, the Rocky Reach HCP Coordinating Committee has routinely evaluated available data, study designs, and tag technology to assess the feasibility of conducting a valid survival study on subyearling Chinook salmon. These evaluations resulted in two SOAs maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for 3 years (approved by the Rocky Reach HCP Coordinating Committee on June 25, 2013, and September 29, 2016, respectively).

In April 2019, the HCP Coordinating Committees began revisiting the feasibility of studying the survival of subyearling Chinook salmon, and subsequently convened three joint discussions of the HCP Coordinating Committees and Priest Rapids Coordinating Committee (PRCC). On May 28, 2019, Douglas PUD presented findings from the draft report, *Wells Project Subyearling Chinook Life-History Study 2011-2013*. This study found that a traditional study of a subyearling population would violate assumptions of a single- and paired-release survival model, including the inability to tag a representative sample (many of the fish are too small to handle the size and weight (burden) associated with active tags), the tag hardware disproportionately affects survival probability, not all individuals have the same probability of survival to the end of the reach, and treatment and control groups would experience unequal river and passage conditions in common reaches. On June 25, 2019, Chelan PUD presented an update of the currently available acoustic tag technology to illustrate improvements that have been made since the last review in 2016. However, this review revealed that not much has improved in terms of tag burden and limited battery life. On July 23, 2019, Dr. Rebecca Buchanan of University of Washington and Columbia Basin Research provided a presentation titled, *Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies – 2019*, which showed there have been no significant developments in the survival models used or ability to meet all assumptions required when employing a paired release-recapture design to estimate reach survival of subyearling Chinook salmon (i.e., a statistical solution to estimating subyearling residualization does not currently exist and therefore, effects of residualization cannot be separated from project effects). On August 27, 2019, the HCP Coordinating Committees held a subyearling studies brainstorming session to discuss the findings from 2016 and the last three joint discussions in 2019. The HCP Coordinating Committees judged that based on the information presented, conducting survival studies on subyearling Chinook salmon was not feasible at this time. On September 24, 2019, the Rock Island and Rocky Reach HCP Coordinating

Committees approved the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years* (Appendix F). The HCP Coordinating Committees also scheduled quarterly subyearling Chinook salmon check-ins to occur during future HCP Coordinating Committees meetings occurring in February, May, August, and November each year, to continue to evaluate or monitor study design, tag technology, and life-history information on a quarterly basis to better understand the feasibility of conducting survival studies on subyearling Chinook salmon in the future.

2.1.2 Assessment of Project Survival

The Rocky Reach HCP requires that Chelan PUD shall work toward a 91% combined adult and juvenile project survival at Rocky Reach Dam, which is achieved by project-improvement measures implemented within the geographic area of the project. Progress toward this objective is described in the sections below.

2.1.2.1 Adult Passage Monitoring

When the Rocky Reach HCP was signed in 2002, it was acknowledged there was no scientifically rigorous method for the Rocky Reach HCP Coordinating Committee to assess adult project passage survival for Plan Species. Existing methods did not differentiate between mortality caused by the project and other sources of mortality (e.g., delayed mortality from injuries resulting from passage at downstream projects, injuries sustained by marine mammals, or harvest activities). Section 5.2 of the Rocky Reach HCP states that given the inability to differentiate between the sources of adult mortality, initial compliance with the combined adult and juvenile salmon and steelhead survival standard would be based on the measurement of 93% juvenile salmon and steelhead project survival or 95% juvenile salmon and steelhead dam passage survival, and an adult survival estimate of 98% to 100%.

Beginning in December 2012, Chelan PUD was able to evaluate adult passage survival through the Rocky Reach Project (dam and reservoir) for steelhead and sockeye salmon, even though unknown harvest mortality remained in the survival estimates. Passive integrated transponder (PIT)-tag detections from the PIT Tag Information System database were used to evaluate adult fish migrating upstream in 2010, 2011, and 2012 to estimate project conversion rates. For steelhead, adult fish destined for the Methow and Okanogan river systems were used for the survival evaluation. For sockeye salmon, adults returning to the Okanogan River Basin were evaluated. The 3-year arithmetic mean survival rates at Rocky Reach Project for adult steelhead and sockeye salmon were 98.93% and 98.92%, respectively (Table 4). A year prior, in 2011, Chelan PUD estimated the 3-year mean survival rates for adult spring Chinook salmon migrating through the Rocky Reach Project. This survival estimate was 99.90% for migration years 2009 through 2011. Chelan PUD will re-evaluate adult passage survival at Rocky Reach in 10-year intervals, as required per the HCP.

Juvenile, adult, and combined (juvenile and adult) survival rates at the Rock Island and Rocky Reach projects are presented in Table 4. Adult conversion rates were calculated from adult passage data for the years 2010 through 2012.[4]

The HCP combined adult and juvenile project survival standard is 91%. The HCP combined adult and juvenile project survival estimates apply to fish actively migrating through the Rock Island and Rocky Reach projects in the mainstem Columbia River and do not include mortality occurring in other locations (i.e., they do not include ocean or tributary mortality).

Table 4
Habitat Conservation Plan Juvenile, Adult, and Combined Survival Rates at Rock Island and Rocky Reach

Project	Species	Juvenile Survival	Adult Survival	Combined[5]
Rock Island	Steelhead	96.75%	99.31%[2]	96.08%
	Spring Chinook Salmon	93.75%[1]	99.89%[3]	93.65%
	Sockeye Salmon	93.27%	98.37%[2]	91.75%
Rocky Reach	Steelhead	95.79%	98.93%[2]	94.77%
	Spring Chinook Salmon	92.37%[1]	99.90%[3]	92.28%
	Sockeye Salmon	93.59%	98.92%[4]	92.58%

Notes:
1. Includes spring-migrating yearling Chinook salmon.
2. Estimate does not account for fish losses due to recreational harvest in any years.
3. No recreational harvest occurred.
4. Estimate adjusted for fish losses from recreational harvest in 2010 and 2011, but not for harvest losses in 2012.
5. Combined survival is the product of juvenile and adult survival estimates (e.g., 98% × 93% = 91%).

2.1.2.2 Valid Study Flow Duration Curve Update

Section 13.24 of the Rocky Reach HCP requires that as part of the 2013 comprehensive review, and every 10 years thereafter, the Rocky Reach HCP Coordinating Committee shall update the spring and summer period Flow Duration Curves used to define valid survival studies. The updated Flow Duration Curves must reflect "Representative Flow Conditions," meaning river flows between the 10th and 90th percentiles on the Flow Duration Curve, as calculated from the Grand Coulee Dam daily average outflow. In 2013, efforts began to update the Flow Duration Curve. The HCP Coordinating Committees agreed to develop the updated Flow Duration Curve with the historical 1929 to 1978 and 1983 to 2001 datasets used previously, to which the new 2002 to 2012 dataset was added. For comparison, Flow Duration Curves were also constructed using only the 1983 to 2012 dataset. The HCP Coordinating Committees also agreed to revise the definition of the summer period to comprise June 1 through

[4] Buchanan, R. A., and J. R. Skalski, 2012. Estimation of the Adult Salmon and Steelhead Conversion Rates through Rock Island and Rocky Reach Projects, 2010-2012. Prepared for Public Utility District No. 1 of Chelan County. December 2012.

August 15, compared to the former July 1 through August 15 period. Updated Flow Duration Curves were expected to become final in early 2014; however, in February 2014, a fracture discovered in Wanapum Dam postponed a number of efforts, including updating the curves, until time allows.

On November 19, 2019, Chelan PUD and Douglas PUD provided a joint presentation to the HCP Coordinating Committees, which addressed the questions asked by the HCP Coordinating Committees in 2013. The presentation also described approaches to updating the curves, including: 1) switching from the Grand Coulee flow duration curves to project-specific curves for the Wells, Rocky Reach, and Rock Island projects; 2) using a rolling average of the most recent 30 years to calculate the curves, such that 10 years from now, 10 years of new data will be added to the dataset and the older 10 years of data will be removed; and 3) including the month of June in the summer flow duration curves. After discussing these proposed updates at length, notably about whether the proposed time frames were representative of Plan Species run-timing and normal river flow conditions, on December 17, 2019, the Rocky Reach HCP Coordinating Committee approved the SOA, *Updated Flow Duration Curves for the Rocky Reach Project for Establishing Representative Flow Conditions* (Appendix F), which included all three proposed approaches to updating the curves.

2.1.2.3 2019 Survival Studies

No survival studies were conducted at the Rocky Reach Project in 2019.

In 2020, the Rocky Reach HCP Coordinating Committee will continue evaluating the feasibility of studying subyearling summer Chinook salmon survival, as stipulated in the SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years (through September 2022), as approved on September 26, 2019 (see Section 2.1.1). The Rocky Reach HCP Coordinating Committee will also continue planning for the upcoming 2021 Survival Verification Study.

2.1.3 Project Operations and Improvements

This section summarizes project operations and progress toward maintaining the juvenile project survival standard at Rocky Reach Dam in 2019. Actions in 2019 were guided by the *2019 Rocky Reach and Rock Island HCP Action Plan* (Appendix H), as approved by the Rocky Reach and Rock Island HCP Coordinating Committees on March 26, 2019 (Appendix A).

2.1.3.1 Operations

2.1.3.1.1 *Juvenile Bypass System and Fish Spill Operations*[5]

At Rocky Reach Dam, juvenile fish spill operations are guided by two documents. The Rocky Reach and Rock Island HCP Coordinating Committees approved both the *2019 Rocky Reach Juvenile Fish*

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[5] 129 FERC ¶ 62,183 (issued December 8, 2009). Order Modifying and Approving Operations Plan Pursuant to License Article 402.

Bypass System Operations Plan (Appendix I) and the *2019 Rocky Reach and Rock Island Fish Spill Plan* (Appendix J) on March 26, 2019. The Rocky Reach Juvenile Fish Bypass System (RRJFBS) operated continuously from April 1 through August 31, 2019, which covered the normal bypass operating period for the outmigration of juvenile salmon and steelhead at Rocky Reach Dam.

The *2018 Rocky Reach Juvenile Fish Bypass System Report* (Appendix K), which summarizes activities at the RRJFBS in 2018, was approved by the Rocky Reach HCP Coordinating Committee on February 26, 2019.

Spill for summer-migrating subyearling Chinook salmon at Rocky Reach Dam began on June 2, 2019, at 0001 hours, and continued uninterrupted for 72 days through 2400 hours on August 12, 2019. The target spill level for the duration of the summer spill period in 2019 was 9% of the estimated daily average river flow, as specified and approved in the *Rocky Reach Fish Spill Plan* (Appendix J). Spill volume for the 72-day summer period averaged 9.09% of the total river flow and comprised 9.02% fish spill and an additional 0.07% unavoidable hydraulic spill. The Columbia River flow rate past Rocky Reach Dam during the spill period averaged 100,417 cubic feet per second (cfs), and the daily average spill rate was 9,131 cfs. Following completion of the bypass operations on August 31, 2019, it was estimated that spill was provided for 99.1% of the subyearling Chinook salmon outmigration passing Rocky Reach Dam.

Complete Rocky Reach Dam 2019 fish spill operations results are summarized in the *2019 Rocky Reach and Rock Island Fish Spill Report* (Appendix L), which was approved by the Rocky Reach and Rock Island HCP Coordinating Committees on December 17, 2019.

2.1.3.1.2 *Rocky Reach Dam Large Unit Repair*

In 2013, Rocky Reach Dam Turbine Units C8, C9, C10, and C11 were modified from their normal Kaplan configuration to a temporary, fixed blade configuration as an interim measure while permanent repairs are fabricated and installed on these four large units (see Section 2.1.3.2.1). An interim operating angle of 31 degrees was selected because it is the most hydraulically efficient angle at full turbine discharge of 23,000 cfs. The 31-degree angle is the safest angle for fish passage (due to it being hydraulically efficient), and it represents the safest position of the blades because at this angle cavitation is minimized and the risk of a turbine runaway is lowest. In 2019, due to delays in recommissioning Turbine Unit C1 (see Section 2.1.3.2.3) and outages of Units C2 and C3, the recommissioning of Turbine Unit C9 was postponed from fall 2019 to February 2020. Maintenance continues on the large units, with a target completion date of first quarter 2023.

2.1.3.1.3 *Rocky Reach Dam Turbine Unit C1 Outage*

In January 2018, Rocky Reach Dam Turbine Unit C1 was taken offline to investigate an oil leak and mechanics discovered a loss of oil from the unit hub via the trunnion seals. Turbine Unit C1 remained offline for the remainder of 2018 while Rocky Reach Dam mechanics worked on repairing the unit (see Section 2.1.3.2.3).

In 2019, Chelan PUD mechanics and engineering staffs attempted multiple solutions to resolve trunnion seal leaks, with the unit ultimately disassembled to replace the trunnion bushings. Due to concurrent maintenance activities at the powerhouse and delayed receipt of parts necessary for the bushing repair, the return-to-service date for Turbine Unit C1 was postponed from August 2019 to January 2020 (note: as of January 2020, the return-to-service date is March 2020).

2.1.3.1.4 *Rocky Reach Dam Surface Collector and Turbine Unit C2 Altered Operations*

In February 2018, in preparation for operating without Rocky Reach Dam Turbine Unit C1 online at the start of the juvenile bypass system operations on April 1 (see Section 2.1.3.1.1), the Rocky Reach HCP Coordinating Committee approved an Operating Plan for the Rocky Reach Dam Surface Collector and Turbine Unit C2 during the Turbine Unit C1 outage. The key changes from normal operations include: 1) using three additional RRJFBS Surface Collector pumps to increase attraction flow from 6,000 to 6,660 cfs into the RRJFBS Surface Collector entrances (3,330 cfs for each entrance); and 2) increasing Unit C2 flow from its normal soft-limit set-point of 12.2 thousand cubic feet per second (kcfs) to a soft-limit flow of 15.2 kcfs.

In 2019, Rocky Reach Dam Turbine Unit C1 was still not operational at the start of the juvenile bypass season on April 1; therefore, the same altered operations implemented during the 2018 juvenile bypass season were implemented during the 2019 juvenile bypass season. The Rocky Reach HCP Coordinating Committee-approved altered operations were appended to the *2019 Rocky Reach Juvenile Fish Bypass System Operations Plan* (Appendix I). These altered operations are also the same as those implemented in June 2014 through the end of the 2014 fish bypass season, when Unit C1 was taken offline to repair a crack in the rotor.

2.1.3.1.5 *Rocky Reach Dam Turbine Unit C2 Outage*

In October 2019, Rocky Reach Dam Turbine Unit C2 was taken offline due to a possible failure of the internal servo rod seal. However, due to concurrent maintenance activities, mechanics were unable to investigate this issue and Turbine Unit C2 remained offline for the remainder of 2019 (see Section 2.1.3.2.5).

2.1.3.1.6 *Rocky Reach Dam Turbine Unit C3 Outage*

In February 2019, Rocky Reach Dam Turbine Unit C3 was taken offline due to leaking trunnion seals. The Rocky Reach HCP Coordinating Committee discussed changes in attraction flow in the cul-de-sac area of the Rocky Reach Dam forebay with both Turbine Units C1 and C3 offline and potential impacts to juvenile and adult yearling Chinook salmon survival performance at Rocky Reach Dam. The Rocky Reach HCP Coordinating Committee reviewed an analysis conducted by Drs. John Skalski and Richard Townsend (Columbia Basin Research) that reviewed juvenile survival data under three scenarios. The purpose of the analysis was to demonstrate how reallocating juvenile yearling Chinook salmon passage and route specific survival from the surface collector and the juvenile intake screens to turbine passage routes might translate into changes in juvenile project survival estimates and the 91% combined juvenile/adult survival metric for Plan Species outlined in the Rocky Reach HCP. This analysis found a slight reduction in collection efficiency, but the project would still meet the survival standard for Plan Species.

Rocky Reach Dam Turbine Unit C3 was repaired and returned to service on September 6, 2019. However, in October 2019, Turbine Unit C3 was taken back out of service to investigate small traces of oil in the tailrace, which ultimately was determined to be caused by Turbine Unit C2 (see Section 2.1.3.2.5). Due to concurrent maintenance and repair activities, Turbine Unit C3 was not returned to service until November 18, 2019. In December 2019, Turbine Unit C3 was taken offline again for an inspection and had not yet been returned to service by the end of 2019 (see Section 2.1.3.2.4).

2.1.3.1.7 *Juvenile Fish Bypass System Pre-Season Marked Fish Releases*

The RRJFBS is used for monitoring the physical condition of fish and species composition. Chelan PUD also uses the facility to evaluate seasonal run-timing for target species. Each year, Chelan PUD conducts pre-season marked fish releases at the RRJFBS to test the system for possible descaling, injury, or mortalities prior to the start of the bypass season, which begins on April 1 at 0000. Test fish are fin-clipped to differentiate between release locations, released into the system, recovered at the sampling facility, are visually inspected, and the results are tallied.

On March 21, 2019, Chelan PUD conducted 2019 pre-season marked fish releases in the RRJFBS and juvenile intake screen system deployed in Rocky Reach Dam Turbine Unit C2. The releases were conducted under the altered operations that were approved by the Rocky Reach HCP Coordinating Committee in 2018 (see Section 2.1.3.1.4). A total of 100 and 100 fish were released in the north and south entrances, respectively; and 99 and 98 fish were recovered, respectively. A release of marked fish into Unit C2 was conducted at a higher velocity and 42 of 100 fish were recovered. Due to low recovery numbers, divers were deployed to inspect the Unit C2 juvenile intake screen and adjusted the screen deployment. A second release into Unit C2 occurred on March 26, 2019, and 96 of 99 fish were recovered. No signs of descaling or injury were observed during any of the releases. A complete report summarizing 2019 activities at the RRJFBS is expected in 2020.

2.1.3.1.8 *Pikeminnow Predator Control*

Chelan PUD has implemented a northern pikeminnow (*Ptychocheilus oregonensis*) predator-control program in the Rocky Reach Project since 1994. Since 1996, the Chelan PUD has contracted annually with the U.S. Department of Agriculture (USDA) to carry out this program. Chelan PUD also provides funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club.

Complete results from the 2017 removal effort were summarized in the *2017 Rock Island HCP Annual Report* and are described in the *2017 Rock Island and Rocky Reach Pikeminnow Control Program Summary Report* (Appendix M), which was approved by the Rock Island and Rocky Reach HCP Coordinating Committees on January 14, 2019. Complete results from the 2018 removal effort were summarized in the *2018 Rock Island HCP Annual Report* and are described in the *2018 Rock Island and Rocky Reach Pikeminnow Control Program Summary Report* (Appendix N), which was approved by the Rock Island and Rocky Reach HCP Coordinating Committees on November 19, 2019.

In 2019, Chelan PUD continued implementing the northern pikeminnow removal program with Columbia Research long-line angling during the pre-migration period to target large pikeminnow that stage in deep reservoir areas and are difficult to capture with other gear types. The 2019 USDA hook-and-line angling program commenced during the peak of the juvenile salmonid migration. The total combined harvest of pikeminnow in 2019 from Rocky Reach and Rock Island reservoirs was 76,247 fish. Harvest numbers from the various control efforts in 2019 were as follows: USDA hook-and-line angling, 47,967 fish; Columbia Research long-line angling, 24,930 fish; East Wenatchee Rotary Club Pikeminnow Derby, 2,028 fish; and removal by Chelan PUD Fish and Wildlife personnel, 1,322 fish. A report summarizing results of the 2019 removal effort is expected sometime in early 2020.

2.1.3.2 Improvements and Maintenance

Facility improvements and maintenance at the Rocky Reach Project in 2019 that had the potential to affect Plan Species are described in this section.

2.1.3.2.1 *Rocky Reach Dam Large Unit Repair*

In 2013, while repairing internal hydraulic issues in Rocky Reach Dam Turbine Unit C10, mechanic crews discovered a deep hairline crack in a stainless steel rod that delivers oil to the servo motor. Rocky Reach Dam Turbine Units C8, C9, and C11 all have the same stainless steel rod design as part of the servo motors. During the 2013/2014 winter maintenance outage, interim fixes were installed on Units C8, C9, C10, and C11 (see Section 2.1.3.1.2). In 2015, permanent fixes were initiated on Turbine Unit C10. Repairs were anticipated to require 6 months per unit and were projected to be completed by 2019, pending any additional unforeseen delays. In 2016, head-cover issues were identified in Unit C8, and cracks were identified in the wheels of the bridge crane required to hoist the turbines for repair. In December 2017, Turbine Unit C8 was repaired and returned to service in February 2018. In 2019, due to delays in recommissioning Turbine Unit C1 (see Section 2.1.3.2.3), the return-to-service date for Turbine Unit C9 was postponed from fall 2019 to February 2020. These unexpected issues, as well as unexpected outages and delays with Turbine Units C1, C2, and C3, postponed the projected completion date of the large unit repairs to first quarter 2023. The priority for the remaining large unit repairs, from highest to lowest, is Unit C9, Unit C10, and finally Unit C11.

2.1.3.2.2 *2018/2019 Rocky Reach Adult Fish Ladder Winter Maintenance*

The upper adult fishway at Rocky Reach Dam was taken offline for annual winter maintenance on January 2, 2019, and the lower adult fishway was taken offline on January 8, 2019. The entire adult fish ladder was returned to service on February 15, 2019. Activities beyond general maintenance included: 1) diffuser inspection; 2) attraction water pump inspection C; and 3) traveling water screen inspection.

In 2018, the HCP Hatchery Committees approved a request from Washington Department of Fish and Wildlife (WDFW) to lethally remove hatchery-origin *O. mykiss* between 12 and 18 inches in length that are encountered during fish rescues associated with fishway maintenance outages at Chelan PUD and Douglas PUD hydroelectric projects. The purpose of this request was to address concerns about hatchery steelhead remaining in the river as resident trout. During the 2018/2019 winter maintenance outage at Rocky Reach Dam, initially, 12- to 18-inch *O. mykiss* collected during fish salvage activities that did not have a coded wire tag were released. It was later clarified that WDFW is interested in removing all 12- to 18-inch *O. mykiss* regardless of tag presence. This was communicated to Chelan PUD staff who turned over to WDFW the remaining 12- to 18-inch *O. mykiss* collected during fish salvage activities at Rocky Reach Dam so WDFW could examine the fish to determine the source of the fish.

Following the fish rescues associated with the 2018/2019 winter maintenance outage, WDFW also expressed interest in collecting any unique species encountered during the fish rescues to determine the source. Chelan PUD and WDFW will coordinate, as needed, prior to conducting fish rescues at Rocky Reach Dam in future years.

2.1.3.2.3 *Rocky Reach Dam Turbine Unit C1 Repair*

In January 2018, Rocky Reach Dam Turbine Unit C1 was taken offline to investigate an oil leak (see Section 2.1.3.1.3). Mechanics discovered a loss of oil from the unit hub via the trunnion seals. New replacement stock trunnion seals were received, installed, and tested; however, the new stock seals failed to stop oil from leaking from the unit hub. Chelan PUD investigated hydraulically locking the blades into place; however, engineers were not confident that operating in a hydraulically locked configuration would not result in an oil leak with a failed trunnion seal. In May 2018, Chelan PUD Board of Commissioners approved entering into a sole-source contract to design and manufacture engineered trunnion seals for Turbine Unit C1 at Rocky Reach Dam. The engineered trunnion seals were installed and tested; however, failed to stop oil from leaking from the unit hub. This led Rocky Reach Dam mechanics to believe the issue may be leaky trunnion seals due to trunnion bushing wear.

In 2019, disassembly of Turbine Unit C1 began to replace the trunnion bushing. Delays were caused by a shortage of headgates, which were being used for other maintenance activities. By May 2019, Turbine Unit C1 was completely disassembled but repairs were postponed due to delayed delivery of necessary components for repair from the vendors. As of the end of December 2019, Rocky Reach Dam mechanics were still waiting to receive the wicket gate servo control unit from the vendor. As of December 2019, the estimated return to service date for Turbine Unit C1 is March 2020.

2.1.3.2.4 *Rocky Reach Dam Turbine Unit C3 Repair*

On February 19, 2019, Rocky Reach Dam Turbine Unit C3 was taken offline for an inspection and mechanics discovered more than 5 gallons of water inside the hub (see Section 2.1.3.1.6). The engineered seals designed for Rocky Reach Dam Turbine Unit C1 were installed in Turbine Unit C3, the unit was pressurized, and the seals did not work. Mechanics implemented the same evaluation process as was done for Turbine Unit C1, including considering hydraulically locking the blades into place, manufacturing new trunnion seals, and possibly using a compound that is injected into the hub to improve the seal and allow the blades to operate in a Kaplan configuration. In June 2019, the new engineered Chesterton seals for Turbine Unit C3 were received and underwent testing to determine if the seals performed as designed. Another new set of trunnion seals were also ordered. On July 17, 2019, Turbine Unit C3 was returned to service with the Chesterton seals installed. On August 26, 2019, Turbine Unit C3 was removed from service and inspected. Two blade seals had minimal oil leaks, but upon draining the oil from the turbine hub, only a very small and acceptable amount of water was found in the turbine hub. The second set of new trunnion seals were installed and tested, and no leakage was observed. Therefore, Turbine Unit C3 was returned to service on September 6, 2019, operating with the second set of new trunnion seals. Mechanical staff continued obtaining daily oil level readings on the unit and if the levels are off, the unit would be taken offline to inspect and test the integrity of the seals. In December 2019, the unit was taken offline for inspection. Results are expected in early 2020.

2.1.3.2.5 *Rocky Reach Dam Turbine Unit C2 Repair*

In October 2019, Rocky Reach Dam Turbine Unit C2 was taken offline to investigate small traces of oil observed in the tailrace. The issue is possibly a failure of the internal servo rod seal causing over-pressurization of the turbine hub (see Section 2.1.3.1.5); however, mechanics have not yet been able to get into Turbine Unit C2 to investigate the issue because crews and equipment (headgates) were addressing Turbine Units C1 (repairs), C3 (seals), C7 (vibration issues), and C9 (repairs). Turbine Units C1 to C7, are designed with the same internal servo rod seals and trunnion seals. In 2020, Chelan PUD mechanics plan to assess these parts across the entire range of small units.

2.1.3.2.6 *Tumwater Dam Fishway Maintenance*

In September 2018, a snorkeling survey at the Tumwater Dam fishway identified erosion at the end of the fishway. In December 2018, a private contractor began drilling core samples within the footprint of the fishway to inform a scope for possible additional work involving installation of pin piles.

In early February 2019, the contractor completed the exploratory drilling and learned two things: 1) the bottom layer of concrete below the fishway was not as thick as depicted on the design drawings such that using pin piles to address the erosion would not be effective; and 2) the extent of erosion was much less than first speculated. Therefore, Chelan PUD engineers determined repairs are not needed at this time. Chelan PUD amended the Tumwater Dam Operations Plan to include further evaluation of these conditions during low water events.

2.1.3.2.7 *2019/2020 Rocky Reach Adult Fish Ladder Winter Maintenance*

On August 27, 2019, the Rocky Reach HCP Coordinating Committee agreed to Chelan PUD's request to begin the 2019/2020 ladder maintenance outage at Rocky Reach Dam 2.5 weeks earlier than usual to allow more time to complete the required work. This includes the recommissioning of Turbine Units C1 and C9, improvements to the fish viewing windows, and completing the preventative, routine maintenance. On December 16, 2019, the adult fish ladder at Rocky Reach Dam was taken offline for annual winter maintenance. The ladder should be back to service by mid-February 2020.

A fish rescue was performed in the upper portion of the adult fish ladder on December 16, 2019, and in the lower portion of the adult fish ladder on January 9, 2020, prior to maintenance activities in the respective areas.

2.2 Hatchery Compensation

Section 8.1 of the Rocky Reach HCP describes a Hatchery Compensation Plan with two primary objectives: 1) to provide compensation for Plan Species; and 2) to implement specific elements of the hatchery program consistent with the overall objectives of rebuilding natural populations and achieving NNI. In 2019, Chelan PUD continued to provide funding and capacity for hatchery production consistent with meeting NNI. Recalculated hatchery production values required to meet NNI through release year 2023 were approved by the Rocky Reach HCP Hatchery Committee on December 14, 2011, and represented in *Chelan PUD's No Net Impact and Inundation Obligations for Release Years 2014-2023*. Hatchery compensation for the Rocky Reach Project in 2019 included the release of 2,561,498 juvenile salmonids (combined Rocky Reach and Rock Island hatchery compensation; Table 5).

In June 2015, the HCP Hatchery Committees agreed to convene joint sessions of the HCP Hatchery Committees and PRCC Hatchery Sub-Committee when discussing agenda items applicable to and requiring participation from both committees. These practices benefit the HCP Hatchery Committees through increased coordination and sharing of expertise. The Grant PUD representatives have no voting authority under the HCPs; however, because these joint discussions influence similar and sometimes overlapping hatchery programs, those discussions are documented and included here, accordingly. The HCP Hatchery Committees and PRCC Hatchery Sub-Committee continued holding joint sections of meetings in 2019 when agenda items pertained to both sets of committees. In May 2019, the HCP Hatchery Committees and PRCC Hatchery Subcommittee agreed to a common set of meeting protocols, shared support and facilitation staff, and a single set of email lists for distributing meeting materials to further improve efficiency among committees (discussions are summarized in Section 2.2.2.10). This coordination and joint process will continue in 2020.

2.2.1 Hatchery Production Summary

Table 5 summarizes and compares HCP hatchery production objectives and actual 2019 smolt releases.

Table 5
2019 Production Level Objectives and Smolt Releases for Rocky Reach Habitat Conservation Plan Hatchery Programs

Species[a]	Program	Final Rearing Site	Rocky Reach Production Level Objectives (2014 to 2023)[b]	Total Releases for Rocky Reach in 2018 (Number of Fish)
Spring Chinook Salmon	Methow	Chewuch Acclimation Facility	60,516	72,000 smolts
Summer Chinook Salmon	Chelan Falls	Chelan Falls Acclimation Facility	576,000	528,567 smolts
Steelhead	Wenatchee	Chiwawa Acclimation Facility	247,300[c]	216,666 smolts
Sockeye Salmon	Okanogan	kł cp̓əlk̓ stim̓ Hatchery	591,050[d] (34% of kł cp̓əlk̓ stim̓ Hatchery production)	1,564,000 fry
Spring Chinook Salmon	Okanogan	Chief Joseph Hatchery	115,000 (12.81% of Chief Joseph Hatchery production)	62,403 smolts
Summer Chinook Salmon	Okanogan	Chief Joseph Hatchery /Omak Pond	94,570 (13.51% of Chief Joseph Hatchery production	0 subyearlings[e]
Summer Chinook Salmon	Okanogan	Similkameen Acclimation Facility	166,569 (12.81% of Chief Joseph Hatchery production)	117,862 yearlings

Notes:

a. Coho salmon mitigation met by the funding agreement with the YN.
b. As specified in the Rocky Reach and Rock Island HCP Hatchery Committees SOA Chelan PUD Hatchery Compensation, Release Years 2014 to 2023, approved December 14, 2011.
c. Steelhead production at Chiwawa Acclimation Facility includes Rock Island and Rocky Reach obligations.
d. Combined with the Rock Island HCP, the Okanogan sockeye salmon production requirement totals 591,050 smolts (production is allocated between the two HCPs); the table includes the number of fry released. By agreement of the HCP Hatchery Committees, this production requirement is satisfied for Okanogan sockeye salmon by funding of the Okanagan Skaha Lake sockeye salmon reintroduction program until otherwise determined by the HCP Hatchery Committees.
e. Due to low egg take for brood year 2018, there was not a subyearling release.

2.2.2 *Hatchery Planning and Implementation*

This section details the actions taken in 2019 that are relevant to planning for hatchery operations that support the HCP.

2.2.2.1 2019 Broodstock Collection Protocols

In February 2019, the HCP Hatchery Committees began their review of the draft 2019 Broodstock Collection Protocols for Chinook salmon and steelhead. The revised draft protocols were approved via email as follows: WDFW, Chelan PUD, Douglas PUD, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), the Colville Confederated Tribes (CCT), and the Yakama Nation (YN) approved on March 22, 2019. The final 2019 Broodstock Collection Protocols (Appendix O) were distributed to the HCP Hatchery Committees on March 28, 2019, and implemented at program hatcheries throughout 2019. As in previous years, the 2019 Broodstock Collection Protocols guide the collection of salmon and steelhead broodstock in the Methow River, Wenatchee River, Chelan River, and Columbia River. The protocols are consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation) and mitigation production levels (i.e., HCPs), and they comply with ESA permit provisions.

2.2.2.1.1 *Broodstock Collection Protocols Development Timeline*

During the development of the 2019 Broodstock Collection Protocols in early 2019, several major topics were raised but not fully discussed in time for inclusion in the document. It was noted that the broodstock collection protocols are intended to be a living document that can be amended in-season; however, it was also noted that topics that require major consideration by the HCP Hatchery Committees should be discussed prior to drafting the Protocols each year. In addition, the Protocols are not the correct place for documenting programmatic changes that would be better documented in SOAs or HCP Decisions. In August 2019, the HCP Hatchery Committees and PRCC Hatchery Sub-Committee jointly agreed to amend the existing Broodstock Collection Protocols Development Timeline SOA to accommodate earlier discussion and editing of the Protocols related to programmatic changes that are not dependent on run-size in advance of the initial annual draft Protocols for review. The Committees also noted that authorship should be shared among permit holders, which includes WDFW and the PUDs, whereas in the past the protocols were largely developed by WDFW. A list of Broodstock Collection Protocols Discussion Topics for 2020 was developed with associated lead representatives and meeting dates to be discussed (Appendix P). In September, the HCP Hatchery Committees and PRCC Hatchery Sub-Committees approved the amended *Broodstock Collections Protocols SOA* outlining a revised timeline for early document development, commencing in the fall prior to a given year's Protocols.

2.2.2.1.2 *Alternative Broodstock Composition and Mating Strategies*

During the development of the 2019 Broodstock Collection Protocols in early 2019, the consequences of potentially including jacks (age-3 fish) in broodstock was raised as a topic that should be researched further, especially considering there could be low numbers of age-4 and older fish available for broodstock collection in 2019. Douglas PUD developed a literature review to address the question and found a body of work on alternative methods for broodstock mating regimes that should also be considered by the HCP Hatchery Committees. Douglas PUD provided their findings to the HCP Hatchery Committees in a presentation in September and accompanying white paper in October entitled "*Review of Hatchery Broodstock and Mating Practices for Conservation Programs*" (Appendix B).

The purpose of conservation programs is to conserve and rebuild populations, minimize negative ecological impacts, conserve diversity, and minimize negative genetic impacts. However, ideal conditions are rarely met, and artificial selection is inevitable in hatchery propagation and due to selectivity of fisheries.

A large body of literature on incorporation of jacks into broodstock and strategies for broodstock management were reviewed. Methods for calculation of a jack incorporation rate were proposed. Two general methods for broodstock management were reviewed. The first method, termed the "genetically benign" approach, seeks to minimize genetic drift and domestication, incorporate wild fish into the broodstock, and randomize broodstock selection and spawning to minimize artificial selection. The second method, termed the "emulating natural processes" approach, seeks to actively counteract artificial selection and emulate the mate choice that occurs in nature. It was suggested to modify the current mating approach by including jacks at a predetermined rate based on natural occurrence and contributions to spawning, and to pair mates based on size. The Committees discussed the challenges to introducing new methods such as ensuring that the mate selection was feasible during actual spawning processes and what effects could be measured to evaluate the success of the modified approaches. Douglas PUD suggested implementing some elements of the new approaches in the Methow Fish Hatchery program in 2020 to test the feasibility in the field, and to inform hatchery managers of the desire to improve practices. Discussions will continue in 2020 as methods are developed for inclusion in the 2020 Broodstock Collection Protocols.

2.2.2.1.3 *Establishing Ranges Around Broodstock Collection Targets*

During the development of the 2019 Broodstock Collection Protocols in 2019, the idea of providing ranges around broodstock collection targets rather than a single numerical target was proposed; however, a method for determining the ranges had not been agreed upon. In October, Douglas PUD gave a presentation entitled "*Managing Risk and Expectations in Broodstock Collection*" that outlined an approach for modeling production targets using basic broodstock calculation that includes several factors such as pre-spawn survival and fecundity. Each of those factors has a mean and associated variance that are calculated from annual datasets, and a random draw from the distribution of each factor is unlikely to give the mean value of the distribution. In other words, if variances around the mean for a factor like fecundity are large, choosing an individual with much less than or much greater than the mean fecundity is more likely. Histograms can be used to depict the distributions of various factors, or alternatively, one can ask the model to identify a number of females by choosing a number of model iterations to test allowable critical levels of females necessary to achieve the target number of smolts while staying below 110% of the production target. By comparing the number of females against the probability of meeting a target and exceeding permitted production levels, one can identify an optimum number of females, or a range around the optimum, to hold for broodstock.

It was suggested that the updated modeled approach be compared with the current calculation method for determining broodstock targets. It was concluded that while the original intent of the method was to provide a range around broodstock targets in broodstock collection protocols, it may be disadvantageous to provide a range to the fish culturists, who will tend to collect the maximum if given a range rather than a single number. The utility of the method is to identify the factors driving the selection for the number of females in a given year (e.g., fecundity) and to be able to make in-season adjustments with greater confidence.

Douglas PUD suggested preparing a white paper with WDFW to use the method across programs coupled with a proposal to implement the method with one of the programs in the 2020 Broodstock Collection Protocols.

2.2.2.1.4 *Differentiating Natural-Origin Okanogan River Spring Chinook Salmon from Natural-Origin Methow Basin Spring Chinook Salmon*

During the development of the 2019 Broodstock Collection Protocols, it was determined that a method for differentiating natural-origin Okanogan River spring Chinook salmon during the collection of Methow Fish Hatchery broodstock at Wells Dam will be needed beginning in 2021, the first year that 4-year-old fish originating from the new Okanogan program would return over Wells Dam. The CCT would like to prevent fish from the Okanogan River from becoming incidentally collected for Methow Fish Hatchery broodstock at Wells Dam, though some would be able to ascend Wells Dam if trapping is not in operation every day at both ladders. A proposed method may also include a retrospective analysis to determine the prevalence of Methow Basin fish in Okanogan program broodstock. Possible methods for differentiating between the two stocks were discussed, focusing specifically on the use of elemental signature analysis on scales or fin-rays in an expedient manner while holding broodstock. A need was identified to begin collecting scales from wild yearling smolts known to originate from the Okanogan Basin during PIT-tagging or snorkel surveys to establish a baseline for the elemental signature of the Okanogan River compared to the Methow River. Similar analyses were done in the Wenatchee Basin; however, life-history variation that caused fish to move between waterbodies created confounding results. It was not known whether elemental signatures laid down into scales or fin rays of juvenile fish would still be present in adult fish 4 and 5 years later. Discussions on the use of elemental signature analysis to differentiate the two stocks will continue in 2019, with a plan to be proposed by the CCT.

2.2.2.1.5 *Surplus Broodstock Collection and Eggs*

2.2.2.1.5.1 Wenatchee River Steelhead and Salmon

In past years, broodstock collection protocols were written to ensure broodstock were collected throughout the return year. In 2019, run forecasts to the Wenatchee Basin were low and it was suggested that opportunities to collect broodstock be maximized by collecting on all days and at all sites available, and a high proportion of early returning fish be retained in a manner that would not be normally advocated but would be a prudent action to avoid under-collecting later in the season. The 2019 Broodstock Collection Protocols were revised to state that, in the Wenatchee Basin, trapping at Dryden Dam Traps and Tumwater Dam could be carried out simultaneously for summer Chinook salmon, summer steelhead, and coho salmon.

2.2.2.1.5.2 Chelan Falls Summer Chinook

In the 2019 Broodstock Collection Protocols, the Wells Dam Volunteer Trap and instream collection via temporary picket weir and beach seining in the Chelan River Habitat Channel were identified as sources for summer Chinook salmon brood used in the Chelan Falls summer Chinook salmon program. Due to safety concerns, the Chelan River Canal Trap previously used to collect broodstock was deemed infeasible to operate without major modifications. The Committees discussed the desire to coordinate the timing of trapping in the Chelan River with collection at the Wells Dam Volunteer Trap. It was also noted that the long-term objective is to collect broodstock for the Chelan Falls program from within the Chelan River, and that collection at Wells Dam is considered a short-term back-stop as collection at sites in the Chelan River is piloted. In 2020, Chelan PUD will present results from the pilot broodstock collection efforts in the Chelan River.

2.2.2.1.5.3 Excess of Methow Spring Chinook Salmon Eggs

In October 2019, it was reported that Methow Fish Hatchery had approximately 8,000 spring Chinook salmon eyed eggs in excess of 110% of program targets due to high fecundities. The eggs were the progeny of hatchery-origin females crossed with wild males; however, the males were crossed with other females whose eggs would be retained so their genes would not be lost from the overall population. The Wells and RR Hatchery Committees discussed whether the eggs could be transferred to the Winthrop National Fish Hatchery (WNFH) and whether eggs from WNFH could be transferred to the CCT's 10j Program at Chief Joseph Hatchery, consistent with the permit that would not allow transfer directly from Methow Fish Hatchery. It was determined that WNFH and the 10j program were at capacity and could not receive the eggs; therefore, the eggs were destroyed to conform to the ESA permit conditions.

2.2.2.2 2019 Rearing and Release Strategies

2.2.2.2.1 *Wenatchee Steelhead Release Plan 2018-2020*

In February 2018, Chelan PUD presented to the HCP Hatchery Committees a Draft 2018-2020 Steelhead Release Plan (Appendix B). The permit for the Wenatchee steelhead programs includes a special condition to minimize residualism and maximize downstream survival, so Chelan PUD and WDFW drafted a three-year release plan with the following objectives: evaluate survival based on size at release to optimize hatchery practices, evaluate rearing vessels, minimize confounding variables, and use data to assess monitoring and evaluation (M&E) objectives. The HCP Hatchery Committees discussed previous release plans, concerns about stray rates, and survival metrics. Analysis for the program included a PIT-tag study and size evaluation. Because NMFS does not provide direction on how to measure residualism and survival to determine baseline conditions for the Wenatchee programs, the HCP Hatchery Committees are responsible for agreeing on a methodology for meeting this permit condition. The HCP Hatchery Committees provided feedback to Chelan PUD and WDFW on release location, tag burden, and study design. In March 2018 the HCP Hatchery Committees approved the *Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)* as follows: Chelan PUD, WDFW, USFWS, NMFS, YN, and CCT approved on March 12, 2018. The plan is a three-year study beginning with the 2018 release year (brood year [BY] 2017).

As part of the 3-year release plan, Chelan PUD prepared a PIT-tagging study to evaluate residualism in early 2018 (described below). In order to reduce the number of co-variates and PIT tag enough steelhead to evaluate residualism, Chelan PUD requested approval to not transfer a proportion of the steelhead overwintered at Chiwawa Acclimation Facility to Blackbird Pond for final acclimation in January 2018, before the final plan was developed. The HCP Hatchery Committees discussed the draft plan and the proposed transfer and approved Chelan PUD's request to move approximately 25,000 hatchery-by-hatchery steelhead, destined for final acclimation at Blackbird Pond, from the enzyme-linked immunosorbent assay (ELISA) pond to Raceway 2 at the Chiwawa Acclimation Facility and forego final acclimation at Blackbird Pond in 2018.

2.2.2.2.1.1 Establishing Baseline Conditions in the Wenatchee Steelhead Program

The Wenatchee steelhead permit also requires Chelan PUD and WDFW to minimize residualism and maximize downstream migration of steelhead. Because NMFS does not direct the permit holders on how to determine baseline conditions for residualism or downstream migration, Chelan PUD developed the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* that the HCP Hatchery Committees reviewed in March 2018. Options to measure residualism included a PIT-tag evaluation, post-release sampling, and an electrofishing and angling study. The HCP Hatchery Committees discussed the options and methods for estimating rates of residualism, as well as sampling ideas and statistical approaches. The Hatchery Evaluation Technical Team met to discuss the draft plan in addition to the Hatchery Committees. Based on feedback from the HCP Hatchery Committees and the Hatchery Evaluation Technical Team, Chelan PUD indicated they intend to complete a PIT-tag evaluation and use gonadosomatic index (GSI) sampling to assess maturation. Only the lethal, post-release, GSI sampling required approval from the HCP Hatchery Committees, which was provided as follows: Chelan PUD, YN, CCT, WDFW, USFWS, and the NMFS approved on April 18, 2018. The PIT-tag study and GSI sampling occurred in 2019 as described in the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Programs* plan.

2.2.2.2.1.2 Wenatchee Steelhead Surplus and Precocial Maturation Study

In November 2018, WDFW and Chelan PUD notified the HCP Hatchery Committees that there was an overage in the Wenatchee steelhead program of about 21,000 excess hatchery-by-hatchery BY 2018 steelhead, which were destined for isolated ponds along Rock Island Reservoir. Chelan PUD developed a plan to study the effects of temperature regime on early maturation using 1,500 of the excess fish. Discussions with steelhead experts at National Oceanic and Atmospheric Administration (NOAA) yielded a recommendation to apply different temperature regimes to overwintering fish to evaluate whether transferring fish to the Chiwawa Acclimation Facility and rearing steelhead on colder water in November may be contributing to early maturation. Chelan PUD decided to rear 500 steelhead in each of three different locations (Eastbank Hatchery, Chiwawa Acclimation Facility, and Chelan Hatchery) with different temperature regimes at similar densities through early March, then transfer all 1,500 fish to the Chiwawa Acclimation Facility where final rearing occurs. The fish were lethally sampled in June 2019 to evaluate the effects of temperature regimes on precocial maturation using GSI sampling. The HCP Hatchery Committees discussed the overage and provided feedback on the study plan, particularly regarding what other data will be collected in addition to GSI sampling. Results will be provided in 2020.

2.2.2.3 Hatchery Monitoring and Evaluation Plan Implementation

2.2.2.3.1 *Hatchery Monitoring and Evaluation Plan – 2019 Update*

Chelan PUD hatchery M&E programs are operated in accordance with the *Monitoring and Evaluation Plan for PUD Programs*. The HCP Hatchery Committees revised the population genetics component of the plan (Objective 7) in 2019. Changes included comparing linkage disequilibrium of natural-origin and hatchery-origin fish over time; monitoring genetic status of hatchery-origin returns to evaluate potential genetic risks to the natural population; and employing equivalence testing in place of statistical hypothesis testing in the future when appropriate (described further in Section 2.2.2.3.5). A previous major revision was conducted in 2017 (to the *Monitoring and Evaluation Plan for PUD Programs – 2013 Update)*, as described in the 2017 Rocky Reach HCP Annual Report.

2.2.2.3.2 *Spatial Scales for Carcass Survey Analysis*

In October 2019, a question was raised about the appropriate spatial scale for analyzing hatchery and natural-origin female carcass distributions, as directed by the PUDs' M&E Plan: 2017 Update (and 2019 Update) and for consideration in the upcoming 10-year Comprehensive Review in 2020.

Management decisions could differ considerably depending on the scale of the analysis (e.g., 100 meters, 500 meters, 1 kilometer). Boundaries of the historical reaches that have been used for analyses over the long term are somewhat arbitrary, yet this is the largest dataset and should be preserved. Spatial distribution is very different depending on the species, size of the river, and reach characteristics such that one prescriptive scale for analysis is not biologically relevant for all cases. The HCP Hatchery Committees and PRCC Hatchery Sub-Committee agreed to evaluate female carcass distribution at the historical reach scale for comparison to past results and also to allow analysts to report distributions at a scale that is appropriate for each location and stock.

2.2.2.3.3 *Independent Scientific Advisory Board Recommendations*

In 2017 and 2018, the Independent Scientific Advisory Board reviewed habitat assessment, research and monitoring, and prioritization and coordination of recovery actions for spring Chinook salmon in the Wenatchee, Entiat, and Methow basins. Their final report, *Review of Spring Chinook Salmon in the Upper Columbia River*,[6] includes several recommendations pertaining to the Hatchery M&E Plan and its appendices. In February 2018, the HCP Hatchery Committees discussed the report and requested that Dr. Tracy Hillman (Chair of the HCP Hatchery Committees) begin updating the M&E Plan and its appendices and analyses as needed.

Hillman worked on this task throughout 2018 and 2019, reporting back to the committees regularly with updates. To date, his review has focused on the statistical analyses in Appendix H of the M&E Plan to compare the productivity of paired treatment streams with hatchery supplementation programs and control streams without hatchery supplementation programs. Improved statistical modeling of the treatment and control comparisons was performed and the methods were reviewed externally by Dr. Barb Downes (University of Melbourne) and Dr. Carl Schwartz (Simon Fraser University, retired). Updates to the plan and its appendices will continue in 2020 as the 10-year Comprehensive Review is developed.

2.2.2.3.4 *Hatchery Monitoring and Evaluation Implementation Plan*

The *Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan* is prepared annually to describe the M&E activities for the next calendar year. In August 2019, the HCP Hatchery Committees provided a draft annual M&E implementation plan for review. The genetic monitoring

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6 Independent Scientific Advisory Board, 2018. Review of Spring Chinook Salmon in the Upper Columbia River. ISAB 2018-1. February 9, 2018. Available at: https://www.nwcouncil.org/sites/default/files/ISAB%202018-1UpColSpringChinookReview10AprilUPDATE.pdf.

objectives were updated to align with the changes made to the PUDs' M&E Plan: 2019 Update (as discussed in Section 2.2.2.3.1). The Rock Island and Rocky Reach HCP Hatchery Committees approved the Chelan PUD 2020 Hatchery M&E Implementation Plan (Appendix Q) on September 18, 2019, following a 30-day HCP Hatchery Committees review period.

2.2.2.3.5 *Genetic Analyses for Habitat Conservation Plan Program Species*

The M&E Plan specifies genetic analyses, which should occur at 10-year intervals in order to examine the potential for changes in genetic diversity of natural populations as a result of hatchery programs. In 2016, the HCP Hatchery Committees recognized the need to reconsider the genetic sampling intervals and scheduling for HCP program species.

WDFW worked on this task throughout 2016 and 2017. They conducted a review of what samples have been collected and analyzed and made a list of relevant reports that includes the results of past analyses. They developed a draft timeline for sample collection, analyses, and reporting to meet all monitoring objectives, and they investigated potential analyses with geneticists to inform updated sampling intervals. This material was shared with the HCP Hatchery Committees in January 2017, then revised and shared again in April 2017. The timeline includes analysis needs, the projected year of the analysis, and the requirements for M&E reporting. The HCP Hatchery Committees discussed whether analysis intervals should be based on listing status or other factors, and whether to synchronize analysis years for the same species across basins, or by each basin. A power analysis was proposed as a way to determine how large of a genetic change could be detected in a population and how rapid it may occur (which would inform the analysis interval). The HCP Hatchery Committees also recognized the need to identify a baseline genetic period for each program, because hatchery programs change over time, especially broodstock. It was determined that the WDFW genetics laboratory should perform a power analysis to inform recommended analysis frequency, and the HCP Hatchery Committees should identify baseline periods for each program. The WDFW Molecular Genetics Laboratory did not complete a power analysis citing the need to be funded to complete this task.

In February 2018, the HCP Hatchery Committees discussed how the timeline and intervals for genetic sampling depend largely on sample sizes and analysis intervals. It was determined that input from geneticists from multiple agencies would help determine a strategy for genetics M&E for the upper Columbia River (UCR) PUD hatchery programs. In June through August 2018, the HCP Hatchery Committees reviewed draft questions for geneticists regarding M&E and nominated geneticists to participate on a panel. The goal of asking questions of the panel was to ensure that genetic analyses and reporting completed as part of hatchery M&E answer appropriate genetic questions for each program. In September 2018, the HCP Hatchery Committees met with the panel of geneticists: Drs. Morgan Robinson (NOAA), Christian Smith (USFWS), Ilana Koch and Shawn Narum (Columbia River Inter-Tribal Fish Commission), and Todd Seamons (WDFW). Discussions focused on the

HCP Hatchery Committees' questions about genetics M&E for PUD programs and populations and processes of concern. Further coordination, questions, and data-sharing followed. In December 2018, the panel responded with consensus answers to the HCP Hatchery Committees' questions about genetics M&E in the memorandum, *Response to questions posed by the HCP Hatchery Committees regarding the PUD M&E Plan* (Appendix B). The HCP Hatchery Committees discussed the recommendations and conclusions of the panel in December 2018 and continued these discussions in 2019.

After reviewing the recommendations and conclusions of the panel, the HCP Hatchery Committees discussed revisions to Objective 7 (monitoring population genetics) of the M&E Plan. In January 2019, the HCP Hatchery Committees discussed the first recommendation, to consider linkage disequilibrium as a metric of genetic status and agreed to add analysis of linkage disequilibrium to the Hatchery M&E Plan. Throughout 2019, they revised the M&E Plan to update the genetic monitoring objectives of the plan and to incorporate linkage disequilibrium. The first set of edits to the plan incorporated an analysis of linkage disequilibrium (based on input from Todd Seamons [WDFW geneticist]) and the testing of statistical hypotheses for natural-origin baseline samples and natural-origin contemporary samples every 10 years. In August 2019, the HCP Hatchery Committees discussed the proposed changes and analysis frequency. Representatives emphasized the importance of putting genetic analysis results in context with the significance of the results by identifying a biologically meaningful effect size. They also revised the hypotheses in the plan to compare contemporary natural-origin fish to contemporary hatchery-origin fish and the natural-origin fish baseline. They discussed the need to analyze hatchery-origin fish and determined that hypotheses for sampling hatchery-origin fish should be program-specific. After further edits, in September 2019 the HCP Hatchery Committees agreed to add hypotheses to the genetic monitoring objectives for equivalence testing approaches in addition to the standard null-hypothesis testing approaches based on suggestions from the Independent Scientific Advisory Board and M&E Plan authors. They sought additional input from geneticists Christian Smith (USFWS) and Todd Seamons to determine biologically significant effect sizes but were not able to prescribe an effect size for the plan. Rather, revisions to the hypotheses reflect the understanding that multiple aspects of a program (such as genetics, stray rate, and productivity) affect how the hatchery population affects the natural population. After completion of the Comprehensive Review, more information will be available to refine the hypotheses.

The HCP Hatchery Committees finalized changes to Objective 7 of the Hatchery M&E Plan with approval of the *Monitoring and Evaluation Plan for PUD Hatchery Programs: 2019 Update* on December 24, 2019 (Appendix R). The genetic analyses and statistical and equivalence testing described in the revisions will be implemented in 2020 and future years.

2.2.2.3.6 *Sampling at the Off-Ladder Adult Fish Trap*

In 2018, WDFW proposed a cost-sharing arrangement between WDFW and the PUDs to continue the existing steelhead PIT-tagging program at Priest Rapids Dam for steelhead (BY 2020 and beyond) to adjust for funding reductions from the Bonneville Power Administration and challenges to maintaining the aging PIT-tag infrastructure in the UCR.

In 2019, Douglas, Chelan, and Grant PUDs continued to consider the cost-share proposal outside the purview of the Hatchery Committees, focused on tagging steelhead at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam and maintaining critical PIT-tag arrays in tributaries used for estimating viable salmonid population metrics.

In January 2019, WDFW informed the HCP Hatchery Committees and PRCC Hatchery Sub-Committee of their intent to shift the focus from steelhead to spring Chinook salmon for mark-recapture model development for the estimation of spawning escapement and PIT-tagging efforts at the OLAFT, potentially affecting BY 2020 fish and beyond. The intent of an escapement model based on PIT-tag detections would be to allow for estimating spawning and pre-spawn mortality rather than relying on spawner surveys to fill a knowledge gap for estimating the number of spring Chinook salmon that return to the Upper Columbia compared to the number that successfully spawn. It was noted that some double-handling of fish could occur across the basin, which could exacerbate pre-spawn mortality, but potentially fewer fish would be handled overall. Reliance on spring Chinook salmon redd and carcass surveys would continue for monitoring the distribution of natural-origin and hatchery-origin spawners, redd distribution, and escapement.

Noting that the PUDs' implementation plans were drafted in advance of WDFW's proposal to shift from PIT-tagging steelhead to spring Chinook salmon in 2019, language documenting the use of the PIT-tag based escapement estimates for steelhead were maintained in the Chelan PUD 2019 Hatchery M&E Implementation Plan that was approved in 2018, and the approved Chelan PUD 2020 Hatchery M&E Implementation Plan. Steelhead were PIT-tagged at the OLAFT in 2019 as in previous years

2.2.2.3.7 *Hatchery Monitoring and Evaluation Plan Reporting*

In September 2019, the Chelan PUD 2018 Hatchery M&E Plan Report, titled *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2018 Annual Report,* which documented M&E activities in 2018 (Appendix S), was finalized following a 30-day HCP Hatchery Committees review period.

In addition, Chelan PUD began working with the HCP Hatchery Committees in 2016 to develop a long-term scheduling plan to logically orchestrate HCP requirements and M&E reporting, including annual and 5-year statistical reports, and the 10-year Comprehensive Review (Rocky Reach HCP: Section 8.7). The *Final M&E Reporting Schedule for the PUD Hatchery Programs,* finalized in March 2017, describes the content and function of each report and development and due dates through 2052.

2.2.2.3.8 *Improving Homing in the Methow Basin: Adult Outplanting Plan*

In 2016, the HCP Hatchery Committees designed a pilot management plan to address Objective 5 (regarding homing and straying of hatchery fish) of the Hatchery M&E Plan. The HCP Hatchery Committees approved the Final Outplanting Adults Plan in April 2017 and intended to implement the study in 2017. However, the translocation study did not occur in 2017, 2018, or 2019 because the spring Chinook salmon runs were small and no surplus hatchery-origin adults were available for translocation. In 2019, the HCP Hatchery Committees re-considered the intent of translocating adult fish in years of low abundance. The original intent was to translocate fish as an alternative to acclimation of juveniles in upstream tributaries and to compare the success of outplanting adults with acclimation of juveniles. Given that runs may continue to be too small to implement the plan as written, alternative perspectives were discussed for prioritizing the productivity of natural spawning with outplanted fish over filling hatchery broodstock with natural-origin spawners, and to consider habitat capacity and improving productivity in reaches with low spawner densities by outplanting fish. Outplanting surplus eggs in artificially constructed redds in areas of low spawner densities was also suggested. Alternative outplanting scenarios that examine translocating different subsets of adults are currently being examined by WDFW and USFWS to determine their impact on proportionate natural influence (PNI) of both the hatchery and naturally spawning groups. The results of the analysis will be presented to the HCP Hatchery Committees and PRCC Hatchery Sub-Committee in 2020, with the goal of revising the adults outplanting plan for the Methow Basin as a stand-alone document that will be treated as experimental until methods can be proven feasible and repeatable in the future.

2.2.2.4 Okanogan Sockeye Salmon Mitigation

In 2018, Chelan PUD provided a thirteenth year of funding for a portion of the Okanagan Nation Alliance's (ONA's) Skaha Lake Sockeye Salmon Reintroduction Program (the current hatchery production obligation for Okanogan sockeye salmon mitigation is a combined 591,050 smolts for Rocky Reach and Rock Island HCPs). Chelan PUD funding contributed to the construction of the kł cp̓əlk̓ stim̓ Sockeye Salmon Hatchery in Penticton, British Columbia, which was completed in September 2014. Currently, Chelan PUD funding contributes to operation and maintenance of the hatchery and to the M&E program. In June 2015, the hatchery held its first official fish release of roughly 1.7 million fry, mostly in Shingle Creek, and some in Okanagan Lake as part of a ceremonial ONA release. The hatchery was designed to support up to an 8-million-egg program; however, the plumbing system initially installed supported a production capacity of 5 million eggs. The egg-take goal of 5 million eggs was achieved for the first time in 2016. In spring 2018, the hatchery released roughly 1,220,000 fry (Chelan PUD's proportion was 414,800) into Skaha Lake.

2.2.2.4.1 *Annual Skaha and Okanogan Lake Sockeye Reintroduction Updates*

In November 2019, Ryan Benson of the ONA (British Columbia, Canada) gave a presentation entitled "*Skaha Lake Sockeye Re-introduction Program Update*" to the HCP Hatchery Committees and PRCC Hatchery Sub-Committee. A summary of hatchery operations and release strategies was given. The hatchery program produces sockeye salmon for reintroduction, with a capacity for producing up to 5 million eggs. In 2019, all fry were released into Lake Okanagan for the first time at three different sites in the lake. Survival and travel time through the Columbia River system are monitored by PIT-tag detections at downstream hydro-projects and survival in the lake is monitored by purse seining, though it can be difficult to recapture fish in the lake. No fry were stocked into Skaha Lake in 2019 due to naturally high escapement in 2018 from fish moving upstream through the Skaha Dam fishway. Reduced growth suggested that an optimum stocking density may have been exceeded in Skaha Lake in 2018, which may vary year to year depending on discharge rate through the lake and fish community dynamics between sockeye salmon, kokanee, and whitefish.

A new mandate allows reintroduction of sockeye salmon into the entire Okanagan Basin including Okanogan Lake, organized by the Okanagan Basin Salmon Restoration Sub-Committee, with support for ultimately releasing 4.2 million fry into Okanagan Lake, and eventually to other upstream lakes. One concern is sockeye salmon residualization and hybridization between sockeye salmon and kokanee.

Restoration actions being undertaken under the Okanagan River Restoration Initiative include gravel augmentation to the Penticton Channel and activation and improvements to the Penticton Dam fishway to pass adult fish into Lake Okanagan. The fishway was pilot tested in 2019 in preparation for early returns from the first large release of approximately 4.5 million sockeye salmon fry.

Implementation of the program has expanded in recent years with support of the Provincial British Columbia government, driven by federal participation in the United Nations Declaration on the Rights of Indigenous People. Implementation of the program activities has benefitted from the Canadian Okanagan Basin Technical Working Group, a successful model for cooperation that has been in place since the 1990s.

2.2.2.5 Hatchery and Genetic Management Plans

Efforts continue to complete the consultation process, including coordination in prior years among Chelan PUD, NMFS, USFWS, the YN, WDFW, the CCT, and Grant and Douglas PUDs.

2.2.2.5.1 *Wenatchee Steelhead*

On October 30, 2015, NMFS issued a Biological Opinion (BiOp) on the Wenatchee River Summer Steelhead Hatchery Program. On November 27, 2017. USFWS, in coordination with NMFS, issued a BiOp for the impact of Wenatchee River programs on bull trout, including the Chiwawa Spring Chinook Salmon, Wenatchee Steelhead, and Wenatchee Summer Chinook Salmon Programs on

November 27, 2017. NMFS issued Section 10 (a)(1)(A) Permit No. 18583 to WDFW, Chelan PUD, and the Yakama Nation (as an authorized agent of Chelan PUD) on December 26, 2017. The permit expires on December 31, 2027.

2.2.2.5.2 *Methow Spring Chinook Salmon*

Rocky Reach HCP Hatchery Committee approved the Chelan PUD Methow Spring Chinook Salmon Hatchery and Genetic Management Plan (HGMP) in March 2014.

NMFS issued the final permits for the combined Methow spring Chinook salmon programs, including Permit 20533 for Chelan PUD, in February 2017, and they will expire in December 2027.

2.2.2.5.3 *Chelan Falls Summer Chinook Salmon*

In May 2013, NMFS requested that Chelan PUD and other Permit No. 1347 permit holders submit letter applications for extension of Permit No. 1347. NMFS indicated that an extension of the existing Permit No. 1347 was feasible. Chelan PUD submitted an extension request letter on August 27, 2013. Subsequently, on September 20, 2013, Chelan PUD received a letter from NMFS indicating that the existing ESA permits would be extended until new consultations are completed, and new permits issued. In 2014, NMFS indicated that, due to higher priority permitting of programs rearing ESA-listed species, permitting of summer and fall Chinook salmon programs would not be addressed until spring 2015. In 2015, permitting of summer and fall Chinook salmon programs was postponed again because parties agreed that these programs are the lowest priority for completing consultation.

In May 2017, NMFS indicated they were drafting the proposed action for the batch of unlisted Chinook salmon programs in the UCR (Wenatchee summer Chinook, Chelan Falls summer Chinook, Wells summer Chinook, Priest Rapids fall Chinook, Methow summer Chinook, and Ringold upriver bright fall Chinook), and would be coordinating with parties to gain needed information. In June 2017, the HCP Hatchery Committees discussed possible consultation pathways for the unlisted programs. In September 2017, NMFS indicated that the BiOp for the Columbia River unlisted summer Chinook salmon programs is being drafted. The applicants officially initiated consultation with request letters in November 2017, and NMFS responded with letters of sufficiency to the applicants on November 25, 2017. The draft BiOp was available for the applicants and HCP Hatchery Committees to review and was finalized on December 26, 2017.

On November 20, 2017, NMFS requested informal consultation with USFWS under Section 7(a)(2) of the ESA on the proposed permitting of the Chelan Falls Summer Chinook program. Informal consultation was completed by USFWS on December 21, 2017.

In February 2018, NMFS indicated that the Section 10 ESA permit for the Chelan Falls summer Chinook salmon program would be issued after completion of the National Environmental Policy Act process, including an environmental assessment (EA) encompassing the Methow steelhead and unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids hatcheries). In September 2018, NMFS indicated the draft EA was under internal review, and an addendum for the HGMP should also be submitted to NMFS with updated information about the proposed action from the most recent BiOp. Chelan PUD reviewed the draft EA in October 2018. In November 2018, NMFS indicated that HGMP addenda were complete for the programs covered by the EA for the UCR steelhead and summer/fall Chinook salmon programs. The EA and HGMPs were reviewed internally by NMFS in March 2019 and made available for a 30-day public comment period in April 2019. No substantive comments were submitted from the public. NMFS finalized the Finding of No Significant Impact in July 2019 stating the actions will not have a significant impact to the environment; therefore, an environmental impact statement will not be necessary. The final EA and Section 10 ESA permits for the Chelan PUD summer Chinook salmon programs were finalized and signed in September 2019 and will expire in 2030.

2.2.2.6 Wenatchee Steelhead Relative Reproductive Success Study

The Rocky Reach HCP, Section 8.5.3, requires that Chelan PUD fund and implement a steelhead relative reproductive success (RRS) study. The Wenatchee Steelhead RRS Study began in 2008 and incorporated data from each subsequent BY to 2011. The study objective was to measure the RRS of hatchery-origin steelhead in the natural environment and determine the degree to which any differences in reproductive success between hatchery- and natural-origin steelhead can be explained by measurable biological characteristics.

In September 2015, WDFW and NMFS presented to the HCP Hatchery Committees the results of the Wenatchee Steelhead RRS Study. In summary, many differences in life-history traits were detected between hatchery and natural fish; however, there were no apparent differences in spawn timing. Additionally, spawning distribution was similar. Hatchery-by-hatchery broodstock male and female fish had the lowest RRS. Hatchery-by-wild broodstock male and female fish had an RRS between those of hatchery-by-hatchery broodstock and wild-by-wild broodstock. Wild-by-wild male and female fish had almost indistinguishable RRS from wild fish, though the RRS had greater variance between years. Size and season also contributed to variation in RRS among individuals. An SOA documenting the completion of the steelhead RRS study will be brought to the HCP Hatchery Committee in 2020.

2.2.2.7 Multi-Species/Expanded Acclimation

In the interest of developing a long-term, multi-species/acclimation plan for UCR salmon mitigation programs, in January 2013, the Joint Fisheries Parties developed a plan outlining multi-species acclimation options for UCR salmon and steelhead mitigation programs. Throughout 2013 and 2014, the YN further discussed with the HCP Hatchery Committees potentially expanding acclimation areas in the Upper Methow Basin and agreed to develop a document summarizing the details of these plans.

2.2.2.7.1 *Methow Spring Chinook Salmon at Goat Wall Acclimation Site*

In October 2014, after review by the HCP Hatchery Committees of the YN's initial proposal to acclimate 50,000 spring Chinook salmon at one of two acclimation sites in the Upper Methow Basin, the YN proposed acclimating 25,000 Methow spring Chinook salmon at the Goat Wall Acclimation Site, located on the Methow River approximately 20 miles upstream of the site used in the past (the Mid-Valley Pond site), and 25 miles upstream of the town of Winthrop. The site is located on a side channel to the Methow River named Cold Creek that conveys approximately 100 cfs in the spring, with water levels that are connected to water levels within the mainstem river. The acclimation area is 30 feet by 100 feet (0.08 acre) with an average depth of 3 feet, flows of 3 to 15 cfs, and water temperatures that ranges from high 30s°F to mid 40s°F, resulting in a capacity of 30,000 smolts at a size of 16 fish per pound and a conservative stocking density. The HCP Hatchery Committees requested that the YN prepare a proposal for expanded acclimation in the Methow Basin, including an explanation of pond operations, tagging, M&E, project objectives, and adult management, to be further discussed in 2015.

In January 2015, the YN, in coordination with the HCP Hatchery Committees, developed a Draft YN Upper Methow Spring Chinook Salmon Acclimation Proposal, as requested. The proposal was to acclimate 25,000 Methow spring Chinook salmon at the Goat Wall Acclimation Site as part of the YN's Upper Columbia Spring Chinook Salmon and Steelhead Acclimation Project (Bonneville Power Administration Project No. 2009-00-001), beginning with the 2016 release (BY 2014), and with releases continuing through 2020. The YN also distributed a Draft Goat Wall Acclimation SOA for HCP Hatchery Committees review. In February 2015, the HCP Hatchery Committees further discussed the draft proposal and SOA (which were also vetted with the Joint Fisheries Parties), and the Wells and Rocky Reach HCP Hatchery Committees approved the YN *Upper Methow Spring Chinook Acclimation Proposal* and Goat Wall Acclimation SOA, with NMFS abstaining, as follows: the YN approved on March 3, 2015; NMFS abstained on March 3, 2015; Chelan PUD, Douglas PUD, WDFW, and the CCT approved on March 4, 2015; and USFWS approved on March 5, 2015.

Chelan PUD and Douglas PUD requested that the YN have its own ESA permit coverage for the planned releases. NMFS indicated, however, that it was unlikely to have permits in place before March 2016 when the fish would need to be transferred. The YN, NMFS, and HCP Hatchery Committees explored options for how to move fish to the site and determined it cannot be done without the proper permits in place. Therefore, due to permitting delays, a 2016 release did not happen, despite HCP Hatchery Committees approval of the proposal and SOA.

NMFS issued a permit to YN for these activities in February 2017.

The YN has now released spring Chinook salmon from the Goat Wall Acclimation Site over 3 years and provided a summary of the past 3 years of activities in 2019 (Table 6).

Table 6
Juvenile Spring Chinook Salmon Released from the Goat Wall Acclimation Site

Release Year	Number Received	Number Released	Transfer Date	Release Start Date	Release End Date	Number PIT-Tagged
2017	25,978	25,894	3/30	4/17	4/26	4,934
2018	28,535	27,970	3/15	4/18	4/29	4,425
2019	29,810	29,777	4/2	4/22	4/30	4,971

The acclimation pond is fully enclosed by nets. Fish transfer date depends on flows and site accessibility and release date is timed to coincide with Methow Fish Hatchery release dates in order to compare survival between the two. A subset of the acclimated fish is PIT-tagged to observe pre-release and post-release survival and travel times. PIT-tag detection systems at the downstream end of the site are used to monitor for fish escapes prior to the release date, estimate survival during the acclimation period, and monitor emigration time once the nets are opened. Escape rates were low (approximately 1.2%) and modeled survival rates during acclimation were relatively high (greater than 98%). Acclimated fish had similar outmigration survival and travel times as fish released from Methow Fish Hatchery to McNary Dam (on the mainstem Columbia River). 2019 is the first year in which adult returns from the study were observed with estimated smolt-to-adult return rates that were similar to those from other Methow Basin hatcheries and acclimation sites. Monitoring of the distribution of adult spawners began in 2019 in order to observe whether study fish showed evidence of homing to the acclimation site; however, it is expected that there may be limitations to interpreting data from spawner surveys in one year because the total run-size was expected to be low in 2019.

The YN intends to conduct a total of 5 years of spring Chinook salmon releases from the Goat Wall Acclimation Site. The Committee discussed an appropriate timeline to evaluate site performance because the complete adult return data may not be available until several years following the last release. Representatives agreed that preliminary evaluations will be valuable, and that evaluation of juvenile performance could be carried out prior to collection of all adult survival and distribution data.

2.2.2.7.2 *Methow Spring Chinook and Coho Salmon at Chewuch Pond*

In 2019, Methow spring Chinook salmon and coho salmon were co-acclimated at Chewuch Pond, a second site in the Methow Basin. The acclimation pond was operated by Chelan PUD. This year was the first year of acclimating coho simultaneously with spring Chinook salmon, with 80,000 coho salmon acclimated in the pond.

2.2.2.8 Egg-to-Emergence Evaluation in the Chelan River

As in 2017, in 2018 Chelan PUD requested surplus steelhead eggs from Douglas PUD to conduct an egg-to-emergence evaluation in the habitat channel of the Chelan River to evaluate the effectiveness of Chelan PUD's Chelan River Biological Evaluation and Implementation Plan. In 2017, researchers used green eggs from Wells Fish Hatchery. In 2018, the study involved using 2,800 eyed eggs from four pairs of broodstock. The Rocky Reach and Rock Island HCP Hatchery Committees approved Chelan PUD's request to collect four female and four male surplus steelhead broodstock from the Wells Fish Hatchery Volunteer Channel to support the egg-to-emergence evaluation in 2018. Chelan PUD spawned the surplus broodstock in March 2018 and planted the eyed eggs in mid-April 2018. Results will be available from the Chelan River Fishery Forum in 2020.

2.2.2.9 Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Programs (2018-2020)

In 2018, WDFW distributed an Adult Prophylactic Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Salmon Programs in 2018-2020 to the HCP Hatchery Committees. WDFW reviewed the plan, which includes a trend away from using antibiotics in prophylactic treatments. The HCP Hatchery Committees discussed which aspects of fish health are the purview of the committees and the importance of communication between fish health staff at different hatcheries and agencies. The initial plan was approved by the HCP Hatchery Committees and implemented in 2018. It was also proposed that the plan be incorporated as an appendix to the Broodstock Collection Protocols in future years.

In 2019, Chelan PUD and WDFW staff revised the plan and included it as Appendix J of the 2019 Broodstock Collection Protocols (Appendix O to this report), *2018-2020 Brood year Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs*. The HCP Hatchery Committees approved the plan during approval of the Broodstock Collection Protocols. The goals of the plan are to ensure integrated and/or recovery programs make the most efficient use of natural-origin broodstock and maximizing natural-origin spawners while minimizing handling and unnecessary activities. The plan describes the proposed methods, including the timing and approach for prophylactic treatment, PIT-tagging strategies, and the program-specific plans for BY 2019.

In 2020, WDFW and Chelan PUD will evaluate results to determine if modifications are needed for BY 2020.

2.2.2.10 Meeting Logistics

The HCP Hatchery Committees and PRCC Hatchery Sub-Committee continued holding joint sections of meetings in 2019 when agenda items pertain to both sets of committees. To further streamline processes for both committee groups, meeting facilitation and support were merged. A single set of merged HCP Hatchery Committees and PRCC Hatchery Subcommittee meeting protocols and distribution lists was agreed to in May 2019 (Appendix B). Merged protocols outlined the approaches for decision making, resolving disputes and conflicts, meeting logistics, records maintenance and distribution, and review of plans and reports. Previously, the HCP Hatchery Committees had drafted a Conflict of Interest SOA that would require members with a personal interest in a decision item to recuse themselves from voting. However, it was determined that because the HCP Hatchery Committees and PRCC Hatchery Subcommittee operate on consensus, the personal interest of a single member could not individually affect a decision. Therefore, the HCP Hatchery Committees agreed not to renew the Conflict of Interest SOA as part of streamlining the meeting protocols.

The Committees discussed the current recipient list for HCP Hatchery Committees and PRCC Hatchery Sub-Committee materials via email, and the utility and objective for using email as a primary means for document distribution. A primary distribution list was developed for the distribution of all materials, draft and final, that included the Committees' and Subcommittee's representatives and alternates, as well as a small group of interested parties whose participation is necessary for reviewing documents. A secondary distribution list was developed that included a broader list of recipients to be copied only on the final versions of agendas, minutes, plans, reports, and other documents. The revised and merged distribution lists were approved by the HCP Coordinating Committees in May 2019. All materials pertaining to the given Committees and Subcommittee will continue to be posted to their respective internal Extranet and SharePoint sites, as well as external websites, per requirements of the HCPs and Priest Rapids Settlement Agreement to maintain documents for the public record.

A summary of HCP Policy Committees guidance directed toward the HCP Hatchery Committees was included in the meeting protocols regarding the process and criteria for elevating topics from the HCP Hatchery Committees to the Policy Committees. The specific guidance resulted from an issue raised in the HCP Tributary Committees that could not be resolved because policy-level considerations took precedence over biological relevance (described in Section 2.3). The following guidance was added to the meeting protocols in October 2019 (Appendix B):

> HCP Hatchery Committees will base decisions on technical merit, and notify respective HCP Coordinating and Policy Committees representatives of any potential policy issues needing to be addressed in those forums.

2.2.3 Maintenance and Improvements

2.2.3.1 Chelan Fish Hatchery Rehabilitation Design

In 2015, a rehabilitation feasibility study began for the Chelan Fish Hatchery Building, which is more than 60 years old. Rehabilitation is planned for the existing hatchery building, including the offices, incubation, early rearing, and ancillary functions. No program changes are proposed at this time. The feasibility study continued in 2016 and will be finalized in 2020.

2.2.3.2 Chelan Falls Canal Trap Engineering Feasibility

In January 2018, Chelan PUD indicated to the HCP Hatchery Committees that a more permanent structure for the Chelan Falls canal trap is being considered. The feasibility of designing permanent facilities for summer Chinook salmon broodstock collection at Chelan Falls was completed in 2019 and Chelan PUD decided not to move forward with design work due to the high cost of constructing a permanent broodstock collection facility at the site.

2.2.3.3 Eastbank Fish Hatchery Generator

In September 2018, Chelan PUD installed a generator as a second backup power source at the Eastbank Fish Hatchery. Programming to automate generator power was finalized in 2019.

2.3 Habitat Conservation Plan Tributary Committees and Plan Species Accounts

As outlined in the Rocky Reach HCP, the signatory parties each designated one member to serve on the HCP Tributary Committee. The Rock Island, Rocky Reach, and Wells HCP Tributary Committees meet on a regularly scheduled basis as a collective group to enhance coordination and minimize meeting dates and schedules. Subject items requiring decisions are voted on in accordance with the terms outlined in the specific HCPs. During 2019, the Rocky Reach HCP Tributary Committee met on nine occasions.

An initial task of the HCP Tributary Committees in 2019 was to review and update their operating procedures that provide a mechanism for decision making. These were initially developed in 2005 and were included in that year's annual report (Anchor 2005).[7] The HCP Tributary Committees also developed Policies and Procedures for soliciting, reviewing, and approving project proposals (Anchor 2005). The Policies and Procedures provide formal guidance to project sponsors on submission of proposals for projects to protect and restore habitat of Plan Species within the geographic scope of the HCP. The HCP Tributary Committees established two complementary funding programs, the General Salmon Habitat Program (GSHP) and the Small Projects Program.

In 2019, the HCP Tributary Committees reviewed their Policy and Procedures document and made edits to clarify language in Section 2.0 (Funding Programs). In addition, the HCP Tributary Committees developed specific evaluation criteria for Section 5.0 (Review Procedures; see Appendix T). Different criteria were established for evaluating restoration, protection, design, and

[7] Anchor Environmental, L.L.C. 2005. Annual Report, Calendar Year 2005, of Activities under the Anadromous Fish Agreement and Habitat Conservation Plan. Rocky Reach Hydroelectric Project, FERC License No. 2145. Prepared for FERC by Anchor Environmental L.L.C. and Public Utility District No. 1 of Chelan County.

assessment projects. Criteria include an evaluation of biological and technical merit, feasibility, durability, and cost effectiveness. Finally, the HCP Policy Committees provided the HCP Tributary Committees guidance on how the HCP Tributary Committees evaluate proposals and make funding decisions (see Section 2.3.3). Those guidelines were incorporated into the Policies and Procedures document.

The HCP Tributary Committees also reviewed and updated their Operating Procedures. The YN designated Brandon Rogers as their voting member and Hans Smith as the alternate on the Wells HCP Tributary Committee.

The HCP Tributary Committees continued the process of identifying high-priority, targeted, habitat projects within each of the Wenatchee, Entiat, Methow, and Okanogan subbasins. Based on the HCP Tributary Committees' extensive knowledge of the subbasins, limiting habitat factors, threats, and limiting life stages, they will identify enhancement or protection actions within each subbasin and call for proposals to implement those actions. They will work closely with the Upper Columbia Regional Technical Team on identifying high priority habitat actions. This is similar to the Bonneville Power Administration Targeted Solicitation Process. Although the HCP Tributary Committees will continue to accept project applications from sponsors anytime during the year, they plan to take a more active role in identifying and funding targeted projects within each subbasin. The HCP Tributary Committees are currently working with project sponsors on developing large, floodplain restoration projects in the Methow and Entiat rivers, and in Peshastin Creek, a tributary to the Wenatchee River.

Dr. Tracy Hillman continued as the Chairperson for the Rocky Reach HCP Tributary Committee. In 2019, the HCP Tributary Committees conducted a formal evaluation of the Chairperson and agreed unanimously to retain Dr. Hillman as the Chairperson for the next three-year period (2020 through 2022). Dr. Hillman is an Ecological Society of America board-certified senior ecologist and chief executive officer of BioAnalysts, Inc. He has over 30 years of experience as an ecologist and has chaired the Rocky Reach HCP Tributary Committee since 2007.

2.3.1 Regional Coordination

Similar to the HCP Hatchery Committees and to improve coordination, a representative from Grant PUD and the facilitator of the PRCC Habitat Sub-Committee were invited to the HCP Tributary Committees monthly meetings. In addition, these representatives received meeting announcements, draft agendas, and meeting minutes. This benefits the HCP Tributary Committees through increased coordination and the sharing of expertise. The Grant PUD representative and PRCC Habitat Sub-Committee facilitator have no voting authority within the HCP Tributary Committees.

The HCP Tributary Committees also coordinate with the Upper Columbia Salmon Recovery Board (UCSRB). Coordination is typically between the chairperson of the HCP Tributary Committees and the

Executive Director or the Natural Resource Program Manager of the UCSRB. In addition, some members of the HCP Tributary Committees typically attend UCSRB meetings to foster coordination in developing and selecting projects for funding. Some members of the HCP Tributary Committees are also members of the UCSRB's Regional Technical Team, which increases coordination in selecting projects for funding. Many of the Policies and Procedures of the Salmon Recovery Funding Board (SRFB) and HCP Tributary Committees are complementary, and annual funding rounds by these funding entities have been coordinated since 2005.

In addition to coordinating with the SRFB process and the PRCC Habitat Sub-Committee, the Rocky Reach HCP Tributary Committee coordinates funding of GSHP proposals with Bonneville Power Administration and the U.S. Bureau of Reclamation. The purpose of this coordination, according to Section 2 of the Tributary Fund Policies and Procedures for Funding Projects, is to collaborate with regional, local, state, tribal, and national organizations that fund salmon habitat projects. The efforts resulted in identification of possible cost-shares for suitable habitat restoration projects.

2.3.2 Fiscal Management of Plan Species Accounts

The HCP Tributary Committees set up methods for the long-term management of the Plan Species accounts for each HCP. The Rocky Reach HCP Tributary Committee appointed the accounting firm Clifton Larson Allen to perform the necessary tasks for fiscal management of the Rocky Reach Plan Species Account. These tasks include the following: 1) develop a long-term approach to maintain the funds and to carry out tax calculations and reporting; 2) conduct the daily management of activities (such as processing of invoices); and 3) provide technical expertise on financial matters to the committees. The beginning balance of the Rocky Reach Plan Species Account on January 1, 2019 was $2,888,124.61. Chelan PUD's annual contribution was $371,474.00. Interest received during 2019 was $39,645.00. Funds disbursed for projects in 2019 totaled $30,813.04. In addition, $4,290.97 was paid to Clifton Larson Allen and Chelan PUD for account administration, $1,000.00 was paid to the UCSRB for sponsorship in the 2020 Upper Columbia Science Conference, and $67.00 was paid in bank fees. The ending balance on December 31, 2019, was $3,263,072.60. The 2019 Annual Financial Report for this Plan Species Account is provided in Appendix U.

The Rocky Reach HCP Tributary Committee delegated signatory authority to the Chairperson for processing of payments for invoices approved by the HCP Tributary Committee, with the HCP Coordinating Committee Chairperson serving as the alternate. Chelan PUD recognizes the uniqueness of the Rocky Reach HCP Tributary Committee decision-making process and delegation of signatory authority to the Chairperson, and the Chelan PUD subsequently has provided funding necessary to assign reasonable liability insurance to the Tributary Chairperson.

2.3.3 Criteria for Making Funding Decisions

In late 2018 the HCP Tributary Committees evaluated a GSHP proposal that was supported by all parties on a technical level but was not supported by one party on a policy level. Thus, because of policy-level intervention, the HCP Tributary Committees elected not to fund the project. As a result, in February 2019, the YN offered a draft SOA titled, *Basis for Decision Making in HCP Tributary Committees,* which addressed the process and criteria by which the HCP Tributary Committees make funding decisions (Appendix V). The purpose of the SOA was to make sure all funding decisions made by the HCP Tributary Committees are based only on the merits of the project (biological benefit, technical merit, durability, feasibility, and cost effectiveness). Any criteria having no direct nexus to Plan Species, their habitat, or their management cannot be considered when evaluating proposed projects. The SOA also noted that any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from voting. The SOA was not supported by the HCP Tributary Committees. In June 2019, the YN formally initiated the dispute resolution process; however, because of timing issues and the need for the dispute to be addressed first by the HCP Coordinating Committees as outlined in the HCPs, the YN withdrew the formal dispute and requested the HCP Policy Committees convene to discuss the issue. The HCP Policy Committees met on July 9, 2019, and provided the following guidance specific to the HCP Tributary Committees (see Section 3.2):

- HCP Tributary Committees will base funding decisions on technical merit, biological benefit, durability, feasibility, and cost effectiveness (using the specific evaluation criteria in Section 5 of the Policies and Procedures document) and will notify respective HCP Coordinating and Policy Committees' representatives of any potential policy issues needing to be addressed in those forums.
- The HCP Tributary Committees should consider abstention in lieu of disapproval to preserve respective policy positions.

2.3.4 General Salmon Habitat Program

The HCP Tributary Committees established the GSHP as the principal mechanism for funding projects. The goal of the program is to fund projects for the protection and restoration of Plan Species habitat. An important aspect of this program is to assist project sponsors in developing practical and effective applications for relatively large projects. Many habitat projects are increasingly complex in nature and infeasible without extensive design, permitting, and public participation. Often, a reach-level project involves many authorities and addresses more than one habitat factor. Because of this trend, the GSHP was designed to fund relatively long-term projects. There is no maximum financial request in the GSHP; the minimum request is $100,000, although the HCP Tributary Committees may approve lesser amounts during a phased project.

The HCP Tributary Committees accept GSHP applications at any time during the year. They also accept SRFB applications for projects where Plan Species Account Funds are included as cost-shares in SRFB proposals.

In an effort to coordinate with ongoing funding and implementation programs within the region, the HCP Tributary Committees used the previously established technical framework and review process for this geographic area and worked with the other funding programs to identify cost-sharing procedures (see Section 2.3.1).

2.3.4.1 2019 General Salmon Habitat Projects

The SRFB announced its 2019 funding cycle in March, with draft proposals due on April 12, 2019, and final proposals due on June 28, 2019. The HCP Tributary Committees received and reviewed 18 draft SRFB proposals. The HCP Tributary Committees identified eight projects they believed warranted full proposals and dismissed ten projects because they were inconsistent with the intent of the Tributary Fund, did not have strong technical merit, were not cost effective, or were funded by another funding entity.

In July, the HCP Tributary Committees received 12 full SRFB proposals to the GSHP. All were cost-shares with the SRFB or other funding entities. The HCP Tributary Committees approved funding for six projects. In addition, the HCP Tributary Committees received five full proposals to the GSHP that were outside the SRFB process. Table 7 identifies the projects, sponsors, total cost of each project, amount requested from Tributary Funds, and, if funded, which Plan Species Account supported the project.

Table 7
General Salmon Habitat Program Projects Reviewed by the Habitat Conservation Plan Tributary Committees in 2019

Project Name	Sponsor[1]	Total Cost	Request from Tributary Committee	Plan Species Account[2]
Salmon Recovery Funding Board Applications				
Nason and Kahler Creek Confluence Acquisition	CDLT	$369,150	$184,575	Not funded [3]
Restore Lower Chiwaukum Creek – Phase 1	CCFEG	$116,256	$55,098	RI: $55,098
Monitor Side Channel Construction	CCNRD	$296,530	$148,265	RI: $148,265
Peshastin River Mile 4.3 Side Channel	CCNRD	$99,010	$19,802	RI: $19,802
IPID Full Season Pumping Project	CCNRD	$135,000	$67,500	Not funded
Nason Ridge Acquisition	CCNRD	$5,500,000	$500,000	RI: $500,000
Wenatchee EDT Model Development	CCNRD	$318,000	$48,000	Not funded
Lower Wenatchee Instream Flow Enhancement	TU	$2,500,000	$250,000	RI: $250,000
Upper Burns & Angle Point Areas Enhancement	YN	$1,070,500	$189,000	RI: $189,000

Project Name	Sponsor[1]	Total Cost	Request from Tributary Committee	Plan Species Account[2]
Golden Doe Large Wood Project	YN	$1,004,590	$200,270	Not funded
Upper Methow Restoration Assessment and Design	CCFEG	$80,200	$35,500	Not funded
Okanogan Basin Barrier Assessment	CCFEG	$193,826	$22,000	Not funded
General Salmon Habitat Program Applications				
Upper Kahler Stream and Floodplain Enhancement	YN	$482,500	$149,000	RI: $149,000
Stormy Project Area "A" Stream and Floodplain	YN	$1,564,211	$823,161	RR: $823,161
Johnson Creek US Hwy 97 Habitat Restoration	TU	$1,562,455	$267,547	W: $267,547
Evaluating Environmental Impacts of Tumwater Dam	CCFEG	$279,600	$139,800	Not funded
2019 Eightmile Creek Fisheries Assessment	WDFW	$130,183	$125,183	Not funded

Notes:

1. CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resources Department, CDLT = Chelan-Douglas Land Trust, TU = Trout Unlimited, WDFW = Washington Department of Fish and Wildlife, and YN = Yakama Nation.
2. RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.
3. The Nason and Kahler Creek Confluence Acquisition Project was funded by the PRCC Habitat Sub-Committee.

In 2019, the Rocky Reach HCP Tributary Committee agreed to fund the following GSHP project:

- **Stormy Project Area "A: Stream and Floodplain Project** for the amount of $823,161 (with cost share the total cost of the project was $1,564,211). This project will construct ten mainstem log structures and two perennial side channels within the middle Entiat River. One side channel will be 200-feet long; the other will be 2,500-feet long. Large wood will also be placed throughout the side channels. This work will maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat.

2.3.4.2 Modifications to General Salmon Habitat Program Contracts

In 2019, the Rocky Reach HCP Tributary Committee received no requests from sponsors asking for modifications to GSHP projects funded by the Committee.

2.3.5 Small Projects Program

The Small Projects Program has an application and review process that increases the likelihood of participation by private stakeholders that typically do not have the resources or expertise to go through an extensive application process. The HCP Tributary Committees encourage small-scale projects by community groups, in cooperation with landowners, to support Plan Species recovery on private property. Project sponsors may apply for funding at any time, and in most cases, will receive a funding decision within three months. The maximum contract allowed under the Small Projects Program is $100,000.

2.3.5.1 2019 Small Projects

In 2019, the HCP Tributary Committees received three requests for funding under the Small Projects Program. Table 8 identifies the projects, sponsors, total cost for each project, amount requested from Tributary Funds, and which Plan Species Account supported the projects.

Table 8
Projects Reviewed by the Habitat Conservation Plan Tributary Committees under the Small Projects Program in 2019

Project Name	Sponsor[1]	Total Cost	Request from Tributary Committee	Plan Species Account[2]
East Fork Mission Creek Floodplain Restoration	CCNRD	$96,169	$74,669	Not funded
Napeequa Side Channel Connection	CCFEG	$58,290	$49,399	RR: $49,399
Sugar Levee Ground Water Evaluation	MSRF	$5,404	$2,940	W: $2,940

Notes:

1. CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resources Department, and MSRF = Methow Salmon Recovery Foundation.
2. RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

In 2019, the Rocky Reach HCP Tributary Committee agreed to fund the following Small Project:

- **Napeequa Side Channel Connection Project** for the amount of $49,399 (with cost share the total cost of the project was $58,290). This project will remove a culvert and associated fill to restore hydraulic connectivity to a side channel along the lower Napeequa River, a tributary to the White River. This action will improve juvenile steelhead and spring Chinook salmon survival and productivity by providing access to an important spring-fed side channel.

2.3.5.2 Modifications to Small Project Contracts

In 2019, the Rocky Reach HCP Tributary Committee received no requests from sponsors asking for modifications to Small Projects funded by the Committee.

2.3.6 Tributary Assessment Program

The Rocky Reach HCP established the Tributary Assessment Program (separate from the Rocky Reach Plan Species Account) to fund M&E of the relative performance of projects funded by the initial contribution to the Plan Species Account. The Tributary Assessment program comprised a fixed (one time) contribution of $200,000, not subject to inflation adjustment. The Rocky Reach HCP Tributary Committee began funding monitoring projects from the Tributary Assessment Program in 2014, with the funding of the ONA proposal to monitor the effects of spawning platforms as adaptive management for designing and construction of more platforms. This work focused on quantifying spawners (redd surveys), egg retention (carcass surveys), egg-to-fry success, and habitat conditions (e.g., gravel stability, thalweg slope, fine sediment deposition, and gravel composition) within treated and untreated areas. Monitoring occurred throughout a 5-year period (2014 through 2018).

The Rocky Reach HCP Tributary Committee did not receive any monitoring or assessment applications in 2019.

To date, Chelan PUD has spent $53,738.14 of the original $200,000.00 total for the Rocky Reach HCP Tributary Assessment Program. The remaining balance of $146,261.86 in the Rocky Reach HCP Tributary Assessment Program is unallocated.

3 Habitat Conservation Plan Administration

This section lists events of note that occurred in 2019 related to the administration of the HCPs and provides a list of reports published in 2019 that relate to the HCPs.

3.1 Mid-Columbia Habitat Conservation Plan Forums

In 2005 and 2006, Mid-Columbia Forums were held as a means of communicating and coordinating with the non-signatories and other interested parties regarding the implementation of the HCPs. Non-signatory parties at the time of the 2006 meeting included the Confederated Tribes of the Umatilla Indian Reservation and American Rivers. As in 2006 through 2018, these parties were invited by letter in 2019 to participate in a meeting with members of the HCP Coordinating, Hatchery, and Tributary Committees, in conformity with the 2005 FERC Order on Rehearing 109 FERC 61208 and in accordance with the offer to non-signatory parties of non-voting membership in HCP Hatchery and Tributary Committees processes. The non-signatory parties again indicated no interest in attending a meeting with the HCP Committees in 2019.

3.1 Upper Columbia Salmon Recovery Board Integrated Recovery

In 2018, Douglas PUD participated in the UCSRB Hydropower Integrated Recovery Technical Advisory Group (IRTAG), along with Grant and Chelan PUDs, the YN, the CCT, and other state and federal agencies. The Hydropower IRTAG provided review and guidance in the development of the UCSRB Hydropower Background Summary as part of the UCSRB Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan's recovery strategies across all four Hs (habitat, harvest, hydropower, and hatcheries). The UCSRB Hydropower Background Summary compiles information on this management area and addresses progress in accomplishing established objectives and goals. The UCSRB presented a status update and the draft summary report during the HCP Coordinating Committees meeting on October 23, 2018. The final UCSRB Hydropower Background Summary was released on March 4, 2019 (https://www.ucsrb.org/mdocs-posts/2019-hydropower-background-summary/). There were no additional discussions within the Rocky Reach HCP Coordinating Committee on this topic in 2019.

3.2 Dispute Resolution – Basis for Decision Making

In late 2018, the HCP Tributary Committees Chairman notified the HCP Coordinating Committees of a potential impending dispute resolution from the HCP Tributary Committees (as memorialized in the minutes of the HCP Coordinating Committees meeting on December 18, 2018, and appended to the *2018 Rocky Reach HCP Annual Report*). The impetus for this arose when the HCP Tributary Committees supported funding a GSHP proposal based on its technical merit (per the criteria outlined in the *HCP Tributary Committees Policies and Procedures for Funding Projects*); however, the HCP Tributary Committees ultimately elected not to fund the project because of policy-level intervention. In early 2019, the HCP Tributary Committees and HCP Coordinating Committees continued discussing this issue and the general consensus was, if a formal dispute arises, resolution likely would not be reached in either committee. At this time, the HCP Coordinating Committees Chairman began notifying HCP Policy Committees representatives of the situation.

On May 23, 2019, the YN submitted a letter to the HCP Tributary Committees Chairman indicating the YN was formally initiating the dispute resolution process as defined in Section 11 of the Rock Island, Rocky Reach, and Wells Hydroelectric Projects Anadromous Fish Agreements and HCPs. The HCP Tributary Committees reviewed and discussed the Issue Statement; however, they could not reach resolution. Therefore, on June 10, 2019, the HCP Tributary Committees requested that the dispute proceed to the HCP Coordinating Committees. The HCP Coordinating Committees and HCP Policy Committees representatives had already been coordinating in anticipation of the dispute being elevated to the respective committees, and on June 11, 2019, the YN agreed to withdraw the formal dispute to provide flexibility in scheduling a discussion within the HCP Policy Committees without the constraints of the tight timeline of the formal dispute resolution process as outlined in the HCPs.

On July 9, 2019, the HCP Policy Committees convened an in-person meeting with three objectives: 1) have a clear exchange of thoughts, opinions, and position on the issue; 2) develop guidance for the HCP Tributary and Hatchery Committees; and 3) maintain the proper functioning and implementation of the HCPs (Appendix D). During this meeting, the HCP Policy Committees developed action items in support of all the meeting objectives. Regarding the basis for decision making, the HCP Policy Committees guidance to the HCP Tributary and Hatchery Committees was to base funding decisions on technical merit, and to notify respective HCP Coordinating and Policy Committees representatives of any potential policy issues needing to be addressed in those forums. Additionally, the HCP Tributary and Hatchery Committees should consider abstention in lieu of disapproval to preserve respective policy positions. The HCP Tributary and Hatchery Committees adopted this guidance in their respective operating protocols.

As of December 31, 2019, no additional discussions or actions had been identified as needed regarding this topic.

3.3 Mid-Columbia HCP Committees' Chairpersons

The Mid-Columbia HCPs contain a requirement to review the performance of the Chairpersons every 3 years. In August 2019, the HCP Committees were tasked with conducting such a review. The review was informal and conducted via email. HCP representatives were asked to provide input on the performance of the Chairpersons. On September 24, 2019, the HCP Coordinating Committees announced their selection to retain HCP Coordinating and Policy Committees Chairperson, Dr. John Ferguson, and support personnel, Kristi Geris, for 3 more years. On October 16, 2019, the

HCP Hatchery Committees announced their selection to retain HCP Hatchery Committees Chairperson, Dr. Tracy Hillman, and support personnel, Larissa Rohrbach, for 3 more years. On September 12, 2019, the HCP Tributary Committees announced their selection to retain HCP Tributary Committees Chairperson, Dr. Tracy Hillman, for 3 more years. The next Chairpersons review will occur in August 2022.

3.4 Habitat Conservation Plan Related Reports and Miscellaneous Documents Published in Calendar Year 2019

The following is a list of reports released in 2019 that are related to the implementation of the Rocky Reach HCP:

- Anchor QEA and Chelan PUD (Public Utility District No. 1 of Chelan County), 2019. Annual Report Calendar Year 2018 of Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan Rocky Reach Hydroelectric Project FERC License No. 2145 Prepared for FERC. April 2019.
- Chelan PUD, 2019. Chelan PUD Rocky Reach and Rock Island HCPs Final 2019 Fish Spill Report. October 18, 2019.
- Chelan PUD, 2019. 2019 Rocky Reach and Rock Island HCP Action Plan – Final. February 2019.
- Hillman, T., T. Kahler, G. Mackey, Andrew Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard, 2019. Monitoring and Evaluation Plan for PUD Hatchery Programs: 2019 Update. Report to the HCP and PRCC Hatchery Committees. December 18, 2019.
- Hillman, T., M. Miller, M. Johnson, M. Hughes, C. Moran, J. Williams, M. Tonseth, C. Willard, S. Hopkins, J. Caisman, T. Pearsons, and P. Graf, 2019. *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs: 2018 Annual Report*. Report to the HCP and PRCC Hatchery Committees. September 15, 2019.
- Hopkins, S.A., 2017. *Northern Pikeminnow Predator Control Program Rocky Reach and Rock Island Hydroelectric Projects Final Summary Report 2017*. December 27, 2017.
- Hopkins, S.A., 2018. *Northern Pikeminnow Predator Control Program Rocky Reach and Rock Island Hydroelectric Projects Final Summary Report 2018*. December 6, 2018.
- Keller, L., and S, Hopkins, 2019. *2018 Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System Final Report*. Prepared for Public Utility District No. 1 of Chelan County. January 2019.
- Keller, L., and S, Hopkins, 2019. *2019 Rocky Reach Juvenile Fish Bypass System Operations Plan*. Prepared for Public Utility District No. 1 of Chelan County. January 2019.
- Mosey, T., 2019. *2019 Fish Spill Plan Rock Island and Rocky Reach Dams*. Prepared for Public Utility District No. 1 of Chelan County. February 8, 2019.

- Murdoch, A., and Mike Ford, 2019. *Clarification of Extension of the Wenatchee spring Chinook RRS Study*. Memorandum to RI HCP Hatchery Committee and PR Hatchery Sub-Committee. September 19, 2019.
- Tonseth, M., 2019. Final HCP and PRCC HSC Approved Upper Columbia River 2019 and 2020 BY Steelhead Hatchery Program Management Plan and Associated Protocols for Broodstock Collection, Rearing/Release, and Management of Adult Returns. Prepared with the Washington Department of Fish and Wildlife. Prepared for NMFS, HCP HC and PRCC Hatchery Sub-Committee. March 28, 2019.
- Washington Department of Fish and Wildlife, 2019. *Rock Island and Rocky Reach HCP Hatchery Committees Final Statement of Agreement Annual Broodstock Collection Protocols*. September 18, 2019.
- Willard, C., 2019. *Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2020 – Final*. September 2019.
- Willard, C., S. Hopkins, and C. Moran, 2018. *Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)*. March 12, 2018.

Appendix A
Habitat Conservation Plan Coordinating Committees 2019 Meeting Minutes and Conference Call Minutes

FINAL

1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: February 26, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the January 22, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, January 22, 2019, from 10:00 a.m. to 12:15 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will provide edits to the revised draft December 4, 2018 HCP Coordinating Committees meeting minutes to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-B). *(Note: Tom Kahler provided Douglas PUD edits to the minutes during the HCP Coordinating Committees meeting on January 22, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- The HCP Coordinating Committees will provide edits or comments on Douglas PUD edits to the revised draft December 4, 2018 HCP Coordinating Committees meeting minutes to Kristi Geris no later than Friday, January 25, 2019; if no edits or comments are received, Geris will distribute the minutes as final (Item I-B). *(Note: no edits or comments were received, and the final December 4, 2018 HCP Coordinating Committees meeting minutes were distributed to the HCP Coordinating Committees by Geris on January 27, 2019.)*
- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- John Ferguson will provide an update to Scott Carlon and Ritchie Graves about the impending dispute resolution from the HCP Tributary Committees (Item III-A). *(Note: Ferguson contacted Carlon and Graves on January 28, 2019, and provided updates as discussed.)*

- John Ferguson will provide an update to Scott Carlon about the Wells HCP Coordinating Committee approval of the Douglas PUD 2020 Survival Verification Study Plan, as revised (Item IV-B). *(Note: Ferguson contacted Carlon on January 28, 2019, and provided updates as discussed.)*
- The HCP Coordinating Committees meeting on February 26, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item VI-B).

Decision Summary

- The Rock Island and Rocky Reach HCP Coordinating Committees approved the 2017 Pikeminnow Report after no disapprovals were received prior to the 30-day review deadline on January 14, 2019.
- Wells HCP Coordinating Committee representatives present approved the Douglas PUD 2020 Survival Verification Study Plan, as revised (Item IV-B). *(Note: the Colville Confederated Tribes [CCT] and National Marine Fisheries Service [NMFS] approved the plan, as revised, via email on January 29, 2019.)*

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- A Wells Project Land-Use Permit Application for a Single-Use Dock (LeSage) was distributed to the HCP Coordinating Committees by Kristi Geris on November 29, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 28, 2019 (Item IV-C).
- A draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, February 12, 2019 (Item IV-F).
- A draft 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on January 16, 2019, which is available for a 30-day review with edits and comments due to Tom Kahler by Friday, February 15, 2019 (Item IV-E).
- A draft *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on January 21, 2019, which is available for review with edits and comments due to Douglas PUD by Monday, February 11, 2019 (Item IV-D).

- A draft 2018 Rocky Reach Juvenile Fish Bypass System Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 24, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, February 25, 2019 (Item V-D).
- A draft 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 24, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, February 25, 2019 (Item V-D).
- A draft 2017 Douglas PUD Pikeminnow Removal Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 29, 2019, which is available for a 60-day review with edits and comments due to Tom Kahler by Thursday, March 28, 2019.
- The draft 2018 Wells HCP Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on February 5, 2019, and is available for a 30-day review with edits and comments due to Geris by Wednesday, March 6, 2019 (Item VI-A).
- A draft 2019 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 12, 2019, which is available for review (Item V-D).
- A draft 2019 Rock Island Bypass Monitoring Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item V-D).
- A draft 2019 Rocky Reach Juvenile Fish Bypass System Operations Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item V-D).
- A draft 2019 Rock Island and Rocky Reach Fish Spill Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item V-D).
- The draft 2018 Rock Island and Rocky Reach HCP Annual Reports were distributed to the HCP Coordinating Committees by Kristi Geris on February 18, 2019, and are available for a 30-day review with edits and comments due to Geris by Monday, March 18, 2019 (Item VI-A).
- Columbia River Inter-Tribal Fish Commission's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019.

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Tom Kahler added a Wells Dam fishway maintenance update
- Lance Keller added a notification of upcoming Chelan PUD documents for review
- Ferguson added a reminder about upcoming HCP annual report reviews

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft December 4, 2018 and revised draft December 18, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into both revised minutes. Geris said she also updated the Review Items in both minutes. HCP Coordinating Committees members present approved the December 18, 2018 meeting minutes, as revised. Tom Kahler said Douglas PUD has additional clarifying edits in the revised draft December 4, 2018 meeting minutes under Douglas PUD's Wells Project Land-Use Permit Applications Gebbers Farm and Repo LLC discussion and will provide these edits to Geris for distribution to the HCP Coordinating Committees. HCP Coordinating Committees members present conditionally approved the December 4, 2018 meeting minutes, contingent on accepting Douglas PUD's latest edits. The HCP Coordinating Committees will provide edits or comments on Douglas PUD edits to the revised draft December 4, 2018 HCP Coordinating Committees meeting minutes to Geris no later than Friday, January 25, 2019; if no edits or comments are received, Geris will distribute the minutes as final. *(Note: Tom Kahler provided Douglas PUD edits to the minutes during the HCP Coordinating Committees meeting on January 22, 2019, which Geris distributed to the HCP Coordinating Committees that same day. No further edits or comments were received from the HCP Coordinating Committees by the January 25, 2019 deadline, and the final December 4, 2018 HCP Coordinating Committees meeting minutes were distributed to the HCP Coordinating Committees by Geris on January 27, 2019.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on December 18, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on December 18, 2018):*

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably*

during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).
This action item will be carried forward.

- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This action item will be discussed during today's meeting and will also be carried forward.
- *Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).*
  Kahler recalled this permit application was regarding an upland property that was formerly an orchard, where Douglas PUD sprays apple shoots and noxious weeds, and the landowner mows and rakes the property. Kahler said the Douglas PUD Commission approved this application.
- *On the behalf of the HCP Coordinating Committees, regarding the General Salmon Habitat Program Proposal titled, Scaffold Camp Acquisition #2 Project, which is under discussion in the HCP Tributary Committees, Keely Murdoch and Kirk Truscott will request from their respective HCP Policy representatives that a policy level discussion take place between the Yakama Nation (YN) and the CCT to reach agreement outside of the formal HCP dispute resolution process (Item II-A).*
  This action item will be discussed during today's meeting.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on January 10, 2019:

- *Project Collaboration*: Steve Kolk (U.S. Bureau of Reclamation [Reclamation]) met with the HCP Tributary Committees to describe Reclamation's vision for habitat restoration work in the upper Columbia River. Kolk discussed the evolution of restoration efforts in the upper Columbia River and concluded that efforts are now at a point where larger, more complex and expensive projects will be implemented than in the past because the easier, smaller projects have mostly been implemented. Reclamation would like to team with a funding partner and work together to identify and scope high priority projects in high priority areas. Once identified, Reclamation will use their resources to develop preliminary, draft, and final designs. Project sponsors would then be selected to implement the projects through a competitive bid process. Reclamation believes this scope-driven approach will reduce costs and increase the certainty of success. The HCP Tributary Committees see value in the process and will continue to discuss it within the HCP Tributary Committees.

- *Time Extension Request*: The Rock Island HCP Tributary Committee received a time extension request from Trout Unlimited on the Barkley Irrigation Company – Under Pressure Project. Because of the size and complexity of the project, and the time needed to complete the project, the sponsor asked to extend the completion date from December 31, 2018, to December 31, 2019. Members present from the Rock Island HCP Tributary Committee approved the time extension. Hillman will secure input from Kate Terrell (U.S. Fish and Wildlife Service [USFWS] and Justin Yeager (NMFS]) once the federal government furlough ends.
- *Icicle Creek Fish Passage – Wild Fish to Wilderness Project*: Recall in December 2018, the HCP Tributary Committees received a General Salmon Habitat Program (GSHP) proposal from Trout Unlimited titled: *Icicle Creek Fish Passage – Wild Fish to Wilderness Project*. The purpose of the project is to enhance fish passage at the Boulder Field (river mile 5.6) on Icicle Creek and thereby provide access to more than 23 miles of habitat. The total cost of the project is $2,275,000. The sponsor requested $375,000 from HCP Plan Species Account Funds. The amount requested from the HCP Tributary Committees would be in addition to the $250,000 approved by the Rock Island HCP Tributary Committee in 2015. In December 2018, all members except the CCT approved funding for the project. The CCT requested additional time before providing their vote on the project. During the HCP Tributary Committees meeting on January 10, 2019, the CCT (like the YN) approved the request with the caveat that a statement of agreement (SOA) regarding anadromous fish management in the Icicle watershed is signed by the YN, the CCT, Washington Department of Fish and Wildlife (WDFW), NMFS, and USFWS. John Ferguson asked about the status of the agreement. Jim Craig said on January 9, 2019, he and Bill Gale (USFWS Deputy Project Leader) finished drafting the Framework for Communication document and provided it to the YN (Steve Parker). Craig said on January 10, 2019, the document was also sent out to NMFS (Dale Bambrick), WDFW (Jim Brown) and the CCT (Chuck Brushwood). Craig said USFWS subsequently received emails from Parker and Brushwood with edits, but both indicated general support for the draft document. Craig also said Gale visited the Snake River Basin to better understand the Annual Operations Planning process implemented there to promote open communication and coordination between partners regarding hatchery operations. Craig said the plan is to format a similar process for the Leavenworth National Fish Hatchery and Icicle watershed. Craig said USFWS is not likely to implement the process this winter; however, USFWS will soon meet with the YN, the CCT, and WDFW to discuss operations for 2019, including predicted fish returns and potential fisheries. Ferguson asked about NMFS' thoughts, and Craig said he believes NMFS will be agreeable; however, USFWS has not yet received comments from NMFS or WDFW.
- *Upper Kahler Stream and Floodplain Enhancement Project*: Recall in December 2018, the HCP Tributary Committees received a GSHP proposal from the YN titled: *Upper Kahler Stream*

and Floodplain Enhancement Project. The purpose of the project is to reduce the risk of an avulsion near river mile 8.6 on Nason Creek by constructing a large, buried, log jam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project would also construct three additional buried bank jams and enhance fish habitat at the downstream end of the avulsion channel. The total cost of the project is $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. In December 2018, the HCP Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the HCP Tributary Committees during a future meeting explaining the design of the project. In January 2019, the YN and their consultant provided a presentation describing the design of the proposed project. Following the presentation, the YN recused themselves and the HCP Tributary Committees discussed the project. The HCP Tributary Committees continue to struggle with filling the avulsion channel with large sediments. The HCP Tributary Committees believe adding wood and a few boulders in the avulsion channel will help trap smaller sediments and fill the channel naturally. The HCP Tributary Committees elected to table a decision on this project until Yeager and Terrell have an opportunity to provide feedback on the project.

- *Stormy Project Area "A" Stream and Floodplain Enhancement Project*: In December 2018, the HCP Tributary Committees received a GSHP proposal from the YN titled: *Stormy Project Area "A" Stream and Floodplain Enhancement Project*. The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat. The total cost of the project is $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. In December 2018, the HCP Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the HCP Tributary Committees during a future meeting explaining the design of the project. In January 2019, the YN and their consultant provided a presentation on the design of the Upper Kahler Stream and Floodplain Enhancement Project. It was explained that the existing side channel the HCP Tributary Committees wanted reconnected is too high on the floodplain to connect with the river and has zero gradient in places. There would also need to be mitigation for the existing network of wetlands that currently exist in the side channel. The purpose of the large wood structures proposed along the banks of the main channel was also described. Following the presentation, the YN recused themselves and the HCP Tributary Committees discussed the project. Given the presentation and discussions, members of the HCP Tributary Committees present elected to fund the project but requested additional information regarding the costs of two items in the $1,140,968.15 budget. The HCP Tributary Committees also directed Hillman to secure feedback from Terrell and Yeager, who were not present because of the federal government furlough. If Yeager approves the project, the Rock Island or Rocky Reach Plan Species Account will support the project. Ferguson asked about Terrell's approval, and Hillman explained that USFWS is not a voting member on the HCP Tributary Committees unless Craig provides a letter indicating USFWS wants to be a voting member. Tom Kahler further explained that the HCP Tributary Committees value the input of everyone on the committees. Kahler said, for example, Douglas PUD cannot vote on projects located downstream of Wells Dam; however, Douglas PUD still participates in those discussions. Keely Murdoch asked why would USFWS not want to vote? Jim Craig said he was unaware that USFWS was not a voting member of the HCP Tributary Committees. Kahler said these voting member discussions took place during HCP negotiations when Mark Miller represented the USFWS, and Miller received input from USFWS General Counsel that USFWS did not want the liability associated with decisions made within the HCP Tributary Committees. Kahler added that USFWS not being a voting member has never been an issue. Craig said if there was an issue, he believes Terrell would have mentioned it. Craig added, however, that he will still look into obtaining a letter requesting that USFWS become a voting member on the HCP Tributary Committees. Hillman and Ferguson agreed this is a good idea. Hillman said the letter should be addressed to both himself and Ferguson indicating that USFWS would like to vote on HCP Tributary Committees decisions. Ferguson further suggested indicating in the letter that the HCP Tributary Committees reviewed the previous decision to not include USFWS as a voting member and now want to change this. Kahler read an excerpt from the meeting minutes of the HCP Tributary Committees meeting on November 24, 2004, as follows: "David Morgan (USFWS HCP Tributary Committees representative) was unable to attend this meeting but relayed to the group through Bob Bugert (HCP Tributary Committees Chairman) that USFWS will maintain its current status as non-voting representative to the Tributary Committees. Morgan said this issue can be revisited from time to time if the Committees feel there is a compelling need." *(Note: USFWS provided a letter requesting to be a voting member on the HCP Tributary Committees to Hillman and Ferguson on January 24, 2019, and Kristi Geris distributed this letter to the HCP Coordinating Committees that same day.)*

- *Johnson Creek US Highway 97 Habitat Restoration Project*: The HCP Tributary Committees received a new GHSP proposal from Trout Unlimited titled: *Johnson Creek US Highway 97 Habitat Restoration Project*. The purpose of the project is to remove a fish passage barrier on Johnson Creek, a tributary to the Okanogan River. The project will replace the existing culvert with a precast concrete structure that will allow passage for all life stages of Chinook salmon and steelhead at all flows. The project will allow fish access to 9 miles of high-quality spawning and rearing habitat in Johnson Creek. The total cost of the project is $1,562,455.00. The sponsor requested $267,547.00 from HCP Plan Species Account Funds. HCP Tributary Committees members present elected to fund the project. Chris Fisher (CCT) recused himself from voting on this project. The HCP Tributary Committees directed Hillman to secure feedback from Terrell and Yeager on this project. If approved by Yeager, the Wells Plan Species Account will support the project. Hillman added that if USFWS provides a letter requesting to be a voting member, Terrell will vote too. Ferguson said he thought there is a law which indicates the State is responsible for replacing culverts, and asked why this project came to the HCP Tributary Committees? Hillman said the State is a cost share on this project because the project was ranked as one of the highest projects by the Upper Columbia Salmon Recovery Board. Andrew Gingerich asked if Johnson Creek is an ephemeral stream? Hillman said the creek is a perennial stream that runs through the town of Riverside, Washington.

- *Review of Tributary Committees' Policies and Procedures, Policies and Procedures for Funding Projects*: The HCP Tributary Committees reviewed their Policies and Procedures document and made a minor edit to clarify language in Sections 2.0 (Funding Programs). The HCP Tributary Committees made no other edits or changes to the document.
- *Review of Tributary Committees' Policies and Procedures, Tributary Committee Operating Procedures*: The HCP Tributary Committees reviewed their operating procedures and made a formatting change to the Introduction. HCP Tributary Committees made no other edits or changes to the document.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on March 14, 2019. Hillman said the HCP Tributary Committees will not meet in February 2019; however, may convene a conference call to discuss any issues which might arise before March 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on January 16, 2019 (*note: joint HCP Hatchery Committees/Priest Rapids Coordinating Committee [PRCC] Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Genetics Monitoring (joint)*: The HCP Hatchery Committees reviewed the responses from the panel of geneticists on how to monitor the effects of hatchery programs on genetics of natural-origin and hatchery-origin fish. The HCP Hatchery Committees were pleased with the responses from the geneticists and will update the Hatchery Monitoring and Evaluation (M&E) Plan accordingly.
- *Broodstock Collection Protocols (joint)*: The HCP Hatchery Committees discussed the preparation of the 2019 Broodstock Collection Protocols including reviewing outstanding issues identified during the preparation of the 2018 Broodstock Collection Protocols. A draft of the 2019 report will be available for HCP Hatchery Committees review by February 11, 2019, which is about 10 days before the HCP Hatchery Committees meeting on February 20, 2019.

- *Re-Evaluation of Conservation Program Size (joint)*: The HCP Hatchery Committees are looking at revising the size of the conservation programs. Importantly, total hatchery production will not change; only the allocation of production between the conservation and safety net programs may change. The HCP Hatchery Committees are currently looking to update input parameters to the spreadsheet calculator that was used during No Net Impact recalculation. Updated inputs will include spawner escapements, smolt-to-adult return data, broodstock needs, pre-spawn losses, and updated stock-recruitment estimates. Discussion on this topic will continue over the next few months.
- *Sampling of Steelhead at the Priest Rapids Dam Off-Ladder Adult Fish Trap (joint)*: WDFW reported that Bonneville Power Administration (BPA) funds will shift from developing tools to estimate steelhead escapements to developing tools to estimate spring Chinook salmon escapements. The model for estimating steelhead escapement has been fully developed and there is no need to continue working on the steelhead model. As such, steelhead PIT tagging at Priest Rapids Dam may be reduced or eliminated, and some of the PIT-tag interrogation arrays may be shut down during times when adult steelhead are moving into spawning streams. Given the reallocation in BPA funding and the desire of WDFW to use remaining funds to evaluate spring Chinook salmon escapements, the HCP Hatchery Committees will need to evaluate how to monitor steelhead escapements in the future. The HCP Hatchery Committees requested that WDFW provide to Chelan and Douglas PUDs an estimate of the cost to PIT-tag steelhead at the Priest Rapids Dam off-ladder adult fish trap and an estimate for PIT-tag array operations and maintenance.
- *Methow 2019 M&E Implementation Plan Statement of Work (Wells)*: The HCP Hatchery Committees are reviewing the Methow 2019 M&E Implementation Plan. The YN proposed general language to the plan in case WDFW and BPA funding for steelhead tagging at Priest Rapids Dam and PIT-tag array operations and maintenance is cut in 2019. Approval of the plan was tabled until members have an opportunity to study the edits made to the plan.
- *2019 Spring Chinook and Coho Salmon Final Acclimation at Chewuch Pond (Rock Island/Rocky Reach)*: Chelan PUD reported that this is the first year coho and spring Chinook salmon will be comingled in the Chewuch Pond. A total of 80,000 coho salmon will be added to the pond.
- *Tumwater Dam Update (Rock Island/Rocky Reach)*: Chelan PUD reported that there will be a slight delay in completing the reinforcement of the fishway walls at Tumwater Dam this winter. Chelan PUD expects the work to be completed by mid- to late-March 2019. This work will not affect fish passage and trapping operations at the dam.
- *Merging the HCP Hatchery Committees and PRCC Hatchery Subcommittee meetings*: The HCP Hatchery Committees agreed to merge the HCP Hatchery Committees and PRCC Hatchery Subcommittee meetings to improve efficiency, sharing, cost, and time. Although the meetings were merged, each committee maintains its independence in

identifying agenda items and decision making. The HCP Hatchery Committees and PRCC Hatchery Subcommittee identified and agreed to a structure for the agendas and meeting notes, and both committees are currently reviewing and updating their meeting protocols and distribution lists.

- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on February 20, 2019.

III. Yakama Nation

A. HCP Tributary Committees Dispute Resolution Update (Keely Murdoch)

Keely Murdoch said there is no official letter yet; however, the YN are expecting to file a dispute regarding the *Scaffold Camp Acquisition #2 Project* that has been discussed within the HCP Tributary Committees. Murdoch said a dispute will not be filed until more research is conducted to better understand what the outcome of the process will be. She said in the meantime, the YN are working to better frame the issue within the HCP Tributary Committees by presenting an SOA to the HCP Tributary Committees. She clarified that if the YN take this issue to dispute, it is not about a territorial issue between the YN and the CCT; rather, the dispute is about the basis for decision-making by the HCP Tributary Committees and the lack of guidance in voting protocols. She said she believes everyone can agree that decisions should be based on having some sort of nexus with the resource; and not be based on arbitrary reasons. She said the dispute is about the decision-making process, notably, how to make decisions.

John Ferguson asked about a timeline. Murdoch said she is uncertain about a timeline, but hopefully the YN can bring something to the HCP Tributary Committees in February 2019. Ferguson said it would be nice to have a full Committee present, i.e., not furloughed, and Murdoch agree this would be ideal.

Chad Jackson asked when funding needs to be secured for this project. Tom Kahler said funds are already available. He said there is no hang-up there because the project has technical merit. Ferguson said there is urgency about settling this issue before the landowner sells the property. Murdoch said at this point, the issue is bigger than implementing the actual project. Kahler said other individual parties have presented projects for funding in the HCP Tributary Committees similar to this project and more can be expected, so it would be good to resolve this issue now. Murdoch agreed this issue will keep arising. She said it would be beneficial if the *Scaffold Camp Acquisition #2 Project* is funded; however, this is not what the dispute is about, it is the catalyst.

Kahler said it would be nice to move forward on the *Scaffold Camp Acquisition #2 Project* regardless of the dispute. He said the YN are not gaining any sort of leverage in regard to what status this project happens to be in at the moment, and he asked if there is a workaround to move this project forward while the YN carry out the dispute. Murdoch said she can discuss this with YN policy staff.

Kahler asked what is the desired outcome of this dispute; removal of policy interference in the decision-making process? Murdoch said she needs to consult with YN policy staff but does not want to frame it as "policy interference." She said within the HCP Hatchery Committees, policy input is often times considered in the decision-making process; however, this input is related to how to manage mitigation and not about something arbitrary or unrelated.

Tracy Hillman clarified that the HCP Tributary Committees have policies and procedures in place to evaluate proposals for both the GSHP and Small Projects Program based on biological and technical merit and cost-effectiveness. Hillman said he believes what Murdoch is saying is, based on those criteria, the *Scaffold Camp Acquisition #2 Project* would clearly be funded. Hillman said, however, there is now an additional policy-level territorial criterion being used to evaluate a project. He said he believes the YN are saying this goes beyond the bounds for making decisions on proposals. He said he does not believe Murdoch is implying there should be no policy guidance; rather, policy staff should not intervene unless it is related to benefiting the project. Murdoch agreed with Hillman's comments. Kahler also agreed the HCP Tributary Committees likely would agree with these comments, but he asked still, where does this end up? Murdoch said she is unsure, but the YN are researching this now.

Ferguson said he was contacted by Steve Parker and they discussed similar questions about what the goal of this dispute is. Ferguson said he encouraged Parker to contact Hillman to discuss HCP Tributary Committees processes, which Parker did. Ferguson also let Parker know that because Parker contacted him, he also called and left a voice mail with Randy Friedlander (CCT) to discuss the pending dispute. Ferguson said, however, he has not yet heard back from Friedlander.

Ferguson said if a letter is received before the next HCP Coordinating Committees meeting on February 26, 2019, the HCP Coordinating Committees will convene via conference call to discuss the letter. Ferguson also said he will provide an update to Scott Carlon and Ritchie Graves about the impending dispute resolution from the HCP Tributary Committees. *(Note: Ferguson contacted Carlon and Graves on January 28, 2019, and provided updates as discussed.)*

IV. Douglas PUD

A. Wells Dam Fishway Maintenance Update (Tom Kahler)

Tom Kahler said the Wells Dam east fishway was dewatered for annual maintenance on January 7, and 8, 2019, as described in a memorandum distributed to the HCP Coordinating Committees by Kristi Geris on January 9, 2019. Kahler said the east fishway will be offline through the end of January 2019. He said a contractor will polish the fishway window this week. He said other work includes routine and fish pump maintenance.

B. DECISION: Douglas PUD 2020 Survival Verification Study Plan (Tom Kahler)

John Ferguson recalled discussing the study schedule at length during the last HCP Coordinating Committees meeting on December 18, 2018, and the Wells HCP Coordinating Committee generally elected a modified Option No. 2 (April 13 to May 12, extended 1 week later to end on May 19). Ferguson said Tom Kahler was tasked with discussing this option internally; and following the meeting on December 18, 2018, Kahler provided an email explaining the ultimate decision to not extend the study 7 days (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris on December 19, 2018. Kahler said the email (Attachment B) included an evaluation of the 2010 Survival Verification Study release replicates, which indicates that to the point whereby 75% of each release has been detected at Rocky Reach Dam requires a minimum time interval of 11 days, and the mean is 23 days. He said based on review of these data, Douglas PUD concluded a 30-day release period for the study is ideal. He said no comments on this email were received from the Wells HCP Coordinating Committee; therefore, Douglas PUD hopes to have a quick discussion and obtain approval of the study plan today.

Ferguson asked Kahler to clarify Douglas PUD's final proposed study start and stop dates. Kahler said Douglas PUD is proposing the original Option No. 2, which starts April 13 and ends May 12. Keely Murdoch said this option starts 1 week earlier than Douglas PUD's initial preferred option but does not include the 1 additional week at the end of the study. Kahler said this is correct. Chad Jackson recalled the reason to add 1 week at the end was to incorporate the tail end of each run. He asked without this additional 1 week, are there enough study fish in the system to represent the untagged fish migrating during this timeframe?

Kahler distributed hard copies of a run timing graph (Attachment C), which was also distributed electronically to the HCP Coordinating Committees by Geris following the meeting on January 22, 2019. Kahler explained that the graph (Attachment C) shows a black box representing study fish releases from April 13 to May 12, and a red hashed box encompassing a 19-day cumulative passage average from the 2010 study. He said this graph indicates that 50% of the fish released on May 12 are still in the reservoir on June 1, based on 2010 study results. He said of all releases in 2010, 87% had passed Rocky Reach Dam by May 31 and 13% of the fish were detected at Rocky Reach Dam after that date. Ferguson asked when the last release was in 2010, and Kahler said on May 17. Jackson asked about the first releases in 2010, and Kahler said 97.5% of the first releases in 2010 passed Rocky Reach Dam by May 31.

Jackson asked if Wells Fish Hatchery staff are still on track for targeting a smaller fish size, and Kahler said yes. Jackson asked if all comments were addressed in the final revised study plan (a final revised draft plan for approval was distributed to the HCP Coordinating Committees by Geris on January 15, 2019). Kahler said yes and all edits are in tracked changes. Jackson said lastly, based on the latest graph Kahler shared indicating there should be sufficient numbers of fish from all groups in the system without the additional 1 week, WDFW is supportive of the proposed Douglas PUD 2020 Survival Verification Study Plan.

Murdoch said the YN appreciates Douglas PUD moving the study forward 1 week to incorporate more coverage for wild spring Chinook salmon. She said she still believes 1 week longer would also be beneficial; however, she is okay without it if it is not feasible. Kahler noted that one effect of releasing study fish 1 week later is that when the releases are spread out and skip days, this results in fewer study fish being released during the height of the normal outmigration distribution and more fish being released on the tails of the distribution. He said it is ideal to release most of the fish during the peaks of the migration when most of the subject populations are emigrating, since the goal of the study is for the study fish to emigrate with the subject populations.

Wells HCP Coordinating Committee representatives present approved the Douglas PUD 2020 Survival Verification Study Plan, as revised.

Ferguson said he will provide an update to Scott Carlon about the Wells HCP Coordinating Committee approval of the Douglas PUD 2020 Survival Verification Study Plan, as revised. *(Note: Ferguson contacted Carlon on January 28, 2019, and provided updates as discussed.)*

Note: Immediately following the HCP Coordinating Committees meeting Kirk Truscott contacted Ferguson, who briefed Truscott on the topics covered during the meeting including the final revised Douglas PUD 2020 Survival Verification Study Plan. The CCT and NMFS approved the Douglas PUD 2020 Survival Verification Study Plan, as revised, via email on January 29, 2019.

C. Wells Project Land-Use Permit Applications (Tom Kahler)

Tom Kahler said there is one remaining Wells Project Land-Use Permit Application out for review (for a single-use dock [LeSage]), which was distributed to the HCP Coordinating Committees by Kristi Geris on November 29, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Kahler by Monday, January 28, 2019. Kahler said comments or indication of no comments have been received from all Parties except NMFS (currently furloughed).

Kahler said regarding the Wells Project Land-Use Permit Applications for Gebbers Farm and Repo LLC, he asked Beau Patterson (Douglas PUD Land Use Specialist) about the expired permits. Kahler said Patterson looked into this and discovered that the landowners have already received new letters of permission from the U.S. Army Corp of Engineers (USACE) but did not provide the letters to Douglas PUD. Kahler said because USACE already released the permits, no further comment will be accepted by USACE anyway. Kahler recalled Kirk Truscott and Jim Craig mentioning plans to submit CCT and USFWS comments, respectively, to USACE; however, the comment period is no longer open.

D. 2019 Wells Dam Gas Abatement Plan and Bypass Operating Plan (Tom Kahler)

Tom Kahler said a draft *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on January 21, 2019, and is available for review with edits and comments due to Douglas PUD by Monday, February 11, 2019. Douglas PUD will be requesting approval of this document during the HCP Coordinating Committees meeting on February 26, 2019. Andrew Gingerich noted that this final approved document is due to the Federal Energy Regulatory Commission by February 28, 2019.

E. 2019 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said a draft 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on January 16, 2019, which is available for a 30-day review with edits and comments due to Kahler by Friday, February 15, 2019.

F. 2018 Wells Dam Post-Season Bypass Report and Passage-Dates Analysis (Tom Kahler)

Tom Kahler said a draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 60-day review with edits and comments due to Kahler by Tuesday, February 12, 2019. Kahler said he received comments from Jim Craig prior to today's meeting on January 22, 2019.

V. Chelan PUD

A. Rocky Reach and Rock Island Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed adult fishway maintenance updates at Rocky Reach Dam and Rock Island Dam, as follows:

<u>Rocky Reach Dam</u>

Keller said the upper adult fishway at Rocky Reach Dam was taken offline for annual winter maintenance on January 2, 2019. He said headgates were installed at the exits allowing the upper fishway to drain down to an elevation equal to the tailwater, and a fish rescue was performed that same day. He said fish rescued included:

Species	Stage/Length	Clip	Count
Pacific lamprey (*Entosphenus tridentatus*)	Adult	Not Applicable	54
Whitefish (*Coregonus clupeaformis*)	Not Reported	Not Applicable	25
Rainbow/steelhead (*Oncorhynchus mykiss*)	1 fish within 12- to 18-inches	Ad-present	10
	Not Reported	Ad-clipped	2

Keller recalled that last year, the number of Pacific lamprey encountered was in the triple digits. He also noted that one adipose (ad)-present *Oncorhynchus mykiss* encountered was within the 12- to 18-inch range in length; however, it had no coded wire tag (CWT) so crews released the fish. He said he later discovered that WDFW is interested in all *Oncorhynchus mykiss* within the 12- to 18-inch range in length regardless of tag presence. Chad Jackson said this is correct because origin can also be determined based on the fish scale pattern.

Keller said the area between the count window and exit was dewatered on January 4, 2019, and a fish rescue was performed that same day. He said fish rescued included:

Species	Stage/Length	Clip	Count
Rainbow/steelhead	Not Reported	Ad-present	8
	1 fish within 12- to 18-inches	Ad-clipped	4
Coho salmon (*Oncorhynchus kisutch*)	Juvenile	Not Applicable	1
Whitefish	Not Reported	Not Applicable	1
Chiselmouth (*Acrocheilus alutaceus*)	Not Reported	Not Applicable	2
Shiner (*Notropis hudsonius*)	Not Reported	Not Applicable	8

Keller said one ad-clipped *Oncorhynchus mykiss* was within the 12- to 18-inch range in length and was turned over to Mike Tonseth (WDFW).

Keller said the lower adult fishway at Rocky Reach Dam was taken offline for annual winter maintenance on January 8, 2019, and a fish rescue was performed that same day. He said fish rescued included:

Species	Stage/Length	Clip	Count
Pacific lamprey	Adult	Not Applicable	11
Steelhead	Adult	Ad-clipped	1
Triploid rainbow	Not Reported	Ad-clipped	5
Cutthroat (*Oncorhynchus clarkii*)	Not Reported	Not Applicable	1
Rainbow/steelhead	3 fish within 12- to 18-inches	Ad-present	9
	5 fish within 12- to 18-inches	Ad-clipped	6
Whitefish	Not Reported	Not Applicable	38
Shiner	Not Reported	Not Applicable	14
Chiselmouth	Not Reported	Not Applicable	4
Peamouth (*Mylocheilus caurinus*)	Not Reported	Not Applicable	6
Sucker (*Catostomus commersonii*)	Not Reported	Not Applicable	1
Pikeminnow (*Ptychocheilus oregonensis*)	Not Reported	Not Applicable	2

Keller noted that during the days leading up to the lower ladder dewatering, all fishway entrances were left open, allowing fish to move out of the ladder on their own volition. He said the triploid rainbows were all big, plump fish. He said three ad-present *Oncorhynchus mykiss* were within the 12- to 18-inch range in length; however, these fish had no CWT, so crews released the fish. He said five ad-clipped *Oncorhynchus mykiss* were within the 12- to 18-inch range in length, which were turned over to Tonseth.

Rock Island Dam

Keller said currently, the right and left adult fish ladders at Rock Island Dam are offline for annual winter maintenance. He said the inspection of the left ladder is nearly complete, and Biomark is still investigating the noise issue in the PIT-tag detector in the right ladder. He said the center ladder is still watered up and is scheduled to be taken offline for maintenance on January 28, 2019 (after the left ladder is returned to service). He said a fish rescue in the center ladder will take place the same day as dewatering. He said the left adult fish ladder was dewatered on January 7, 2019, and a fish rescue was conducted that same day. He said fish rescued included:

Species	Stage/Length	Clip	Count
Rainbow/steelhead	Not Reported	Ad-present	8
	1 fish within 12- to 18-inches	Ad-clipped	5
Sucker	Not Reported	Not Applicable	1

Keller said one ad-clipped *Oncorhynchus mykiss* was within the 12- to 18-inch range in length; however, had no CWT so crews released the fish.

Keller said after Biomark completes their noise investigation in the right adult fish ladder, the ladder will be returned to service by the end of February 2019.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam mechanics are progressing well with disassembling Turbine Unit B4. Keller said return-to-service date for Turbine Unit B4 is still July 2019. He said mechanical staff are continually evaluating all components of the turbines to understand what needs to be refurbished and replaced. He said the priority is the small units. He recalled reporting during the last HCP Coordinating Committees meeting on December 18, 2018, that the rotor has been removed from Turbine Unit B4 and the turbine and hub will come out shortly.

C. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said disassembly of Turbine Unit C1 to replace the trunnion bushing will begin in mid-February 2019. Keller said there is a slight time delay due to a shortage of headgates. He said all headgates required to remove another unit from service are in use for blade block inspections and fishway maintenance. He said once the adult fish ladder is returned to service in mid-February 2019, these gates will become available for Turbine Unit C1. He said the unfortunate part about starting disassembly of Turbine Unit C1 in mid-February 2019, is that the planned outage is 6 months, which lasts into mid-August 2019. He said, therefore, it can be expected that in 2019 operation of Turbine Unit C1 will be similar to 2018 and it will not be operated for the duration of the juvenile fish bypass season, which runs from April 1 to August 31, 2019. He said Rocky Reach Dam bypass operations in 2019 will include: 1) using three additional Rocky Reach Juvenile Fish Bypass System Surface Collector (RRJFBS SC) pumps to increase attraction flow from 6,000 to 6,660 cubic feet per second (cfs) into the RRJFBS SC entrances (3,330 cfs on each side); and 2) increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12,200 cfs (12.2 kcfs) to a soft-limit flow of 15.2 kcfs.

Keller said these modified operations for the RRJFBS SC and Turbine Unit C2 will be appended to the 2019 Rocky Reach Juvenile Fish Bypass System Operations Plan.

D. Upcoming Chelan PUD Documents for Review (Lance Keller)

Lance Keller notified the Rock Island and Rocky Reach HCP Coordinating Committees that a number of documents will be distributed for review shortly, including a draft 2019 RRJFBS Operations Plan, draft 2019 Rock Island Dam Smolt Monitoring and Gas Bubble Trauma Evaluation Plan, draft 2019 Rock Island and Rocky Reach HCP Action Plan, and draft 2019 Rock Island and Rocky Reach Dams Fish Spill Plan.

A draft 2018 RRJFBS Report and draft 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report were distributed to the HCP Coordinating Committees by Kristi Geris on January 24, 2019, which are available for a 32-day review with edits and comments due to Keller by Monday, February 25, 2019.

A draft 2019 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Geris on February 12, 2019, which is available for review.

A draft 2019 Rock Island Bypass Monitoring Plan, draft 2019 RRJFBS Operations Plan, and draft 2019 Rock Island and Rocky Reach Fish Spill Plan were distributed to the HCP Coordinating Committees by Geris on February 15, 2019, which are available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019.

VI. HCP Administration

A. 2018 HCP Annual Reports (John Ferguson)

John Ferguson reminded the HCP Coordinating Committees of upcoming review timelines for the 2018 HCP Annual Reports, as follows:

- 2018 Wells HCP Annual Report due to the Wells HCP Coordinating Committee for a 30-day review on Wednesday, February 6, 2019
- 2018 Rock Island and Rocky Reach HCP Annual Reports due to the Rock Island and Rocky Reach HCP Coordinating Committees for a 30-day review on Monday, February 18, 2019

Ferguson suggested that HCP Coordinating Committees representatives coordinate accordingly with their respective HCP Hatchery and Tributary Committees representatives for adequate review of these reports.

The draft 2018 Wells HCP Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on February 5, 2019, and is available for a 30-day review with edits and comments due to Geris by Wednesday, March 6, 2019.

The draft 2018 Rock Island and Rocky Reach HCP Annual Reports were distributed to the HCP Coordinating Committees by Geris on February 18, 2019, and are available for a 30-day review with edits and comments due to Geris by Monday, March 18, 2019.

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on February 26, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The March 26, and April 23, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Email explaining the decision to not extend the 2020 Wells Project Survival Verification Study
Attachment C	2020 Wells Project Survival Verification Study Plan – run and study timing graph

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris†	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

From:	Kristi Geris
To:	Jackson, Chad S (DFW); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keely Murdoch (murk@yakamafish-nsn.gov); Keller, Lance; kirk.truscott@colvilletribes.com; Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc:	Aaron Beavers; Alene.Underwood@chelanpud.org; Andrew Gingerich (andrewg@dcpud.org); Bill Tweit; Bob Rose; Casey Baldwin; Catherine Willard; Dale Bambrick; Gallaher, Becky; Justin Yeager; "Mary Mayo"; Mike Tonseth; Ritchie Graves; Shane Bickford (sbickford@dcpud.org); Steve Hemstrom (steven.hemstrom@chelanpud.org); Steve Parker; Towey, Bill <bill.towey@chelanpud.org>; Verhey, Patrick M (DFW); "william_gale@fws.gov"
Subject:	FW: Extending the study to 37 days
Date:	Wednesday, December 19, 2018 08:40:26 AM
Attachments:	image002.png image006.png

Hi HCP-CC: please see the email below from Tom regarding extending the Douglas PUD 2020 SVS to 37 days.

The email below is also available for download from the HCP Coordinating Committees Extranet Site, under: Draft Documents > All by Mtg Date > 1/22/2019 (instructions below). Thanks! – kristi

Instructions:

To gain access to the HCP Coordinating Committees Extranet Homepage, please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcpcc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

You should now be at the HCP CC homepage.

If you encounter problems, or need a login username and password to access the site:
Please feel free to contact me or Julene McGregor [jmcgregor@dcpud.org; (509) 881-2236] and we will gladly assist you with questions or issues.

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com
C 360.220.3988

From: Tom Kahler <tomk@dcpud.org>
Sent: Tuesday, December 18, 2018 17:21
To: Kristi Geris <kgeris@anchorqea.com>
Cc: John Ferguson <jferguson@anchorqea.com>; Andrew Gingerich <andrewg@dcpud.org>
Subject: Extending the study to 37 days

Hi Kristi,

Please distribute this to the CC.

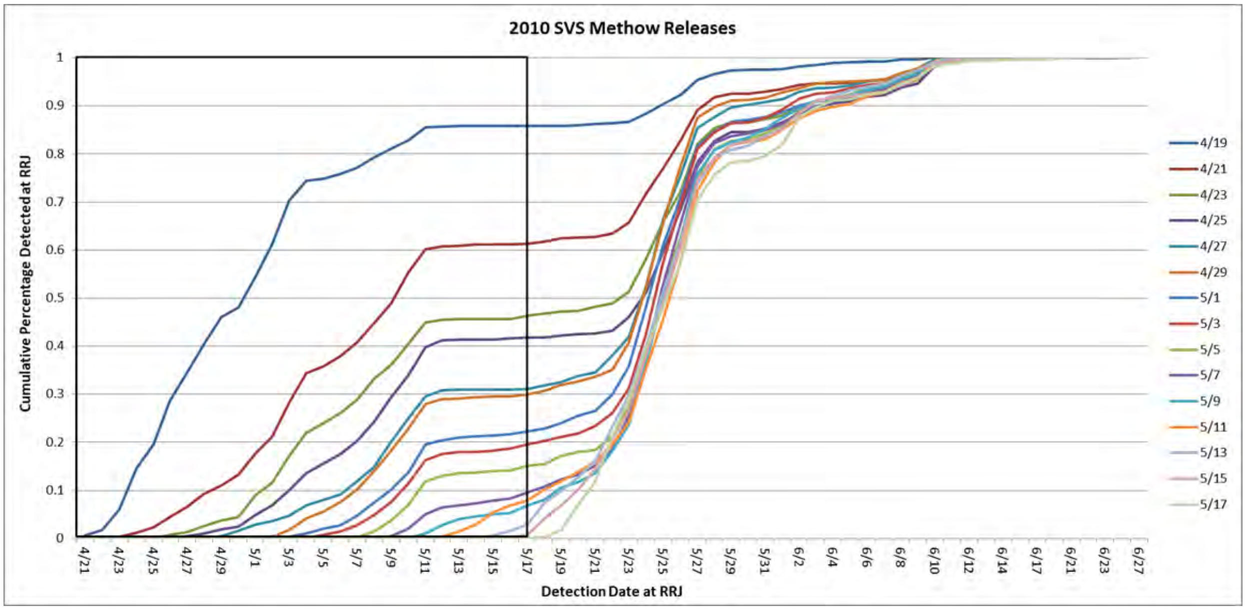
Thanks,

Tom

In thinking about the CC's interest in extending the study beyond 30 days to 37 days, I went back and looked at the Methow releases during the 2010 SVS to see how the passage distributions from each release compared with the release dates. The chart below the table shows the cumulative RRJ detection dates for each release as cumulative percentages. The now-familiar box encompasses the release period for all replicates (minus the first two days because of travel times to first detections from the 4/19 release). Contrary to what I recall, the first release moved rather rapidly, but stalled out for the final 20% of the release. However, that's not the point of this message.

Please note that for every release, the passage distribution extends over a month (see chart). In fact, to the point of 50% passage for each release, the minimum time interval is 9 days and the mean is 19 days, and to 75% passage the minimum is 11 days and the mean 23 days (see table below). Therefore the repeated releases are flooding the river with tagged study fish, and the effect of multiple releases extends well beyond the final release date. The take-home point, is that I see no need to add 7 days to the release schedule to encompass greater percentages of the runs of the respective stocks. The passage distributions for each release effectively add that desired bonus coverage.

	Days to Cumulative Percentage		
Release	**25%**	**50%**	**75%**
4/19	7	12	16
4/21	12	19	34
4/23	13	30	34
4/25	14	29	32
4/27	14	27	29
4/29	12	25	27
5/1	19	24	26
5/3	19	22	24
5/5	18	20	22
5/7	16	18	20
5/9	15	16	18
5/11	13	15	17
5/13	10	12	15
5/15	8	11	13
5/17	6	9	11
Average	**13**	**19**	**23**


2010 SVS Methow Releases
Cumulative Percentage Detected at RRJ
Detection Date at RRJ
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4/21
4/23
4/25
4/27
4/29
5/1
5/3
5/5
5/7
5/9
5/11
5/13
5/15
5/17
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5/13
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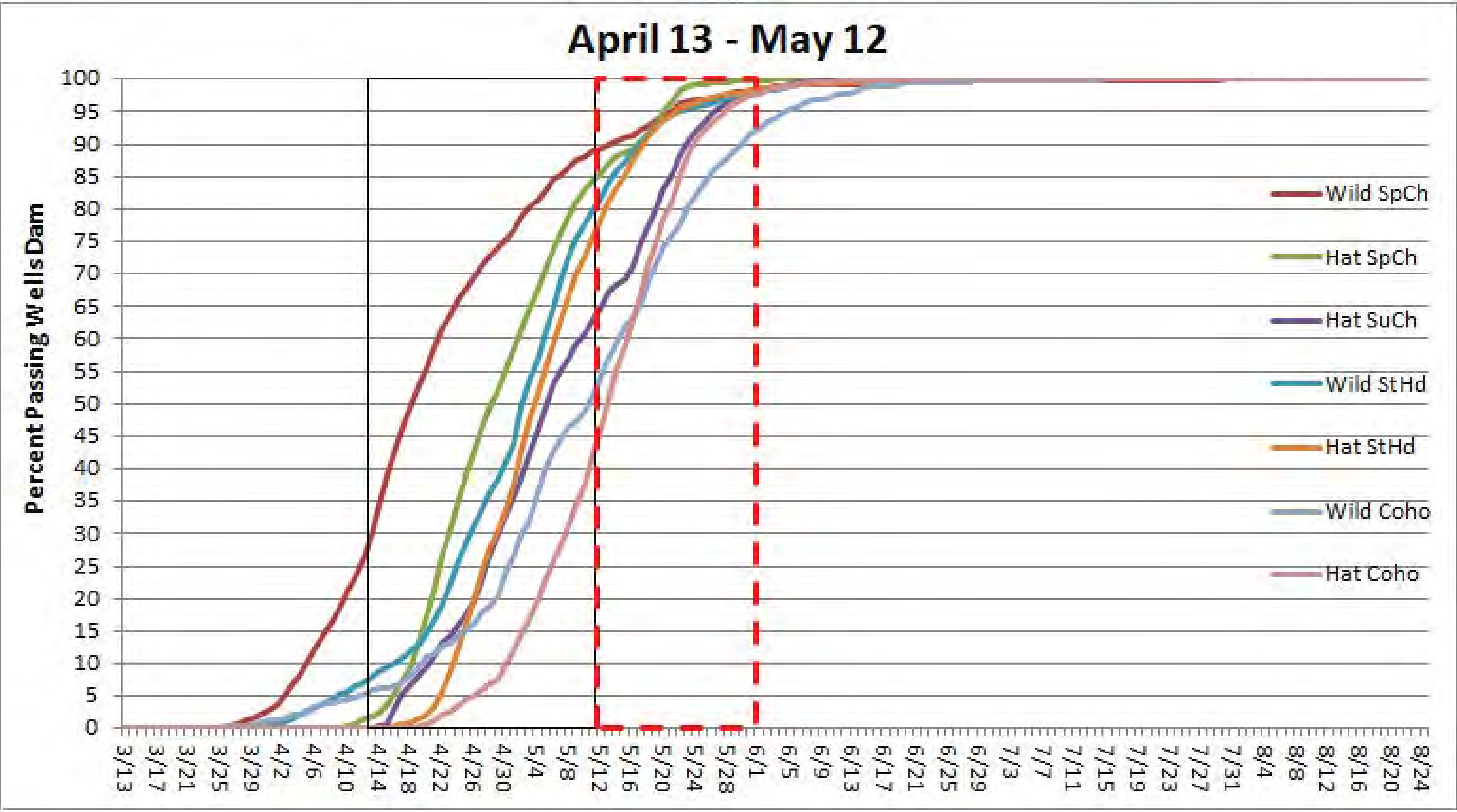
5/17


April 13 - May 12
Percent Passing Wells Dam
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
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7/27
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8/12
8/16
8/20
8/24
Wild SpCh
Hat SpCh
Hat SuCh
Wild StHd
Hat StHd
Wild Coho
Hat Coho

FINAL

1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: March 26, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the February 26, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, February 26, 2019, from 10:00 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will revise the draft 2018 Wells HCP Action Plan, as discussed, and will provide a final plan to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-A). *(Note: Kahler provided the final plan to Geris following the meeting on February 26, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Lance Keller will determine whether the weir box within the intake of Turbine Unit C1 was fixed to facilitate river flow through this area of the Intake Screen System with Turbine Unit C1 out of service during the 2019 bypass season (Item IV-A).
- Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific Lamprey at the Rocky Reach Juvenile Fish Bypass System (RRJFBS) and releasing these fish at an upstream location (Item IV-A).
- The HCP Coordinating Committees meeting on March 26, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-C).

Decision Summary

- Wells HCP Coordinating Committee representatives present approved the 2018 Wells HCP Action Plan, as revised (Item III-A). *(Note: Chad Jackson provided Washington Department of Fish and Wildlife's [WDFW's] approval of the plan via email on February 27, 2019.)*
- Wells HCP Coordinating Committee representatives present approved the 2018 Post-Season Bypass Report and Passage-Dates Analysis (Item III-B).
- Wells HCP Coordinating Committee representatives present approved the *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* (Item III-C). *(Note: Chad Jackson provided WDFW's approval of the plan via email on February 27, 2019.)*
- Rocky Reach HCP Coordinating Committee representatives present approved the 2018 RRJFBS Report (Item IV-A).
- Rock Island HCP Coordinating Committee representatives present approved the 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report (Item IV-B).
- The 2018 Wells HCP Annual Report was approved by the Wells HCP Coordinating Committee on March 22, 2019, after no disapprovals were received prior to the 37-day review period deadline and edits and comments received on the report were addressed and approved by the Colville Confederated Tribes (Item V-B).
- The 2018 Rock Island and Rocky Reach HCP Annual Reports were approved by the Rock Island and Rocky Reach HCP Coordinating Committees after no disapprovals were received prior to the 30-day review period deadline on March 18, 2019 (Item V-B).

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- A draft 2017 Douglas PUD Pikeminnow Removal Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 29, 2019, which is available for a 60-day review with edits and comments due to Tom Kahler by Thursday, March 28, 2019.
- A draft 2019 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 12, 2019, which is available for a 30-day review with edits and comments due to Lance Keller by Thursday, March 14, 2019 (Item IV-G).
- A draft 2019 Rock Island Bypass Monitoring Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item IV-H).

- A draft 2019 RRJFBS Operations Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item IV-H).
- A draft 2019 Rock Island and Rocky Reach Fish Spill Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Lance Keller by Monday, March 18, 2019 (Item IV-I).
- Columbia River Inter-Tribal Fish Commission's (CRITFC's) annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019 (Item III-E).
- The HCP Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Subcommittee-approved 2019 Broodstock Collection Protocols were distributed to the HCP Coordinating Committees by Kristi Geris on March 23, 2019.

Finalized Documents

- The final 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 26, 2019 (Item III-A).
- The final *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on March 2, 2019 (Item III-C).
- The final 2018 Wells HCP Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on March 25, 2019 (Item V-B).

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Tom Kahler added CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft January 22, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Geris said she also updated the Review Items, as additional items were distributed for review. Lance Keller said Chelan PUD has one additional edit regarding Sampling of Steelhead at the Priest Rapids Dam Off-Ladder Adult Fish Trap under the HCP Hatchery Committees Update. Keller clarified that given the "reallocation" (not "reduction") in BPA funding and the desire of WDFW to use remaining funds to evaluate spring Chinook salmon escapements, the HCP Hatchery Committees will need to evaluate how to monitor steelhead escapements in the future. HCP Coordinating Committees members present approved the January 22, 2019 meeting minutes, as revised. National Marine Fisheries Service (NMFS) abstained, because a NMFS representative was not present during the January 22, 2019 meeting.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on January 22, 2019, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on January 22, 2019):*

- *Douglas PUD will provide edits to the revised draft December 4, 2018 HCP Coordinating Committees meeting minutes to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-B).*
  Tom Kahler provided Douglas PUD edits to the minutes during the HCP Coordinating Committees meeting on January 22, 2019, which Geris distributed to the HCP Coordinating Committees that same day.
- *The HCP Coordinating Committees will provide edits or comments on Douglas PUD edits to the revised draft December 4, 2018 HCP Coordinating Committees meeting minutes to Kristi Geris no later than Friday, January 25, 2019; if no edits or comments are received, Geris will distribute the minutes as final (Item I-B).*
  No edits or comments were received, and the final December 4, 2018 HCP Coordinating Committees meeting minutes were distributed to the HCP Coordinating Committees by Geris on January 27, 2019.
- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This will be discussed during today's meeting and will also be carried forward.
- *John Ferguson will provide an update to Scott Carlon and Ritchie Graves about the impending dispute resolution from the HCP Tributary Committees (Item III-A).*
  Ferguson contacted Carlon and Graves on January 28, 2019, and provided updates as discussed.

- *John Ferguson will provide an update to Scott Carlon about the Wells HCP Coordinating Committee approval of the Douglas PUD 2020 Survival Verification Study Plan, as revised (Item IV-B).*
  Ferguson contacted Carlon on January 28, 2019, and provided updates as discussed.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman reported that the HCP Tributary Committees did not meet in February 2019 and will next meet on March 14, 2019. Hillman said the Yakama Nation (YN) provided a draft Statement of Agreement (SOA) titled, "Basis for Decision Making in HCP Tributary Committees," to the HCP Tributary Committees on February 25, 2019, which will be discussed during the HCP Tributary Committees meeting on March 14, 2019. John Ferguson asked what happens if the SOA is not approved? Keely Murdoch described two potential outcomes: 1) the YN takes no further action; or 2) the YN takes the SOA to dispute resolution. Murdoch added that the HCP Tributary Committees could approve the SOA with edits. Lance Keller said historically, the HCP Coordinating Committees have been effective in discussing, compromising, and editing SOAs until approved. Tom Kahler agreed this has been the pattern within the HCP Hatchery Committees, as well.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on February 20, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Broodstock Collection Protocols (joint)*: The 2019 Broodstock Collection Protocols are under review. Comments on the protocols are due to WDFW by March 1, 2019. There will be a conference call on March 11, 2019, to address any outstanding issues. WDFW will request approval of the protocols during the HCP Hatchery Committees meeting on March 20, 2019.
- *NMFS Consultation (joint)*: Consultation fell behind due to the government furlough. NMFS is completing the Draft Environmental Assessments for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs. These will soon be available for public review. Permits for the unlisted Chinook salmon programs are under review by the General Council.
- *Methow 2019 Monitoring and Evaluation Implementation Plan Statement of Work (SOW; Wells)*: The Wells HCP Hatchery Committee is reviewing the Methow 2019 Monitoring and Evaluation Implementation Plan SOW. Possible language changes to the SOW addressing estimation of steelhead escapements are being discussed in the event that WDFW/Bonneville Power

Administration funding for steelhead tagging at Priest Rapids Dam and PIT-tag array operations and maintenance funding is cut in 2019.

- *2019 Wells HCP Action Plan (Wells)*: The Wells HCP Hatchery Committee reviewed the 2019 Wells HCP Action Plan. The Wells HCP Hatchery Committee (and Wells HCP Tributary Committee) expressed no edits or concerns with the plan, which is now ready for Wells HCP Coordinating Committee approval.
- *Job Opening (Wells)*: Douglas PUD has an opening for a Hatchery Specialist.
- *2019 Rock Island and Rocky Reach HCP Action Plan (Rock Island/Rocky Reach)*: The Rock Island and Rocky Reach HCP Hatchery Committees (and Rock Island and Rocky Reach HCP Tributary Committees) are currently reviewing the 2019 Rock Island and Rocky Reach HCP Action Plan. Comments are due to Chelan PUD by March 11, 2019.
- *Tumwater Dam Update (Rock Island/Rocky Reach)*: Recall in 2018, adult Pacific lamprey surveys conducted at Tumwater Dam documented erosion of the fishway pad. A private contractor conducted core sampling, analyzed the samples, and determined erosion of the fishway pad is not as bad as originally thought. Therefore, there will be no reinforcement work to the fishway in 2019.
- *Joint Meetings of the HCP Hatchery Committees and PRCC Hatchery Subcommittee*: The HCP Hatchery Committees and PRCC Hatchery Subcommittee now have the same Chairperson. Therefore, the HCP Hatchery Committees and PRCC Hatchery Subcommittee are currently reviewing and updating the meeting protocols and distribution lists. Hillman noted that the PRCC Hatchery Subcommittee email distribution list may include individuals not already included on the HCP email lists and HCP Coordinating Committees representatives may be bringing these individuals to the HCP Coordinating Committees for approval.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on March 11, 2019 (conference call) and March 20, 2019 (regular monthly meeting).

III. Douglas PUD

A. DECISION: 2019 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said a draft 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on January 16, 2019. The action plan was available for a 30-day review with edits and comments due to Kahler by Friday, February 15, 2019.

Kahler said under the Wells HCP Hatchery Committee section, "Annual Implementation – Okanagan Sockeye Fish/Water Management Tools" (Item No. 5) was expanded to include six additional bullets describing the timing of various tasks. He said the HCP Hatchery Committees were notified of these changes.

Kahler said under the Wells HCP Coordinating Committee section, the "Fishway Outage Schedule for Fishway Inspection, Maintenance, and Fishway Projects" action indicates incorrect dates, which will be corrected in the final plan.

Wells HCP Coordinating Committee representatives present approved the 2018 Wells HCP Action Plan, as revised. *(Note: Chad Jackson provided WDFW's approval of the plan via email on February 27, 2019.)*

Kahler will revise the draft 2018 Wells HCP Action Plan, as discussed, and will provide a final plan to Geris for distribution to the HCP Coordinating Committees. *(Note: Kahler provided the final plan to Geris following the meeting on February 26, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*

B. DECISION: 2018 Wells Dam Post-Season Bypass Report and Passage-Dates Analysis (Tom Kahler)

Tom Kahler said a draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which was available for a 60-day review with edits and comments due to Kahler by Tuesday, February 12, 2019. Kahler said the only comment received was an indication of no comment from Jim Craig prior to today's meeting on January 22, 2019.

Wells HCP Coordinating Committee representatives present approved the 2018 Post-Season Bypass Report and Passage-Dates Analysis.

C. DECISION: 2019 Wells Dam Gas Abatement Plan (Tom Kahler)

Tom Kahler said a draft *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on January 21, 2019, and this final approved document is due to the Federal Energy Regulatory Commission (FERC) by February 28, 2019. Kahler said the Aquatic Settlement Work Group (SWG) and Washington Department of Ecology already approved the document on February 20, 2019. Andrew Gingerich noted that WDFW also already approved the document within the Aquatic SWG. Kahler said no comments were received from the Wells HCP Coordinating Committee.

Kirk Truscott requested for documents similar to this one where there are minimal changes year-to-year, that a redline version be provided to showcase what changed. Gingerich agreed a redline version would be easy to share. He said since the initial revisions in the first years of Douglas PUD's Clean Water Act Section 401 Water Quality Certification, the Plan has remained largely the same document. He said the 2019 plan includes installing forebay temperature sensors to help decrease forced spill events and also continues concentrating spill through Spillway 7.

Truscott recalled language in the draft plan about Douglas PUD's ability to spill for fish passage at times determined by incoming flow and total dissolved gas received from Chief Joseph and Grand Coulee dams as primarily a function of peak flows above the 7-day, 10-year-frequency (7Q10) flow at Wells Dam. Truscott said if this is the case, how often can Douglas PUD not spill for fish passage when there is no flow exceedance, and is this a regular issue? Gingerich said regardless of incoming flow and total dissolved gas at Wells Dam, bypass operations during the fish passage season trump total dissolved gas standard requirements (i.e., fish passage standards will not be deferred, and Douglas PUD will accept total dissolved gas violations to facilitate bypass at Wells Dam). John Ferguson said Douglas PUD has also paid Project Participants (customers) to take power from Wells Dam to help facilitate bypass operations and control total dissolved gas.

Wells HCP Coordinating Committee representatives present approved the *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149*. *(Note: Chad Jackson provided WDFW's approval of the plan via email on February 27, 2019.)*

The final *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Geris on March 2, 2019.

D. Wells Dam Fishway Maintenance Update (Tom Kahler)

Tom Kahler recalled reporting during the last HCP Coordinating Committees meeting on January 26, 2019, that the Wells Dam east fishway was dewatered for annual maintenance on January 7, 2019. Kahler said the east fishway was back in service by February 5, 2019. He said the west fishway was dewatered for annual maintenance on February 12, 2019, and should be back online by March 1, 2019. Kahler said east and west ladder fish salvage memorandums were distributed to the HCP Coordinating Committees by Kristi Geris on January 9 and February 15, 2019, respectively. *(Note: As of March 18, 2019, the west fishway remains out-of-service while mechanics work on improvements to the trapping infrastructure at Pool 40.)*

Kahler said west fishway maintenance activities included improvements to aid Pacific lamprey passage (i.e., closing diffuser grating gaps), which the Aquatic SWG was able to tour. Kahler said the background behind the count windows was painted and the windows were polished. He said damaged brushes designed to prevent fish from accessing certain areas through the fishway were also replaced.

E. CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam in 2019 (Tom Kahler)

Tom Kahler said CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019. Kahler said Douglas PUD will request approval during the HCP Coordinating Committees meeting on March 26, 2019.

IV. Chelan PUD

A. DECISION: 2018 RRJFBS Report

Lance Keller said a draft 2018 RRJFBS Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 24, 2019, which was available for a 32-day review with edits and comments due to Keller by Monday, February 25, 2019. Keller said Jim Craig distributed USFWS comments on the draft report to the HCP Coordinating Committees prior to the meeting on February 26, 2019. Keller reviewed USFWS comments, as follows:

Comment 1: Overview of 2018 RRJFBS Operations (page 3 of the draft report) describes maintenance of the associated screens and trash racks, including "when high differentials were observed at the trashracks in Unit 2, an outage period of 5 to 6 hours was usually required for divers to manually remove debris from the trashracks." How often did this occur during the sampling season?

Keller said this varies year-to-year and timing depends on debris loading and river flow. He said outages are initiated when there is a 2- to 3-foot differential across the trash racks and are conducted in the early hours of the day to avoids impacts to juvenile monitoring, which is also a safer timeframe for divers to conduct the work.

Comment 2: Observational comment.

Comment 3: Figure 2 (page 11 of the draft report) is really hard to read. Suggest updating to make consistent with Figure 2 in the draft 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report.

Keller said this will be addressed in the 2019 report.

Comment 4: Observational comment.

Comment 5: In Appendix A (Collection flows in the RRJFBS April 1 to August 31, 2018), why did the flows through the Intake Screen System, which had been largely consistent at approximately 120 cubic feet per second (cfs) since the second week in April 2018, suddenly reduce to 60 cfs on May 23, 2018? These reduced flows (52 to 60 cfs) stayed this way until sampling ended on August 31, 2018.

Keller explained that the intake screens in Turbine Unit C1 and Turbine Unit C2 include three weir slots per unit, and each is equipped with two valves that provide 10 cfs of water each through the respective slots. He said with Turbine Unit C1 offline for maintenance, there were issues with isolating Turbine Unit C1 and providing water to all areas of the Intake Screen System. He said he is unsure whether this has been addressed for the 2019 bypass season; however, he noted that this does not affect collection efficiency of fish in Turbine Unit C2 because the systems merge after a conduit system. He said he will determine whether the weir box within the intake of Turbine Unit C1 was fixed to facilitate river flow through this area of the Intake Screen System with Turbine Unit C1 out of service during the 2019 bypass season.

Kirk Truscott said he will provide Colville Confederated Tribes comments for consideration in the 2019 report. He said one comment is regarding how well the specified primary collection period corresponds to when subyearlings are actually passing Rocky Reach Dam. Keller said this question is related to an outstanding Chelan PUD action item. He said he has discussed this question internally with Steve Hemstrom who has previously discussed the question with Dr. John Skalski (Columbia Basin Research) and determined as long as the index samples are conducted at the same time each year, the run-timing forecast is applicable (i.e., regarding spill protection dates there is no statistical concern).

Truscott said another comment is regarding the 46 adult Pacific lamprey that were migrating downstream but were collected at the RRJFBS and relocated upstream at Lincoln Rock State Park. He asked, why relocate downstream-migrating fish upstream? Keller said will inquire internally about this reasoning.

Rocky Reach HCP Coordinating Committee representatives present approved the 2018 RRJFBS Report.

B. DECISION: 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report

Lance Keller said a draft 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 24, 2019, which was available for a 32-day review with edits and comments due to Keller by Monday, February 25, 2019. Keller said Jim Craig distributed USFWS comments on the draft report to the HCP Coordinating Committees on February 25, 2019. Keller reviewed USFWS comments, as follows:

Comment 1: The 2016-2017 pilot study results indicate holding of fish in the 4.4 cubic meter raceway up to 24 hours significantly increased evidence of gas bubble trauma (GBT). Any idea why?

Keller explained that fish with high levels of gas in the bloodstream compensate by migrating deeper in the water column. He said when fish are collected for GBT monitoring using the "traditional" method, samples are held in the shallower depths of the collection raceway for up to 24 hours before being observed for signs of GBT, which is forcing the gas out of the bloodstream. He is fairly confident this is the cause for the higher levels of observed GBT expression. He said it is Chelan PUD's goal to collect fish directly from the dewatering screens for GBT monitoring, which they have labeled the "fresh" fish collection method. This seems to be a truer reflection of GBT expression in run of the river fish. He said, however, using the latter method is difficult because the Fish Passage Center (FPC) requests a sample size of 75 to 100 fish (with 100 being ideal), creating time and staffing limitations. He said Chelan PUD has requested additional funding through the FPC Smolt Monitoring Program

(SMP) in order to collect the entire sample using the fresh fish collection method. Craig suggested clarifying this in future reports, as needed.

Keely Murdoch agreed with Keller's comments. She said it would be beneficial if there was a deeper holding area at Rock Island Dam; however, recognized this could be difficult and expensive given the site constraints. Keller agreed creating a deeper area would be a logistical challenge due to the location.

Keller said GBT monitoring is conducted twice per week and monitoring involves investigation of the eyes, paired fins, and caudal fin. He said the lateral line is no longer included in GBT monitoring. John Ferguson said a change in the protocol occurred in 2002 when inspection of the lateral line was removed from the protocol.

Kirk Truscott asked about reporting monitoring of fresh versus traditional fish, and Keller said these fish are reported separately. Keller said crews are encouraged to conduct as many fresh fish collections as possible and the remainder of the sample is comprised of fish collected in the traditional method, which is included in the 2019 Rock Island Bypass Monitoring Plan. Truscott asked if GBT monitoring is conducted on subyearlings, and Keller said monitoring is conducted on both yearling and subyearling Chinook salmon.

Comment 2: Unclear and inconsistent fish origin classifications (examples provided in the original email).

Keller said the nomenclature comes from FPC SMP. He said the SMP protocols stipulate classifying Chinook salmon as clipped or unclipped and steelhead as hatchery or wild, using an additional evaluation of "eroded fin" to help identify an adipose-present hatchery steelhead. Keller said Chelan PUD follows FPC SMP protocols because Chelan PUD receives funding from FPC SMP to conduct GBT monitoring.

Comment 3: In Table 5 (page 7 of the draft report), why do you think subyearling Chinook salmon had nearly double the injury rate and a 5.5-times higher mortality rate compared to yearling Chinook salmon at the Rock Island Dam Juvenile Sampling Facility? Sockeye salmon injury and mortality are also higher than yearling Chinook salmon and steelhead. Is there an issue with the 4.4 cubic meter raceway/holding tank or somewhere else in the conveyance? Is this a density issue?

Keller said he attributes the increase in injury and mortality rates to the prevalence of fry. He said FPC SMP protocol combine clipped and unclipped fry with subyearlings. He said the majority of mortalities are fry, and are largely due to fry being impinged, eaten by another fish and spit back out, and water temperatures. Truscott asked if less than 75 millimeters is considered a fry, and Keller said this is correct. *(Note: Keller later corrected himself and clarified fry are Chinook, coho, or sockeye salmon equal to or less than 60 millimeters.)*

Comment 4: Add a footnote to Table 7 (page 8 of the draft report) to denote the AP, AB, AS, and MP column headings[1].

Keller said this can be done.

Comment 5: Similar comment to Comment 1, which was addressed.

Comment 6: Observational comment.

Rock Island HCP Coordinating Committee representatives present approved the 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report.

C. Rocky Reach and Rock Island Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed adult fishway maintenance updates at Rocky Reach Dam and Rock Island Dam, as follows:

Rocky Reach Dam

Keller said the adult fishway at Rocky Reach Dam was returned to service on February 15, 2019. He said this was made possible because: 1) there was a minimal maintenance list for the fishway this year; and 2) mechanical crews wanted to start disassembly of Turbine Unit C1 to replace the trunnion bushing, and the headgates required to remove another unit from service were in use for the fishway maintenance.

Rock Island Dam

Keller said the left adult fish ladder was returned to service on January 26, 2019.

Keller said the right adult fish ladder is still out-of-service and Biomark is wrapping up installation of an additional PIT-tag array, which will boost the overall detection efficiency throughout the Rock Island Dam right adult fish ladder. He recalled there was an unresolvable noise issue; however, maintenance on the existing array and installation of a new array will return the ladder to high detection efficiency. He said the new antenna is located between the powerhouse and auxiliary water system building in fairly close proximity to the existing antenna. He said there is a section of ladder with two overflow weirs and two orifices, each equipped with four arrays. He said early testing indicates the noise issues have been alleviated. He said Biomark is now waiting on fiber and an addition power conduit to finish the work and the anticipated water up date is March 1, 2019. *(Note:*

[1]AP = Ammocoete (Pacific); AB = Ammocoete (Brook); AS = Ammocoete (Unknown); and MP = Macropthalmia (Pacific)

Keller provided an email following the meeting on February 26, 2019, clarifying that all necessary work associated with the new PIT-tag array was completed as of February 25, 2019, and the right adult fish ladder was returned to service on February 25, 2019 at 10:00 a.m.)

Keller said the middle adult fish ladder was taken offline for annual winter maintenance on January 28, 2019. He said a fish rescue was performed and three juvenile rainbow/steelhead, adipose-present and between 4 to 6 inches, were rescued. He said the main inspection in the middle ladder will occur in the lower section. He recalled the installation of new butterfly valves 2 years ago, and when crews inspected the gear boxes the first one was full of water. He said the valves are still under warranty and were removed and sent to Texas for repair. He said the valves should be returned to Rock Island Dam for installation in time for the ladder to be returned to service by March 15, 2019. Keller said he had asked the mechanical foreman if there is any way to operate the ladder for the 2019 season without repairing the valves during this winter outage, and address this as the first issue during the 2019/2020 winter outage. Keller said the foreman did not have confidence in operating the ladder in this condition in 2019, which is the reasoning behind making the valve repairs and extending the expected return-to-service date of March 1 to March 15, 2019. Keller said as far as fish passage, the middle ladder is used the least compared to the right and left ladders, with the bulk of fish passage through the right ladder.

D. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam mechanics completed the disassembly of Turbine Unit B4 and are now working with Andritz Hydro to inspect the condition on the unit. Keller said the return-to-service date for Turbine Unit B4 is still July 2019.

E. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said disassembly of Turbine Unit C1 is continuing and mechanics are preparing to remove the rotor. Keller said the return-to-service date for Turbine Unit C1 is still August 2019.

F. Tumwater Dam Update (Lance Keller)

Lance Keller said in early February 2019, the contractor completed the exploratory drilling and learned two things: 1) the bottom layer of concrete below the fishway is not as thick as depicted on the design drawings and pin piles will not be effective; and 2) the extent of erosion was much less than first speculated. Keller said therefore, engineers do not think repairs are needed at this time. He said Chelan PUD is amending the Tumwater Dam Operations Plan to include further evaluation of these conditions during low water events.

G. 2019 Rock Island and Rocky Reach HCP Action Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 12, 2019. Keller said this plan is available for a 30-day review with edits and comments due to Keller by Thursday, March 14, 2019. He said Chelan PUD will request approval of the plan during the HCP Coordinating Committees meeting on March 26, 2019. Keller said there were no significant changes to the HCP Coordinating Committees section; rather, only updates to dates. He asked that the Rock Island and Rocky Reach HCP Coordinating Committees contact him with questions.

H. 2019 Rock Island Bypass Monitoring Plan and 2019 RRJFBS Operations Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island Bypass Monitoring Plan and draft 2019 RRJFBS Operations Plan were distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, and are available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019. Keller said Chelan PUD will request approval of these plans during the HCP Coordinating Committees meeting on March 26, 2019.

Keller said changes to note in the 2019 Rock Island Bypass Monitoring Plan, include: 1) additional tagging of 3,000 wild and hatchery steelhead above and beyond the amount outlined for FPC SMP, which will be part of a Grant PUD avian predation study; and 2) continue fresh fish collection for GBT monitoring to the best of Chelan PUD's ability and as the run allows.

Keller said a change to note in the 2019 RRJFBS Operations Plan includes the integration of the altered operations to provide additional attraction water at the RRJFBS Surface Collector (SC)[2] directly into the plan. He clarified these operations will not be appended to the plan as was done in 2018; rather, the operations are now integrated into the 2019 plan.

I. 2019 Rock Island and Rocky Reach Fish Spill Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island and Rocky Reach Fish Spill Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, which is available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019. Keller said Chelan PUD will request approval of the plan during the HCP Coordinating Committees meeting on March 26, 2019. He said the plan is similar to past plans, including a note about converting selected notch gates to full gate capacity to provide Rock Island Dam with more immediate spillway capacity during heavy spring river flow events.

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[2] Rocky Reach Dam bypass operations in 2019 will include: 1) using three additional RRJFBS SC pumps to increase attraction flow from 6,000 to 6,660 cfs into the RRJFBS SC entrances (3,330 cfs on each side); and 2) increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12,200 cfs (12.2 kcfs) to a soft-limit flow of 15.2 kcfs.

V. HCP Administration

A. HCP Tributary Committees U.S. Fish and Wildlife Service Voting Member (John Ferguson)

John Ferguson said a letter requesting that USFWS be a voting member on the HCP Tributary Committees was received from Jim Craig on January 24, 2019.

B. 2018 HCP Annual Reports (John Ferguson)

John Ferguson reminded the HCP Coordinating Committees of upcoming review timelines for the 2018 HCP Annual Reports, as follows:

- 2018 Wells HCP Annual Report comments are due Wednesday, March 6, 2019
- 2018 Rock Island and Rocky Reach HCP Annual Reports comments are due Monday, March 18, 2019

The 2018 Wells HCP Annual Report was approved by the Wells HCP Coordinating Committee on March 22, 2019, after no disapprovals were received prior to the 37-day review period deadline and edits and comments received on the report were addressed and approved by the Colville Confederated Tribes. The final report was distributed to the HCP Coordinating Committees by Kristi Geris on March 25, 2019.

The 2018 Rock Island and Rocky Reach HCP Annual Reports were approved by the Rock Island and Rocky Reach HCP Coordinating Committees after no disapprovals were received prior to the 30-day review period deadline on March 18, 2019.

C. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on March 26, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The April 23 and May 28, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:

* Denotes HCP Coordinating Committees member or alternate

† Joined by phone

†† Joined by phone for the HCP Tributary and Hatchery Committees Update

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: April 23, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the March 26, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, March 26, 2019, from 10:00 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Lance Keller will notify Jim Craig of what he determined about operating the weir box within the intake of Turbine Unit C1 to facilitate river flow through this area of the Intake Screen System with Turbine Unit C1 out of service during the 2019 bypass season (Item I-C).
- Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific lamprey at the Rocky Reach Juvenile Fish Bypass System (RRJFBS) and releasing these fish at an upstream location (Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-E).
- Tom Kahler will distribute recent reports by the Columbia River Inter-Tribal Fish Commission (CRITFC) that summarize findings from their sockeye salmon monitoring efforts (Item IV-A).
- The HCP Coordinating Committees meeting on April 23, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-C).

Decision Summary

- Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2019 Rock Island and Rocky Reach HCP Action Plan (Item III-A). *(Note: Jim Craig provided U.S. Fish and Wildlife Service [USFWS] approval of the plan via email on March 18, 2019, and Kirk Truscott provided Colville Confederated Tribes [CCT] approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*
- Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2019 Rock Island and Rocky Reach Fish Spill Plan, as revised (Item III-B). *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*
- Rock Island HCP Coordinating Committee representatives present approved the 2019 Rock Island Bypass Monitoring Plan, as revised (Item III-C). *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*
- Rocky Reach HCP Coordinating Committee representatives present approved the 2019 RRJFBS Operations Plan, as revised (Item III-D). *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*
- Wells HCP Coordinating Committee representatives present approved the 2019 Broodstock Collection Protocols (Item IV-B). *(Note: Kirk Truscott provided CCT approval of the protocols via a phone call to Kristi Geris on March 25, 2019.)*

Agreements

- HCP Coordinating Committees representatives present agreed to add Emi Kondo (National Marine Fisheries Service [NMFS]) to select HCP Hatchery Committees email distribution lists (Item V-B).

Review Items

- CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019 (Item IV-A).
- A draft 2017 Douglas PUD Pikeminnow Removal Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on January 29, 2019, which is available for a 60-day review with edits and comments due to Tom Kahler by Thursday, March 28, 2019.

Finalized Documents

- The Wells Project Survival Verification Study – Final 2020 Study Plan, which was approved by the Wells HCP Coordinating Committee on January 22, 2019, was distributed to the HCP Coordinating Committee by Kristi Geris on March 28, 2019.
- The Final 2018 Post-Season Bypass Report and Passage-Dates Analysis, which was approved by the Wells HCP Coordinating Committee on February 26, 2019, was distributed to the HCP Coordinating Committee by Kristi Geris on March 28, 2019.
- The Final 2019 Broodstock Collection Protocols were distributed to the HCP Coordinating Committee by Kristi Geris on March 29, 2019 (Item IV-B).
- The final 2018 Rock Island and Rocky Reach HCP Annual Reports were distributed to the HCP Coordinating Committees by Kristi Geris on April 8, 2019 (Item V-A).

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Scott Carlon added under HCP Administration a request to add Emi Kondo to select HCP Hatchery Committees email lists
- Tom Kahler added a Wells Dam bypass operations update

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft February 26, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Geris said a minor edit was received from the Yakama Nation (YN) after the revised minutes were distributed. She said under Chelan PUD's 2018 Rock Island Smolt and Gas Bubble Trauma Evaluation Report topic, Keely Murdoch clarified that her comment about past sampling efforts at Rock Island Dam and observed gas bubble trauma expression was unrelated to efforts conducted by the YN, and she asked to omit this comment and leave the statement as her agreeing with Lance Keller's comments. Geris said she also updated the Review Items and Finalized Documents, as additional items were distributed. She also updated the Decision Summary to include approval of the Wells, Rock Island, and Rocky Reach HCP Annual Reports. HCP Coordinating Committees members present approved the February 26, 2019 meeting minutes, as revised. *(Note: Jim Craig provided USFWS approval of the February 26, 2019 meeting minutes via email on March 19, 2019, and Kirk Truscott provided CCT approval of the minutes via a phone call to Geris on March 25, 2019.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on February 26, 2019, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on February 26, 2019):*

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This action item will be discussed during today's meeting and will also be carried forward.
- *Tom Kahler will revise the draft 2018 Wells HCP Action Plan, as discussed, and will provide a final plan to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-A).*
  Kahler provided the final plan to Geris following the meeting on February 26, 2019, which Geris distributed to the HCP Coordinating Committees that same day.
- *Lance Keller will determine whether the weir box within the intake of Turbine Unit C1 was fixed to facilitate river flow through this area of the Intake Screen System with Turbine Unit C1 out of service during the 2019 bypass season (Item IV-A).*
  Keller said this fix was not completed because in order to troubleshoot the issue, the vertical barrier screen needs to be operational, which cannot occur while Turbine Unit C1 is out of commission. He said, however, a flushing valve will provide about 10 cubic feet per second (cfs) through the area to prevent fish from exiting the Turbine Unit C2 weir box and entering the Turbine Unit C1 weir box. Keller recalled this action item was to address a question Jim Craig asked about the 2019 RRJFBS Report, and Keller said he will communicate this response to Craig to close out the action item.
- *Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific Lamprey at the RRJFBS and releasing these fish at an upstream location (Item IV-A).*
  This action item will be carried forward.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on March 20, 2019 (*note: joint HCP Hatchery Committees/Priest Rapids Coordinating Committee [PRCC] Hatchery Subcommittee* *items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Broodstock Collection Protocols (joint)*: The HCP Hatchery Committees and PRCC Hatchery Subcommittee reviewed, edited, and approved the 2019 Broodstock Collection Protocols. The protocols were sent to the Wells HCP Coordinating Committee for review and approval. Once approved, the protocols will be submitted to NMFS.
- *Spring Chinook Salmon Carcass Recovery Bias (joint)*: The Washington Department of Fish and Wildlife (WDFW) provided a presentation titled, "Spring Chinook Carcass Recovery Bias in the Upper Wenatchee Basin." WDFW discussed how carcass bias was assessed, the factors affecting bias, and development of a model that can be used to adjust spawning escapements based on factors affecting bias. In general, bias is affected by stream flows, stream type, channel type, and fish size (age) and sex. Hillman said before, it was assumed that hatchery fish had a higher pre-spawn mortality rate; however, once escapements were adjusted for bias, WDFW found little difference in pre-spawn mortality between hatchery and natural-origin adults.
- *NMFS Consultation (joint)*: The Draft Environmental Assessment for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs is undergoing internal review and will soon be available for public review. Permits for the unlisted Chinook salmon programs are under review by General Council.
- *Bacterial Kidney Disease Testing (Wells)*: Douglas PUD has been sending virology samples (consisting of ovarian fluid, kidney, and spleen samples) to Washington Animal Disease Diagnostic Laboratory (WADDL) for processing and kidney samples to WDFW for traditional bacterial kidney disease ELISA (enzyme-linked immunosorbent assay) testing. Douglas PUD reported that WADDL has recently revised their protocols and can now report Optical Density values for bacterial kidney disease. Douglas PUD will determine if there is a cost difference between laboratories. The intent is to send all samples to WADDL for analysis.
- *Marking of 2018 Brood Chiwawa Spring Chinook Salmon (Rock Island/Rocky Reach)*: The Chiwawa spring Chinook salmon conservation program consists of juveniles from natural-origin spawners and hatchery-origin spawners. The question the Rock Island HCP Hatchery Committee is considering is should all fish within the program be marked the same or should fish within the program be marked differentially based on the origin of their parents? Unfortunately, the Spring Chinook Salmon Management Plan, Biological Opinions, Hatchery and Genetic Management Plans, and Permits are not clear and tend to conflict with each other on how the fish should be marked. The Rock Island HCP Hatchery Committee is working to resolve this issue.
- *Joint Meetings of the HCP Hatchery Committees and PRCC Hatchery Subcommittee*: The HCP Hatchery Committees and PRCC Hatchery Subcommittee are currently reviewing and updating their meeting protocols and distribution lists.

- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on April 17, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on March 14, 2019:

- *Upper Kahler Stream and Floodplain Enhancement Project*: In December 2018, the HCP Tributary Committees received a General Salmon Habitat Program proposal from the YN titled, "Upper Kahler Stream and Floodplain Enhancement Project." The purpose of the project is to reduce the risk of an avulsion near river mile 8.6 on Nason Creek by constructing a large, buried, log jam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project will also construct three additional buried bank jams and enhance fish habitat at the downstream end of the avulsion channel. The total cost of the project was $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. In December 2018, the HCP Tributary Committees elected to not fund this project as currently designed but invited the YN to provide a presentation to the HCP Tributary Committees to explain the design of the project. In January 2019, the YN and their consultant provided a presentation describing the design of the proposed project. The HCP Tributary Committees struggled with the proposed filling of the avulsion channel with large sediments and recommended instead adding wood and a few boulders in the avulsion channel. These structures should help trap smaller sediments and fill the channel naturally. The YN provided a written response to the HCP Tributary Committees concerns and identified four alternatives, one of which was the original proposed action. After discussing the alternatives with the YN and their engineer, the Rock Island HCP Tributary Committee agreed to fund the four large wood structures within Nason Creek; however, elected to not fund any actions that would fill the avulsion channel and asked the YN to provide a cost estimate for constructing the four wood structures within Nason Creek. Hillman said once the Rock Island HCP Tributary Committee receives a budget and approves it, the YN can start construction. John Ferguson asked if the proposal is to rely on wood structures to trap sediment in the avulsion channel? Hillman said no, all wood structures will be placed in Nason Creek for bank stabilization, structure, and fish habitat; and the HCP Tributary Committees elected to not fund filling the avulsion channel. Hillman said the river will eventually migrate through the avulsion channel and the intent of this project is to prevent this from happening soon. He said the landowner reached out to the YN for help on this.
- *Stormy Project Area "A" Stream and Floodplain Enhancement Project*: In December 2018, the HCP Tributary Committees received a General Salmon Habitat Program proposal from the YN titled, "Stormy Project Area 'A' Stream and Floodplain Enhancement Project." The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel

juvenile rearing habitat. The total cost of the project was $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. In December 2018, the HCP Tributary Committees elected to not fund this project as currently designed but invited the YN to provide a presentation to the HCP Tributary Committees to explain the design of the project. In January 2019, the YN and their consultant provided a presentation on the design of the Stormy Area A Project. Following the presentation and discussions with all members of the HCP Tributary Committees, the HCP Tributary Committees agreed to support the excavation of the perennial side channel on river right and the side channel on river left, including installing apex log jams used to control flows into the side channels. The HCP Tributary Committees asked the YN for a revised budget for the construction of the perennial side channels and apex jams. In February 2019, the YN submitted a revised proposal and cost estimate. The total cost of the project was reduced to $1,564,211.15 and the YN requested $823,161.15 from HCP Plan Species Account Funds. The Rocky Reach HCP Tributary Committee approved $823,161.15 for the project.

- *East Fork Mission Creek Floodplain Restoration Project*: The HCP Tributary Committees received a Small Project proposal from Chelan County Natural Resource Department (CCNRD) titled, "East Fork Mission Creek Floodplain Restoration Project." The purpose of this project is to develop permit-ready designs that will result in improved base flows in the Mission Creek watershed by reconnecting floodplain in a severely incised system and improve habitat for steelhead. CCNRD intends to accomplish this by removing an eroding road prism located within the floodplain, adding in-stream wood, and addressing potential passage barriers. The project is located along a 2.8-mile stretch of East Fork Mission Creek in the upper Mission Creek watershed. The total cost of the design project is $96,169. The sponsor requested $74,669 from HCP Plan Species Account Funds. The HCP Tributary Committees were unable to make a funding decision without more information on the status of the road. It is unclear if the road is permanently closed and formally abandoned. The HCP Tributary Committees have asked CCNRD to provide clarification on the closure of the road. Once this is received, the HCP Tributary Committees will make a funding decision.
- *2019 Eightmile Creek Fisheries Assessment Project*: The HCP Tributary Committees received a Small Project proposal from WDFW titled, "2019 Eightmile Creek Fisheries Assessment Project." The purpose of this project is to assess the status of fish within Eightmile Creek, a tributary to the Chewuch River in the Methow River Basin. These data will be used to determine a strategy for removing brook trout and restoring native salmonids to 21 kilometers of stream. Currently, a fish passage barrier near the mouth of Eightmile Creek precludes steelhead (and bull trout) from migrating into the stream. Because the YN are looking to remove the barrier, managers want information on species composition, fish abundance, stream flows, and temperatures within Eightmile Creek. Tissue samples from bull trout and

O. mykiss will also be collected within Eightmile Creek to determine genetic composition. The total cost of the project is $67,200. The sponsor requested the full amount from HCP Plan Species Account Funds. The HCP Tributary Committees were unable to make a funding decision and asked the sponsor to: 1) include a management plan that clearly identifies decision rules for determining which strategy would be selected for removing brook trout (i.e., what results are needed to determine whether to use electrofishing, piscicides, or other removal techniques); and 2) consider using electrofishing rather than snorkeling to conduct the assessments. Complete census surveys with electrofishing gear can be used to provide data on species richness and abundance and can be used to remove brook trout during the surveys. Hillman said the HCP Tributary Committees sent a letter to WDFW asking WDFW to address these issues, and once resolved, the HCP Tributary Committees can then make a funding decision.

- *Presentation by CCNRD on the Monitor Side Channel Design Project*: CCNRD and their consultants provided an update on the Monitor Side Channel Restoration Design Project, which the Rock Island HCP Tributary Committee funded in 2018. CCNRD described the goals and objectives of the project and identified design challenges and constraints. They also provided results from their hydraulic modeling work and presented conceptual designs that included boulder clusters, bank engineered log jams, weir logs, and willow trenches. Members provided feedback on the proposed conceptual designs. CCNRD and their consultants will continue working on the designs and will provide additional updates to the HCP Tributary Committees in the near future.
- *Wells HCP Tributary Committee Action Plan*: On January 17, 2019, Douglas PUD provided the HCP Tributary Committees with the Draft 2019 Wells HCP Action Plan for a 30-day review. Wells HCP Tributary Committee representatives reviewed the tributary section of the action plan and provided minor edits, which were incorporated into the plan. No other edits or comments were provided.
- *Rock Island and Rocky Reach HCP Tributary Committees Action Plans*: On February 11, 2019, Chelan PUD provided the HCP Tributary Committees with the Draft 2019 Rock Island and Rocky Reach HCP Action Plan for a 30-day review. Rock Island and Rocky Reach HCP Tributary Committees representatives reviewed the tributary section of the action plan and had no comments or edits.
- *Plan Species Account Deposits*: At the end of January 2019, the PUDs deposited funds into each of the Plan Species Accounts. Chelan PUD deposited $784,331.00 into the Rock Island Plan Species Account and $371,474.00 into the Rocky Reach Account. Douglas PUD deposited $284,793.79 into the Wells Account. As of March 2019, the unallocated balances within each account are $6,910,306.00 in the Rock Island Account, $3,215,267.00 in the Rocky Reach Account, and $1,813,698.00 in the Wells Account. Thus, among the three accounts, there is

about $11,939,271 available. Ferguson asked if the unallocated balance includes the decisions made in March 2019? Hillman said it does not, but accounting for decisions made during the meeting on March 14, 2019, the combined balance would decrease by about $1,000,000.

- *Review of a Draft Statement of Agreement*: On February 25, 2019, the YN submitted a draft Statement of Agreement (SOA) to the HCP Tributary Committees for review. The purpose of the draft SOA is to provide a basis for decision-making in the HCP Tributary Committees. The YN asked the HCP Tributary Committees to review and, if necessary, edit the draft SOA. The YN would like the HCP Tributary Committees to vote on the SOA during the HCP Tributary Committees meeting on April 11, 2019. There was a lot of discussion on the draft SOA including what precipitated the need for an SOA, why an SOA is necessary, and what will be accomplished by approving the SOA. Most members did not see a need for an SOA, thought the language was too strong, and took away each member's discretionary rights when reviewing and voting on project proposals. The CCT noted they cannot support any SOA that will take away their right to prevent the YN from owning land in the Methow River Basin. It was also pointed out that editing the draft SOA to preserve the discretionary voting rights of signatory parties would result in a very complicated document that would no longer fulfill the intent of the YN preparing the SOA. Most members thought it would be more appropriate to update Section 5 in the HCP Tributary Committees' Policies and Procedures for Funding Projects document. They thought the evaluation criteria currently being reviewed by the HCP Tributary Committees could be inserted into the Policies and Procedures document, and those can be reviewed and updated annually or more frequently if necessary. The HCP Tributary Committees believe this would eliminate the need for an SOA. That said, the YN asked members to review and edit the draft SOA and be prepared to discuss it and vote on it during the HCP Tributary Committees meeting on April 11, 2019. Hillman said no edits or comments have been received on the draft SOA to date. Ferguson asked each HCP Coordinating Committees representative if they had any questions or wanted to provide any additional comments at this time. Keely Murdoch reiterated that the YN will likely request a vote on the draft SOA during the HCP Tributary Committees meeting on April 11, 2019, but the YN are still discussing the SOA and reviewing their options. No other comments were expressed.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on April 11, 2019.

III. Chelan PUD

A. DECISION: 2019 Rock Island and Rocky Reach HCP Action Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 12, 2019, and was available for a 30-day review with edits and comments due to Keller by Thursday, March 14, 2019. Keller said the tributary and hatchery sections have already been approved by the respective HCP Committees, and there are no outstanding edits or comments to be discussed.

Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2019 Rock Island and Rocky Reach HCP Action Plan. *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Geris on March 25, 2019.)*

B. DECISION: 2019 Rock Island and Rocky Reach Fish Spill Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island and Rocky Reach Fish Spill Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, and was available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019. Keller said questions were received from USFWS on March 6, 2019, which Keller responded to on March 15, 2019. Keller summarized USFWS questions, as follows:

Question 1: How was “shaped spill” derived for Rock Island and Rocky Reach dams?

Keller explained that spill shaping at both Rock Island and Rocky Reach dams was developed and informed from hydroacoustic data.

Question 2: For Rocky Reach Dam, why does the “spill shape %” not add up to 100?

Keller explained that spill shaping is a continuous event where the first hour of spill is a continuation of the last 13 hours of the previous day. He said Jim Craig expected the sum of the block releases to equal 100, which would be true if the values were representing total flow passing the project; however, this is not the case. Keller said it is just a coincidence that summing the block releases at Rock Island Dam equals 98.

Keller said his responses seemed to have adequately addressed Craig’s questions because Craig provided USFWS approval of the plan via email on March 18, 2019.

Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2019 Rock Island and Rocky Reach Fish Spill Plan, as revised. *(Note: Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*

C. DECISION: 2019 Rock Island Bypass Monitoring Plan (Lance Keller)

Lance Keller said a draft 2019 Rock Island Bypass Monitoring Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019, and was available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019. Keller said editorial comments were received from USFWS on March 11, 2019, including wordsmithing to improve the flow of information and the addition of page numbers.

Rock Island HCP Coordinating Committee representatives present approved the 2019 Rock Island Bypass Monitoring Plan, as revised. *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*

D. DECISION: 2019 Rocky Reach Juvenile Fish Bypass System Operations Plan (Lance Keller)

Lance Keller said a draft 2019 RRJFBS Operations Plan was distributed to the HCP Coordinating Committees by Kristi Geris on February 15, 2019 and was available for a 32-day review with edits and comments due to Keller by Monday, March 18, 2019.

Rocky Reach HCP Coordinating Committee representatives present approved the 2019 RRJFBS Operations Plan, as revised. *(Note: Jim Craig provided USFWS approval of the plan via email on March 18, 2019, and Kirk Truscott provided CCT approval of the plan via a phone call to Kristi Geris on March 25, 2019.)*

E. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said the rotor has been removed from Turbine Unit C1 and mechanics are continuing disassembly of the unit to reach the trunnion bushings.

Keller said mechanics have now also detected a trunnion seal leak in Turbine Unit C3. He said on October 31, 2018, Turbine Unit C3 was taken offline for routine overhaul work and mechanics discovered about 5 gallons of water inside the hub, but no recordable oil loss was documented. Keller said considering the issues experienced with Turbine Unit C1, mechanics decided to run and test the unit, which the unit passed, and the unit was returned to service on December 31, 2018. Keller said mechanics continued monitoring the tailrace for the presence of oil, and on February 19, 2019, the unit was taken offline to check the level of oil in the unit. He said this time, mechanics discovered more than 5 gallons of water inside the hub, and crews are still working internally to determine how much oil has been lost. He said last week, the engineered seals designed for Turbine Unit C1 were installed in Turbine Unit C3, the unit was pressurized, and the seals did not work; therefore, Turbine Unit C3 is out-of-service. He said mechanics are now moving through the same evaluation process as was done for Turbine Unit C1, including considering hydraulically locking the blades into place. He said a person working for Alstom on Turbine Unit C9 suggested using a compound that is injected into the hub to improve the seal and allow the blades to operate in a Kaplan configuration. He said Rocky Reach Dam mechanics are currently considering both of these options as well as others. He said two key things to note, include: 1) based on current snowpack and water forecasts, Chelan PUD is not expecting an impact to total dissolved gas due to the decreased powerhouse capacity; and 2) work on Turbine Unit C3 will not impact the return-to-service date for Turbine Unit C1, which is still August 2019.

Keely Murdoch asked if having both Turbine Unit C1 and Turbine Unit C3 out-of-service will affect attraction flow? Keller said there are no available survival study data to review that specifically address this; however, he discussed this with Steve Hemstrom and Alene Underwood, and they do not anticipate an impact. Keller said additionally, Turbine Unit C1 and Turbine Unit C3 are located in a cul-de-sac which provides six passage routes (three turbine routes, two bypass screen routes, and one route via the surface collector structure). He said Turbine Unit C2 is currently the closest operating turbine passage route to the surface collector structure, and with both Turbine Unit C1 and Turbine Unit C3 offline, it seems once fish reach the cul-de-sac area the odds of fish passing via the collection system is increased with Turbine Unit C3 out-of-service.

Keller said Chelan PUD did ask Dr. John Skalski (Columbia Basin Research) to review juvenile survival data in terms of meeting survival standards with Turbine Unit C1 out-of-service. Keller said with Turbine Unit C1 offline, this means half of the available passage routes via diversion screens are not available. He said Skalski used spring Chinook salmon data from 2010 and 2011 to determine route-specific survival and passage proportions. Keller said Skalski took an estimated reduction in bypass collection efficiency (i.e., reduced 50% use in diversion screens) and applied this to the powerhouse passage route to determine the overall project survival and combined adult and juvenile survival. Keller said all three scenarios involved a 50% reduction in bypass screen efficiency, and then additional reductions of 2.5%, 5%, and 7.5% in the proportion of overall fish bypassed via the surface collector passage route were applied. He said day and night passage proportions and survivals were applied to dam survival and then project survival, and those were then multiplied to calculate the combined adult and juvenile survival. He said Skalski also found under all scenarios the project will continue to meet combined 91% juvenile and adult survival standard on a year-to-year basis. Keller said in summary, Chelan PUD does not believe there will be an impact from Turbine Unit C3 being out-of-service. He said if there is a slight reduction in collection efficiency, the project will still meet the survival standards under all three scenarios Skalski modeled.

Scott Carlon asked about the modified bypass operations to increase flow through the screens. Keller explained that these operations will include: 1) using three additional RRJFBS surface collector pumps to increase attraction flow from 6,000 to 6,660 cfs into the RRJFBS surface collector entrances (3,330 cfs on each side); and 2) increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12,200 cfs (12.2 kcfs) to a soft-limit flow of 15.2 kcfs. Keller recalled these modified operations were initially developed in 2013 to accommodate repairs to the wedge carriers in Turbine Unit C1 and Turbine Unit C2. He said the operations were developed in consultation with Bryan Nordlund (NMFS, retired) and the Rocky Reach HCP Coordinating Committee to increase velocity through the area without creating concern for impingement.

Keller said a marked fish release was also conducted last week in the RRJFBS and intake screen system deployed in Turbine Unit C2 to verify no impingements under the modified bypass operations. He said there were issues with the Turbine Unit C2 release, and crews plan to retest this release at a later date.

Chad Jackson asked if the Turbine Unit C1 and Turbine Unit C3 repairs will impact planning for the 2021 survival study. Keller said as of now, Chelan PUD does not foresee these repairs impacting the study.

Murdoch asked if this issue with failing trunnion seals might be happening in the other turbine units. Keller said the larger units, Turbine Units C8 to C11, are all designed the same, and the smaller units, Turbine Units C1 to C7, are all designed the same. He said Rocky Reach Dam mechanics are monitoring trunnion bushing wear in the units and Rocky Reach Dam engineers are using the information from Turbine Unit C1 and Turbine Unit C3 to evaluate the other small units. Keller said the Rocky Reach Dam engineers are also looking to refine the data on the trunnion bushings and Chelan PUD is also looking into other seal contractors, as well.

Keller said he will add Turbine Unit C3 to the regular Turbine Unit C1 updates to the HCP Coordinating Committees.

F. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said as of last month, Rock Island Dam mechanics completed the disassembly of Turbine Unit B4 and they are now developing a plan to inspect the liner. Keller said this entails accessing the discharge ring and liner to analyze what repairs are needed. He explained that the liner is the interaction point where the tips of the turbine blades meet the rest of the turbine pit. He said the unit is equipped with its original discharge ring and liner, so mechanics are investigating what is needed to uphold the integrity of these components. Keller said the return-to-service date for Turbine Unit B4 is still July 2019.

John Ferguson asked what work is planned after Turbine Unit B4? Keller said the maintenance will continue moving towards the Douglas County side of the river starting with Turbine Unit B3. He recalled Turbine Unit B4 is the closest small unit to the spillway and the first small unit in the operating sequence of Powerhouse 1.

G. Rock Island Adult Fishway Maintenance Update (Lance Keller)

Lance Keller recalled when the attraction water system valves installed in the bottom of the middle fish ladder at Rock Island Dam were inspected, mechanics found water and scouring in the gear boxes. Keller said the mechanical foreman did not have confidence to operate the ladder for the 2019 season without first repairing the valves; therefore, the valves (still under warranty) were extracted and sent to Texas for repair. Keller said the valves were received and installed and the middle fish ladder was back online on March 15, 2019. He noted that March 15, 2019, is outside the regular maintenance window of December to February, but also noted that as far as fish passage, the middle ladder is used the least compared to the right and left ladders, with the bulk of fish passage occurring through the right ladder. Keller said all fish ladders at Rock Island Dam are now fully operational.

IV. Douglas PUD

A. CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam in 2019 (Tom Kahler)

Tom Kahler said CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019. Kahler said Kirk Truscott indicated the CCT are not yet ready to vote on this request (via a phone call to Geris on March 25, 2019), and Douglas PUD is okay with postponing the vote. Kahler said a vote will be needed no later than the HCP Coordinating Committees meeting on May 28, 2019.

Kahler said Jim Craig provided USFWS approval of this request via email on March 12, 2019. Kahler said Craig also suggested developing and distributing an annual post-tagging report containing data such as how many fish were tagged and problems encountered, if any, as well as a final summary report of findings when the study concludes. Kahler said the HCP Coordinating Committees made a similar request years ago, and in 2013, Jeff Fryer (CRITFC) provided an in-person presentation to the HCP Coordinating Committees about Fryer's work in general and working with the Okanagan Nation Alliance in British Columbia towards monitoring Canadian Okanagan River sockeye salmon. Kahler said Fryer publishes reports on this work and makes them publicly available. Kahler said he will distribute recent reports by CRITFC, which summarize findings from their sockeye salmon monitoring efforts.

B. DECISION: 2019 Broodstock Collection Protocols (Tom Kahler)

Tom Kahler said the draft 2019 Broodstock Collection Protocols were distributed to the HCP Coordinating Committees by Kristi Geris on March 23, 2019. Kahler recalled the Wells HCP stipulates that the Wells HCP Coordinating Committee will review the protocols, particularly regarding trapping effects on fish passage. Kahler said there were no changes in the proposed trapping under this year's protocols compared to last year's Wells HCP Coordinating Committee-approved protocols and he is unaware of any reasons not to approve the 2019 protocols. He said once approved, the protocols will be submitted to NMFS by April 15, 2019.

John Ferguson noted that Kahler and Keely Murdoch already provided Douglas PUD and the YN approval, respectively, via the HCP Hatchery Committees and PRCC Hatchery Subcommittee approvals on March 22, 2019. Ferguson said Kirk Truscott provided CCT approval of the protocols via a phone call to Geris on March 25, 2019.

Wells HCP Coordinating Committee representatives present approved the 2019 Broodstock Collection Protocols. The Final 2019 Broodstock Collection Protocols were distributed to the HCP Coordinating Committee by Geris on March 29, 2019.

C. Wells Dam Bypass Operations Update (Tom Kahler)

Tom Kahler said Wells Dam mechanical staff are in the process of installing the bypass barriers at Wells Dam. Kahler said all barriers are in place except for one in Bypass Bay 2. He further explained that the turbine intakes and spillway intakes are staggered, and the bypass barrier for one of the intake slots for Bypass Bay 2 is not yet installed, which is located above one of the turbine unit intakes for Turbine Unit 2. Kahler clarified this is not the same as the baffles with the PIT-tag antenna, which are installed all of the time. He said bypass operations begin on April 9, 2019.

V. HCP Administration

A. 2018 HCP Annual Reports (John Ferguson)

John Ferguson said the 2018 Wells HCP Annual Report was approved by the Wells HCP Coordinating Committee on March 22, 2019, after no disapprovals were received prior to the 37-day review period deadline and edits and comments received on the report were addressed and approved by the CCT. The final report was distributed to the HCP Coordinating Committees by Kristi Geris on March 25, 2019.

Ferguson said the 2018 Rock Island and Rocky Reach HCP Annual Reports were approved by the Rock Island and Rocky Reach HCP Coordinating Committees after no disapprovals were received prior to the 30-day review period deadline on March 18, 2019. Geris said the final reports will be distributed in early April 2019. *(Note: the final 2018 Rock Island and Rocky Reach HCP Annual Reports were distributed to the HCP Coordinating Committees by Geris on April 8, 2019.)*

B. HCP Hatchery Committees Email Distribution List – Emi Kondo (Scott Carlon and John Ferguson)

John Ferguson said a request was received from Brett Farman (NMFS HCP Hatchery Committees Representative) to replace Amilee Wilson (NMFS) with Emi Kondo on the final HCP Hatchery Committees agendas and meeting minutes email distribution lists. Keely Murdoch said Wilson formerly worked on permitting for the HCP Hatchery Committees, but now Kondo does this work.

HCP Coordinating Committees representatives present agreed to add Kondo to select HCP Hatchery Committees email distribution lists.

C. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on April 23, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The May 28 and June 25, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Chad Jackson*	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation

Notes:

* Denotes HCP Coordinating Committees member or alternate

† Joined by phone

†† Joined by phone for the HCP Tributary and Hatchery Committees Update

FINAL

1201 3rd Avenue, Suite 2600
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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: May 28, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the April 23, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, April 23, 2019, from 10:00 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific lamprey at the Rocky Reach Juvenile Fish Bypass System (RRJFBS) and releasing these fish at an upstream location (Item I-C).
- Tom Kahler will distribute recent reports by the Columbia River Inter-Tribal Fish Commission (CRITFC) that summarize findings from their sockeye salmon monitoring efforts (Item I-C). *(Note: Kahler provided a CRITFC report covering 2016 and 2017 tagging efforts to Kristi Geris on May 20, 2019, which Geris distributed to the HCP Coordinating Committees that same day; the 2018 report will be available in late summer 2019.)*
- Tracy Hillman will further discuss with the HCP Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Subcommittee about combining the committees' email distribution lists and will report back to the HCP Coordinating Committees regarding the path forward (Item II-A). *(Note: Hillman provided updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists for HCP Coordinating Committees approval to Kristi Geris on May 20, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Kirk Truscott will contact Jeff Fryer (CRITFC) to obtain clarification on questions the Colville Confederated Tribes (CCT) have about CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 (Item III-A).

- Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item IV-A).
- Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item IV-A).
- Kristi Geris will coordinate with Denny Rohr (PRCC Facilitator) regarding moving the PRCC meeting on May 22, 2019 to May 29, 2019, to dovetail with the HCP Coordinating Committees meeting on May 28, 2019 (Item V-A). *(Note: Geris confirmed with Rohr via email on April 25, 2019, that the PRCC meeting on May 22, 2019 has been rescheduled to May 29, 2019.)*
- The HCP Coordinating Committees meeting on May 28, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019 (Item III-A).

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Lance Keller added: 1) Rock Island Dam 2019 Spring Spill; and 2) Subyearling Chinook Salmon Statement of Agreement (SOA)
- Ferguson added HCP Hatchery Committees and PRCC Hatchery Subcommittee Email Distribution Lists under the HCP Hatchery Committees Update

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft March 26, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. HCP Coordinating Committees members present approved the March 26, 2019 meeting minutes, as revised. The CCT and U.S. Fish and Wildlife Service (USFWS) abstained, because CCT and USFWS representatives were not present during the March 26, 2019 meeting.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on March 26, 2019, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on March 26, 2019):*

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  This action item will be carried forward.
- *Lance Keller will notify Jim Craig of what he determined about operating the weir box within the intake of Turbine Unit C1 to facilitate river flow through this area of the Intake Screen System with Turbine Unit C1 out of service during the 2019 bypass season (Item I-C).*
  Keller said he and Craig discussed this action item.
- *Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific lamprey at the RRJFBS and releasing these fish at an upstream location (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-E).*
  This will be discussed during today's meeting.
- *Tom Kahler will distribute recent reports by CRITFC that summarize findings from their sockeye salmon monitoring efforts (Item IV-A).*
  Kahler said past reports up to 2015 are available for download from CRITFC's website; however, more current reports were not available. He said he will contact Jeff Fryer to ask about more recent reports. This action item will be carried forward.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on April 17, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Marking of 2018 Brood Chiwawa/Nason Conservation Program Spring Chinook Salmon (joint)*: Recall the Chiwawa spring Chinook salmon conservation program consists of juveniles from natural-origin spawners (wild-by-wild [WxW]) and hatchery-origin spawners (hatchery-by-hatchery [HxH]). During the HCP Hatchery Committee meeting on March 11, 2019, the Rock Island HCP Hatchery Committee discussed whether all fish within the Conservation Program should be marked the same or differentially based on the origin of their parents. Following the meeting, the Joint Fisheries Parties convened and identified a possible marking strategy. The Joint Fisheries Parties proposed a second mark/tag for HxH fish within the conservation programs. Thus, HxH spring Chinook salmon within the Chiwawa Conservation Program will receive a coded wire tag (CWT) in the snout and a blank wire tag in the caudal area. WxW spring Chinook salmon in the Chiwawa Conservation Program will only receive a CWT in the snout. All conservation fish will retain the adipose (ad) fin. Only safety net program fish will be ad-clipped. Safety net program fish will also receive a CWT in the snout. Unlike the Chiwawa Conservation Program, both WxW and HxH Nason Creek conservation fish will receive a double tag; WxW spring Chinook salmon will receive a CWT in the snout and a blank wire tag in the dorsal area, and HxH spring Chinook salmon will also receive a CWT in the snout and a blank wire tag in the caudal area. Thus, all release groups and crosses will be uniquely marked. The Rock Island HCP Hatchery Committee approved the marking strategy provided Grant PUD approves the strategy for the Nason Creek programs.
- *Broodstock Collection Protocols Timeline (joint)*: The 2019 Broodstock Collection Protocols are now complete, and the HCP Hatchery Committees and PRCC Hatchery Subcommittee are now planning for the next protocols, including beginning the process of updating the protocols in September. This will allow the Committees time to identify major program changes that require extensive review and approval by the Committees (e.g., through an SOA) versus issues that can simply be addressed within the protocols document. In addition, the Committees will identify members who can help develop different sections of the Broodstock Collection Protocols. Historically, the protocols have been written by Washington Department of Fish and Wildlife, and this will allow all Committees members to contribute, including the PUDs.

Additionally, an earlier start on the protocols should reduce the time needed to review and discuss protocol changes in the new year.

- *National Marine Fisheries Service (NMFS) Consultation Update (joint)*: NMFS recently requested public comment on the Draft Environmental Assessment for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs and their associated Hatchery and Genetics Management Plans. Comments on these documents are due to NMFS on May 2, 2019. Permits for the unlisted Chinook salmon programs are under review by General Council. Kirk Truscott asked if NMFS provided an update on the release of the steelhead permits. Hillman said they did not, and he thinks the last update provided was that NMFS was unsure about the release timing of the permits.
- *Joint Meetings of the HCP Hatchery Committees and PRCC Hatchery Subcommittee (joint)*: The HCP Hatchery Committees are reviewing their email distribution lists. Hillman said logistically, it would be easiest to distribute a single email to both the HCP Hatchery Committees and PRCC Hatchery Subcommittee, as opposed to separate emails to each respective committee, which would also reduce duplicative emails to members on multiple lists. He said some people on the PRCC Hatchery Subcommittee email lists are not currently on the HCP lists and vice versa. He said he believes it is important to develop two lists; one list to receive all materials (draft and final) and one list for final materials only. He suggested the HCP Hatchery Committees develop these lists for HCP Coordinating Committees review, including justification for why non-Committees members are included on the lists. He suggested that Grant PUD representatives are to be included on the all materials list. John Ferguson said he liked the idea of the HCP Hatchery Committees vetting the lists carefully and bringing the lists to the HCP Coordinating Committees for review. Ferguson said since this is a question about adding Grant PUD staff to HCP lists and there are no Grant PUD members on the HCP Coordinating Committees, he suggested that Hillman as Chair of the HCP Hatchery Committees bring this request forward for review. Truscott said the CCT approves of this approach or would also accept a memorandum from the HCP Hatchery Committees as a whole. Hillman noted that the HCP Hatchery Committees have not yet heard back from Grant PUD about whether Grant PUD wants PRCC Hatchery Subcommittee products distributed to the HCP distribution lists; therefore, it is still unclear if merging the lists will actually happen. Hillman said he will further discuss combining the committees' email distribution lists with the HCP Hatchery Committees and PRCC Hatchery Subcommittee and will report back to the HCP Coordinating Committees regarding the path forward. *(Note: Hillman provided updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists for HCP Coordinating Committees approval to Kristi Geris on May 20, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on May 15, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on April 11, 2019:

- *Upper Kahler Stream and Floodplain Enhancement Project*: Recall this General Salmon Habitat Program proposal has been under discussion since 2018. The project is on Nason Creek. The Rock Island HCP Tributary Committee agreed to fund the four large wood structures associated with the project, which was submitted by the Yakama Nation (YN). During the HCP Tributary Committees meeting on March 14, 2019, the Rock Island HCP Tributary Committee indicated they would not fund any actions associated with filling the avulsion channel. The Rock Island HCP Tributary Committee asked the YN to provide a detailed budget for the construction of the four large wood structures within Nason Creek. On April 1, 2019, the YN provided a revised budget for the construction of the four wood structures within Nason Creek. After review, the Rock Island HCP Tributary Committee approved the budget for $149,000.
- *Evaluating Environmental Impacts of Tumwater Dam*: The HCP Tributary Committees received a General Salmon Habitat Program proposal from Cascade Columbia Fisheries Enhancement Group titled, "Evaluating Environmental Impacts of Tumwater Dam." The purpose of the project is to evaluate how Tumwater Dam affects water quality and habitat forming processes. Specifically, the project will: 1) quantify the difference between existing and historical habitat conditions within the vicinity of the dam and Lake Jolanda; 2) evaluate how water quality (e.g., temperature and dissolved oxygen) in Lake Jolanda may affect fish migration and behavior; 3) quantify and classify sediments stored behind Tumwater Dam; 4) test sediment behind Tumwater Dam for toxins or heavy metals; and 5) evaluate hydraulics and slope stability of Highway 2 and Lake Jolanda shorelines within a dam removal scenario. The total cost of the project is $279,600. The sponsor requested $139,800 from HCP Plan Species Account Funds. After careful review, the HCP Tributary Committees elected to not fund the assessment. Although the HCP Tributary Committees see value in better understanding entrance efficiency, thermal regimes, and sediments, the HCP Tributary Committees believe the cost of the proposed work is too expensive and noted that results from the work will not be compelling enough to lead to dam removal in the near future. Much of this work would need to be repeated in the future should dam removal ever be considered. Furthermore, the effects of Tumwater Dam on fish have not been identified as important data gaps by the Regional Technical Team, nor is Tumwater Canyon (middle Wenatchee) a priority area for restoration.
- *East Fork Mission Creek Floodplain Restoration*: In March 2019, the HCP Tributary Committees received a Small Project proposal from Chelan County Natural Resource Department (CCNRD) titled, "East Fork Mission Creek Floodplain Restoration Project." The purpose of this project is to develop permit-ready designs that will result in improved base flows in the Mission Creek watershed by reconnecting floodplain in a severely incised system and improve habitat for steelhead. CCNRD intends to accomplish this by removing an eroding road prism located

within the floodplain, adding in-stream wood, and addressing potential passage barriers. The project is located along a 2.8-mile stretch of East Fork Mission Creek in the upper Mission Creek watershed. The total cost of the design project is $96,169. CCNRD requested $74,669 from HCP Plan Species Account Funds. During the HCP Tributary Committees meeting on March 14, 2019, the HCP Tributary Committees were unable to make a funding decision because it was unknown whether the U.S. Forest Service (USFS) road is officially and permanently closed. On March 27, 2019, CCNRD informed the HCP Tributary Committees the road is not officially and permanently closed. Based on this information, the HCP Tributary Committees elected to not fund the project. The HCP Tributary Committees indicated they would reconsider the proposal if the road is officially and permanently closed, and an upland trail is constructed. Jim Craig asked if there is any desire by USFS to close this road. Hillman said his understanding is there is not because the road is used by recreational vehicles. He said, however, USFS is interested in building a new trail for recreational vehicle use upland of the existing road and proposed project area so USFS can remove the existing road. Craig asked if there is movement to build the trail. Hillman said yes, the project sponsor is currently seeking a cost share or separate funding to complete this work. He said once the new trail is built and the existing road is closed, the HCP Tributary Committees will reconsider funding this project.

- *Coordination with the U.S. Bureau of Reclamation on the Sugar Levee Project*: The U.S. Bureau of Reclamation (Reclamation) met with the HCP Tributary Committees to discuss a cooperative relationship between Reclamation and the HCP Tributary Committees on the Sugar Levee Project. The purpose of the project is to evaluate removal or breaching of the Sugar Levee, which is located near river mile 42.2 in the Middle Reach of the Methow River just upstream from the Town of Twisp. This project will reconnect side channels and more than 17 acres of floodplain habitat. This project was identified as a possible targeted project by the HCP Tributary Committees. Following the meeting with Reclamation, the HCP Tributary Committees agreed to work with Reclamation on developing the Sugar Levee Enhancement Project. Importantly, the relationship allows any party to exit the process at any time if the party sees the process going in the wrong direction. Ferguson asked what this partnership means? Hillman said this means HCP Tributary Committees members will be participating in meetings with Reclamation on behalf of the HCP Tributary Committees. He explained that Reclamation is identifying target project areas similar to what the HCP Tributary Committees are doing, and Sugar Levee is a common target between the two. He said Reclamation will take the lead on moving this project forward and at some point, Reclamation will not have the resources to move the project forward; therefore, Reclamation needs a funding partner. He said Reclamation distributed a request for proposals to design the project and develop alternatives for removing the levee, which is where the HCP Tributary Committees come in. He said Reclamation also has technical services in Colorado to complete the modeling work at no cost to the HCP Tributary Committees. He said the HCP Tributary Committees indicated interest in being involved in every step of the process and the Committees can provide funding to help move the project forward; however, if the HCP Tributary Committees believe the process is headed in the wrong direction the Committees have the option to opt out. He said Reclamation is doing most of the planning and modeling, while the HCP Tributary Committees would help with the design and provide funding.

- *Review of the YN Draft SOA*: On February 25, 2019, the YN submitted a draft SOA to the HCP Tributary Committees for review. The purpose of the draft SOA is to provide a basis for decision-making in the HCP Tributary Committees. The YN asked members to review the draft SOA, edit it as necessary, and vote on it during the HCP Tributary Committees meeting on April 11, 2019. Because no edits were offered prior to or during the meeting on April 11, 2019, Hillman asked each member to vote on the existing SOA and provide their reasons for their yes or no vote. All members except the YN voted no on the SOA. The primary reason given for members' lack of support for the SOA was because members found no need for an SOA, especially given the recent and ongoing development of evaluation criteria. Some noted the SOA is too restrictive and others suggested the SOA does not address the underlying issue between the YN and the CCT. The CCT voted no because the CCT cannot support an SOA that removes their right to prevent the YN from owning property in the Upper Columbia River Basin. The YN are currently evaluating whether they will dispute the decision by the HCP Tributary Committees. Ferguson asked Tom Kahler and Keely Murdoch if Douglas PUD or the YN, respectively, have updates to add. Kahler and Murdoch said they have nothing further to add.
- *Review of Section 5 of the Policies and Procedures Document*: During the HCP Tributary Committees meeting on March 14, 2019, the HCP Tributary Committees directed Hillman to add the evaluation criteria into Section 5 of the Policies and Procedures for Funding Projects document. Hillman added the criteria to Section 5 and the HCP Tributary Committees reviewed and edited the criteria. After discussion, the HCP Tributary Committees approved the revisions to Section 5 of the Policies and Procedures document.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on Wednesday, May 8, 2019 (rather than the typical second Thursday of the month) because the HCP Tributary Committees will be reviewing approximately 15 to 20 draft Salmon Recovery Funding Board and HCP Tributary Committees proposals. Hillman said the proposals will be evaluated as fundable or not fundable. He said for fundable proposals, the HCP Tributary Committees will ask sponsors to submit a final proposal to be evaluated in July 2019.

III. Douglas PUD

A. CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam in 2019 (Tom Kahler)

John Ferguson recalled CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019. Ferguson also recalled that Kirk Truscott requested additional time before voting to address a few questions he had about the request.

Truscott said he has not yet addressed these questions. He said he knows a decision is needed by May 2019 and he hopes to be ready to vote before this time. Tom Kahler asked if there is anything Douglas PUD can do to help address these questions. Truscott said no; rather, he needs to coordinate with Jeff Fryer to obtain clarification on a few details. Truscott said the request does not specify what will be used to anesthetize the fish. Keely Murdoch said she believes Aqui-S will be used similar to last year. Truscott said he also has a preference on tag location (i.e., what part of the fish will be tagged). He said a portion of the sockeye salmon run is already receiving tags at Bonneville Dam. He said the less these fish are handled the better. He said CRITFC's request also indicates that sampling will be coordinated with brood collection, and he wants to verify this means trapping will be conducted concurrent with the other collection efforts.

Truscott said he will contact Fryer to obtain clarification on questions the CCT have about CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019. Ferguson suggested that Truscott email the HCP Coordinating Committees with the responses to these questions once obtained and before the HCP Coordinating Committees meeting on May 28, 2019.

B. Wells Dam Bypass Operations Update (Tom Kahler)

Tom Kahler said an email about bypass operations at Wells Dam was distributed to the HCP Coordinating Committees by Kristi Geris on April 10, 2019.

Kahler said when bypass operations started at Wells Dam (on April 9, 2019 at 00:00 hours), Douglas PUD was in the process of recommissioning Turbine Unit 2, which had been offline for a unit overhaul; therefore, Spillway 2 remained offline. He said additionally, per the Wells Dam 2019 Bypass Operating Plan, a turbine cannot be operated without an adjacent bypass unit operating, which means while Spillway 2 is not in operation, Turbine Unit 1 also cannot be in operation. He said because the barriers for a bypass sit on top of the turbine intake bulkheads, recommissioning a turbine unit requires a labor-intensive process involving removing the bulkheads, installing the trash racks, and reinstalling the bypass barriers back on top of the trash racks. He said crews completed this process for Turbine Unit 2, the unit was reset to re-water, and commissioning of Spillway 2 was initiated; but then a contractor removed a pipe and underestimated the pressure of the water inside, which ultimately flooded Turbine Units 1, 2, and 3. Kahler said, therefore, commissioning of Turbine Unit 2 was halted, and Turbine Unit 1 remained offline. He said Spillway 2 finally resumed operation on April 22, 2019, and Turbine Unit 1 is now also online. He said Spillway 4 was taken offline today, April 23, 2019 (because the rebuild of Turbine Unit 3 began). He said Turbine Units 3 and 4 will remain offline until the trash racks and bulkheads are swapped in the intakes of Turbine Unit 3 and the bypass barriers are reinstalled. He said then Turbine Unit 4 and Spillway 4 will resume operation, and Turbine Unit 3 will remain offline until completion of the rebuild.

Kirk Truscott asked how long Spillway 2 was offline. Kahler said the spillway was on and off over one weekend. Truscott noted that Spillway 2 is the bay with the PIT-tag array where the HCP Coordinating Committees are hoping to collect data on emigration timing of early yearling spring Chinook salmon. Kahler said yes, this was unfortunately a lost data opportunity. Truscott asked why this rebuild and recommissioning of Turbine Unit 2 was not scheduled to be complete prior to the fish passage season. He said these types of setbacks do not sit well with him in that it seems fish are an afterthought in scheduling. Kahler said the schedule was to have Turbine Unit 2 operational by the end of 2018, but things went wrong on the contractors' side that resulted in unexpected delays. He said this was a complete overhaul, which typically requires an 18-month schedule. Truscott said this is unfortunate and asked if there is any way to prevent this from happening in the future. He asked if this is a 20-year contract to rebuild the entire system, and Kahler replied yes.

Kahler said another challenge is that the Wells Project Chief Engineer, Ken Pflueger, who was on staff for over 30 years retired last fall. Kahler said Pflueger was a contractor/consultant working on projects associated with Wells Dam before joining Douglas PUD and was an excellent nexus between Natural Resource staff, contractors, and dam operations. Kahler said Pflueger was an advocate for natural resources, was great at anticipating conflicts between contracts and operations, and understood compliance with the Federal Energy Regulatory Commission and total dissolved gas requirements. Kahler said since Pflueger retired, the importance of his role in the seamless consideration of fish in project operations has become apparent, and Natural Resource staff are working to establish necessary coordination with dam operations regarding operations with potential to affect compliance with agreements. He added that every turbine unit is taken offline at least once every 2 years for biannual maintenance, in addition to any units removed from service for overhauling. He said so long as Natural Resource staff are involved in these conversations, they can have influence, which has been done in the past. Truscott noted that it is a big deal to have all spillways online as required by the Wells HCP. Kahler said at least four of five spillways have been in operation during this bypass season, which is consistent with Section 4.3 of the Wells HCP. He said Spillway 2 where the PIT-tag antenna is located is the only spillway that was not in operation. Truscott said this is what is frustrating; that the HCP Coordinating Committees discussed and planned using this location to collect data on early emigrating yearling spring Chinook salmon and the data were missed. Kahler said some data were collected. He said fish can swim into this area in the forebay even though water is not flowing through the spillway or associated unit. He said he plans to develop event logs and asked when the CCT started releasing subyearlings. Truscott said April 15, 2019. Kahler said there were detections of Omak and Similkameen fish last week.

IV. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said the disassembly of Turbine Unit C1 is progressing as planned. He said the runner and hub might be removed by now or mechanics are very close to doing so, which will allow access to the trunnion seals.

Keller said Rocky Reach Dam mechanical staff are still working with engineers to develop a solution for Turbine Unit C3. He said hydraulically locking the blades into place via governor control or manufacturing new trunnion seals are all still being considered. He recalled discussing during the last HCP Coordinating Committees meeting on March 26, 2019, that the engineered seals designed for Turbine Unit C1 were installed in Turbine Unit C3 and did not work, and Chelan PUD may try another contactor who has previously completed work and provided seals for units at Rock Island Dam. Keller said the path forward for Turbine Unit C3 will not affect the repair schedule for Turbine Unit C1.

Kirk Truscott said he reviewed the meeting minutes from the HCP Coordinating Committees meeting on March 26, 2019, and he reviewed the report by Drs. John Skalski and Richard Townsend (Columbia Basin Research) titled, "Projections of Joint Juvenile/Adult Survival Performance at Rocky Reach Dam under Alternative Juvenile Passage Distributions," (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris on April 5, 2019. Truscott asked about the rationale behind the three scenarios selected to assess survival. Keller said these scenarios were developed to help think about how decreased juvenile yearling Chinook salmon passage via Turbine Unit C3 and the bypass screens (Turbine Unit C1) might translate into changes in juvenile project survival estimates and ultimately the 91% combined juvenile/adult survival metric for Plan Species outlined in the Rocky Reach HCP. Truscott asked how the values 2.5%, 5.0%, and 7.5% were selected (the three scenarios modeled included rerouting 50% of the fish that passed via the bypass screens and 2.5%, 5.0%, or 7.5% of the fish that passed via the surface collector (SC) through the powerhouse and estimating project survival accordingly). Keller said these values were selected after internally discussing and judging the potential decrease in bypass passage routes and attraction flow in the cul-de-sac area with Turbine Units C1 and C3 offline while also considering the modified bypass operations to increase flow through the area, including the following:

Normal Operations (Turbine Units C1 and C3 online)	Modified Operations (Turbine Units C1 and C3 offline)
Individual Fish Passage Routes	
3 turbine routes (via Turbine Units C1, C2, and C3)	1 turbine route (via Turbine Unit C2)
2 bypass screen routes (via Turbine Units C1 and C2)	1 bypass screen route (via Turbine Unit C2)
2 bypass entrance routes (via two entrances to SC)	2 bypass entrance routes (via two entrances to SC)
Considerations	
7 passage routes total	4 passage routes total + 3 additional RRJFBS SC pumps to increase attraction flow from 6 to 6.66 kcfs into the RRJFBS SC entrances (3.33 kcfs on each side) + Increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12.2 kcfs to a soft-limit flow of 15.2 kcfs

Keller said with these considerations, Chelan PUD wanted to know what decrease in survival could possibly result should bypass system fish collection decrease with Turbine Units C1 and C3 not operating. He said Skalski took nautical day and night passage proportions and route specific survivals and applied them to day and night dam survival and then project survival, and those were then multiplied by the specific annual observed adult survival to calculate the combined adult and juvenile survival. Keller said Skalski also included confidence intervals around these results.

Truscott said he is concerned about the attraction flow through the cul-de-sac area. He asked, for example, what if there is a 25%, 40%, or 85% reduction in attraction flow? He asked what can the HCP Coordinating Committees do, notably when turbine units are offline and there is no option to spill. He asked if there is a way to provide additional flow into this area. He also asked if there is a certain amount of flow Chelan PUD is trying to replace. Keller said with Turbine Units C1 and C3 offline and with the modified operations in place, attraction flow into the cul-de-sac area will essentially be reduced by approximately 10,000 cubic feet per second (10 kcfs) compared to normal operations. He added that it is convenient that this issue is occurring during a low flow year. Truscott said his concern is that 40% of fish pass Rocky Reach Dam via the cul-de-sac area and it is important to make sure these fish get there. He added that one could suggest having 30% less attraction flow might translate into 30% less fish passing there. John Ferguson pointed out flow into the bypass is now a much greater proportion of flow passing through Turbine Units C1 to C3 (i.e., bypass flow is competing with flow going into one unit not three). Truscott agreed but indicated his concern is whether fish are being attracted to the cul-de-sac area. Keller said Chelan PUD would take a closer look into attraction flow in the cul-de-sac area. Truscott said he will also contact Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance.

Ferguson asked if Chelan PUD chooses to hydraulically lock the blades into place as the preferred path forward for Turbine Unit C3, what input is needed from the HCP Coordinating Committees. He asked if the HCP Coordinating Committees need to suggest a particular efficiency setting to maximize survival through the turbine unit. Keller said it is desirable to operate the unit near peak efficiency to avoid wear and tear. He said a unit will run rough until it reaches a setpoint. Jim Craig added that running a unit below peak efficiency will cause cavitation. Keller agreed and added that the way turbine units are designed, the more efficient a unit operates (less cavitation) the better that is for the unit and fish passing through the unit. Truscott said if Turbine Unit C3 comes off and on for load, this could result in operating the unit inefficiently as it ramps up from a dead stop. Keller said he believes if the Turbine Unit C3 blades are hydraulically locked at a fixed point, the unit will be turned on and operated for an extended period of time to reduce starts and stops. He said the unit would be given a hard setpoint based on the blade angle and efficiency curve, which are based on the forebay elevation, and the other turbine units would be adjusted as needed. He added that given the low snowpack estimates for 2019 to date, as well as the fact that Turbine Unit C3 is the next unit to sequentially operate behind Turbine Unit C2, if Turbine Unit C3 were to shut down due to decreased flows, Turbine Unit C2 would be the only operating unit in the Rocky Reach Dam powerhouse (Turbine Unit C2 is the first unit on and last unit off). He said at this point, he believes the most appropriate action item is to provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available.

Tom Kahler asked when Turbine Unit C1 will be returned to service. Keller said August 2019, so the unit will be back online for the 2020 juvenile fish bypass season. Kahler summarized that Turbine Unit C1 will be back in operation in 2020 along with Turbine Unit C2, and Chelan PUD is unsure about Turbine Unit C3? Keller said this is currently correct.

B. Rock Island Dam 2019 Spring Spill (Lance Keller)

Lance Keller said an email notification that spring fish spill was initiated at Rock Island Dam on April 17, 2019, at 00:00 hours was distributed to the HCP Coordinating Committees by Kristi Geris on April 18, 2019. Keller said Chelan PUD monitored the daily index counts at the Rock Island Dam Juvenile Fish Bypass Trap and as of April 16, 2019, Program RealTime indicated all passage estimates for juvenile yearling Chinook salmon, sockeye salmon, and steelhead had remained below 1.0%. He said based on these data, Chelan PUD did not see a need to initiate spill before April 17, 2019, to meet the 95% spill coverage target for spring migrating HCP Plan Species at Rock Island Dam.

Keller said Rock Island Dam will transition from spring to summer spill when subyearlings detections begin at the dam.

C. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam mechanics continue to work on the liner in Turbine Unit B4. Keller said the plan is to reuse or repair the liner currently installed in the unit. He said the return-to-service date for Turbine Unit B4 is still July 31, 2019.

D. Subyearling Chinook Salmon SOA (Lance Keller)

Lance Keller said Chelan PUD's current SOA maintaining Rock Island and Rocky Reach subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for up to 3 years expires on September 29, 2019, and Keller said he believes Grant PUD may have a similar agreement in place.

Keller recalled in 2016, the HCP Coordinating Committees and PRCC convened a Subyearling Chinook Salmon Passage Survival Workshop in SeaTac, Washington. He said attendees included various agencies and speakers included Grant, Chelan, and Douglas PUDs, and Dr. John Skalski, among others. Keller said topics and presentations addressed the feasibility of conducting subyearling studies, including discussion on life history, tag technology, and statistical analyses. He said at that time, largely due to subyearlings having varying life history, lack of tag technology, and Skalski's findings, it was concluded that conducting subyearling studies in the Rock Island and Rocky Reach projects was not feasible. He said based on these findings, the Rock Island and Rocky Reach HCP Coordinating Committees approved the SOA maintaining Rock Island and Rocky Reach subyearling Chinook salmon in Phase III (Additional Juvenile Studies) on September 29, 2016.

Keller said to his knowledge, there are now tags available that are smaller in size, but the battery life is still comparable and remains an issue, and Skalski's calculation capability remains the same. Keller said Chelan PUD may propose another SOA maintaining Rock Island and Rocky Reach subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years, perhaps coupled with an updated presentation from Skalski.

Tom Kahler said there is still the fundamental problem of the inability to distinguish mortalities from non-migrants. Keller agreed and said a battery with a much longer lifespan than what is currently available is needed to conduct a project-scale study. Kahler said additionally, fish are not migrating, and the HCPs specify studying migrants. He said the hope was to identify migrants based on characteristics, but this has not yet been accomplished.

Kahler also noted that the long-awaited Douglas PUD subyearling report is currently being tech edited and should be available soon. He said the report evolved into something much more than what Douglas PUD was presenting annually during the study, including more analyses. He said the report should be useful for everyone.

Jim Craig said it is beneficial to rehash the ability to study subyearlings every so often. Keller agreed and said there is language in Chelan PUD's current SOA to provide quarterly updates; however, after no changes happened during the first few quarters no further updates were provided or requested by the HCP Coordinating Committee. He said if there is another 3-year SOA, Chelan PUD will be sure to add subyearlings to the agenda each quarter.

John Ferguson suggested adding subyearling Chinook salmon to each agenda through September 2019 to continue this discussion and keep reviewing information as it becomes available. He said this information may include a new SOA from Chelan PUD, the Douglas PUD subyearling report, perhaps a presentation of the data, and possibly a presentation by Skalski. Ferguson said the meeting minutes will then document what the HCP Coordinating Committees discussed and reviewed. He said Chelan PUD can then take this documentation and perhaps include a bulleted list of activities in the background of an SOA and reference documents.

Kirk Truscott said besides the tagging effort conducted by Douglas PUD, there have been no additional studies. Truscott said the CCT are perplexed that subyearlings are being tagged at Gebbers Landing and there are no adults being detected at Bonneville Dam, but there are recaptures of juveniles at detection locations. He said this indicates the fish are moving. He said Douglas PUD conducted tagging efforts from 2011 to 2013 and the CCT have been conducting tagging efforts since 2014, and at some point, someone is going to ask why subyearling Chinook salmon have been maintained in Phase III for 12 years and no studies have been conducted. He said his question is, where are these fish going?

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on May 28, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

HCP Coordinating Committees members who are also members on the PRCC noted that as the calendar falls in May 2019, the PRCC meeting is scheduled 1 week prior to the next HCP Coordinating Committees meeting instead of the day after. Kristi Geris said she will coordinate with Denny Rohr regarding moving the PRCC meeting on May 22, 2019, to May 29, 2019, to dovetail with the HCP Coordinating Committees meeting on May 28, 2019. *(Note: Geris confirmed with Rohr via email on April 25, 2019, that the PRCC meeting on May 22, 2019, has been rescheduled to May 29, 2019.)*

The June 25 and July 23, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Projections of Joint Juvenile/Adult Survival Performance at Rocky Reach Dam under Alternative Juvenile Passage Distributions

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

Attachment B

COLUMBIA BASIN RESEARCH

Projections of Joint Juvenile/Adult Survival Performance at Rocky Reach Dam under Alternative Juvenile Passage Distributions

14 March 2019

TO: LANCE KELLER
PUD No. 1 of Chelan County
P.O. Box 1231, Wenatchee, Washington 98801

FROM: JOHN R. SKALSKI AND RICHARD L. TOWNSEND
Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington
1325 Fourth Avenue, Suite 1515, Seattle, Washington 98101-2540

1 Introduction

This report summarizes the results of projections of joint juvenile/adult survival values at Rocky Reach Dam under alternative juvenile passage distribution. Using either the 2010 or 2011 acoustic tag data on route-specific yearling Chinook salmon passage proportions and survival (Skalski et al. 2011, 2012), estimates of dam passage survival were recalculated based on three alternative redistribution scenarios. Those three scenarios were as follows:

- Scenario 1. Reroute 50% of the fish that passed via the bypass screens and 2.5% of the fish that passed via the surface collector and route them through the powerhouse and apply average survival of units 1–11 to those fish. Calculate new project survival for each year and standard error.
- Scenario 2. Reroute 50% of the fish that passed via the bypass screens and 5.0% of the fish that passed via the surface collector and route them through the powerhouse and apply average survival of units 1–11 to those fish. Calculate new project survival for each year and standard error.
- Scenario 3. Reroute 50% of the fish that passed via the bypass screens and 7.5% of the fish that passed via the surface collector and route them through the powerhouse and apply average survival of units 1–11 to those fish. Calculate new project survival for each year and standard error.

Dam passage survival was calculated as the route-specific survival values weighted by the route specific passage proportions (Appendix A). Estimates of dam passage survival were calculated separately for day and night and then the values weighted by diel passage proportions (Appendix A). Finally, the joint juvenile/adult survival values were calculated as the product

$$\overset{\circ}{S} = \hat{S}_{\text{DAM}} \cdot \hat{S}_{\text{POOL}} \cdot \hat{S}_{\text{ADULT}}$$

where in both years $\hat{S}_{\text{ADULT}} = 0.999$ ($\widehat{SE} = 0.06$). The adult survival value is based on a conversion rate/survival estimates from the years 2009–2011 (Buchanan and Skalski 2011).

Appendix A defines the formula used to calculate dam passage survival under different redistribution scenarios. Appendix B has the yearling-specific juvenile passage data used in the calculations.

2 Results

The HCP specifies a combined adult juvenile survival benchmark of 0.91. The observed value of dam passage survival in 2010 (i.e., 0.9304) was lower than in 2011 (i.e., 0.9642) (Table 1). Shifting fish distributions from high survival routes (i.e., bypass, spill) to lower survival routes (i.e., powerhouse) uniformly results in lower projected values of dam passage survival in all circumstances (Table 1).

Combining the projected estimates of dam passage survival with pool passage survival and the adult survival, the resulting estimates of joint juvenile/adult survival for yearling Chinook salmon remain ≥ 0.91 under all circumstances (Table 2).

Table 1. Projected values of yearling Chinook salmon juvenile survival ($\hat{S}_{\mathrm{DAM}}$) at Rocky Reach Dam for the years 2010 and 2011 for the three alternative redistribution scenarios.

	Year	
Scenario	2010	2011
Actual annual estimate	0.9304 (0.0088)	0.9642 (0.0091)
Scenario number one	0.9225 (0.0103)	0.9593 (0.0175)
Scenario number two	0.9203 (0.0107)	0.9578 (0.0182)
Scenario number three	0.9181 (0.0112)	0.9563 (0.0188)

Table 2. Projected values of joint juvenile/adult survival ($\hat{S}_o$) for the three alternative redistributions of passage proportions using either 2010 or 2011 year-specific acoustic tag information

	Year	
Scenario	2010	2011
Actual annual estimate	0.9241 (0.0573)	0.9285 (0.0566)
Scenario number one	0.9162 (0.0584)	0.9237 (0.0594)
Scenario number two	0.9140 (0.0583)	0.9223 (0.0595)
Scenario number three	0.9119 (0.0582)	0.9209 (0.0596)

3 Discussion

The results suggest the estimate of joint juvenile/adult survival is rather robust to year effects and the three scenarios we examined. In all six cases examined, the projections remained above 0.91.

Appendix A

Formula used to project dam passage survival for yearling Chinook salmon under alternative redistribution scenarios

$$\hat{S}_{\mathrm{DAM}} = p_D \left[\begin{array}{l} S_{SC}(p_{SC} - \mathbf{\Delta}_{SC}) + S_{BY}\, p_{BY}(1 - \mathbf{\Delta}_{BY}) \\ + \left(\dfrac{2S_{1-2} + 9S_{3-11}}{11} \right) (p_{1-2} + p_{3-11} + \mathbf{\Delta}_{SC} + p_{BY}(1 - \mathbf{\Delta}_{BY}) \end{array} \right]$$

$$+ pN \left[\begin{array}{l} S_{SC}(p_{SC} - \mathbf{\Delta}_{SC}) + S_{BY}\, p_{BY}(1 - \mathbf{\Delta}_{BY}) \\ + \left(\dfrac{2S_{1-2} + 9S_{3-11}}{11} \right) (p_{1-2} + p_{3-11} + \mathbf{\Delta}_{SC} + p_{BY}(1 - \mathbf{\Delta}_{BY}) \end{array} \right]$$

where $\rho_D = 1 - \rho_N$ = proportion of fish passing through the dam during daytime,

S_{SC} = survival probability through surface collector,

S_{BY} = survival probability through bypass,

S_{SP} = survival probability through spillway,

S_{1-2} = survival probability through turbine units 1– 2,

S_{3-11} = survival probability through turbine units 3–11,

p_{SC} = proportion of fish passing through surface collector,

p_{BY} = proportion of fish passing through bypass,

p_{SP} = proportion of fish passing through spillway,

p_{1-2} = proportion of fish passing through turbine units 1–2,

p_{3-11} = proportion of fish passing through turbine units 3–11,

Δ_{SC} = proportion of fish in surface collector shifted to units 1–11,

Δ_{BY} = proportion of fish in bypass collector shifted to units 1–11.

Appendix B

Route-specific passage proportions and survival for juvenile yearling Chinook salmon at Rocky Reach Dam, 2010–2011

Table B1. Estimates of acoustic-tagged yearling Chinook salmon passage proportions at Rocky Reach Dam during nautical day and night periods in 2010. Standard errors in parentheses.

	Passage proportions	
Route	Nautical day	Nautical night
Surface collector	0.4262 (0.0224)	0.6000 (0.0316)
Bypass screens	0.0676 (0.0114)	0.0208 (0.0092)
Units 1–2	0.1906 (0.0178)	0.0833 (0.0178)
Units 3–11	0.3156 (0.0210)	0.2958 (0.0295)

Table B2. Estimates of route-specific survival at Rocky Reach for yearling Chinook salmon during nautical day and night periods in 2010. Standard errors in parentheses.

	Absolute survival	
Parameter	Nautical day	Nautical night
$S_{\text{Surface collector}}$	0.9685 (0.0091)	0.9685
$S_{\text{Bypass screens}}$	0.9231 (0.0424)	0.9891 (0.0152)
$S_{\text{Units 1–2}}$	0.9192 (0.0276)	0.8902 (0.0677)
$S_{\text{Units 3–11}}$	0.8359 (0.0301)	0.9194 (0.0332)

Table B3. Estimates of acoustic-tagged yearling Chinook salmon passage proportions at Rocky Reach Dam during day and night periods in 2011. Standard errors in parentheses

	Passage proportions	
Route	Nautical day	Nautical night
Surface collector	0.3800 (0.0224)	0.2229 (0.0222)
Bypass screens	0.0510 (0.0101)	0.0657 (0.0132)
Units 1–2	0.0488 (0.0099)	0.0657 (0.0132)
Units 3–11	0.4777 (0.0230)	0.5857 (0.0263)
Spillway	0.0425 (0.0093)	0.0600 (0.0127)

Table B4. Estimates of route-specific survival at Rocky Reach for yearling Chinook salmon during day and night periods in 2011. Standard errors in parentheses.

	Absolute survival	
Parameter	Nautical day	Nautical night
$S_{\text{Surface collector}}$	0.9976 (0.0053)	0.9974
$S_{\text{Bypass screens}}$	1.0146 (0.0113)	1.0106 (0.0141)
$S_{\text{Units 1–2}}$	0.9264 (0.0605)	0.8788 (0.0720)
$S_{\text{Units 3–11}}$	0.9469 (0.0199)	0.9464 (0.0216)
S_{Spillway}	1.0146 (0.0113)	1.0106 (0.0141)

Table B5. Day (p_D) and (p_N) passage proportions and pool survival for year 2010 and 2011 for yearling Chinook salmon.

Year	p_D	p_N	S_{POOL}
2010	0.52	0.48	0.9942
2011	0.409	0.591	0.9639

Literature Cited

Buchanan, R., and J. Skalski. 2011. Estimation of adult salmon and steelhead conversion rates through Rocky Reach project, 2009–20011. Prepared for Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Skalski, J. R., R. L. Townsend, T. W. Steig, and P. A. Nealson. 2011. Survival, diel passage, and migration dynamics of yearling Chinook salmon smolts at Rocky Reach Dam in 2010. Prepared for Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Skalski, J. R., R. L. Townsend, T. W. Steig, and P. A. Nealson. 2012. Survival, diel passage, and migration dynamics of yearling Chinook salmon smolts at Rocky Reach Dam in 2011. Prepared for Public Utility District No. 1 of Chelan County, Wenatchee, WA.

DRAFT

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: June 25, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the May 28, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, May 28, 2019, from 10:00 a.m. to 12:45 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item II-C).
- Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item II-C).
- Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item II-C).
- Anchor QEA, LLC, will contact Jim Craig to obtain U.S. Fish and Wildlife Service (USFWS) approval of the updated HCP Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Subcommittee email distribution lists (Item III-A). *(Note: Kristi Geris emailed Craig with this request following the meeting on May 28, 2019, and Craig provided USFWS approval of the lists via email on May 29, 2019, as distributed to the HCP Coordinating Committees by Geris that same day.)*
- The HCP Coordinating Committees will begin discussing the necessity and significance of the data behind the Columbia River Inter-Tribal Fish Commission's (CRITFC's) annual request to tag sockeye salmon at Wells Dam during the HCP Coordinating Committees meeting in December 2019 (Item IV-A). *(Note: Kristi Geris added this to the agenda for December 2019.)*

- Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item IV-B).
- The HCP Coordinating Committees meeting on June 25, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item VI-C).

Decision Summary

- HCP Coordinating Committees representatives present approved the updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists, contingent on USFWS approval of the lists (Item III-A). *(Note: Jim Craig provided USFWS approval of the lists via email on May 29, 2019.)*
- Wells HCP Coordinating Committee representatives present approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019, with the caveat that approval of the tagging will be reviewed again if low flow and warm water migration conditions develop, potentially affecting adult sockeye salmon survival (Item IV-A). *(Note: Jim Craig provided USFWS approval of this request via email on May 23, 2019.)*

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019, and is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, July 23, 2019 (Item I-A).

Finalized Documents

- There are no documents that have been recently finalized.

I. Joint HCP Coordinating Committees and PRCC

A. PRESENTATION: Douglas PUD Subyearling Chinook Salmon Report (Tom Kahler)

Tom Kahler shared a presentation titled, "Post-emergence Behavior of Subyearling Summer/Fall Chinook in Wells Reservoir and Implications for the Measurement of Passage Survival through the

Wells Hydroelectric Project" (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris following the HCP Coordinating Committees meeting on May 28, 2019.

Slide 2 of Attachment B

Kahler said this HCP Decision Flow Chart is copied from Section 14 of the Wells HCP. He said the chart indicates that if the combined adult and juvenile project survival cannot be measured for a species and a juvenile dam passage study cannot be conducted, then juvenile dam passage survival can be calculated, and the species can be designated in Phase III (Additional Juvenile Studies). He said this is what was done for subyearling Chinook salmon in 2005.[1]

Kahler recalled subyearling studies conducted by Billy Connor (USFWS) in the Snake River and other U.S. Army Corps of Engineer (USACE) subyearling studies, which prompted Douglas PUD to ask whether subyearlings in the Columbia River behave similarly as in the Snake River. Kahler said in 2009, the HCP Coordinating Committees and PRCC convened a "Subyearling Summit" and invited various guest speakers, including Connor and Eric Hockersmith (Northwest Fisheries Science Center), among others. Kahler said based on these discussions it appeared that subyearlings might be different in the upper Columbia River compared to the Snake River, so Douglas PUD decided to start studying subyearlings in the Wells Reservoir. He said PIT-tagged subyearlings were already being monitored at Rocky Reach Dam, but meaningful analysis was not possible because of the small number tagged individuals. Douglas PUD tagged additional subyearlings to add to this number.

Slides 3 to 4 of Attachment B

Kahler said the photo on slide 3 shows a mixed school of subyearlings, stickleback, and other species. He said in this particular photo, no fish were greater than 60 millimeters (mm) in length. He said several of these schools were observed in the Wells Reservoir during spring, so Douglas PUD decided to attempt a tagging effort. He said summer/fall Chinook salmon spawn in the Okanogan and Methow rivers, and near Chief Joseph Dam, among other locations, and progeny of these spawners occupy Wells Reservoir temporarily.

Slides 5 to 7 of Attachment B

Kahler said the photo on slide 5 shows a beach seining effort. He said Douglas PUD set net-pens in the river and contracted Biomark to conduct the PIT-tagging. He said a tagging station was set up on a barge that was towed to the different tagging locations. He said collected fish were placed in the net-pens overnight to empty their stomachs and were tagged into empty net-pens the next day, then released the following morning.

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[1] Per the Statement of Agreement (SOA) titled, "Wells HCP Coordinating Committee Summary Agreement Adult Fallback Studies," as approved by the Wells HCP Coordinating Committee on February 22, 2005.

Slides 8 to 10 of Attachment B

Kahler said crews attempted several seining locations in 2011. He said most of the shoreline immediately downstream of Washburn Island was too hard to seine due to high current velocity at this location near the thalweg of the river; however, the short stretch of shoreline closest to the levy was a productive location initially. He said other locations included at the mouth of the Okanogan River up to the Highway 97 bridge and Gebbers Landing, which is a high bluff with a sand and cobble beach, with little debris. He said all locations had bycatch except Gebbers Landing, and crews ended up abandoning all locations except Gebbers Landing.

Kirk Truscott asked about the species of bycatch encountered. Kahler said there were juvenile whitefish, suckers, stickleback, and pikeminnow, to name a few. Truscott asked if any steelhead were encountered. Kahler said not often, but sometimes a yearling, smolt, or triploid were encountered. He said most fish were juveniles. He said some juvenile kokanee were encountered, as well.

Kahler said crews also seined at the mouth of the Methow River; however, there was a lot of debris and high river flow. He said crews also tried downstream near Wells Dam, but never found a productive location. He said in 2012, at river left near Wells Dam, there was one location similar to Gebbers Landing in terms of beach characteristics. He said this location was productive; however, it was not as productive as Gebbers Landing. He said sampling this site resulted in a lot of tagged fish being recaptured.

Slide 11 of Attachment B

Kahler said, in summary, fish were first detected at Rocky Reach Dam about 3 to 6 days after release. He said Douglas PUD seined through the second week in July; he noted that by the end of seining, subyearlings were difficult to collect. He said the total number tagged equaled nearly 51,000 fish over the 3-year effort. He said detections at RRJ (Rocky Reach Dam Juvenile Bypass System) were fairly consistent, with the most detections occurring in 2013. He said the percent detected at RRJ ranged from approximately 6% to 11% of total tagged fish per year. He also noted the high number of unique detections when including all detection sites combined.

Andrew Gingerich said Douglas PUD also conducted scoping efforts to determine when fish were available in the Wells Reservoir each year. He said this table just summarizes what was tagged. Kahler agreed and said the tagging threshold was 60 mm. He said the contractor tagged down to 58 mm, but did not tag many at that size. He said by 2013, Douglas PUD set the lower size-at-tagging threshold firmly at 60 mm. Kahler said, as Gingerich explained, crews conducted sampling to monitor how large the fish were and when the mean fish size reached 60 mm, Biomark would come out and start tagging.

Truscott asked how the unique detections for subyearlings compared to yearling Chinook salmon. Kahler said he has not examined that comparison; however, it would be easy to do by reviewing the Wells Project 2010 Survival Verification Study.

Slides 12 to 15 of Attachment B

Kahler said again, crews started seining long before tagging was initiated. He said when sufficient numbers of taggable-sized fish were available, the tagging effort would commence. He said in 2011, tagging commenced about the third week of June. He said in 2012, tagging started 1 week later compared to the previous year because fish were too small to tag. He said in 2013, tagging started earlier because the fish sizes were similar to 2011.

Kahler said in 2014, although the Colville Confederated Tribes (CCT) took over tagging efforts this year, Douglas PUD conducted another scoping effort to collect another year of data on early season fish size and availability.

Slides 16 to 17 of Attachment B

Kahler said crews were seeing swim-up fry in May. He noted that in 2012, crews were collecting fish less than 45 mm into the second week of July and fish less than 55 mm at the end of July. He questioned where these fish came from. Truscott said mainstem fish spawn in November and December, and he asked if there were more late small fish at Washburn Island compared to Gebbers Landing. Gingerich said fish collected at Washburn Island may be from mainstem spawners. He said these fish were not available as long as at the Gebbers location. He said 2 to 3 weeks into tagging the Washburn fish were no longer available. Kahler said perhaps these could be spring Chinook salmon that have been washed out from the upper watershed.

Slides 18 to 20 of Attachment B

Kahler said in 2011, detections at downstream projects peaked a few weeks after tagging commenced. He noted the multi-modal distribution of the detection pattern continuing downstream. He said once fish reached MCN (McNary Dam), the downstream migration rate increased dramatically. He noted that fish were being detected into November at downstream projects. He said 2012 data are similar, except that the multi-modality pattern at RRJ turned into a bimodal distribution at downstream projects. He said one fish was detected into the second week of December.

Peter Graf (Grant PUD) asked if Douglas PUD looked at whether study fish emigrated as yearlings. Kahler said at RRJ, there was only one yearling detected (tagged in 2011), and for downstream locations, there were 3 fish detected as yearling migrants. He added that this was surprising considering the persistent rate of reservoir-type juveniles identified by the scales of returning adults.

Truscott said it seems in the past 6 to 7 years, there has been a reduction of adults returning with reservoir-type scale patterns. Kahler agreed.

Slide 21 of Attachment B

Kahler said this slide summarizes travel rates in kilometers per day. He noted the lowest flow year was also the slowest rate.

Slides 22 to 27 of Attachment B

Kahler said in 2011, travel time and tagging length data appeared to show a break at fish tagged at 87 mm fork length, where fish less than 87 mm took longer to migrate and fish greater than 86 mm were faster. He said when these two size classes were compared, 2011 data showed that fish tagged at 87 mm or larger were five times faster in emigration compared to fish tagged at less than 87 mm. He said additionally, both size classes accelerated as they moved downstream from McNary Dam, but the larger fish showed greater acceleration. He said, however, 2012 data showed a similar pattern but not as pronounced; and 2013 data showed not much difference at all in emigration rate between the two size classes downstream from McNary Dam.

Graf asked if the larger fish were tagged later, and Gingerich said this was generally the case. Kahler said there is a general increase in size over time, but the increase was not as large as expected. He said the mean fish size at tagging increased from 70 to 80 mm over the tagging period in all 3 years.

Slide 28 of Attachment B

Kahler said when comparing detection rates by size class, the data indicate larger fish have a significantly higher chance of being detected compared to smaller fish.

Slides 29 to 36 of Attachment B

Kahler said travel times compared to tagging length were variable from 2011 to 2013. He said travel times for all years showed that fish showed a diversity of travel times to RRJ, with some fish emigrating rapidly (within 20 days), and others showing protracted residency (greater than 20 days). Those residing longer tended to comprise the smaller two-thirds of the size distribution, while those emigrating rapidly comprised the entire size range. This observed break between categories of travel time to RRJ varied by tagging week, ranging from 15 to 20 days, but in the dataset combining all weeks, the break was at 20 days.

Slides 37 to 38 of Attachment B

Kahler said during Week 1 of 2013 tagging, the distribution of fish sizes and travel times were similar at the upstream and downstream sites. He said by Week 3, there was an interesting shift of quite a few larger fish near the Wells Dam forebay exhibiting longer travel times.

Slides 39 to 41 of Attachment B

Kahler said travel times, post-tagging, from release to RRJ were compared for fish with travel times less than or equal to 20 days versus greater than 20 days. He said a high proportion of fish tagged in Week 1 exhibited longer travel times, but the proportions of fish with short or long travel times shifted over the tagging period such that a greater proportion fish tagged in Week 3 exhibited short travel times. He said there were also a number of fish recaptured in Wells Reservoir before emigrating to RRJ; therefore, post-recapture travel times to RRJ for fish recaptured in Wells Reservoir were also reviewed. He said the proportions of recaptured fish with travel times of less than or equal to 20 or greater than 20 days matched that in the entire population of fish detected at RRJ. He said fish with residence times less than 7 days between tagging and recapture manifested almost the same proportion of individuals with travel times greater than 20 days as the population of fish detected at RRJ; however, fish with residence times greater than or equal to 7 days between tagging and recapture had very different post-release travel time proportions (skewed toward long travel times). He added that these data indicate that fast emigrants to RRJ are not fish that had already resided in Wells Reservoir for a week or more prior to emigration to RRJ.

Slides 42 to 43 of Attachment B

Kahler said length at tagging of all tagged fish was compared to length at tagging of returning adults. He said the mean length at tagging of returning adults is significantly larger than that of all tagged fish, suggesting higher survival for larger fish. He said additionally, travel times from release to RRJ for all tagged fish were compared to travel times from release to RRJ for returning adults. He noted the bimodal distribution and said travel times between the two groups were not statistically different, suggesting there is no survival advantage to a lengthy residence time or rapid emigration. Graf summarized that returning adult fish are generally larger at tagging but not generally faster emigrants, and Kahler said this is correct.

Slide 44 of Attachment B

Kahler said fish growth in mm per day was compared across 2011, 2012, and 2013. He noted that inaccurate measuring during the 2011 and 2012 effort was corrected in 2013. He said generally, post-tagging, growth rates were relatively low for the first few days, but gradually increased so that by two weeks post-tagging growth rates typically exceeded 0.8 mm per day. He said by 20 days post-tagging, growth rate generally exceeded 1 mm per day, which is similar to estimated growth rates of untagged fish. He said that the lack of any evidences of a relationship between length at tagging and growth rates, indicates that the low growth rate post-tagging seems to result from the tagging process rather than from tag burden. He explained that seined fish were held in a pen, tagged, held again for recovery (from anesthesia), and then released. He said it takes a few days for a fish to recover from the tagging process, since they can’t freely feed during the threeday period.

Slides 45 to 53 of Attachment B

Kahler reviewed passage timing and corresponding fork-length data from historical fyke-net efforts compared to recent beach-seine efforts. He noted on slide 48 that in early June there were quite a few fyke-net catches and he suspects these were entrained fry, notably because the timing was around the typical peak of the freshet. He also pointed out the larger subyearlings in the fyke-net catches and speculated that these may be active migrants and noted that fish of those lengths were not well represented in the beach-seine catches. He said on slide 49, in the second and third weeks of June, which is the timing when tagging efforts commenced in 2011 to 2013, the data start showing alignment of distributions between fyke-net and beach seining efforts, but the beach-seine catches underrepresent the larger fish caught in the fyke-nets.

John Ferguson noted, from slide 50 to 51, the shift to the right where it seems the fyke-net effort at Wells Dam was collecting fish that had been in the reservoir longer compared to the beach seining efforts. Kahler said these data could be interpreted a number of ways. He said the beach seining efforts are not sampling everything that passes Wells Dam. Truscott said there are also two different populations. He said the beach seining efforts are more heavily biased to Gebbers Landing, whereas those fish in the fyke-net catches might be influenced more from the Methow River. Kahler said in retrospect, it would have been beneficial to collect genetic samples. Kahler emphasized the important point that the beach-seining effort was unsuccessful in capturing the larger fraction of subyearlings in the reservoir as indicated by the fact that the length distribution of beach-seine catches encompassed approximately the smaller one-half of the length distribution of fyke-net catches.

Kahler noted, on slide 52, that the beach seining efforts struggled to find fish; and on slide 53, in the last weeks of fyke-netting in August, the sample size decreased significantly.

Slides 54 to 55 of Attachment B

Kahler said the graphic on slide 54 compares the lengths of fish during Weeks 28 to 29, captured by night purse seining, mostly night fyke-netting, and day beach seining. He said the fyke-net and 1984 purse-seine data match, and though the 1983 purse-seine data align more closely with the beach-seine data, it still represents a population of larger fish than that represented in the beach-seine catches. He noted that the beach seining efforts were unable to collect larger fish compared to the other efforts, and also captured smaller fish not observed in the other efforts. He said slide 55 shows that neither daytime beach seining nor the capture of an offshore school by beach seining were able to catch fish within the size range of those captured by nighttime purse seining at approximately the same river mile. He noted that while the purse seining succeeded in obtaining large fish, it yielded very small numbers of catch during this time of the year (Week 27).

Slide 56 of Attachment B

Kahler said this slide shows the progression in fork length at tagging of fish captured in fyke-nets compared to beach-seined fish. He noted that the mean fork length is smaller, and the progression rate is lower in beach-seined fish compared to fish captured in fyke-nets.

Slides 57 to 59 of Attachment B

Kahler said these next slides show travel times by fish length at tagging for fish detected at WEJ (Wells Dam Bypass Bay Sample) and RRJ in 2017 and 2018. He said because WEJ was installed after the Douglas PUD tagging effort, these data are CCT-tagged fish. He said 30 of 32 fish were detected at WEJ within 20 days post-release. He said when proportional travel times are added to these data, the extrapolated travel times from WEJ to RRJ are mostly less than or equal to 20 days. He noted that all of the 7 fish captured at WEJ and RRJ were detected at WEJ within 10 days of release, and all but 2 spent most of their total travel time in the Rocky Reach Reservoir.

Slide 60 of Attachment B

Kahler said this slide shows the time of day fish were detected at WEJ compared to fish detected at RRJ. He said while about 65% of fish detected at WEJ were during the dusk-to-dawn timeframe, the actual times differed compared to the group at large detected at RRJ. Ferguson asked if these data differed from the fyke-net data, and Kahler said yes but the fyke-net data were individual events and not continuous sampling.

Slide 61 of Attachment B

Kahler said this slide was presented during the Subyearling Workshop held in 2016 and shows the estimated probability of mortal injury for certain sized fish carrying a certain sized tag when passing through a simulated turbine. He said according to this graph, a 60-mm Chinook salmon carrying a PIT-tag weighing approximately 0.1 gram would have just under a 20% probability of mortal injury at a given ratio of pressure change. He said the current Juvenile Salmon Acoustic Telemetry System (JSATS) tag weighs 0.22 gram, and in a 60-mm fish this tag burden would result in a 100% chance of mortality based on these studies. He said Pacific Northwest National Laboratory (PNNL) has recently developed a new ELAT (eel and lamprey acoustic tag) that is almost the same size and mass as a PIT-tag, only with a 20-day battery life. He said PNNL has reached a 35-day battery life in some ELATs; however, even if the ELAT battery life improves, there will still be sample size limitations.

Slides 62 to 68 of Attachment B

Kahler reviewed the conclusions and acknowledgements.

Discussion

Truscott thanked Douglas PUD for the effort in developing this presentation and report. He said it is interesting that fish passing Wells Dam (the fyke-net catches) are considerably larger than fish collected during beach seining efforts. Gingerich suggested resolving this question by taking fish detected at RRJ and applying a growth rate estimate based on what is known about growth in the Wells Reservoir. Kahler agreed, recalling that almost all 32 fish detected at WEJ were within 20 days of release, and within 15 days post-release fish growth was up to 0.8 to 1 mm per day. He said this curve can be applied to fish detected at RRJ to estimate fish size at Wells Dam.

Graf asked if there is a population of untagged fish sampled at RRJ and suggested perhaps comparing the run-at-large to PIT-tagged fish at RRJ to determine whether bias exists. Gingerich said he does not believe it is accurate to say the run-at-large is completely measured; for example, fry are only enumerated. Lance Keller agreed and said fry are enumerated and the species is recorded. He said for subyearlings exceeding the fry size threshold, a subsample of lengths and weights are collected each day until 100 fish of each species encountered are collected; therefore, not every fish is measured. He added that for recaptures, only lengths are recorded. Graf noted that the Entiat River produces a different fish. Gingerich also noted that the sample at RRJ is conducted during the morning hours and fish availability will be limited based on when subyearlings pass RRJ compared to when the sample is conducted. Keller said Chelan PUD conducted all-day sampling for 3 years and most of those fish were dominated by hatchery fish and subyearlings would show up after that initial hatchery pulse.

Ferguson noted the diverse behavior in the Wells and Rocky Reach reservoirs, but by the time fish reach MCN migration times are quick. He questioned how far upstream from MCN does this behavior start. Graf said Tom Desgroseillier (formerly USFWS, now WDFW) studied this with Entiat River fish and he found there was also a lot of diversity upstream of MCN before sorting out. Graf added that there were more than a few fish that overwintered near MCN.

Kahler said Dennis Dauble (PNNL, retired) conducted night sampling at a location in the Hanford Reach and most subyearling Chinook salmon captured were in fast, deep water and near the bottom, and only a fraction were caught off the shoreline. *(Note: Kahler later clarified the sampling method was fyke-netting with nets set along a cross-section of the river at various depths. Kahler said Dauble's team also beach-seined in nearshore areas; however, Kahler is unsure whether these activities were conducted during nighttime hours.)*

Truscott recalled requirements in the HCPs to study active migrants; however, he said impacts of a project on a population may apply to more than just active migrants. He said it seems from a population management standpoint, it might not be the best decision to only study active migrants.

Kahler said prior to the development of the Mid-Columbia River dams, records indicate that subyearlings emigrated rapidly and did not have lengthy residence times upriver. He said once the dams and projects were developed, it created a different river and fish have adapted to a reservoir environment. He questioned whether this is a good or bad thing for fish populations. He said perhaps the reservoir environment is an overall better rearing strategy verses immediately emigrating out to the estuary and around those predators.

Ferguson said the draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Geris on May 24, 2019, and is available for a 60-day review with edits and comments due to Kahler by Tuesday, July 23, 2019. Kahler said he has already found a handful or typos that he will correct, including on page 38, Table 12, he said the sample sizes for less than 7 days and 7 or more days should be flipped.

B. Subyearling Chinook Salmon Studies (All)

John Ferguson recalled discussing during the last HCP Coordinating Committees meeting on April 23, 2019, Chelan PUD's current Statement of Agreement (SOA) maintaining Rock Island and Rocky Reach subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for up to 3 years, which expires on September 29, 2019. Ferguson asked if Chelan PUD has any updates on this. Lance Keller said no, that Chelan PUD would like to take more time to review Douglas PUD's report.

Keller said in Douglas PUD's study, the 2011 travel time and tagging length data showing a break at fish tagged at 87 mm fork length was promising. Andrew Gingerich agreed and recalled thinking the same thing until the additional years of data did not show the same pattern. Kirk Truscott noted that 2011 and 2012 were high water years, and suggested reviewing data for other high water years to determine if there may be an effect from high flow. He also noted the lack of large fish that are tagged. Tom Kahler recalled discussing, during the 2016 Subyearling Workshop, using a lampara net to collect larger fish. Kahler said Geoff McMichael (Mainstem Fish Research) attempted this but was unsuccessful at capturing the numbers of fish necessary for a study.

Gingerich said perhaps the fish collected during fyke-netting were feeding heavily in increasing water temperatures resulting in increased growth rates, and then these rapidly growing fish are what was collected during fyke-netting and are omitted from the beach-seining catches.

Truscott asked if Douglas PUD sacrificed any fish to determine how well the stomachs were evacuated. Kahler said no and asked if the CCT did. Truscott said no.

Truscott said he is curious about the 20,000 tagged subyearlings from the CCT tagging effort that have not returned as adults. Kahler said the CCT did take over tagging right when ocean conditions were going bad. Ferguson asked about the mean fish size at tagging. Truscott said fish were tagged down to 60 mm. He said some fish have been detected at RRJ and MCN, so the fish are not dying right away. Ferguson said based on a recent study in the Yakima River Basin (Knudsen et al. 2009), delayed smolt-to adult survival suppression from PIT-tagging is about 30% to 40%.

II. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Lance Keller added a Rock Island Dam bypass incident
- Keely Murdoch added an introduction to the new Yakama Nation (YN) HCP Coordinating Committees Alternate Representative, Brandon Rogers

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft April 23, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. HCP Coordinating Committees members present approved the April 23, 2019 meeting minutes, as revised. *(Note: Jim Craig provided USFWS approval of the minutes via email on May 23, 2019.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on April 23, 2019, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on April 23, 2019):*

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  Keller said a diel graph is undergoing internal review, which shows PIT-tagged subyearlings arriving at Rocky Reach Dam. He said the data indicate a large proportion of nighttime passage and a lower proportion of daylight passage. He recalled the question was about the timing of the sample period at the RRJSF, and he said Dr. John Skalski (Columbia Basin Research) indicated that so long as the index sample is conducted at the same time each year, the data are representative and comparable among years. This action item will be carried forward.

- *Lance Keller will inquire internally about the reasoning behind taking downstream-migrating Pacific lamprey at the Rocky Reach Juvenile Fish Bypass System (RRJFBS) and releasing these fish at an upstream location (Item I-C).*
  Keller said he discussed this with Steve Hemstrom who indicated this was a decision made within the Rocky Reach Fish Forum (RRFF). Keller said the RRFF decided that a healthy adult Pacific lamprey encountered in a RRJFBS sample could be a fallback and should be returned upstream of the dam. He suggested moving this topic to the RRFF if it warrants further discussion. Kirk Truscott said there does not seem to be much Pacific lamprey in-ladder passage prior to spring emigration trapping, which is why he is skeptical about identifying these as fallbacks. Keller said crews closely assess whether the Pacific lamprey is healthy or spawned out, and only healthy Pacific lamprey are released upstream. Truscott asked about when Pacific lamprey are migrating through the fish ladders at Rocky Reach Dam, and Keller said these data can be reviewed and compared to the capture dates at the sampling facility. John Ferguson suggested taking this topic to the RRFF.
- *Tom Kahler will distribute recent reports by CRITFC that summarize findings from their sockeye salmon monitoring efforts (Item I-C).*
  Kahler provided a CRITFC report covering 2016 and 2017 tagging efforts to Kristi Geris on May 20, 2019, which Geris distributed to the HCP Coordinating Committees that same day; the 2018 report will be available in late summer 2019.
- *Tracy Hillman will further discuss with the HCP Hatchery Committees and PRCC Hatchery Subcommittee about combining the committees' email distribution lists and will report back to the HCP Coordinating Committees regarding the path forward (Item II-A).*
  Hillman provided updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists for HCP Coordinating Committees approval to Kristi Geris on May 20, 2019, which Geris distributed to the HCP Coordinating Committees that same day.
- *Kirk Truscott will contact Jeff Fryer (CRITFC) to obtain clarification on questions the CCT have about CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 (Item III-A).*
  Truscott said he spoke with Fryer and will further discuss this during today's meeting.
- *Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item IV-A).*
  This action item will be carried forward.
- *Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item IV-A).*
  This action item will be discussed during today's meeting and will also be carried forward.

- *Kristi Geris will coordinate with Denny Rohr (PRCC Facilitator) regarding moving the PRCC meeting on May 22, 2019 to May 29, 2019, to dovetail with the HCP Coordinating Committees meeting on May 28, 2019 (Item V-A).*
  Geris confirmed with Rohr via email on April 25, 2019, that the PRCC meeting on May 22, 2019, has been rescheduled to May 29, 2019.

III. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on May 15, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Streamlining HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings (joint)*: The HCP Hatchery Committees reviewed, updated, and approved the meeting protocols. The protocols are a living document and can be updated anytime. Hillman said these protocols will likely be reviewed annually. The HCP Hatchery Committees also reviewed, updated, and approved two email distribution lists. A primary list includes individuals who will receive all communications, and a secondary list includes individuals who will receive only final products. The HCP Hatchery Committees are now requesting HCP Coordinating Committees approval of these two distribution lists. John Ferguson said these lists were distributed to the HCP Coordinating Committees by Kristi Geris on May 20, 2019, which is just short of the required 10 calendar days for decision items, per the HCPs. Ferguson said if the HCP Coordinating Committees representatives present are ready to vote now, Anchor QEA will contact Jim Craig to obtain USFWS approval of the email distribution lists via email. HCP Coordinating Committees representatives present approved the updated HCP Hatchery Committees and PRCC Hatchery Subcommittee email distribution lists, contingent on USFWS approval of the lists. *(Note: Geris emailed Craig following the meeting on May 28, 2019, and Craig provided USFWS approval of the lists via email on May 29, 2019, as distributed to the HCP Coordinating Committees by Geris that same day.)*
- *National Marine Fisheries Service (NMFS) Consultation Update (joint)*: NMFS is completing the Finding of No Significant Impact for the Steelhead and Summer Chinook Salmon Environmental Assessments (EAs). NMFS received no major comments from the public on the Steelhead or Summer Chinook Salmon draft EAs. Permits for the programs are under review by General Council.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on June 19, 2019.

Hillman said the HCP Tributary Committees met on May 8, 2019; participated in site tours on May 9, May 13, and May 14, 2019; and held a conference call on May 21, 2019, to discuss observations from the site tours:

- *General Salmon Habitat Program (GSHP) Draft Proposals*: The HCP Tributary Committees received 18 GSHP draft proposals. These are cost-share proposals with the Salmon Recovery Funding Board. The HCP Tributary Committees identified 10 projects that did not warrant a full proposal, because the project did not have strong technical or biological merit or were not cost-effective (low benefits per cost). The HCP Tributary Committees solicited full proposals from seven projects, which are due on June 28, 2019. The proposed projects are in the Wenatchee, Entiat, and Methow rivers basins.
- *Napeequa Side Channel Connection Project*: One of the 18 GSHP applications reviewed was from Cascade Columbia Fisheries Enhancement Group and was titled, "Napeequa Side Channel Connection Project." The purpose of the project is to remove a culvert and associated fill to restore hydraulic connectivity to a side channel along the lower Napeequa River, a tributary to the White River. This action will improve juvenile steelhead and spring Chinook salmon survival and productivity by providing access to an important spring-fed side channel. The total cost of the project is $58,290. After careful review of the proposal, the Rocky Reach HCP Tributary Committee elected to contribute $49,399 to the project (the project has a cost share of $8,891).
- *YN Initiation of Dispute Resolution*: Hillman said this item occurred after the HCP Tributary Committees meeting on May 8, 2019. On May 23, 2019, the YN submitted a letter to the HCP Tributary Committees Chairman indicating the YN are formally initiating the dispute resolution process as defined in Section 11 of the Anadromous Fish Agreement and HCPs. Hillman said, to be clear, the YN are not disputing the HCP Tributary Committees decision to not fund the Scaffold Camp #2 Acquisition Project; rather, the dispute is only about the HCP Tributary Committees' rejection of the YN's SOA titled, "Basis for Decision Making in HCP Tributary Committees." The HCP Tributary Committees have 20 days from the receipt of the dispute to review and discuss the dispute before elevating the dispute to the HCP Coordinating Committees. Hillman said the HCP Coordinating Committees will then have 20 days to resolve the dispute or elevate the dispute to the HCP Policy Committees, who will then have 30 days to resolve the dispute. Ferguson said he will coordinate with Hillman regarding scheduling to align the HCP Coordinating Committees review of the dispute during the regularly scheduled HCP Coordinating Committees meeting on June 25, 2019. Ferguson asked Hillman if the HCP Tributary Committees plan to convene to discuss the dispute prior to the next scheduled HCP Tributary Committees meeting? Hillman said when the HCP Tributary Committees voted on the SOA, members made it clear this dispute could not be resolved within the HCP Tributary Committees. He said he distributed to the HCP Tributary

Committees a packet of information for review. He said if these materials change minds about resolving the dispute, the HCP Tributary Committees will convene by conference call. Hillman said, however, at this point, he does not believe the outcome will change over another conference call. Ferguson suggested the HCP Coordinating Committees start thinking about this, including discussing the dispute with respective HCP Policy Committees representatives and perhaps review the meeting minutes to remind themselves of the discussions. Keely Murdoch said reviewing the HCP Coordinating Committees meeting minutes might be useful; however, the dispute is about an SOA and issue paper that the HCP Coordinating Committees did not receive. She said the HCP Coordinating Committees meeting minutes focus more on the Scaffold Camp #2 Acquisition Project, which is not what the dispute is about. Ferguson agreed and said the SOA and issue paper will be included in the package received from the HCP Tributary Committees.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on July 16, 2019. Hillman said in June 2019, the HCP Tributary Committees will be attending GSHP proposal presentations and will not officially meet unless something arises with the dispute.

IV. Douglas PUD

A. DECISION: CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam in 2019 (Tom Kahler)

CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on February 20, 2019. There was an action item for Kirk Truscott to contact Jeff Fryer to obtain clarification on questions the CCT have about CRITFC's request. Tom Kahler asked Truscott if the CCT concerns were addressed by Fryer.

Truscott said he and Fryer discussed the significance of the data. Truscott said for 2019, the CCT will approve tagging; however, he said the HCP Coordinating Committees need to have a serious discussion about whether these data are still necessary. He asked, what management decisions are being made based on tagging sockeye salmon at Wells Dam? He said the CCT is conducting a qualitative assessment for almost all salmonid species except spring Chinook salmon and steelhead, and Fryer's reports are the only source of sockeye salmon data available, which has been useful. He asked, however, how many years of these data are actually needed? He said at this point, he believes handling these fish less is more important than the data.

John Ferguson asked when Truscott would like to start these discussions, and Truscott said in December 2019. The HCP Coordinating Committees will begin discussing the necessity and significance of the data behind CRITFC's annual request to tag sockeye salmon at Wells Dam during the HCP Coordinating Committees meeting in December 2019. *(Note: Geris added this to the agenda for December 2019.)*

Kahler said Fryer has mentioned potentially tagging fewer sockeye salmon during future events, maybe around 300 fish as (opposed to 800 fish). Truscott added that it is unknown how this water year will shape up. He said with the warmer weather it may be wise to revisit approval of this request if there are issues with water temperature and river flow. Andrew Gingerich noted that the Okanogan River is already very low this year. He said if the CCT are concerned about adult escapement, the Okanogan River may be tough by the time sockeye salmon arrive.

Wells HCP Coordinating Committee representatives present approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2019, with the caveat that approval of the tagging will be reviewed again if low flow and warm water migration conditions develop potentially affecting adult sockeye salmon survival. *(Note: Jim Craig provided USFWS approval of this request via email on May 23, 2019.)*

Ferguson suggested, if needed, the CCT request revisiting approval of tagging sockeye salmon at Wells Dam in 2019, during a future HCP Coordinating Committees meeting. Truscott agreed. *(Note: on May 29, 2019, Geris notified Fryer of the Wells HCP Coordinating Committee approval of CRITFC's request, including the caveat to revisit the approval pending river conditions.)*

B. Wells Dam Bypass Operations Update (Tom Kahler)

Tom Kahler said a Summary of Wells Dam Bypass Operations in April 2019 was distributed to the HCP Coordinating Committees by Kristi Geris on May 10, 2019. Kahler said the summary explains Wells Dam bypass non-compliance events that occurred in April 2019. He said he has already discussed these events with each Wells HCP Coordinating Committee representative, and each representative said they planned to review the summary document. Kahler asked if there were questions about the summary or if the Wells HCP Coordinating Committee wants him to walk through what happened.

Kirk Truscott said what is most important is that there is follow-through to make sure the same thing does not happen again. He said Douglas PUD developed a good roadmap to minimize the chances of something like this reoccurring.

Keely Murdoch asked if there is any idea of how these non-compliance events affect fish passage survival? Kahler said it is unknown how many fish were present and what passage routes were used when these events occurred. He said he knows there were hatchery releases in the water around this time, including Winthrop, Methow, Chewuch, and Twisp river fish. Truscott suggested reviewing PIT-tag data for abnormally low values compared to past years. Murdoch cautioned there is high variability in these data. Truscott agreed but said it may be an exercise worth doing. Murdoch asked if Truscott is suggesting calculating smolt-to-smolt survival to Rocky Reach Dam or McNary Dam, and Truscott said to McNary Dam would provide more data points. Truscott suggested reviewing the Annual Program Review reports. He said these reports are cumulative and are listed by release group. Kahler asked about the release dates for CCT hatchery fish. Truscott said fish were semi-volitionally released the week of April 15, 2019, and by April 18, 2019, most fish were forced out. Kahler said Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project.

V. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said the hub of Turbine Unit C1 is now completely disassembled and work is progressing. He said he has no measurable updates on Turbine Unit C3. He recalled last month describing the following: 1) installing in Turbine Unit C3 the engineered seals designed for Turbine Unit C1, without success; 2) specific engineered seals designed for Turbine Unit C3, which should have arrived last week; and 3) investigating hydraulically locking the blades into place via governor control.

Kirk Truscott asked how long does it take and what is involved to evaluate hydraulically locking the blades into place? Keller said this involves a modeling exercise, and Chelan PUD has contracted an external consulting firm from Italy who specializes in these types of repairs and modifications. He said a mechanical installation is needed to hold the blades in place and it is extremely important that the blade angle is accurate to not cause runaway. He said the only way to stop runaway blades is to place headgates in to stop the unit, which is very serious and is why this evaluation also includes a risk assessment.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam mechanics are progressing on Turbine Unit B4. He said work is completed on the discharge liner and the new stainless-steel portion of the liner will be installed next. He said as mechanics continue disassembly of Turbine Unit B4, components of the unit are being inspected for condition and expected lifespan. He said parts initially planned for re-use are now being identified as needing replacement, which has pushed back the estimated return-to-service date from July to November 2019. He said, for example, mechanics found structural issues in the wicket gate control that regulates the amount of water coming into the unit. He said this ring sits on top of the wickets gates and controls all gates. He said whether the unit undergoes an extensive repair or complete rebuild, the schedule will have to be moved out. He said at this time, he is unsure how Turbine Unit B4 will affect the remaining schedule.

Kirk Truscott asked if there is concern the other units might be in the same condition? Keller said Chelan PUD will definitely inspect the other units; however, mechanics do not have the ability to do this at this level until the unit is disassembled. Truscott asked if Chelan PUD plans to order additional parts now in case these same issues are discovered in the other units, opposed to losing 3 to 4 months per unit. Keller said he expects this will be the case, and he added that some time may be gained with the other units from learning efficiencies gained from the maintenance of Turbine Unit B4.

C. Rock Island Dam Bypass Incident (Lance Keller)

Lance Keller said in late-April and early May 2019, Chelan PUD identified and resolved an issue at the Rock Island Dam bypass. He said in late April 2019, steelhead collected at the bypass dropped below 100 fish per day, yet there was a slight increase in the mortality rate. He said on April 20, 2019, the mortality rate was 1.3% (2 mortalities out of 109 fish collected that day). He said on April 25, 2019, the mortality rate was 5.8% (4 mortalities out of 69 fish collected that day). He said what was perplexing was these fish were not fresh mortalities and it was obvious these fish were not dying in the trap. He said additionally, all fish had descaling on one side of the body. He said crews inspected the gates that control river flow into the trap; however, no issues were identified. He said additional mortalities were discovered in the trap with the same characteristics as the others (i.e., not fresh and descaling on one side). He said crews then suspected an issue within the traveling water screen portion of the system. He said there was an increase in the time period when the screens in this system are sprayed and based on the descaling fish might be becoming impinged on the screens. He said crews isolated all flow from the traveling water screen system and there was a subsequent decrease in mortality rate to 1.09% on April 30, 2019.

Keller said on May 1, 2019, a fishway attendant identified another potential source of the fish mortalities in the R11 gate, which is one of the gates that controls river flow into the trap from the Powerhouse 2 portion of the system. He said a drain plug was removed from the gate during the adult fishway maintenance period and inadvertently was not reinstalled (this was overlooked during the first inspection of the gate). He said crews attempted to reinstall the plug, operated R11 to the highest capacity, and 30 minutes later there were additional mortalities with the same characteristics as the others. He said on May 1, 2019, crews took the juvenile bypass system offline for a brief 40-minute outage. He said the spill water level in R11 was decreased enough to physically see the plug hole, the plug was installed, and the system was returned to service. He said initially after testing, there were a few more mortalities, and on May 3, 2019, there were zero mortalities.

Keller said ultimately, the mortalities were attributed to the drain hole in R11. He said with the plug removed and at certain operational heights, the increased velocity through the area caused fish to slip through the hole or stack up against the hole resulting in mortalities. He said May 1, 2019, was the highest mortality day with 13 mortalities out of 143 steelhead collected. He explained that the drain hole was installed to previously help dewater the area, but a larger dewater pump has since been installed so the drain hole is no longer needed. He said during the next outage crews will modify the drain hole to ensure the plug will not be removed, and the appropriate protocols will be updated to not remove the plug moving forward.

Kirk Truscott asked what proportion of emigrants arriving at Rock Island Dam are subject to the bypass? Keller said to the best of his knowledge it varies but maybe around 2.5% or less. He said the collection efficiency of that system is low.

VI. HCP Administration

A. YN HCP Coordinating Committees Alternate Representative – Brandon Rogers (John Ferguson)

John Ferguson said Bob Rose retired last Friday, May 24, 2019, and Brandon Rogers is Rose's replacement as the YN HCP Coordinating Committees Alternate Representative.

B. Douglas PUD Support Staff – Amber Nealy (John Ferguson)

John Ferguson said Mary Mayo is retiring this Friday, May 31, 2019, and Amber Nealy will be replacing Mayo as Douglas PUD support staff. Tom Kahler said Nealy has been shadowing Mayo for a few weeks, which has been fortunate because Mayo does so much for Douglas PUD Natural Resources Department (NRD). Kahler said Mayo helps with all filings for the Federal Energy Regulatory Commission by the NRD, she conducts a lot of the technical editing for NRD documents, and she manages NRD postings to multiple websites, among other things. Kahler said he believes Nealy will do a good job.

C. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on June 25, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

John Ferguson said Kristi Geris will be out-of-country June 15 to July 5, 2019, and Larissa Rohrbach (HCP Hatchery Committees support staff) will be managing emails and attending the HCP Coordinating Committees meeting on June 25, 2019. Ferguson said Geris will have Rohrbach's contact information in her out-of-office message as a reminder to distribute emails to Rohrbach during this time.

The July 23 and August 27, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A List of Attendees

Attachment B Post-emergence Behavior of Subyearling Summer/Fall Chinook in Wells Reservoir and Implications for the Measurement of Passage Survival through the Wells Hydroelectric Project

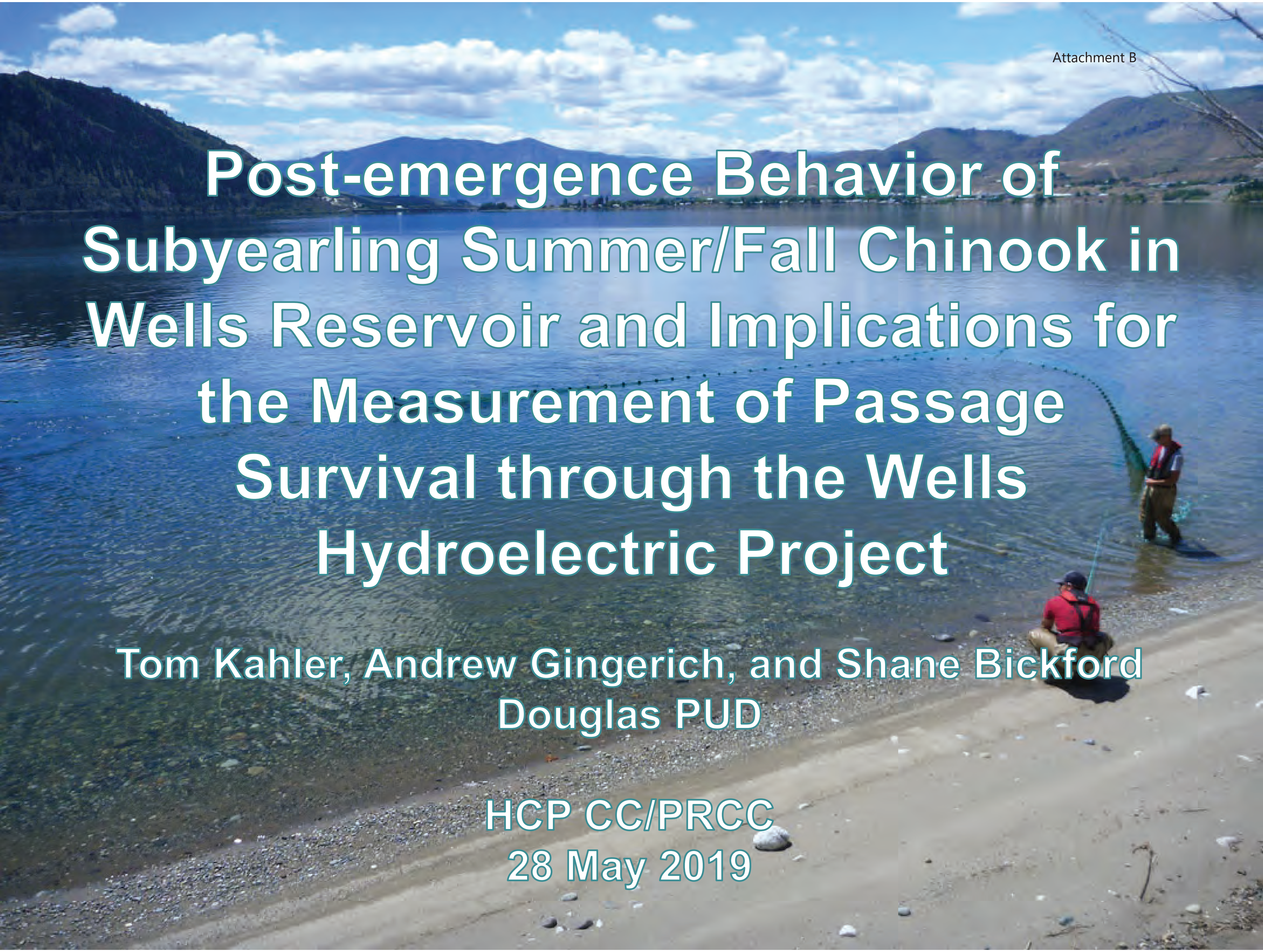
Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†† ¨	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Curt Dotson ¨	Grant PUD
Peter Graf ¨	Grant PUD
Tom Skiles ¨	Columbia River Inter-Tribal Fish Commission
Scott Carlon*†	National Marine Fisheries Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:

- * Denotes HCP Coordinating Committees member or alternate
- † Joined by phone
- †† Joined by phone for the HCP Tributary and Hatchery Committees Update
- ¨ Joined by phone for the Douglas PUD Subyearling Chinook Salmon presentation

Attachment B

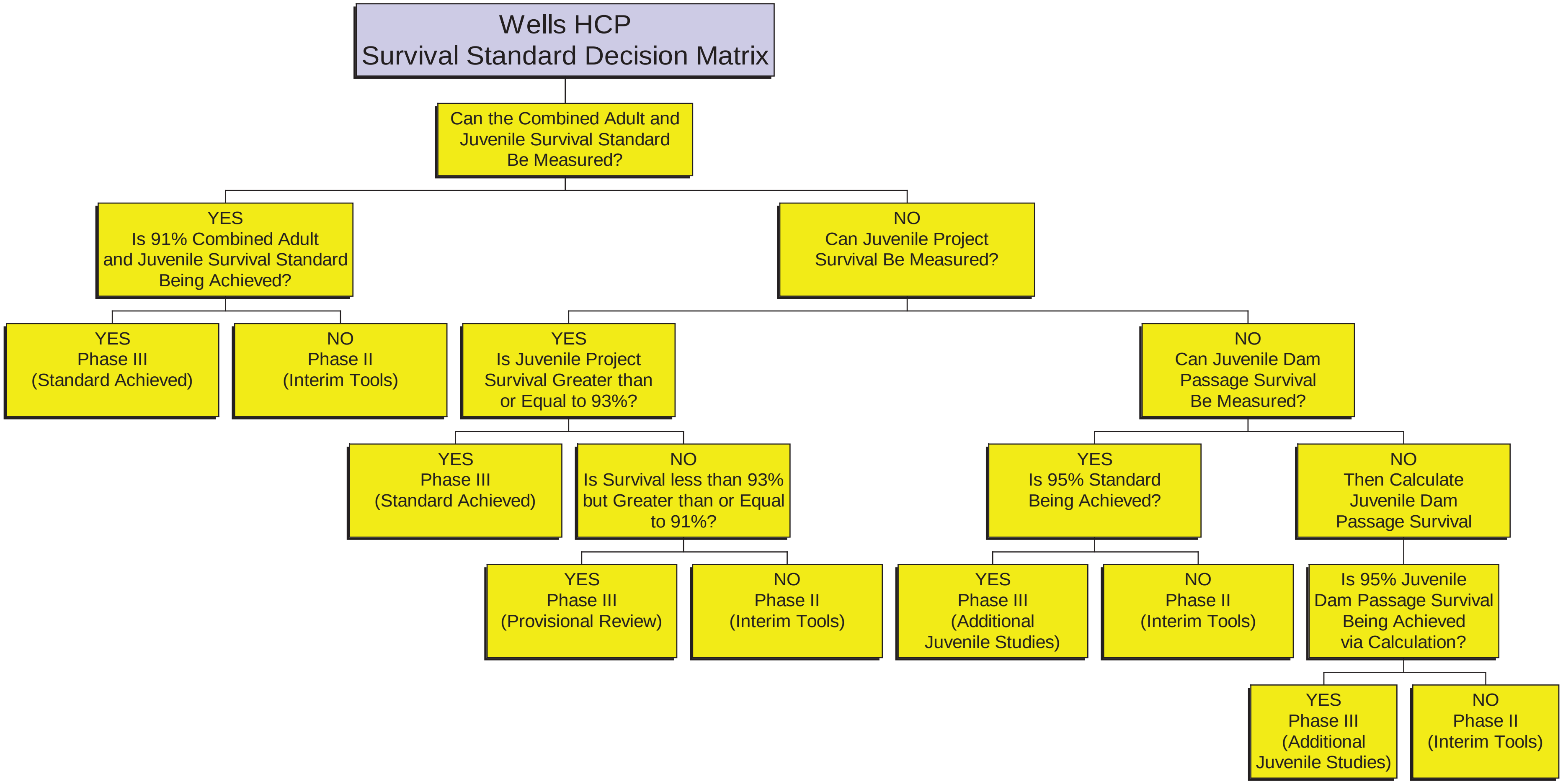


Post-emergence Behavior of Subyearling Summer/Fall Chinook in Wells Reservoir and Implications for the Measurement of Passage Survival through the Wells Hydroelectric Project

Tom Kahler, Andrew Gingerich, and Shane Bickford
Douglas PUD

HCP CC/PRCC
28 May 2019

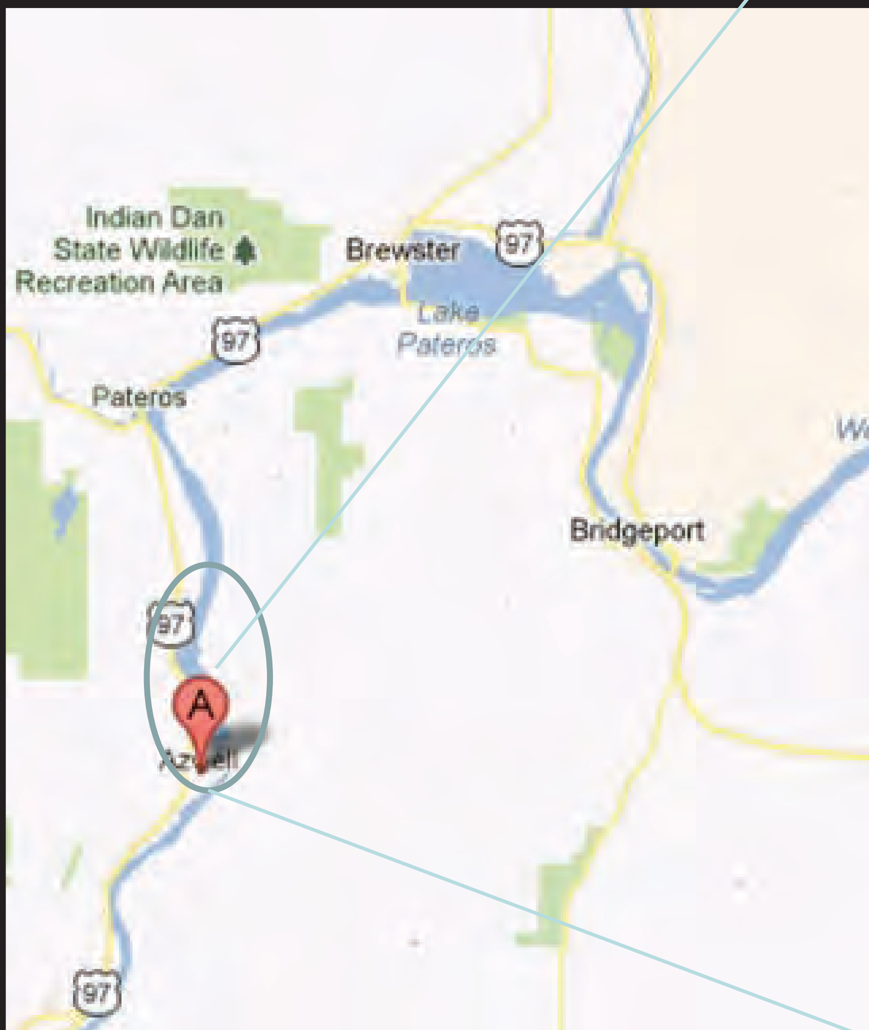
HCP Decision Flow Chart



Wells Reservoir

2011 Seining Locations

2011 Locations Below the Methow

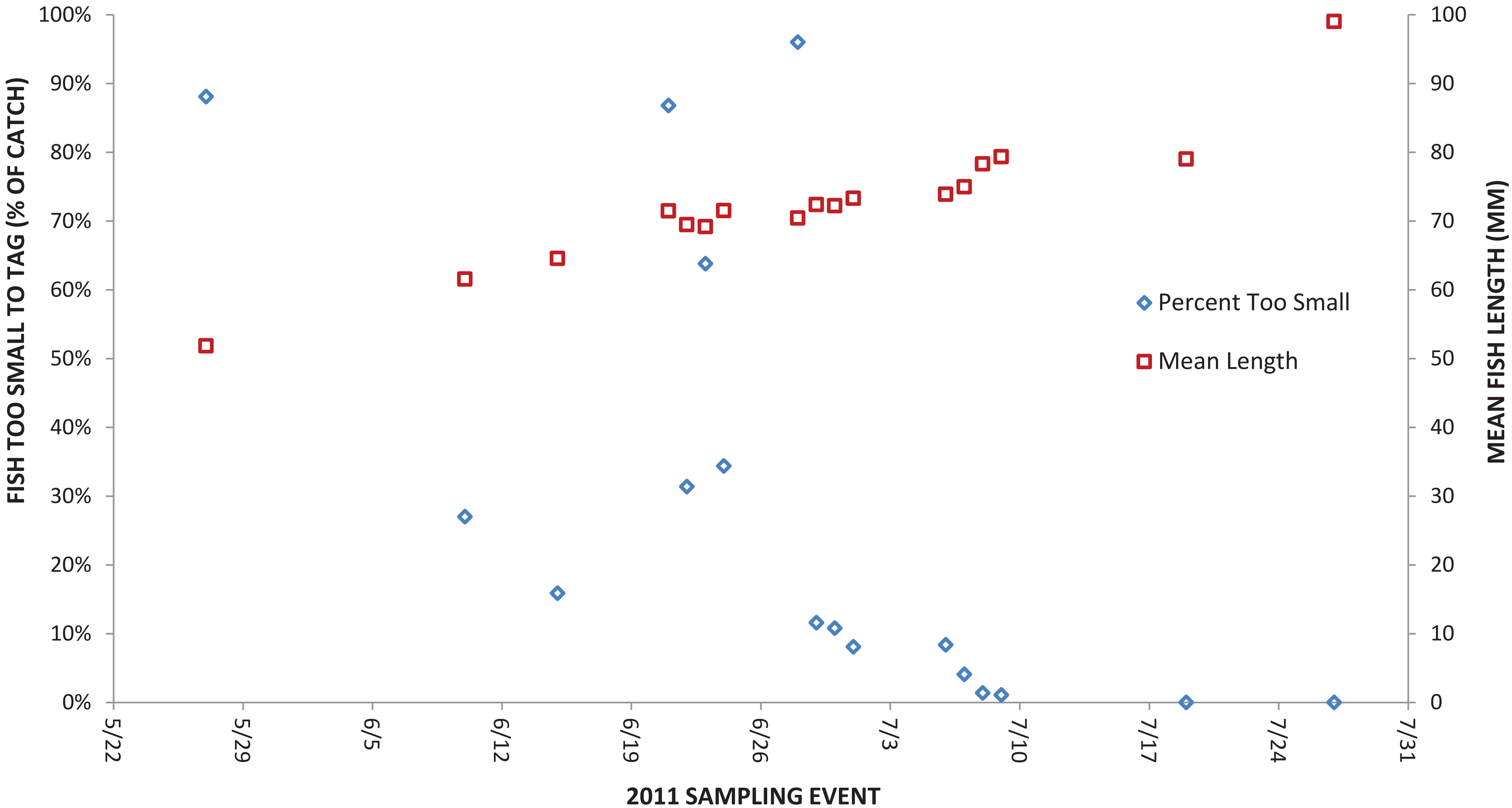


Seining Location Added in 2012

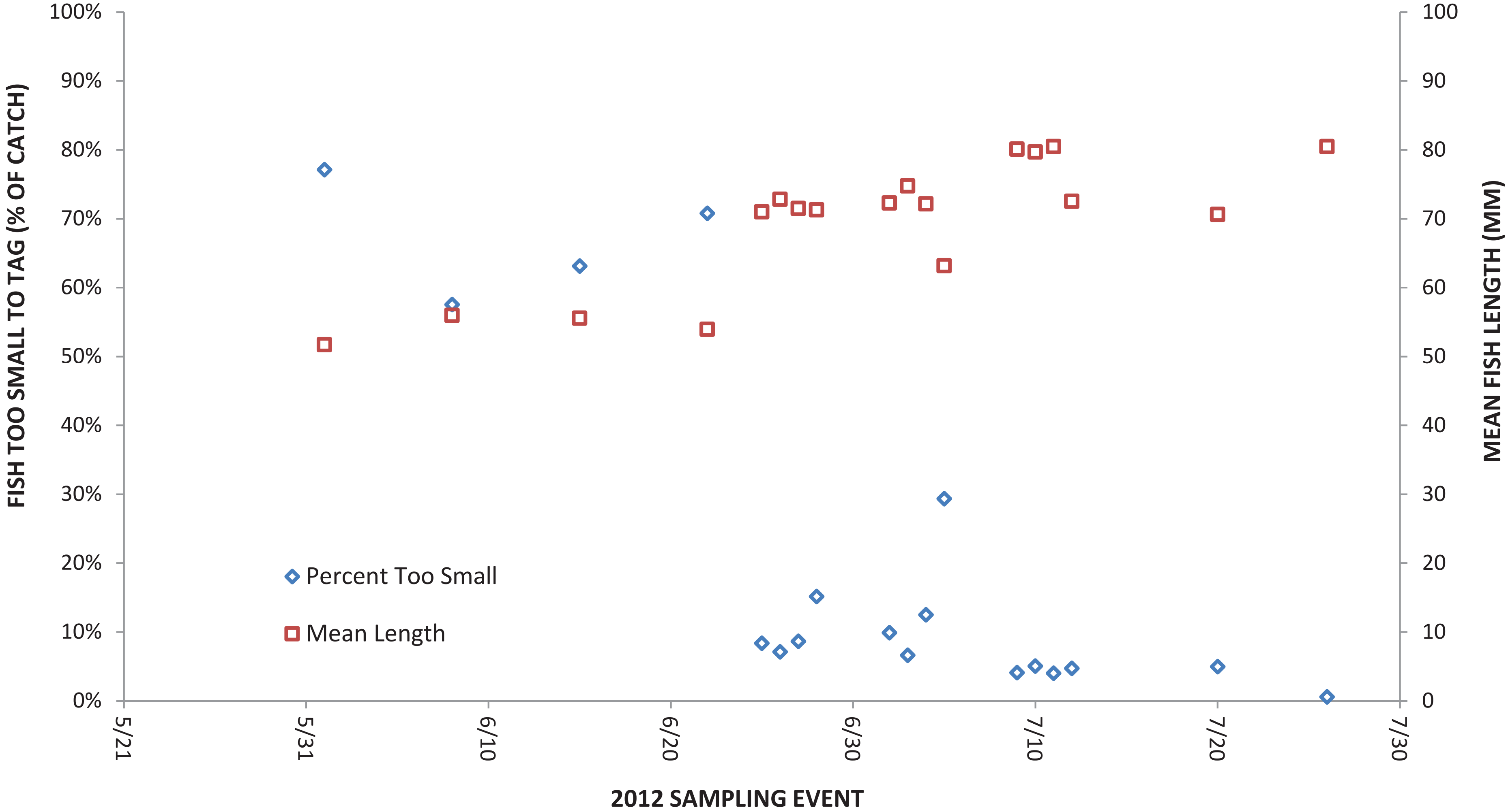
Summary Statistics

	2011	*2012*	*2013*	*Total*
First Release Date	22-Jun	26-Jun	19-Jun	--
First Arrival to Rocky Reach	25-Jun	30-Jun	25-Jun	--
Last Release Date	10-Jul	14-Jul	12-Jul	--
Last Arrival to Rocky Reach	2012	31-Aug	31-Aug	--
Total Tagged and Released	13,223	19,876	17,665	50,764
Total Detected at RRJ	1,200	1,157	1,989	4,346
Total Detections all Sites	2,762	3,552	3,365	9,679
Unique Detections all Sites	2,312	3,109	2,945	8,366
Percent Detected	17.5%	15.6%	16.7%	16.5%
Percent Detected at RRJ	9.1%	5.8%	11.3%	8.6%

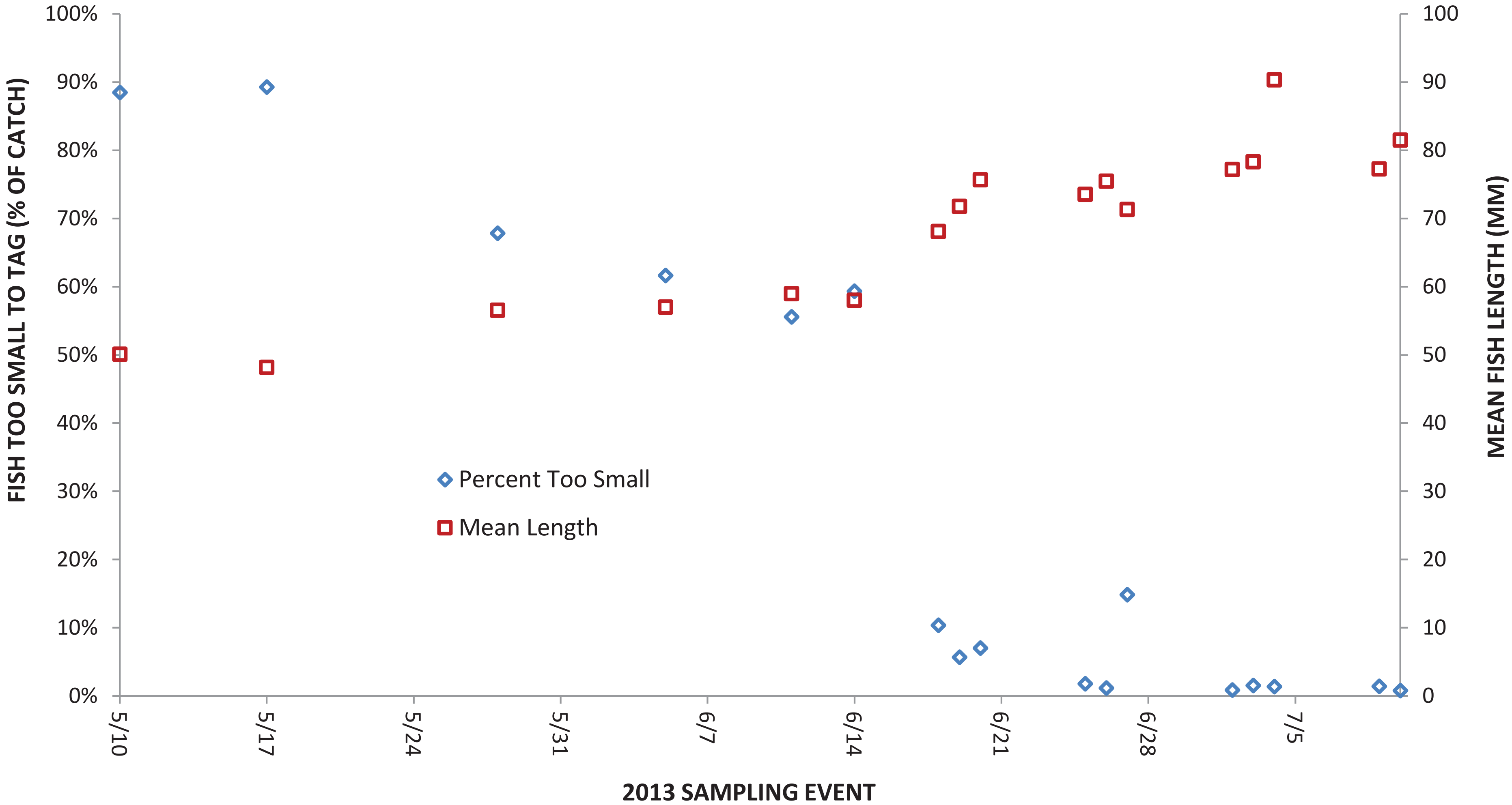
Size Composition 2011



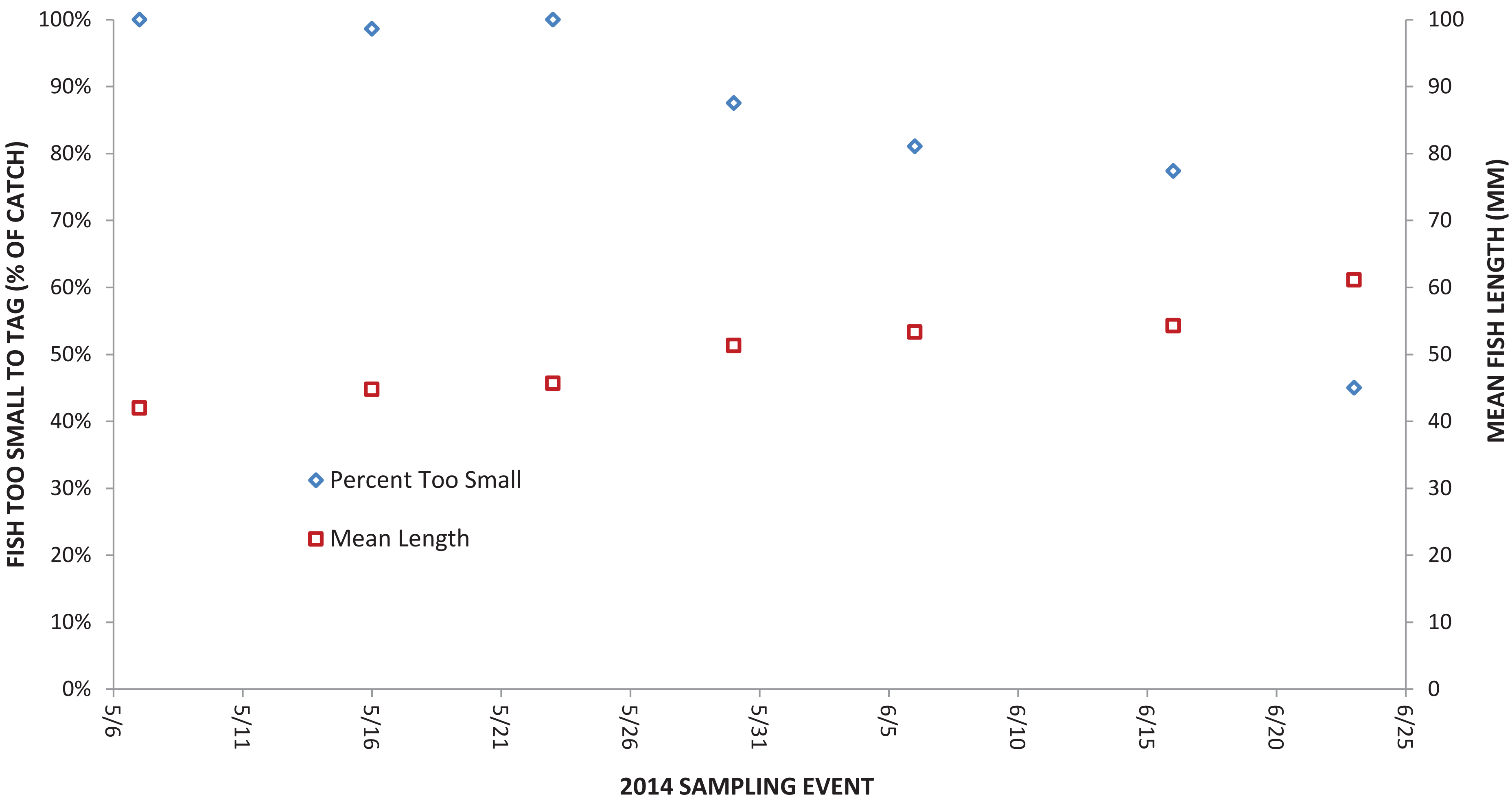
Size Composition 2012



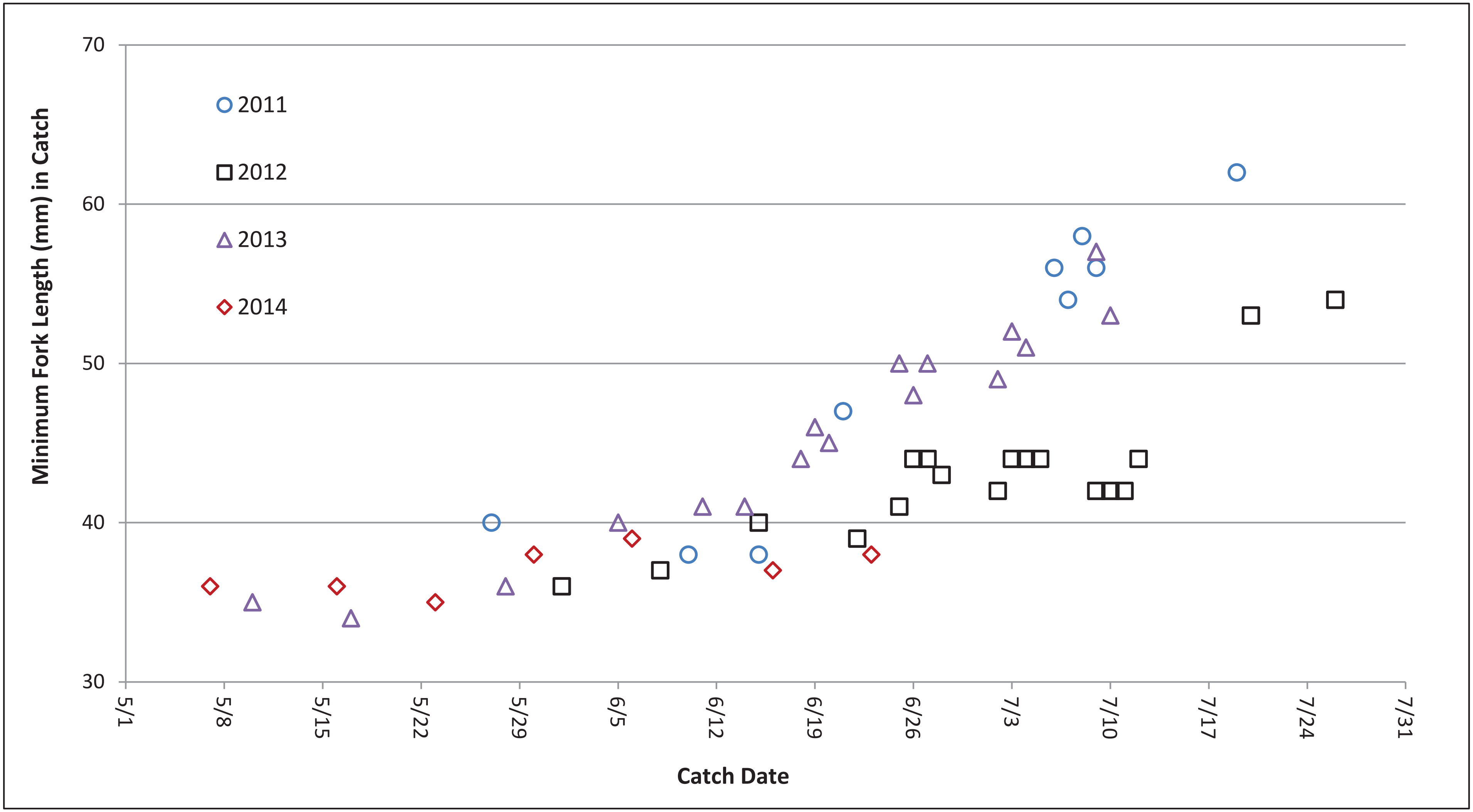
Size Composition 2013



Size Composition 2014

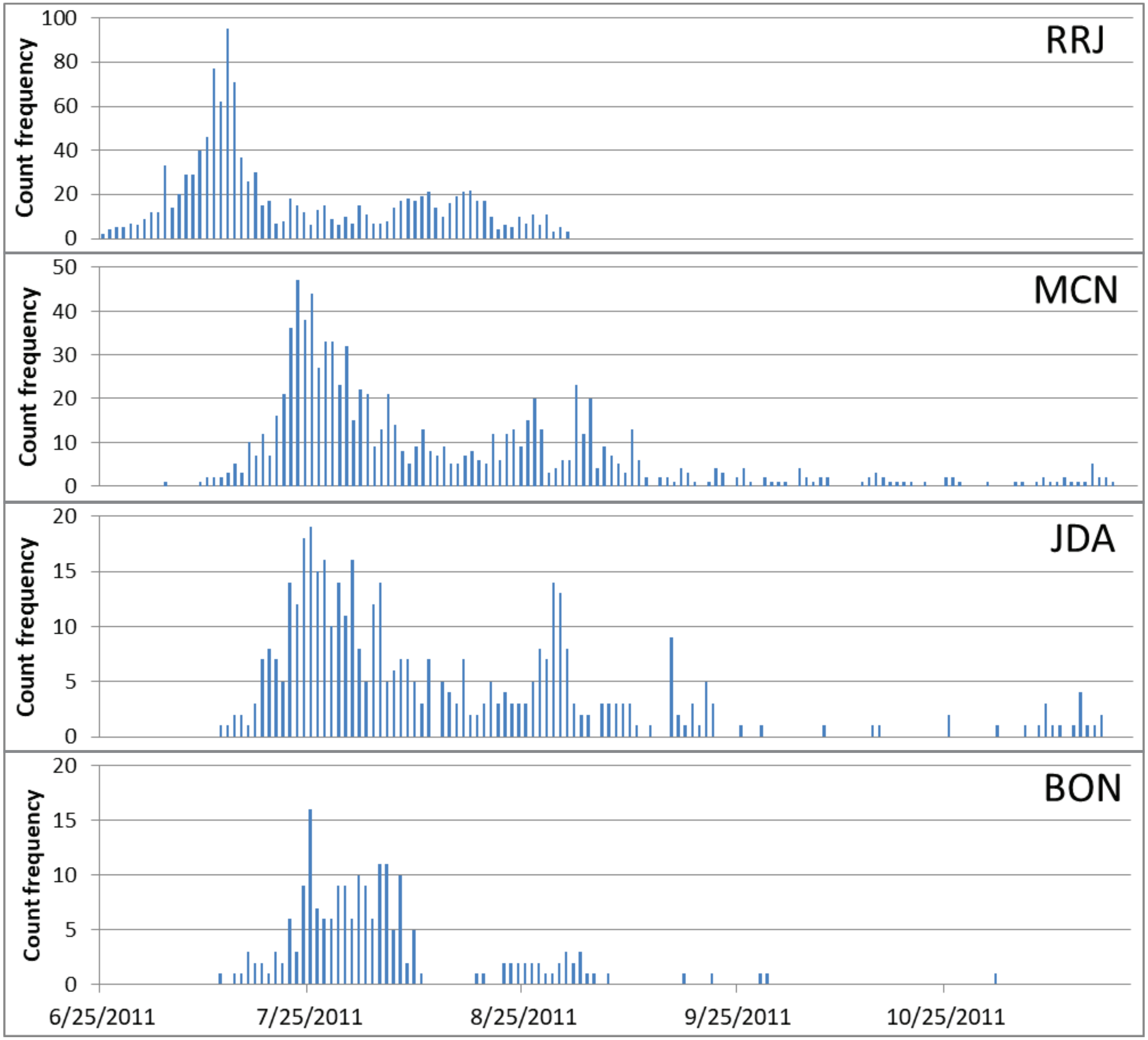


Smallest Fish By Capture Date

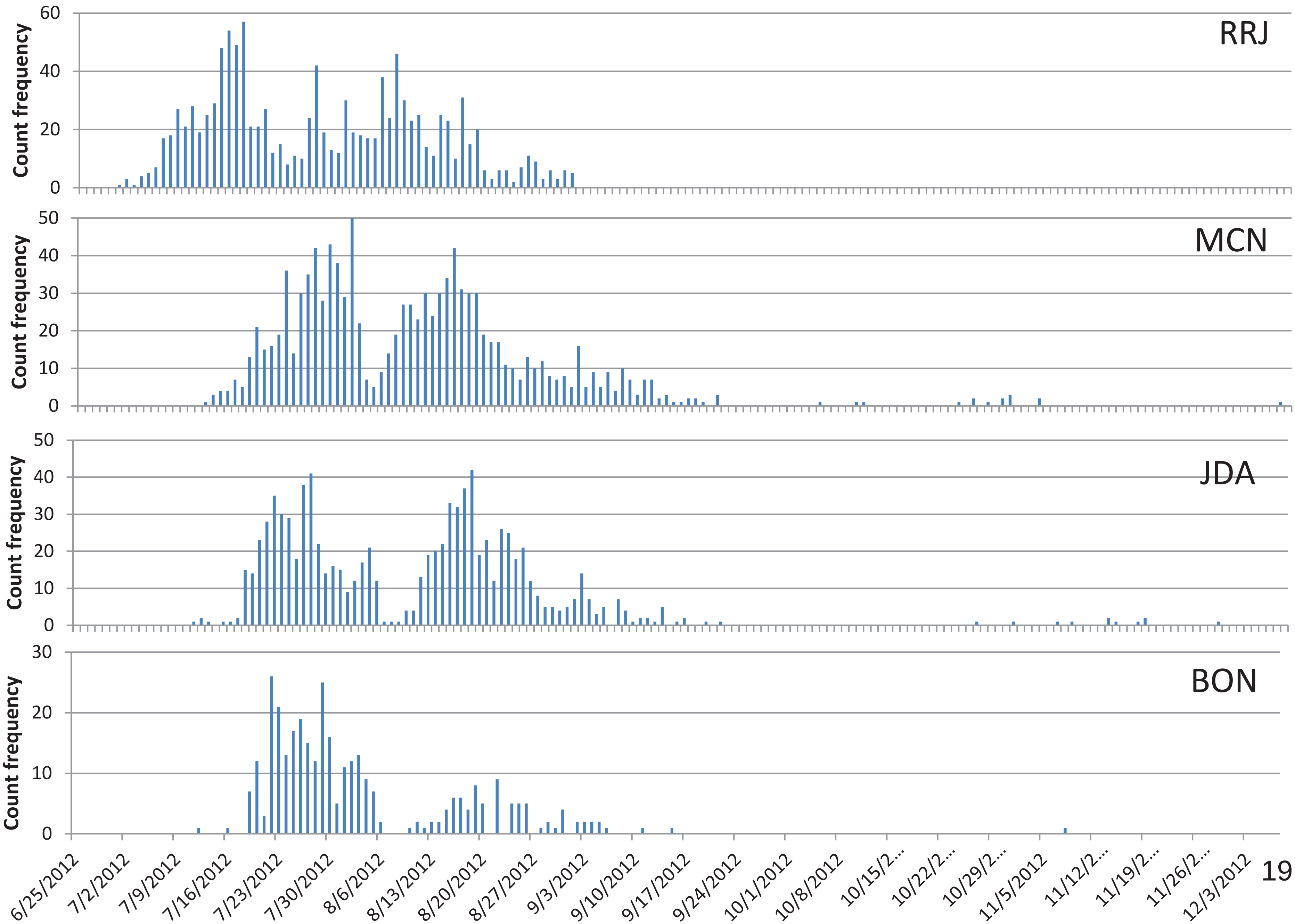


Lots of these…

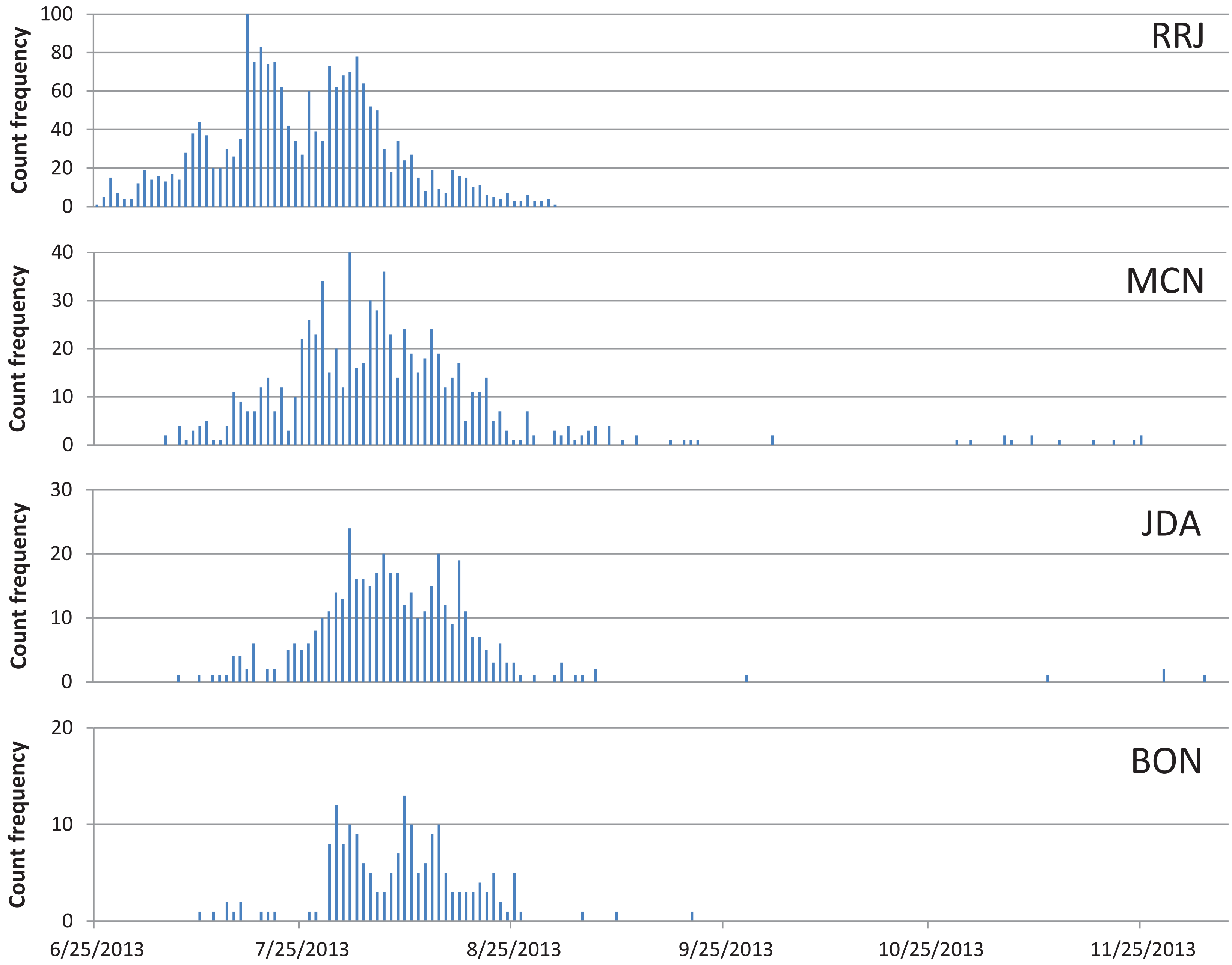
2011 Detections at Downstream Projects



2012 Detections at Downstream Projects



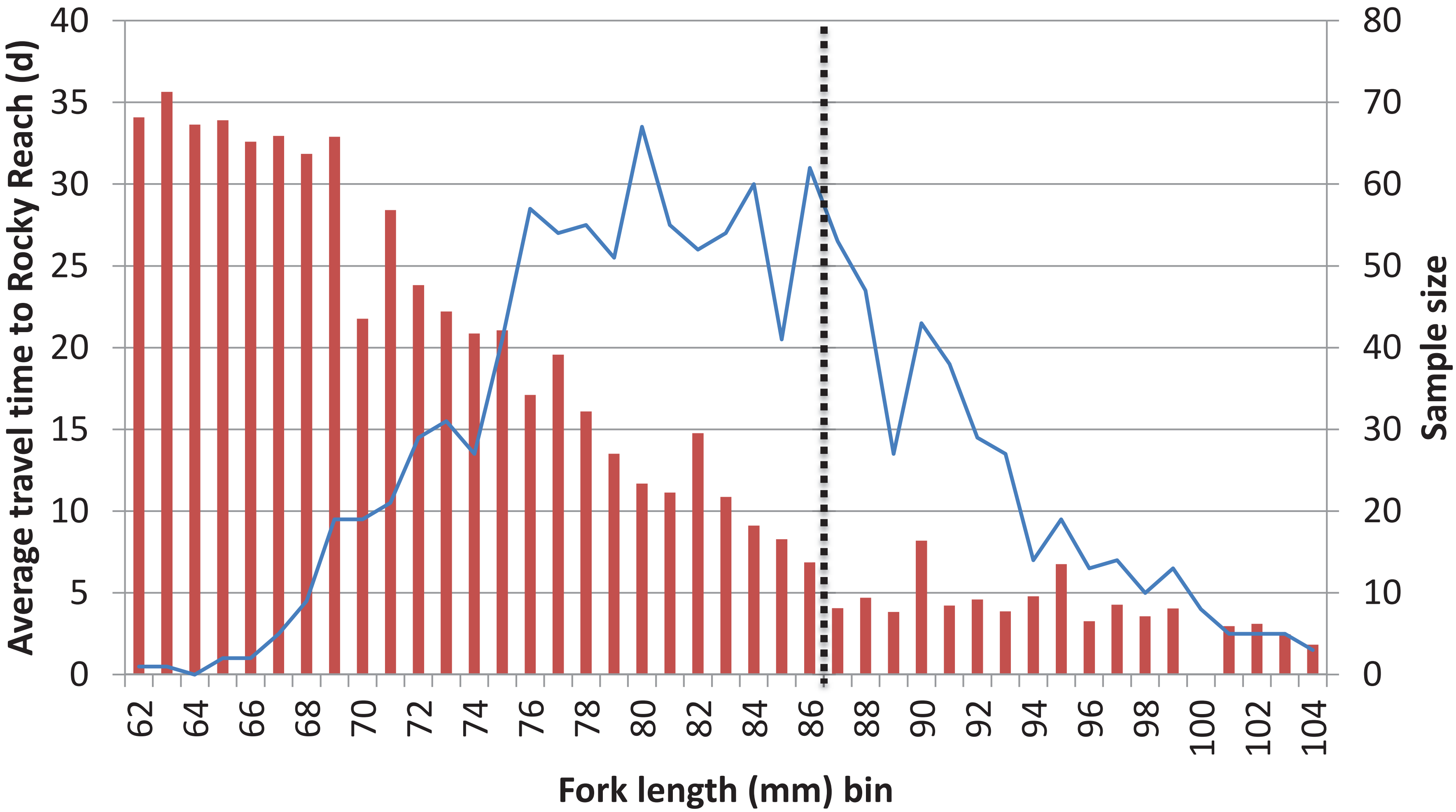
2013 Detections at Downstream Projects



Reach-Specific Travel Times & Rates

	Location (River KM)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
	Release (856)	**19.7** (SE 0.48; n = 1185)	**4.8**						
	RRH (762)			**20.1** (SE 0.98; n = 188)	**14.5**				
	MCN (470)					**7.6** (SE 0.99; n = 99)	**16.2**		
	JDA (347)							**2.5** (SE 0.29; n = 33)	**44.6**
2012	**Release (856)**	**24.8** (SE 0.44; n = 1083)	**3.8**						
	RRH (762)			**15.7** (SE 1.04; n = 119)	**18.6**				
	MCN (470)					**5.0** (SE 0.51; n = 118)	**24.6**		
	JDA (347)							**1.8** (SE 0.05; n = 47)	**64.0**
2013	**Release (856)**	**27.1** (SE 0.30; n = 1765)	**3.5**						
	RRH (762)			**12.5** (SE 0.75; n = 180)	**23.4**				
	MCN (470)					**3.7** (SE 0.27; n = 43)	**33.1**		
	JDA (347)							**2.1** (SE 0.13; n = 24)	**54.4**

Travel Times & Tagging Length - 2011



Different Size Classes - 2011

≥87 mm

Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**4.7** (SE 0.41; n = 121)	**20**						
RRH (762)			**15.8** (SE 3.08; n = 17)	**18.5**				
MCN (470)					**3.2** (SE 0.33; n = 6)	**38.1**		
JDA (347)							**1.9** (SE 0.17; n = 7)	**58.3**

<87 mm

Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**21.2** (SE 0.5; n = 1080)	**4.4**						
RRH (762)			**20.5** (SE 1.02; n = 173)	**14.2**				
MCN (470)					**7.9** (SE 1.05; n = 93)	**15.6**		
JDA (347)							**2.7** (SE 0.37; n = 26)	**41.9**

Different Size Classes - 2012

≥87 mm

Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**11.1** (SE 0.7; n = 166)	**8.5**						
RRH (762)			**11.7** (SE 0.91; n = 15)	**25.0**				
MCN (470)					**3.1** (SE 0.2; n = 19)	**40.2**		
JDA (347)							**1.5** (SE 0.06; n = 13)	**72.7**

<87 mm

Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**27.2** (SE 0.46; n = 917)	**3.5**						
RRH (762)			**16.2** (SE 1.18; n = 104)	**18.0**				
MCN (470)					**5.4** (SE 0.60; n = 99)	**22.9**		
JDA (347)							**1.8** (SE 0.07; n = 34)	**61.5**

Different Size Classes - 2013

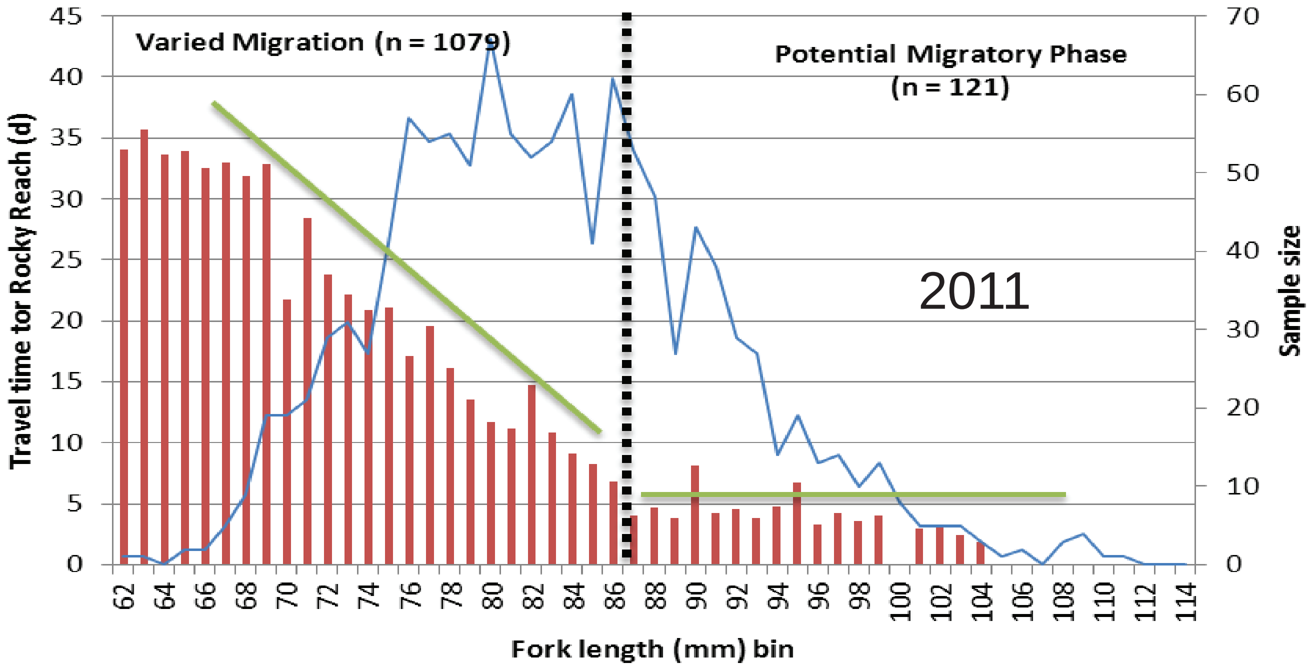
≥87 mm

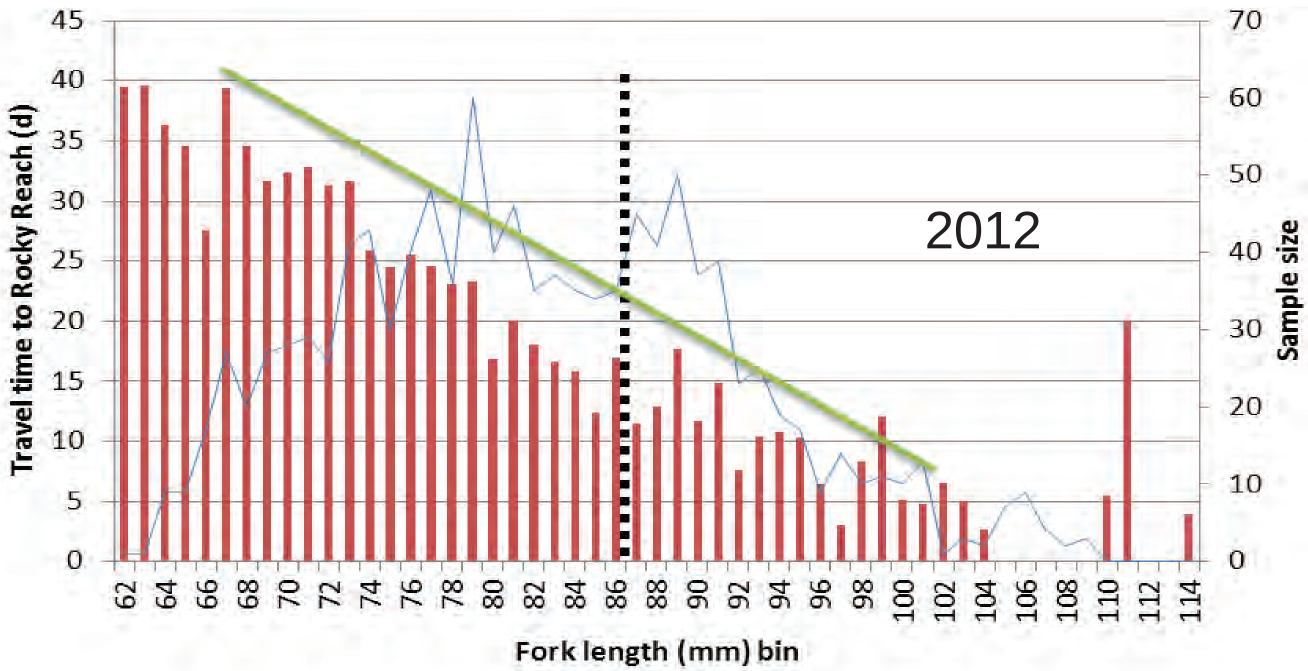
Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**14.8** (SE 0.56; n = 299)	**6.4**						
RRH (762)			**11.4** (SE 1.01; n = 18)	**25.6**				
MCN (470)					**3.9** (SE 0.65; n = 9)	**31.5**		
JDA (347)							**1.9** (SE 0.17; n = 4)	**58.9**

<87 mm

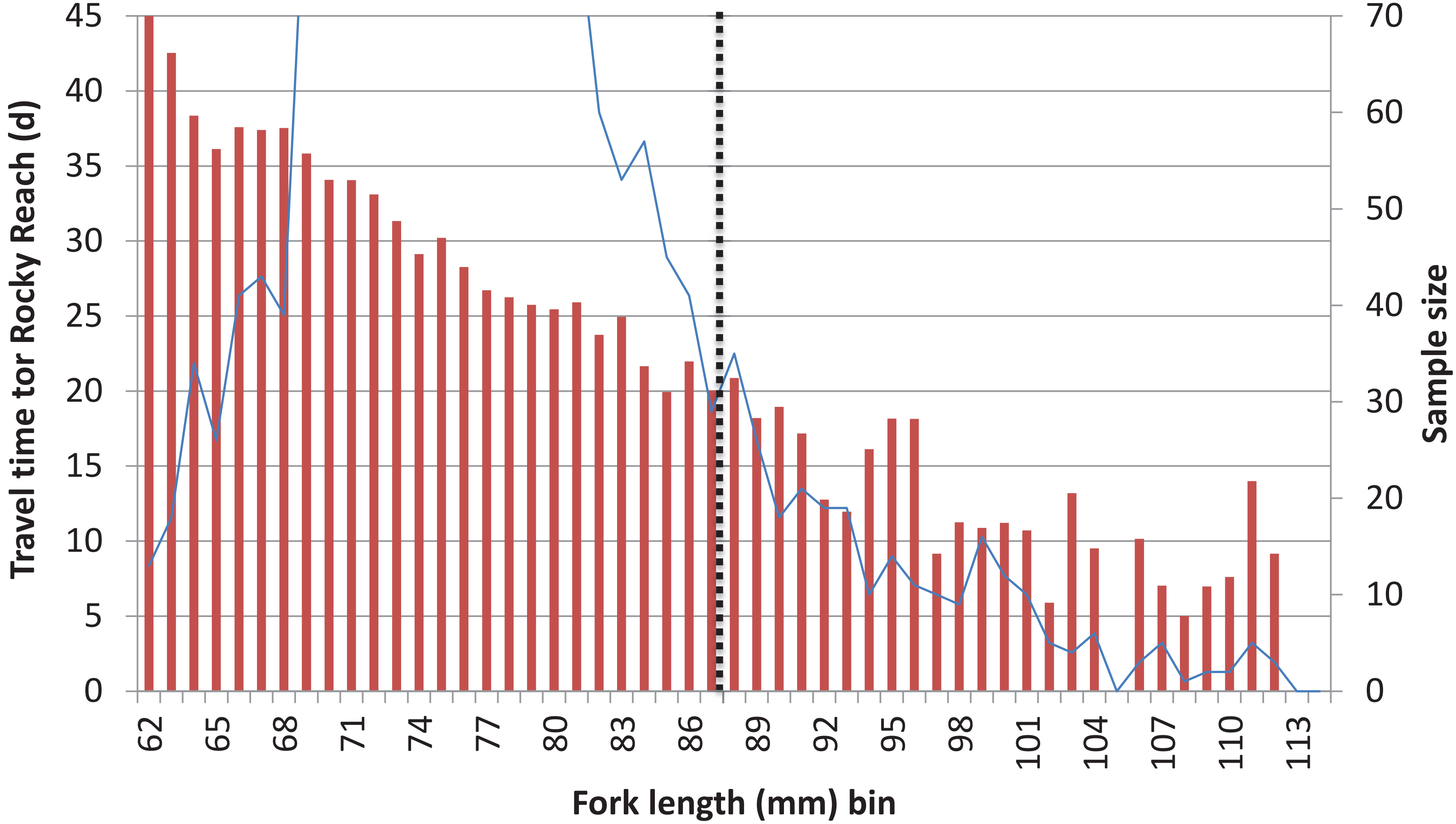
Location (River km)	RRH (762) Travel Time (d)	RRH (762) Rate (km/d)	MCN (470) Travel Time (d)	MCN (470) Rate (km/d)	JDA (347) Travel Time (d)	JDA (347) Rate (km/d)	BON (235) Travel Time (d)	BON (235) Rate (km/d)
Release (856)	**29.3** (SE 0.28; n = 1688)	**3.2**						
RRH (762)			**12.4** (SE 0.76; n = 178)	**23.5**				
MCN (470)					**3.6** (SE 0.28; n = 37)	**34.2**		
JDA (347)							**2.1** (SE 0.13; n = 24)	**53.3**

Relationship Between Length at Tagging and Travel Time to RRJFB





Travel Times & Tagging Length - 2013



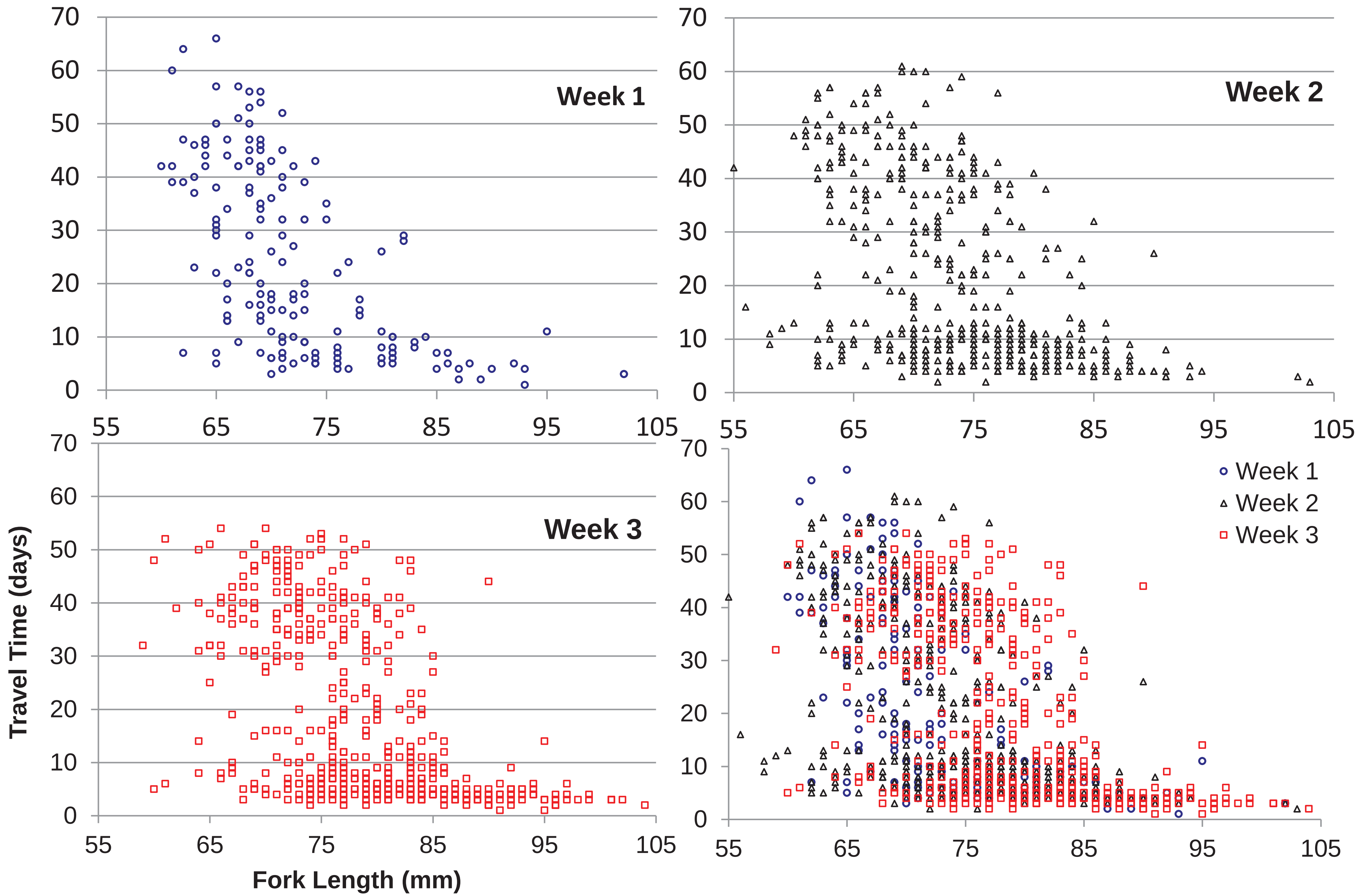
Travel Times & Detection Rates by Size Class

Release Year	*Size range (mm)*	*Number tagged*	*Number detected*	*% of size class detected*	*Mean travel time (days)*	*Standard Deviation*
2011	**<87**	12192	1079	8.9	21.2	16.6
	>86	1028	121	11.8	4.7	4.5
2012	**<87**	16710	966	5.8	27.2	14.1
	>86	2877	187	6.5	11.1	8.9
2013	**<87**	15744	1687	10.7	29.3	11.5
	>86	2003	300	15.0	14.8	10.2

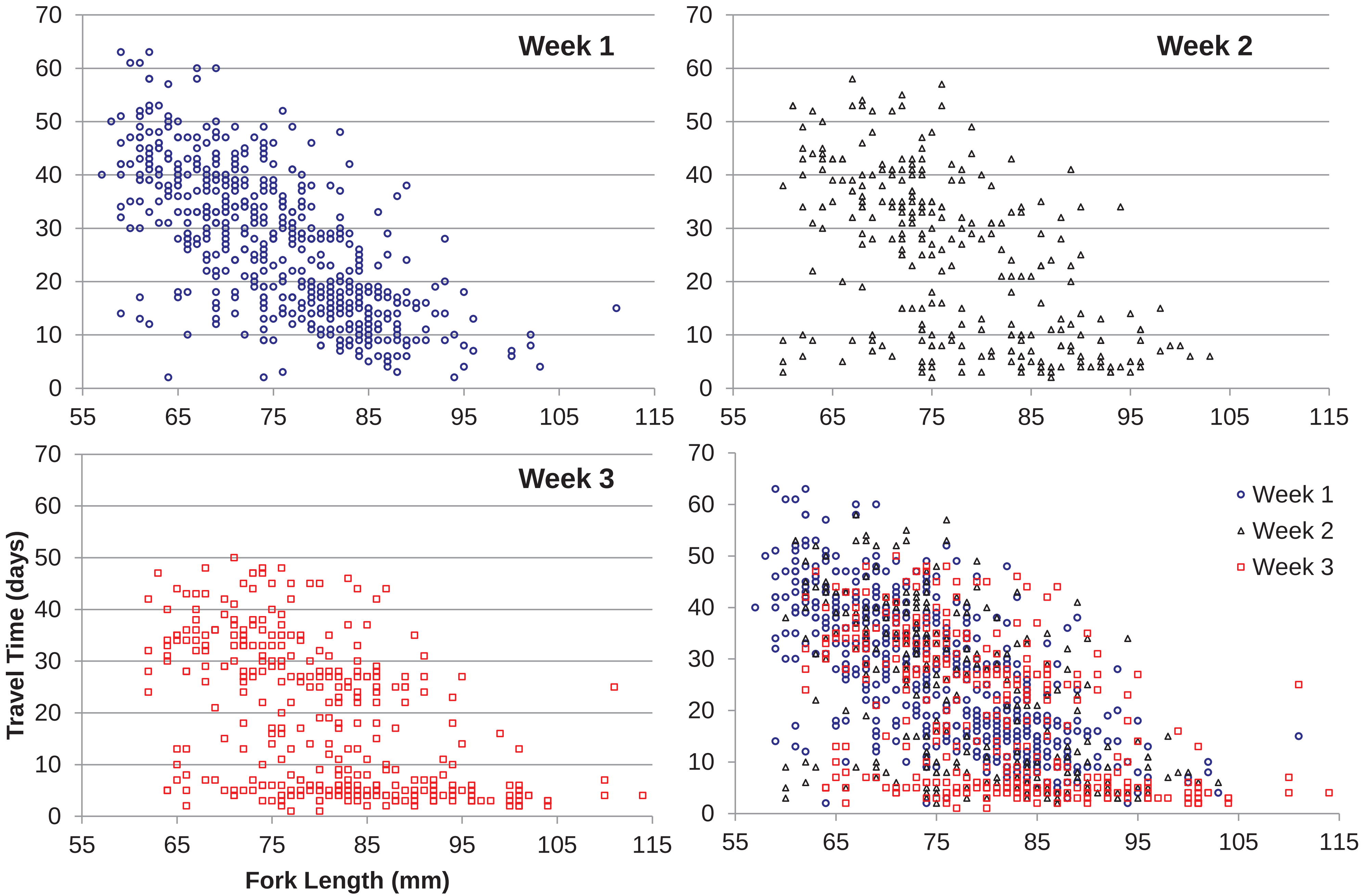
Release to Any Downstream Detection Project

Release Year	*Size range (mm)*	*Number tagged*	*Number detected*	*Proportion detected (%)*
2011	**<87**	12192	2046	16.8
	>86	1028	271	26.4
2012	**<87**	16970	2474	14.6
	>86	2877	621	21.6
2013	**<87**	15744	2495	15.8
	>86	2003	447	22.3

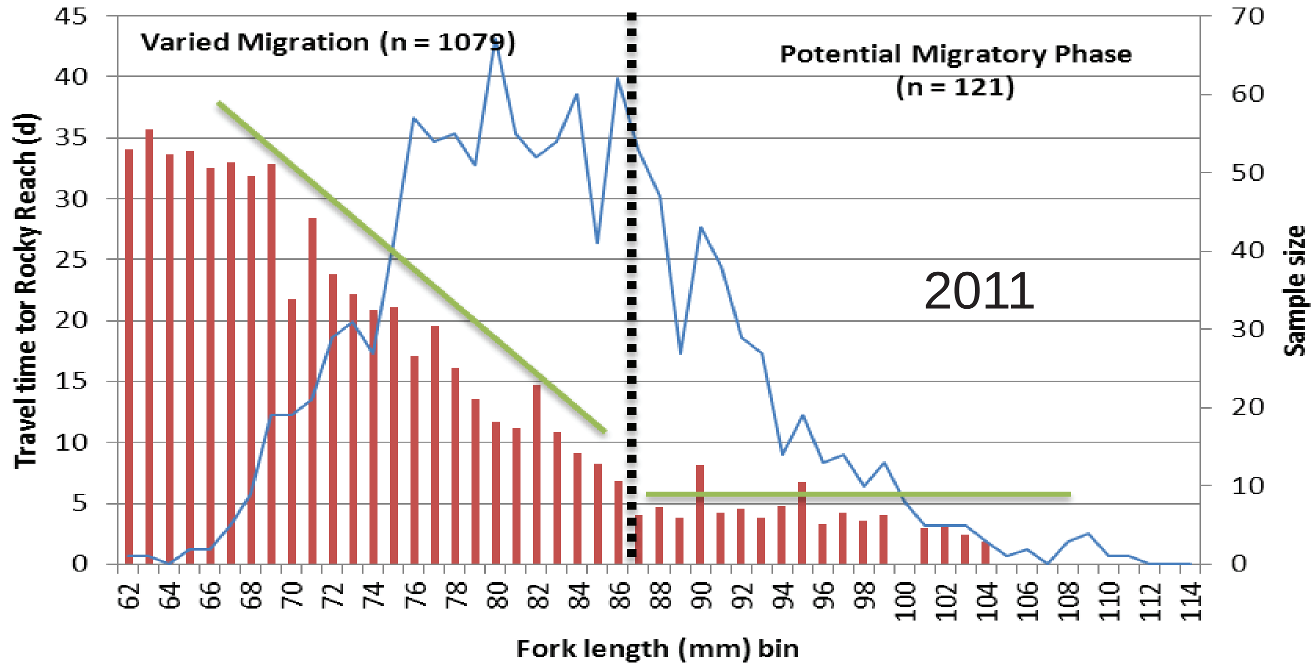
Travel Times & Tagging Length - 2011

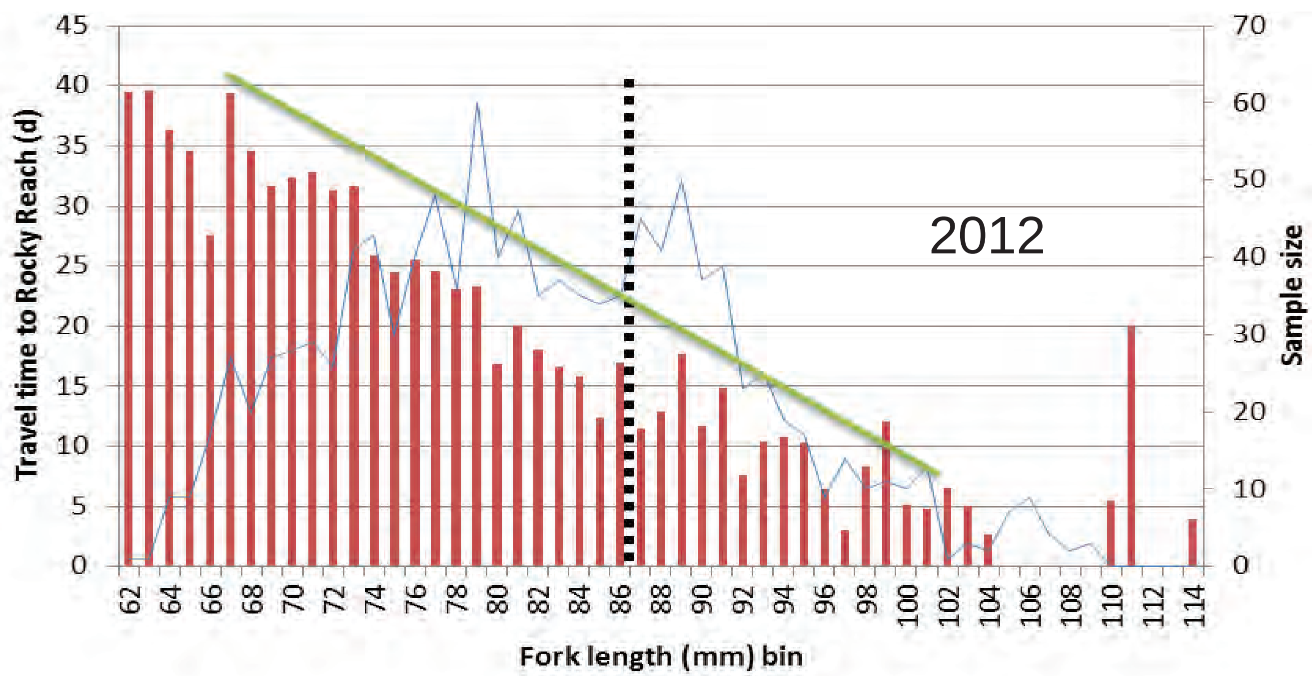


Travel Times & Tagging Length - 2012

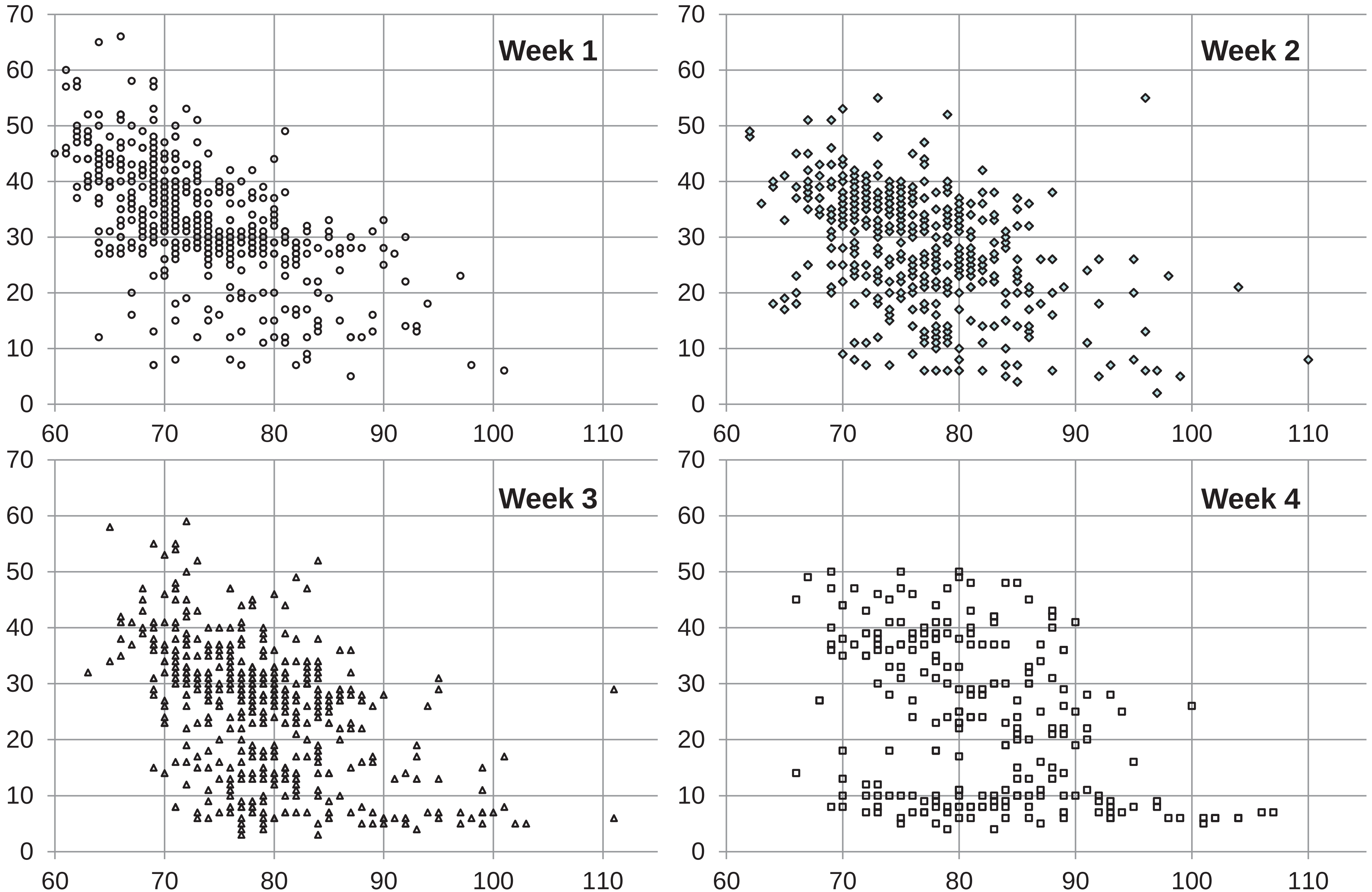


Relationship Between Length at Tagging and Travel Time to RRJFB

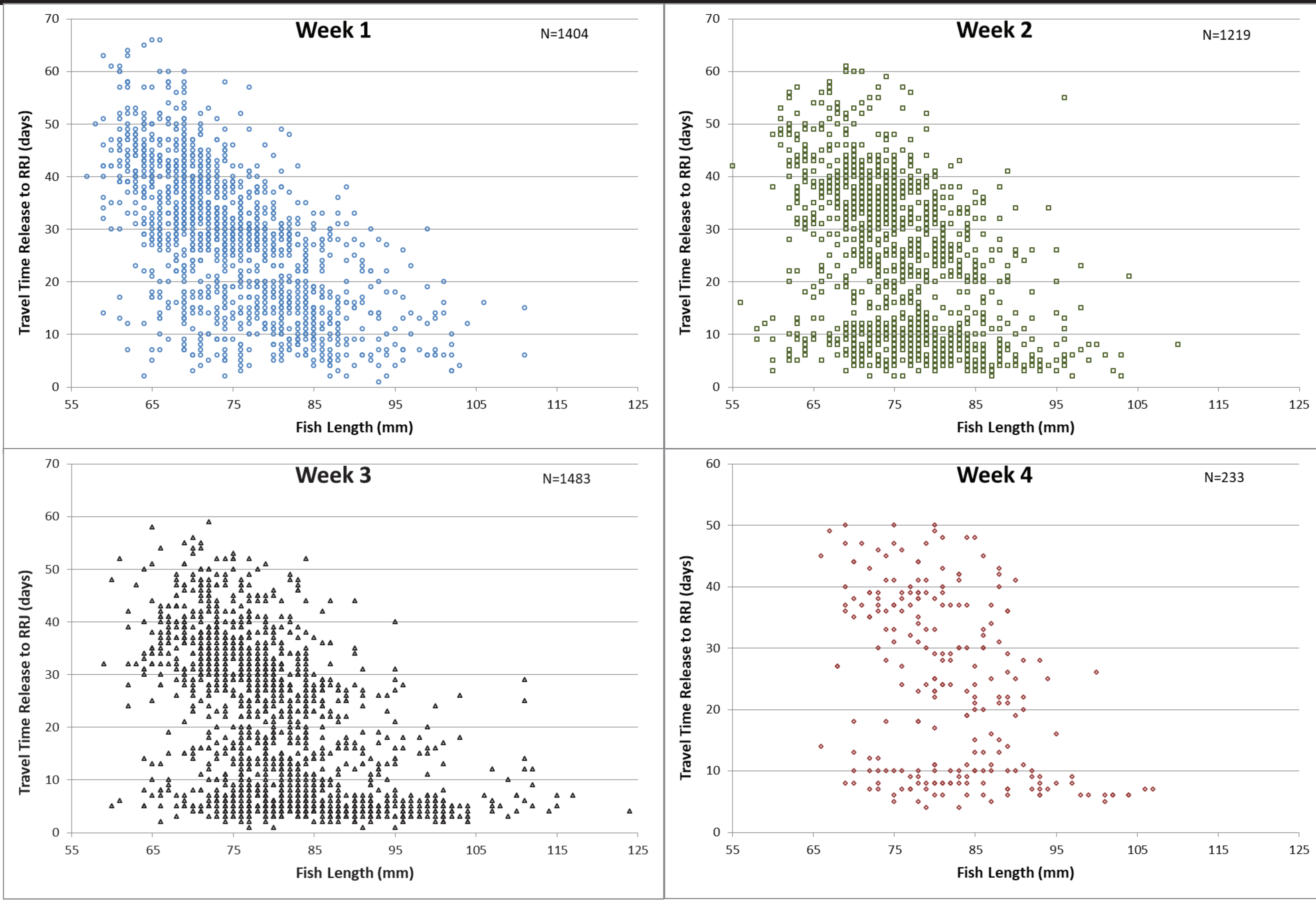




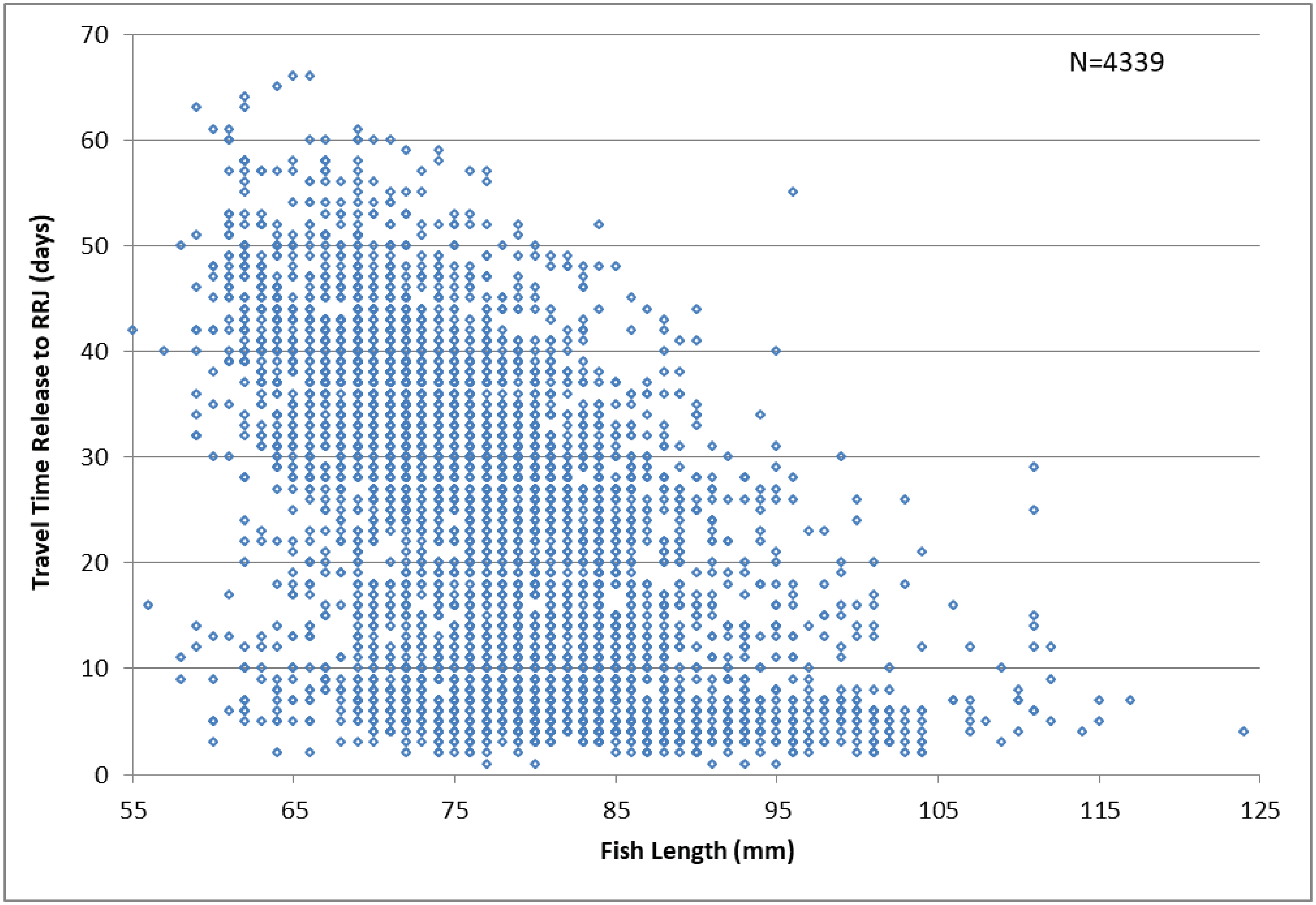
Travel Times & Tagging Length - 2013



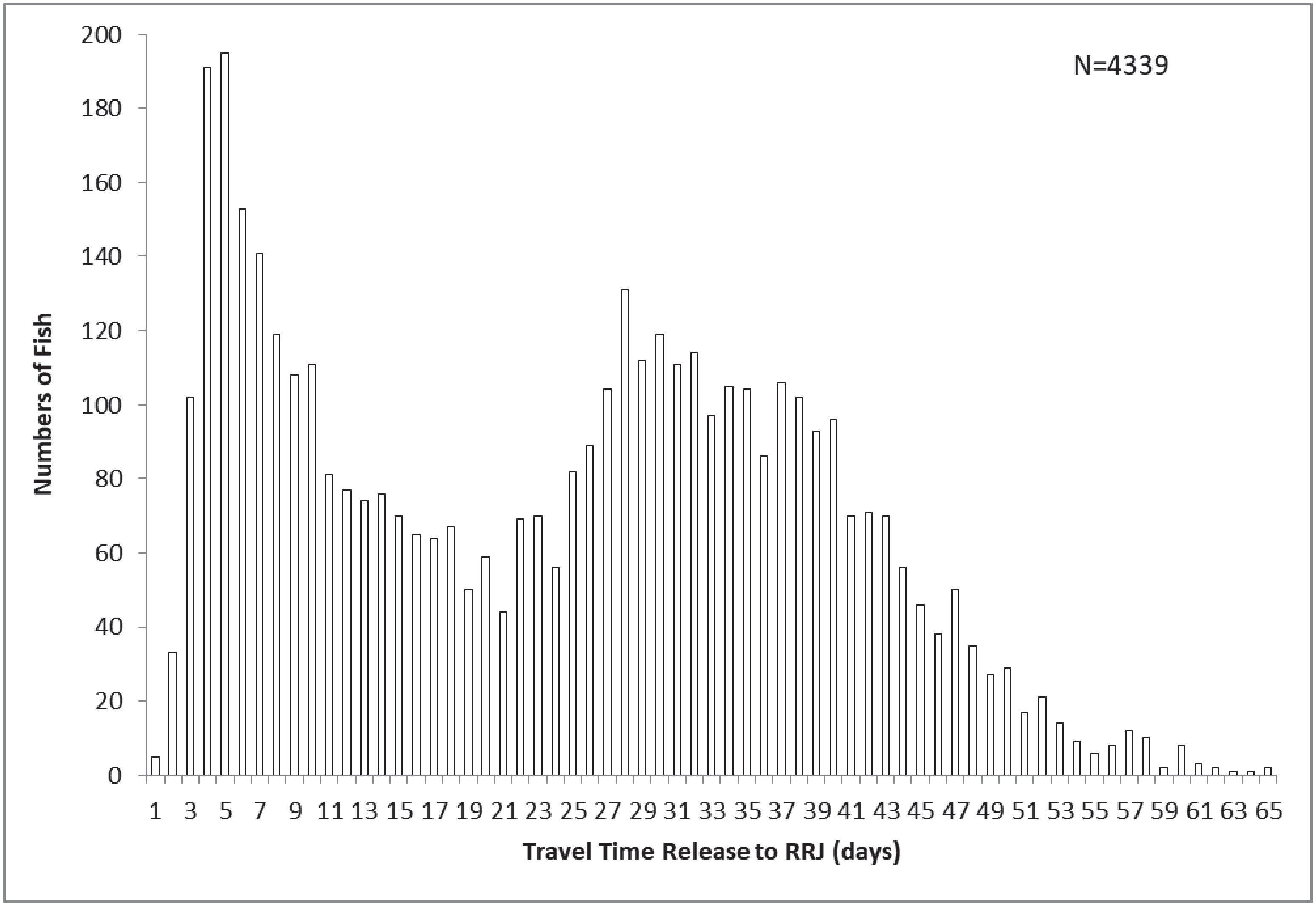
Travel Times & Tagging Length – All Years



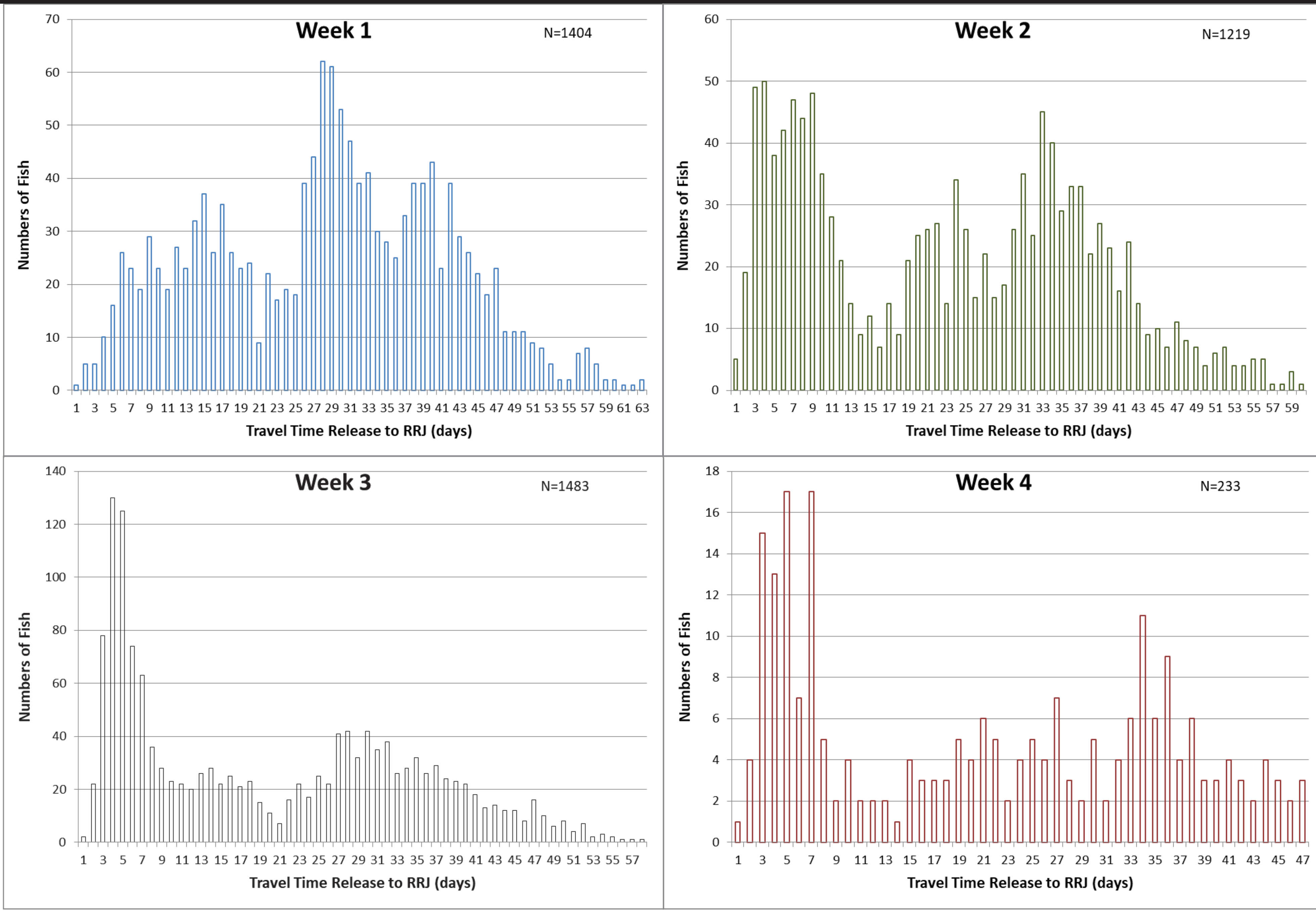
Travel Times & Tagging Length – All Years



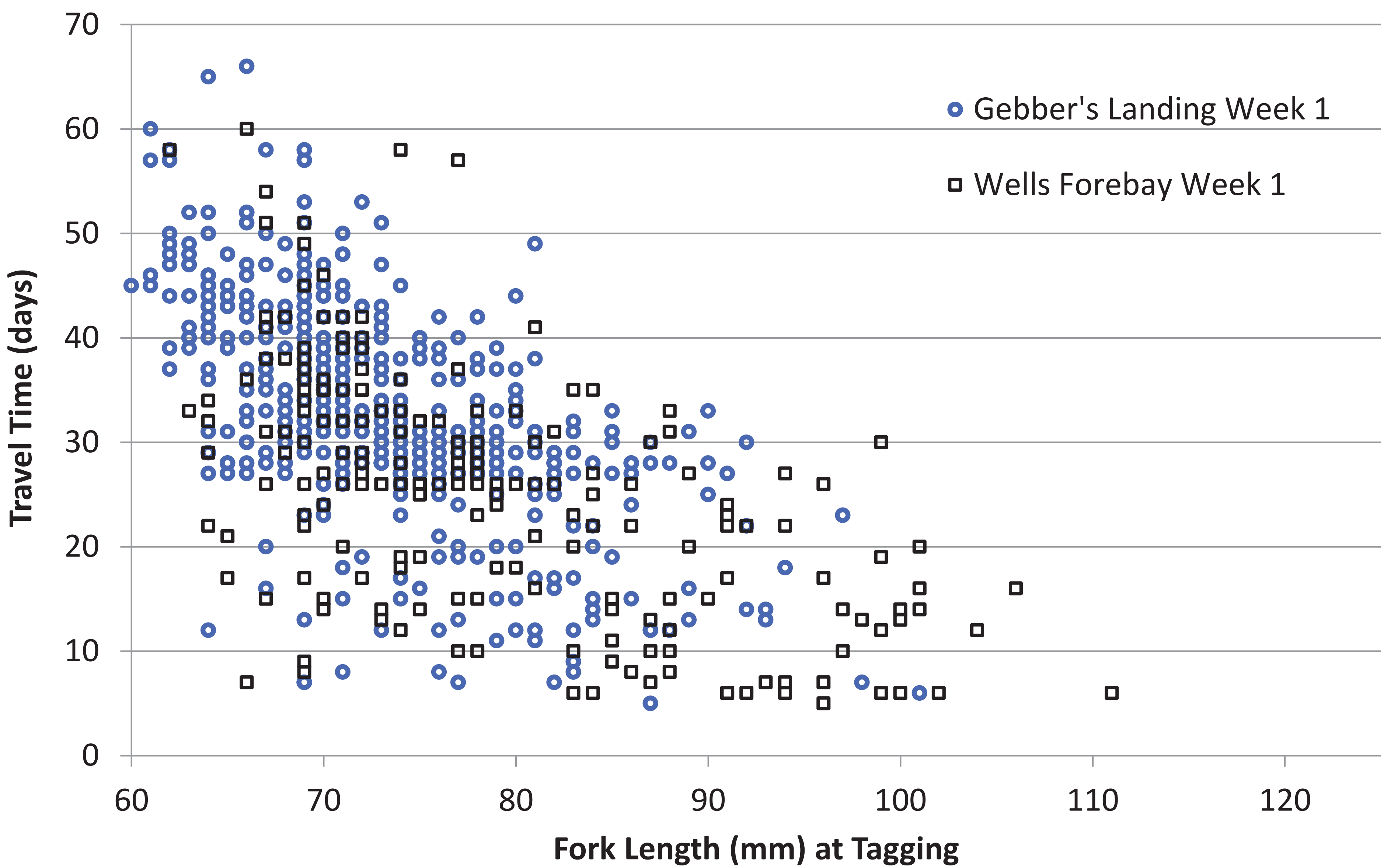
Travel Times & Fish Numbers – All Years



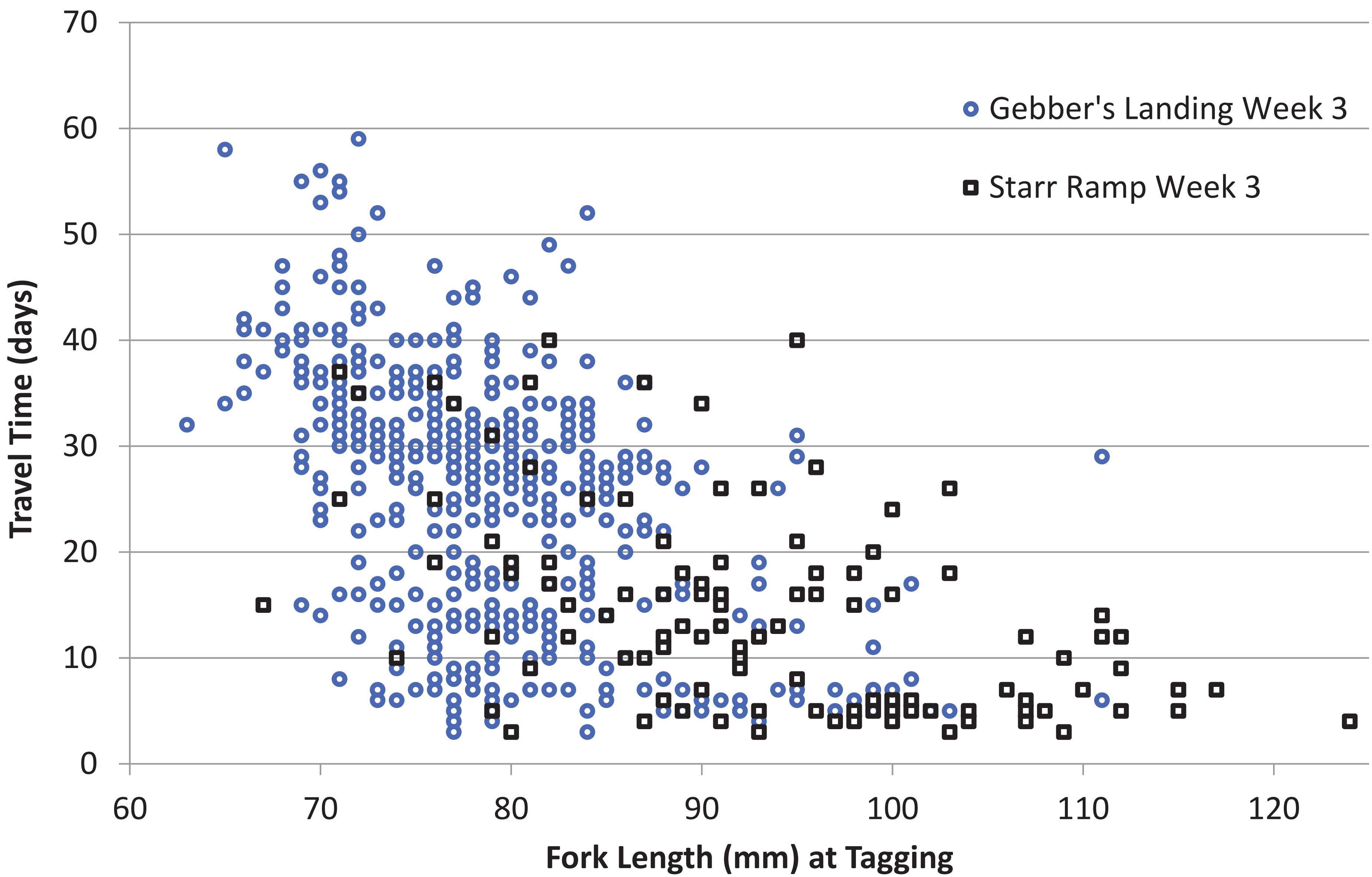
Travel Times & Fish Numbers – All Years



Travel Times & Tagging Length - 2013



Travel Times & Tagging Length - 2013



Proportions of Fish With Travel Times ≤20 or >20 Days

Travel Time Post-Tagging Release to RRJ for All Tagged Fish

Travel Time	All Weeks (N=4,339)	Week 1 (N=1,404)	Week 2 (N=1,219)	Week 3 (N=1,483)	Week 4 (N=233)
≤20 Days	0.42	0.31	0.42	0.54	0.44
>20 Days	0.58	0.69	0.58	0.46	0.56

Proportions of Fish With Travel Times ≤20 or >20 Days

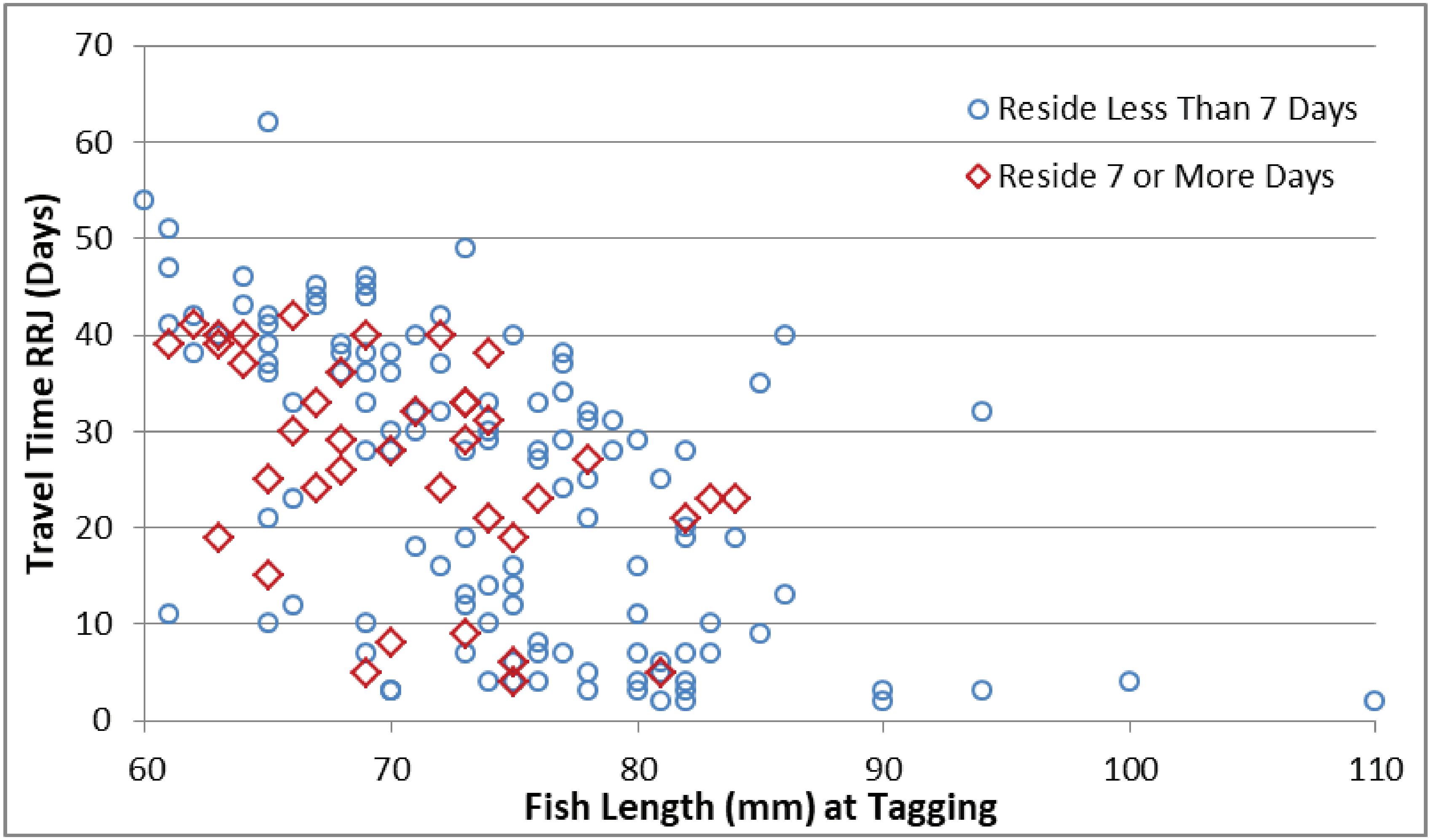
Travel Time Post-Tagging Release to RRJ for All Tagged Fish

Travel Time	All Weeks (N=4,339)	Week 1 (N=1,404)	Week 2 (N=1,219)	Week 3 (N=1,483)	Week 4 (N=233)
≤20 Days	0.42	0.31	0.42	0.54	0.44
>20 Days	0.58	0.69	0.58	0.46	0.56

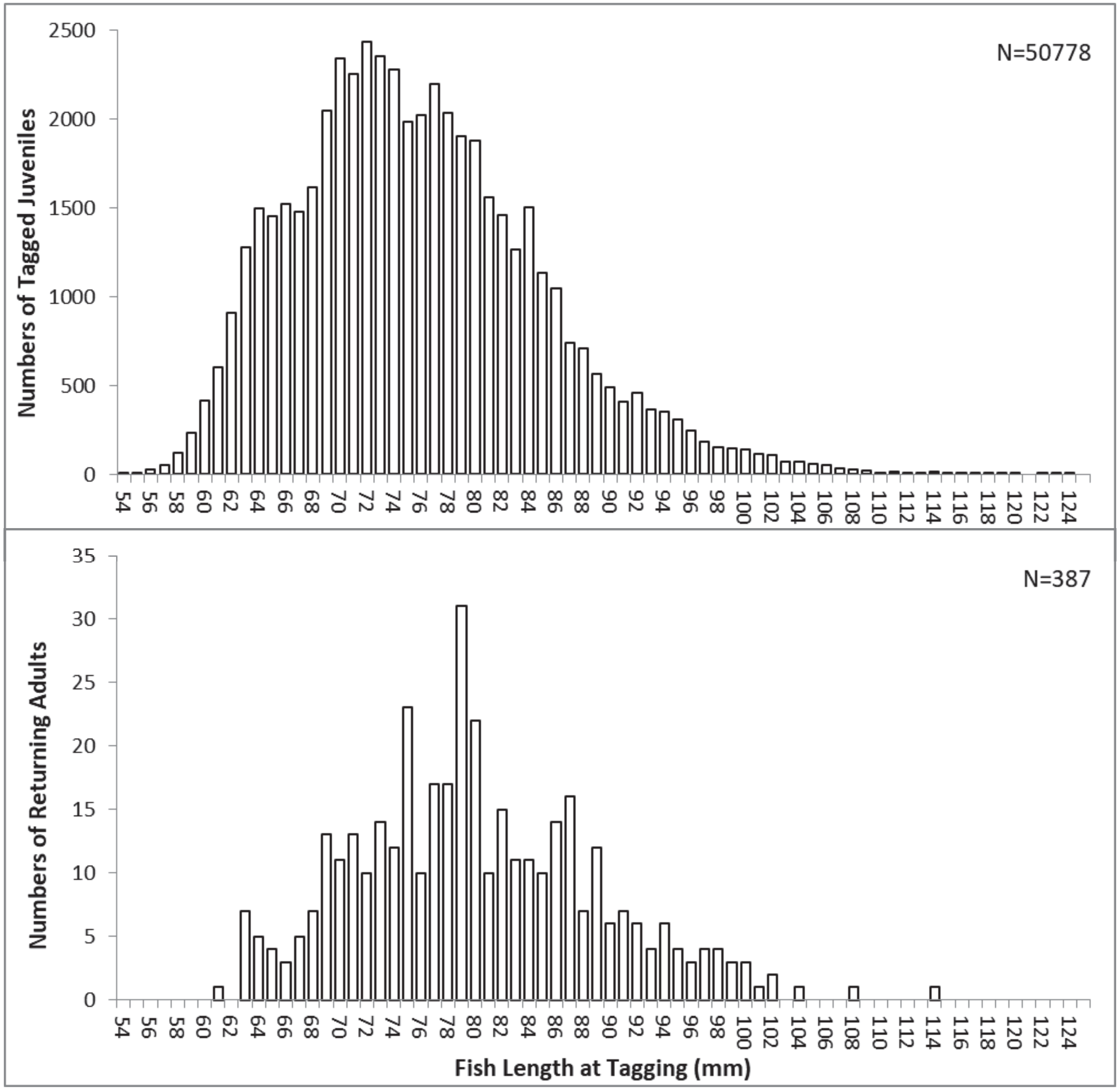
Post-Recapture Travel Time to RRJ for Fish Recaptured in Wells Reservoir

Travel Time	All Tagged Fish (N=4339)	All Recaptured Fish (N=162)	Reservoir Residence Time Prior to Recapture	
			≥7 Days (N=40)	**<7 Days (N=122)**
≤20 Days	0.42	0.38	0.22	0.43
>20 Days	0.58	0.62	0.78	0.57

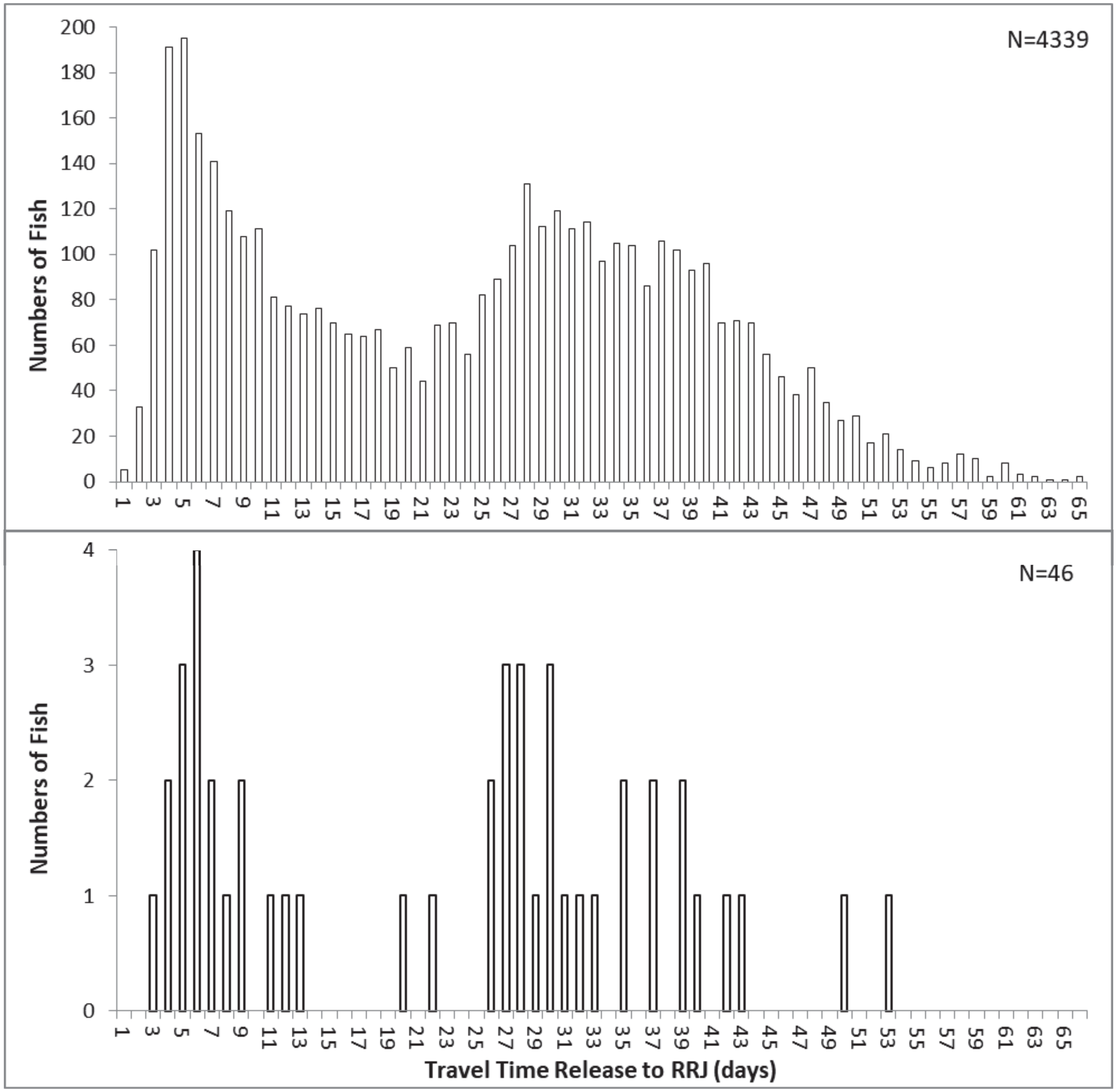
Proportions of Fish With Travel Times ≤20 or >20 Days

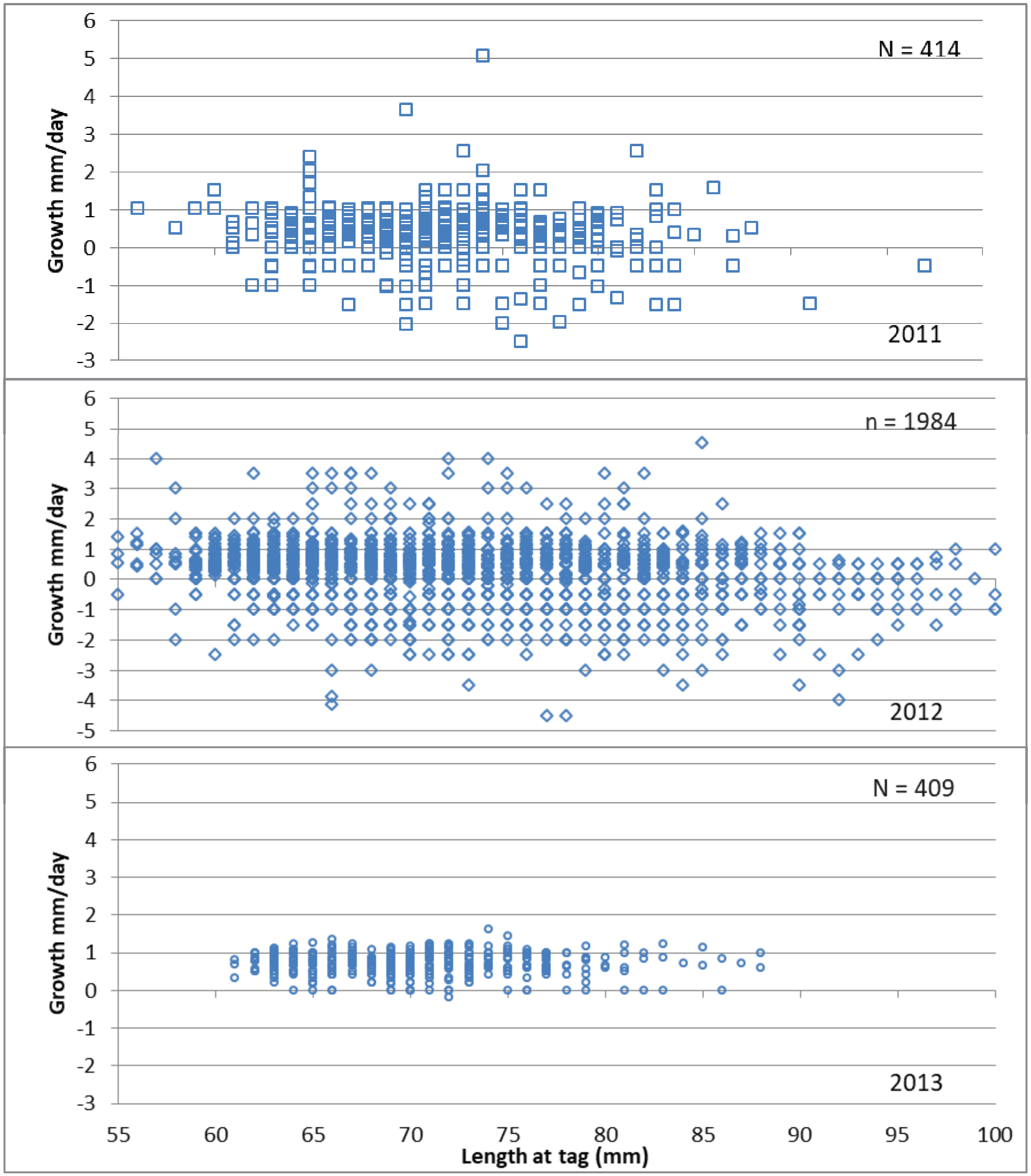


Distributions of Lengths (at tagging) of All Tagged Fish and Those That Returned as Adults



Distributions of Travel Times from Release to RRJ of All Tagged Fish and Those That Returned as Adults

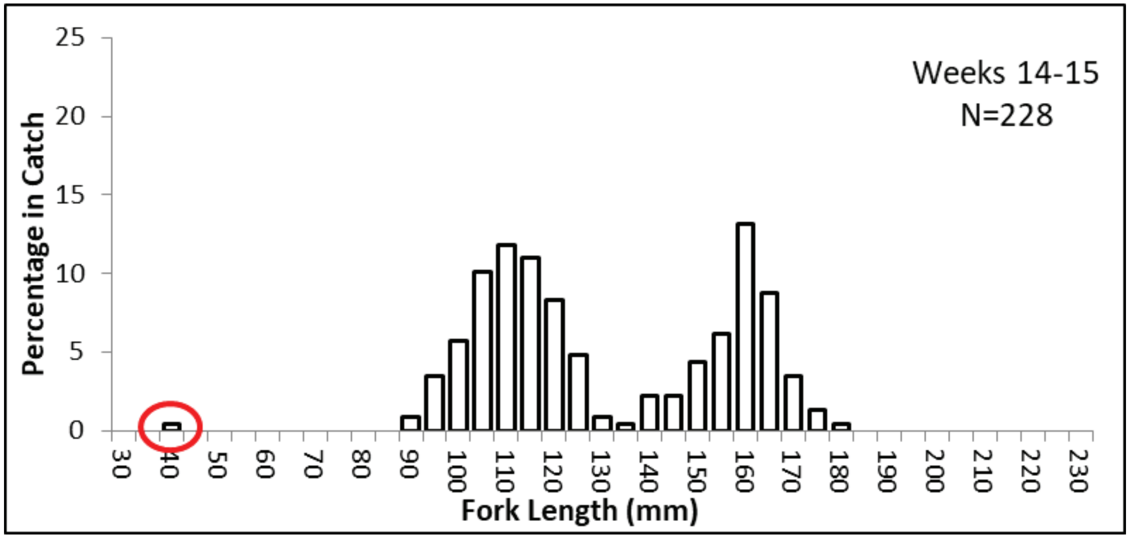




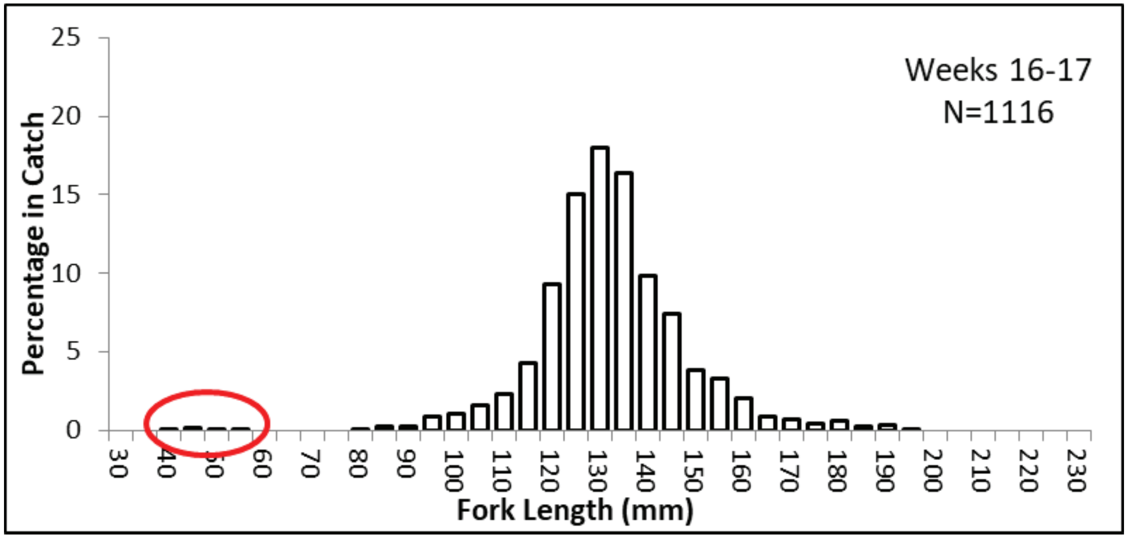
N = 414
2011
n = 1984
2012
N = 409
2013
Growth mm/day
Length at tag (mm)

Wells Chinook Passage Timing From 1984-1995 Fyke-Net Data

First two weeks in April



Third and Fourth weeks in April

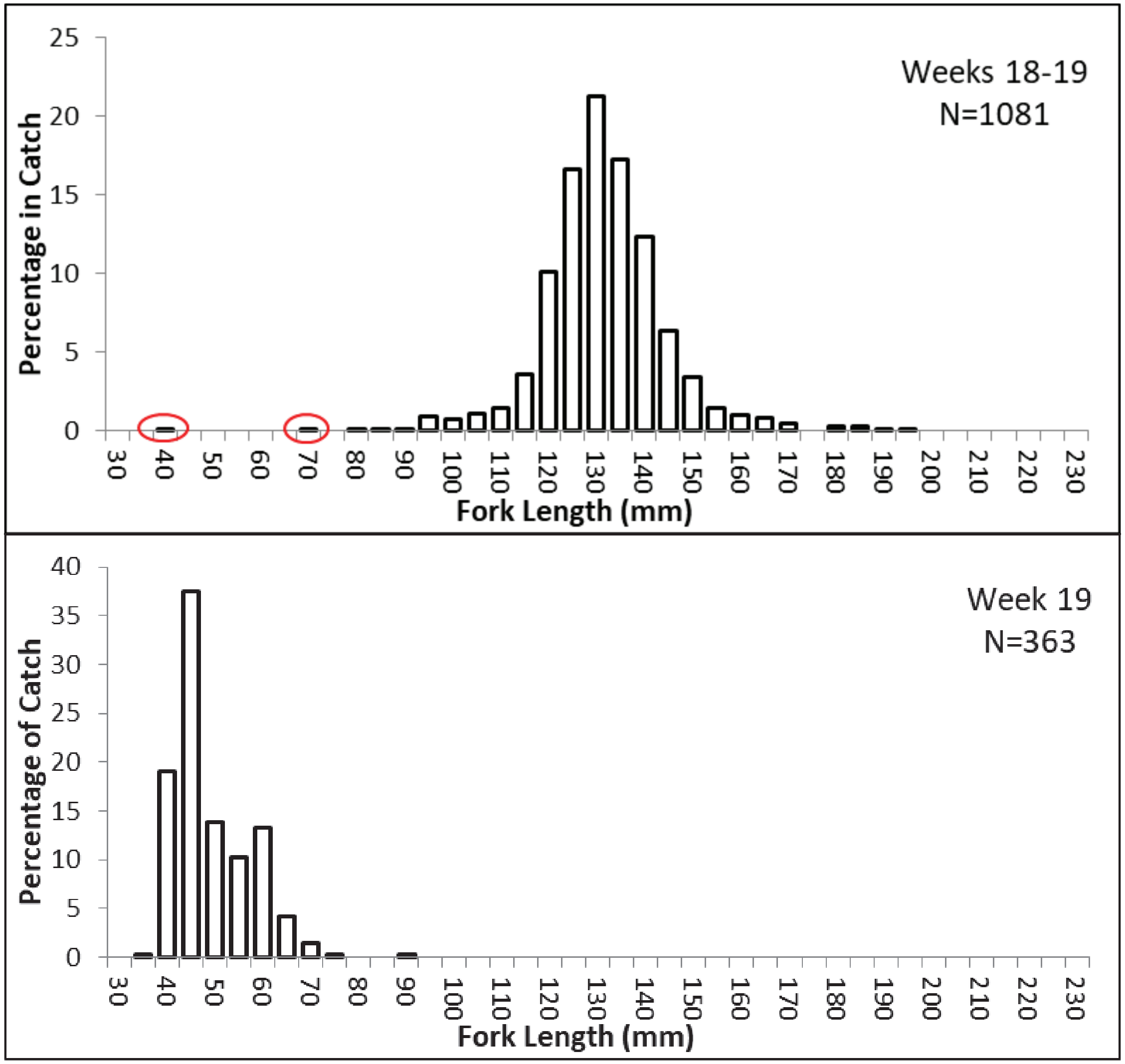


Historical Fyke-Net Data vs. Recent Beach-Seine Data

First two weeks in May

Fyke-Net

2011-2014
Beach Seine

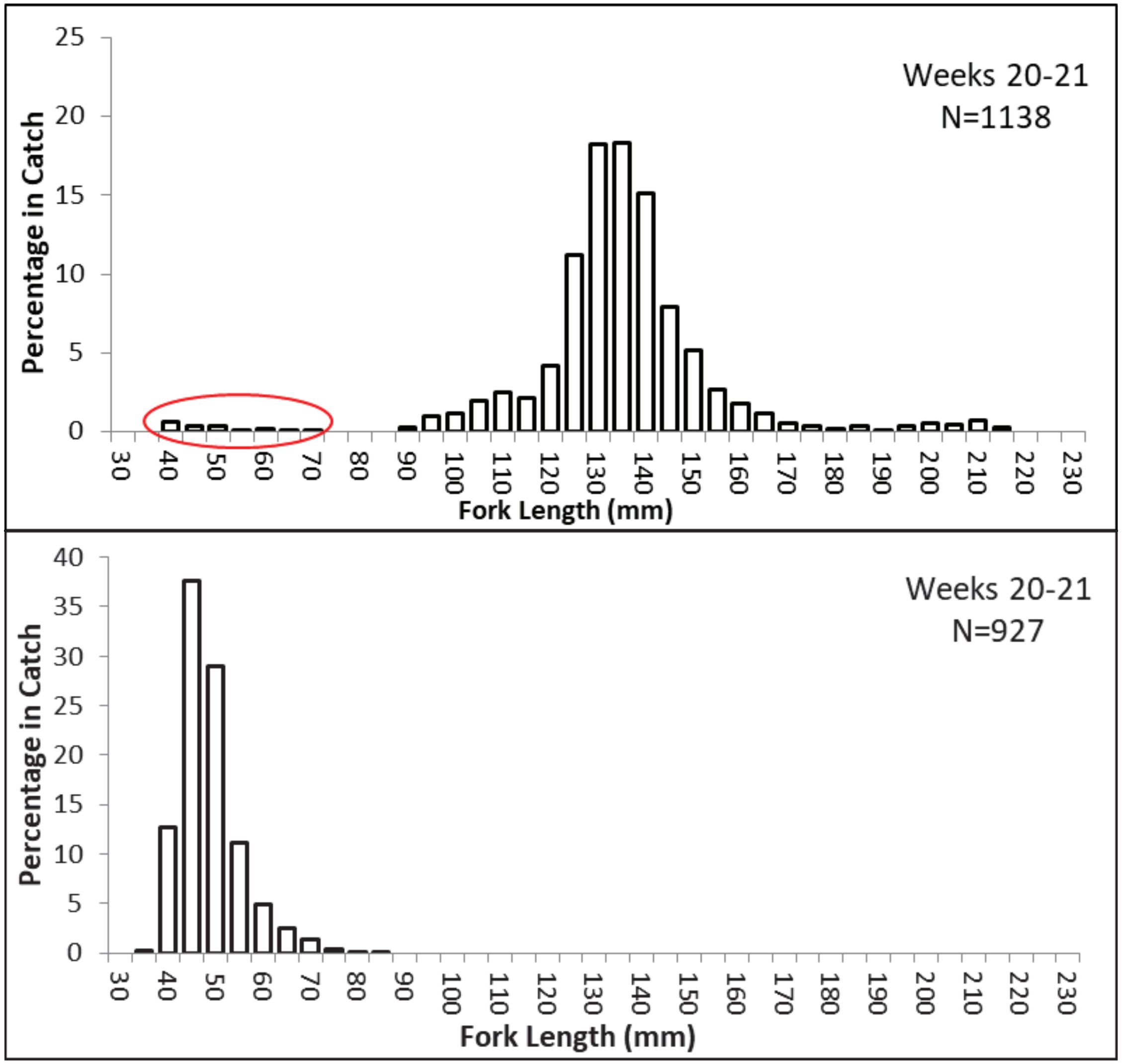


Historical Fyke-Net Data vs. Recent Beach-Seine Data

Third and Fourth weeks in May

Fyke-Net

2011-2014
Beach Seine

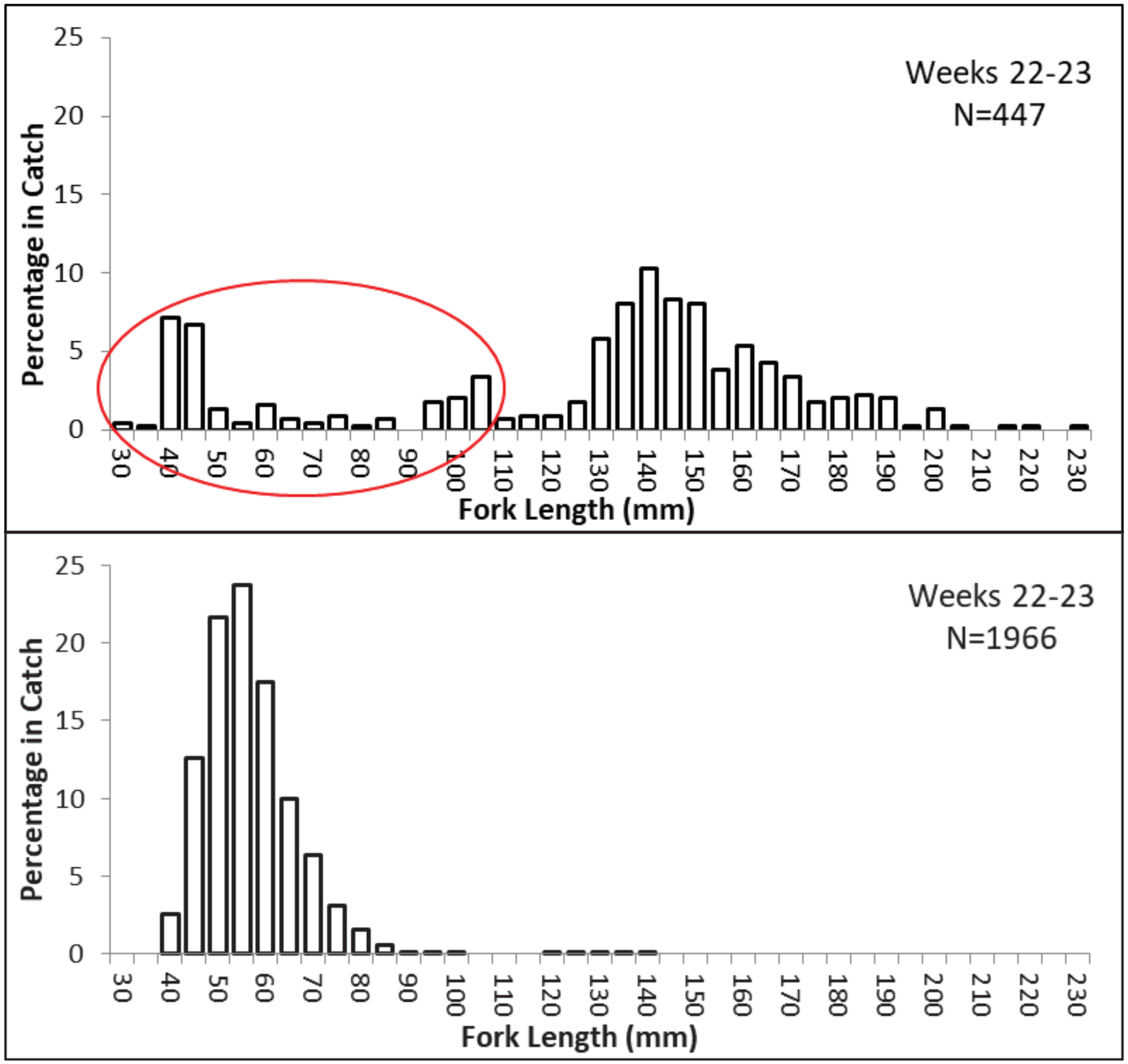


Historical Fyke-Net Data vs. Recent Beach-Seine Data

Last week in May, first week in June

Fyke-Net

2011-2014
Beach Seine

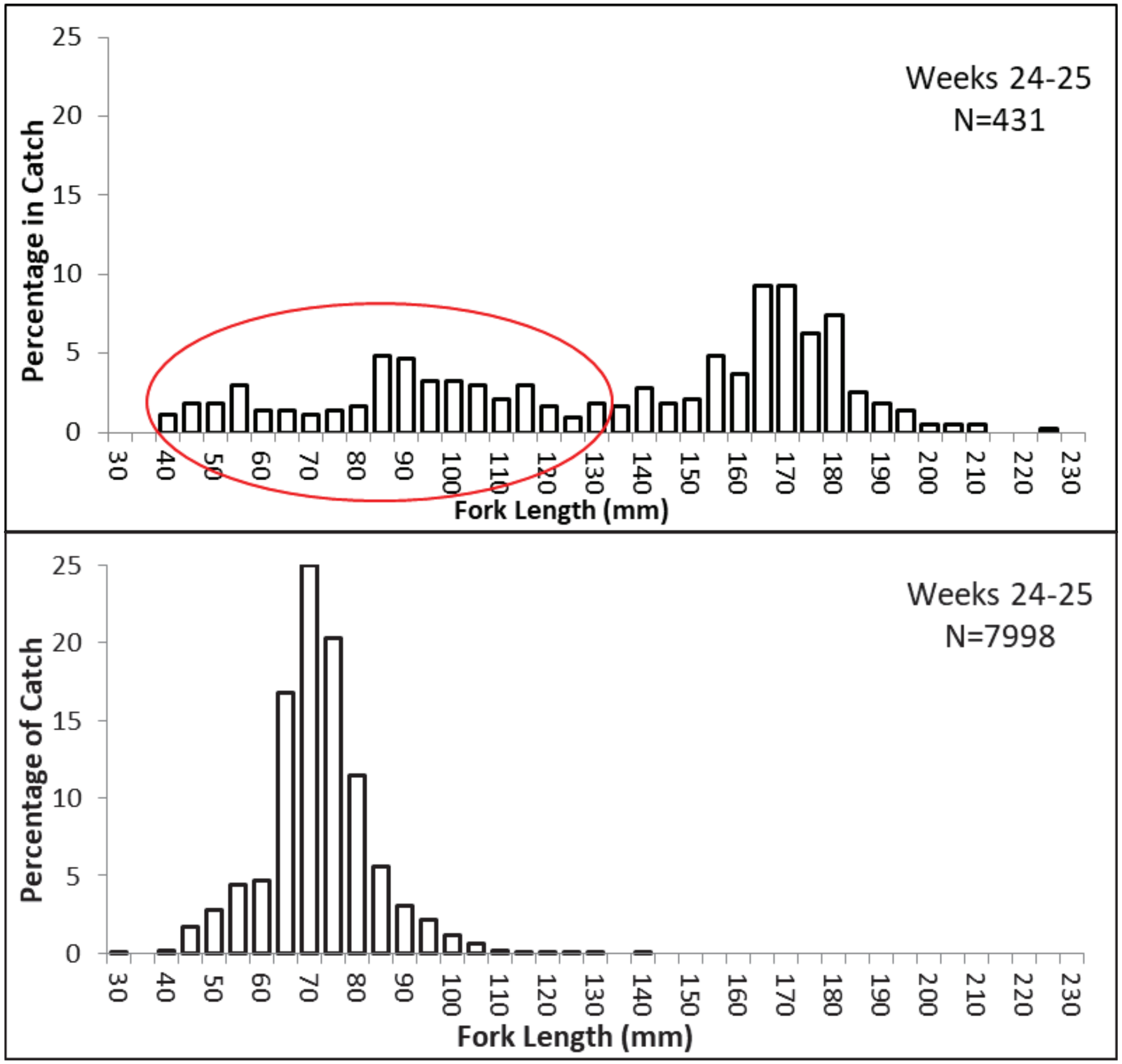


Historical Fyke-Net Data vs. Recent Beach-Seine Data

Second and third weeks in June

Fyke-Net

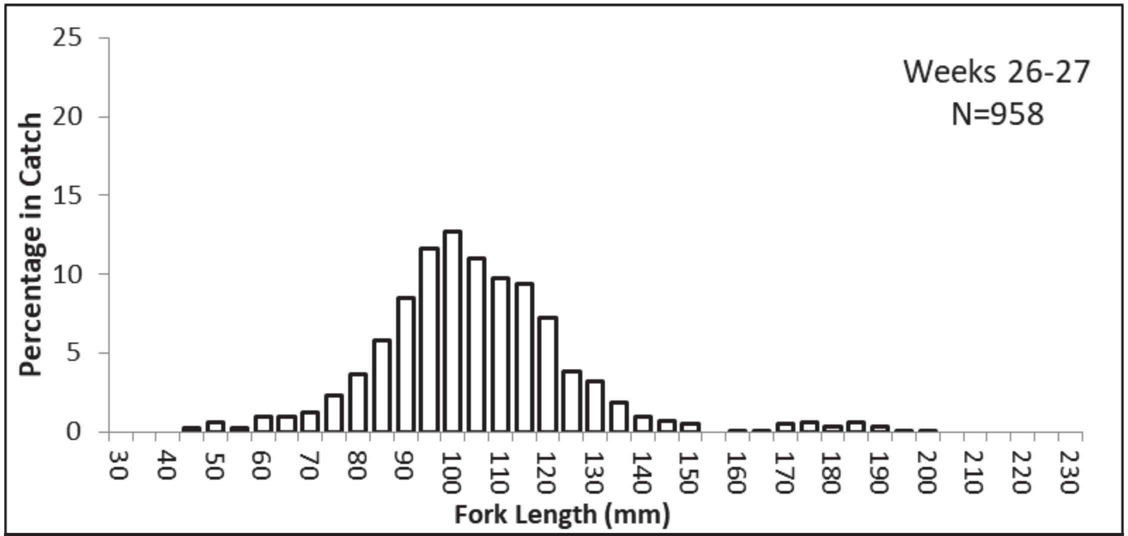
2011-2014
Beach Seine



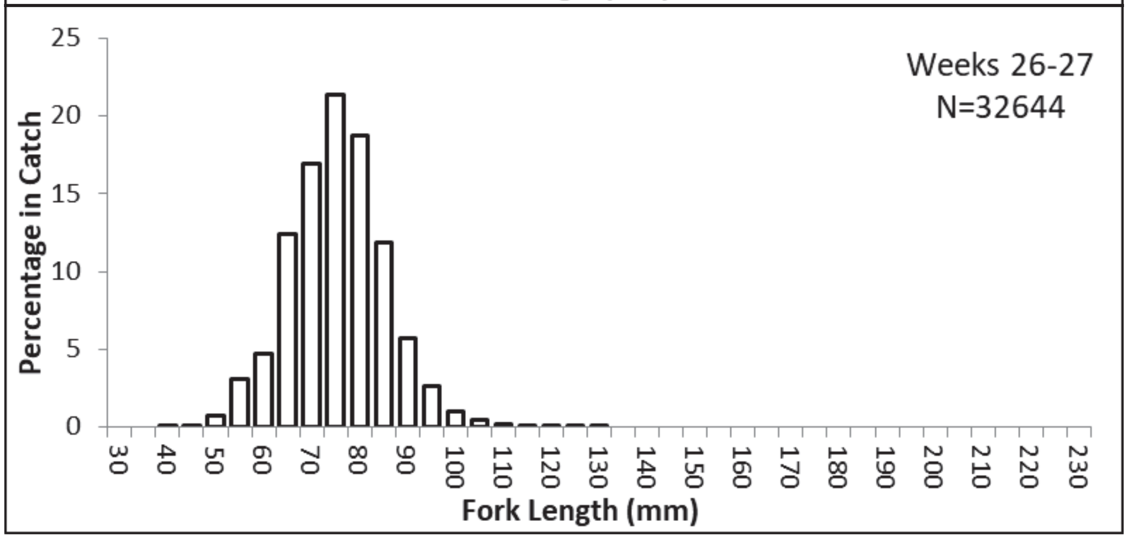
Historical Fyke-Net Data vs. Recent Beach-Seine Data

Last week of June, first week of July

Fyke-Net



2011-2013
Beach Seine

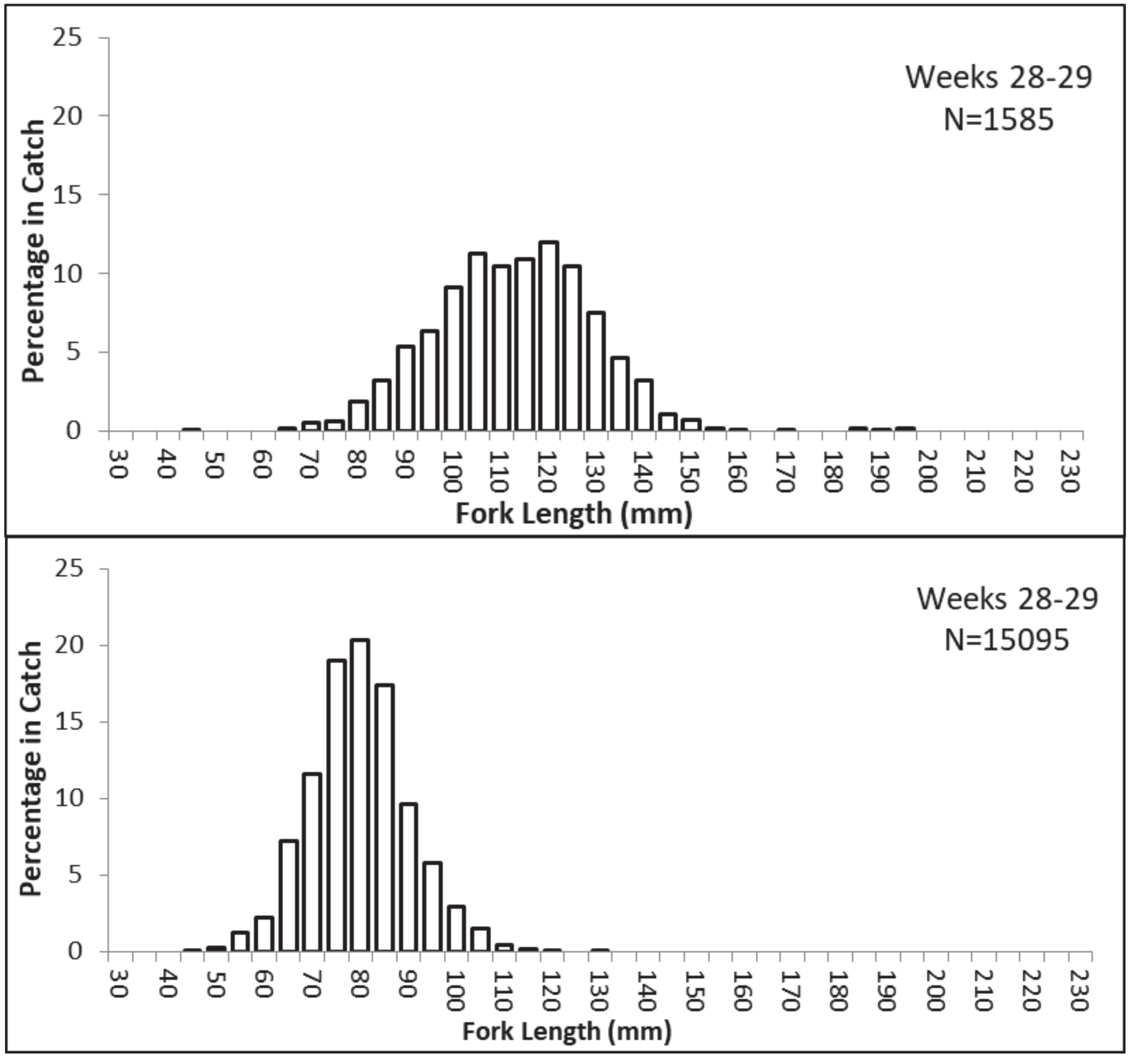


Historical Fyke-Net Data vs. Recent Beach-Seine Data

Second and third weeks of July

Fyke-Net

2011-2013 Beach Seine

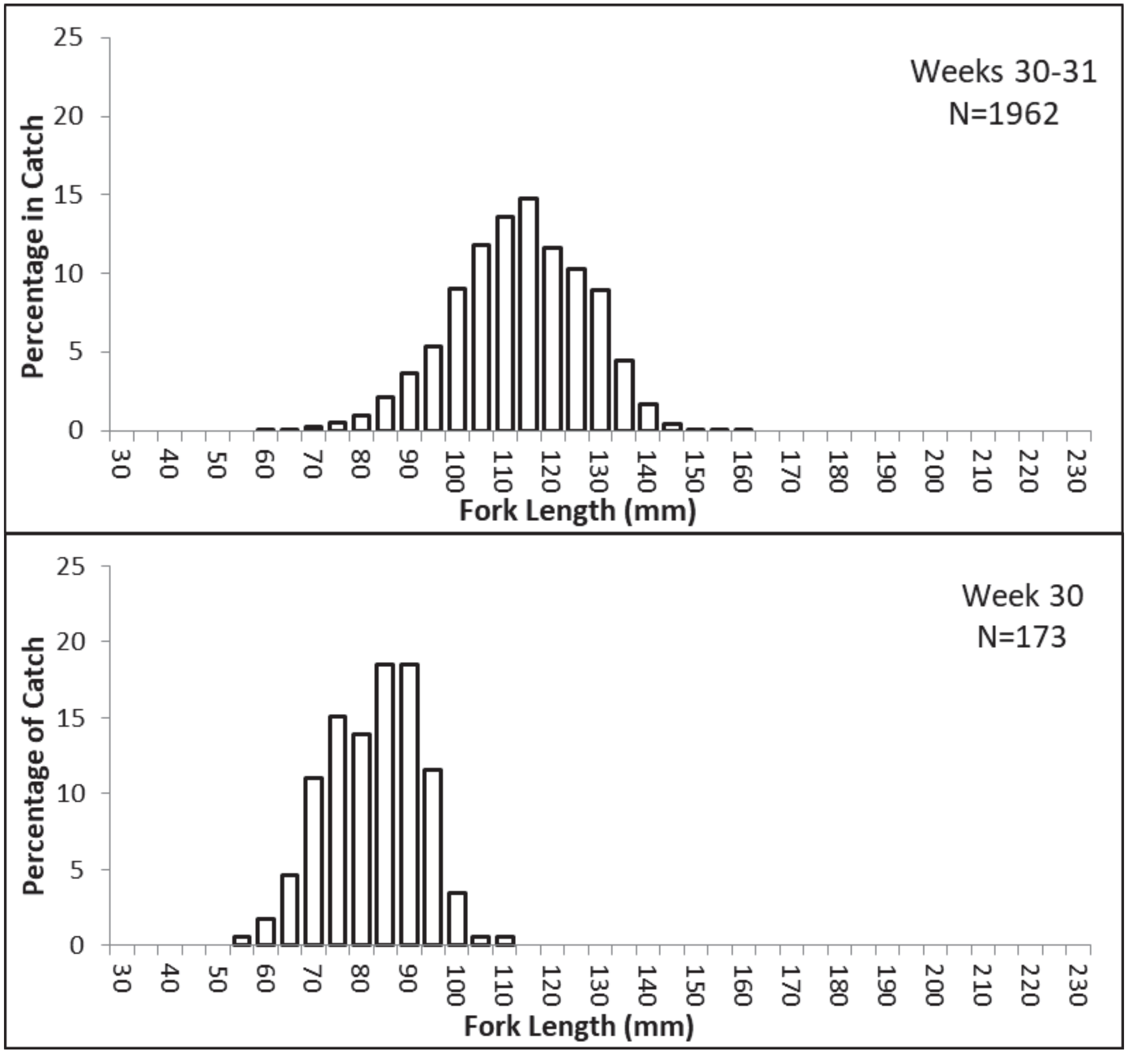


Historical Fyke-Net Data vs. Recent Beach-Seine Data

Fourth and fifth weeks of July, or early August

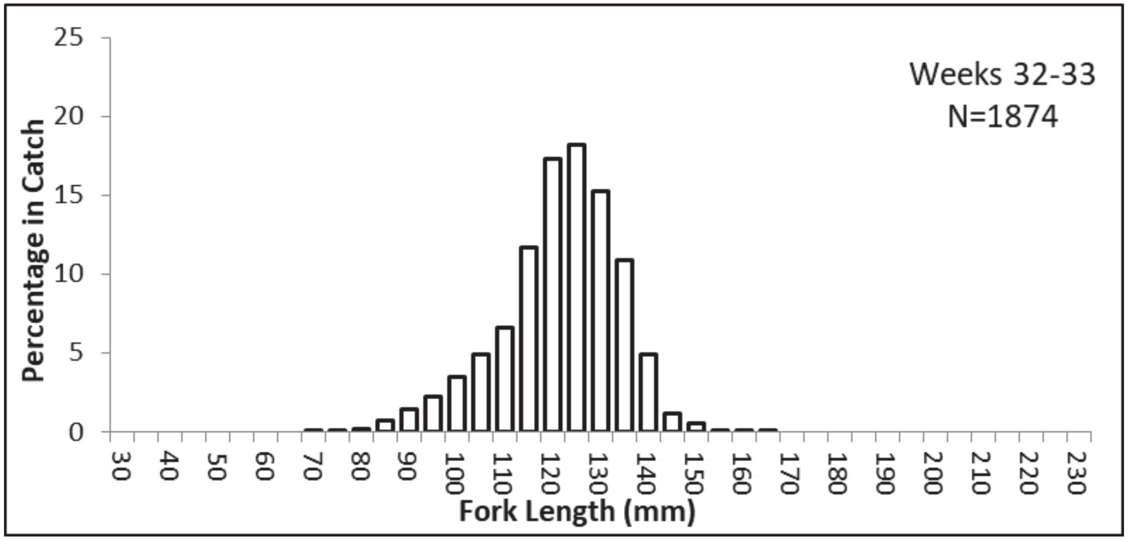
Fyke-Net

2011-2013
Beach Seine

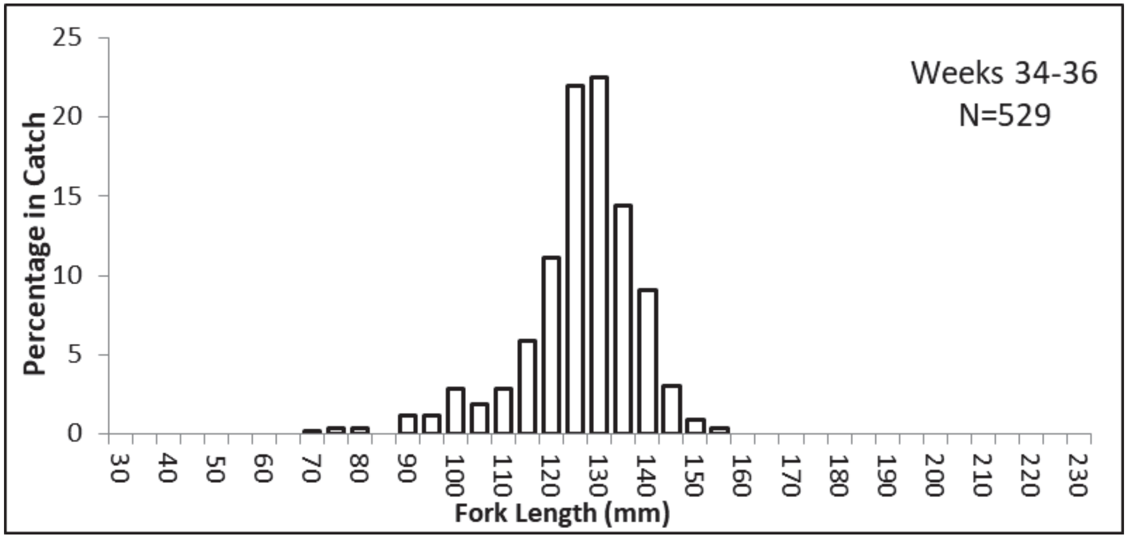


Wells Chinook Passage Timing From Historical Fyke-Net Data

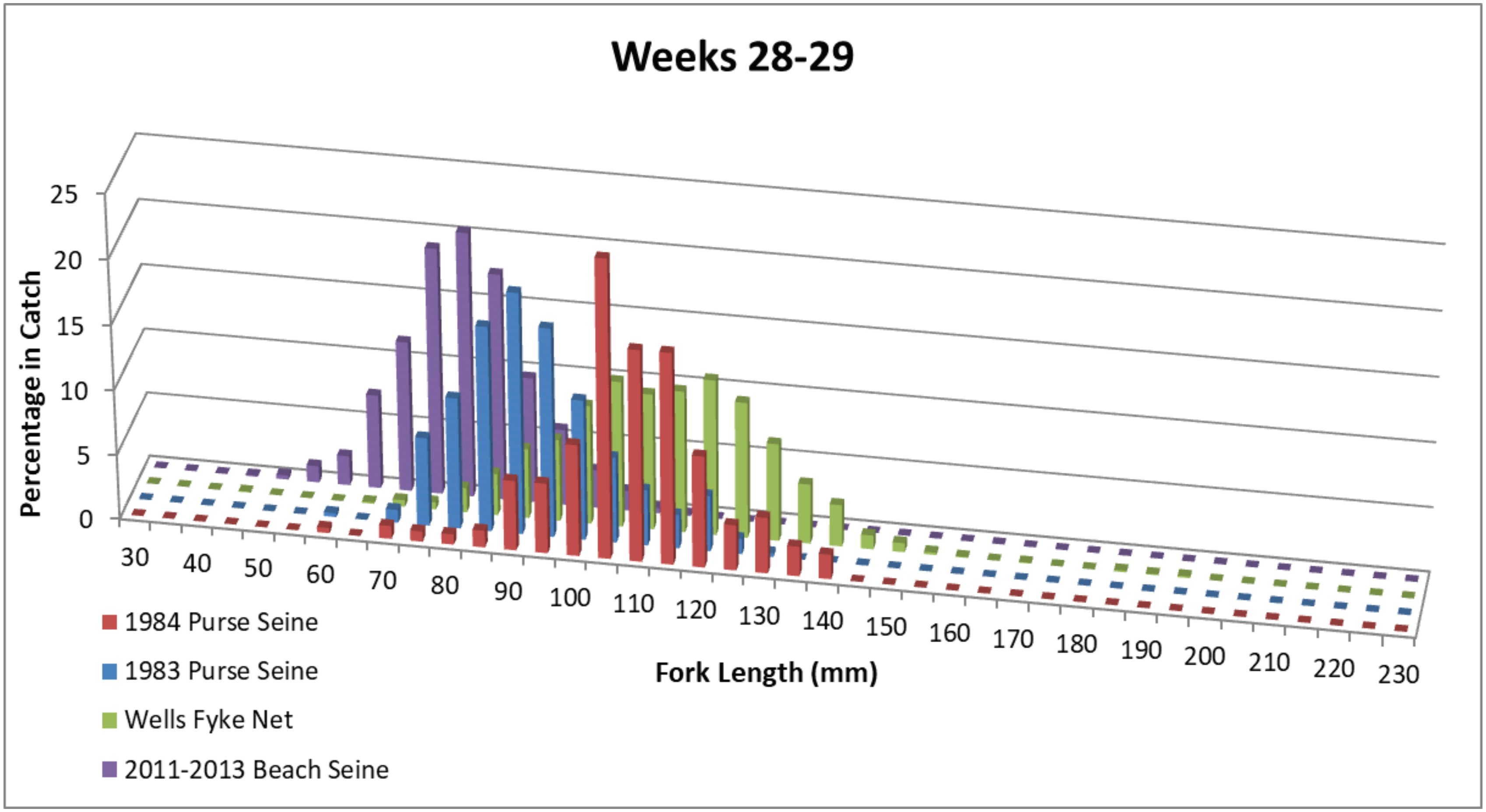
First and second weeks of August



Last two to three weeks of August

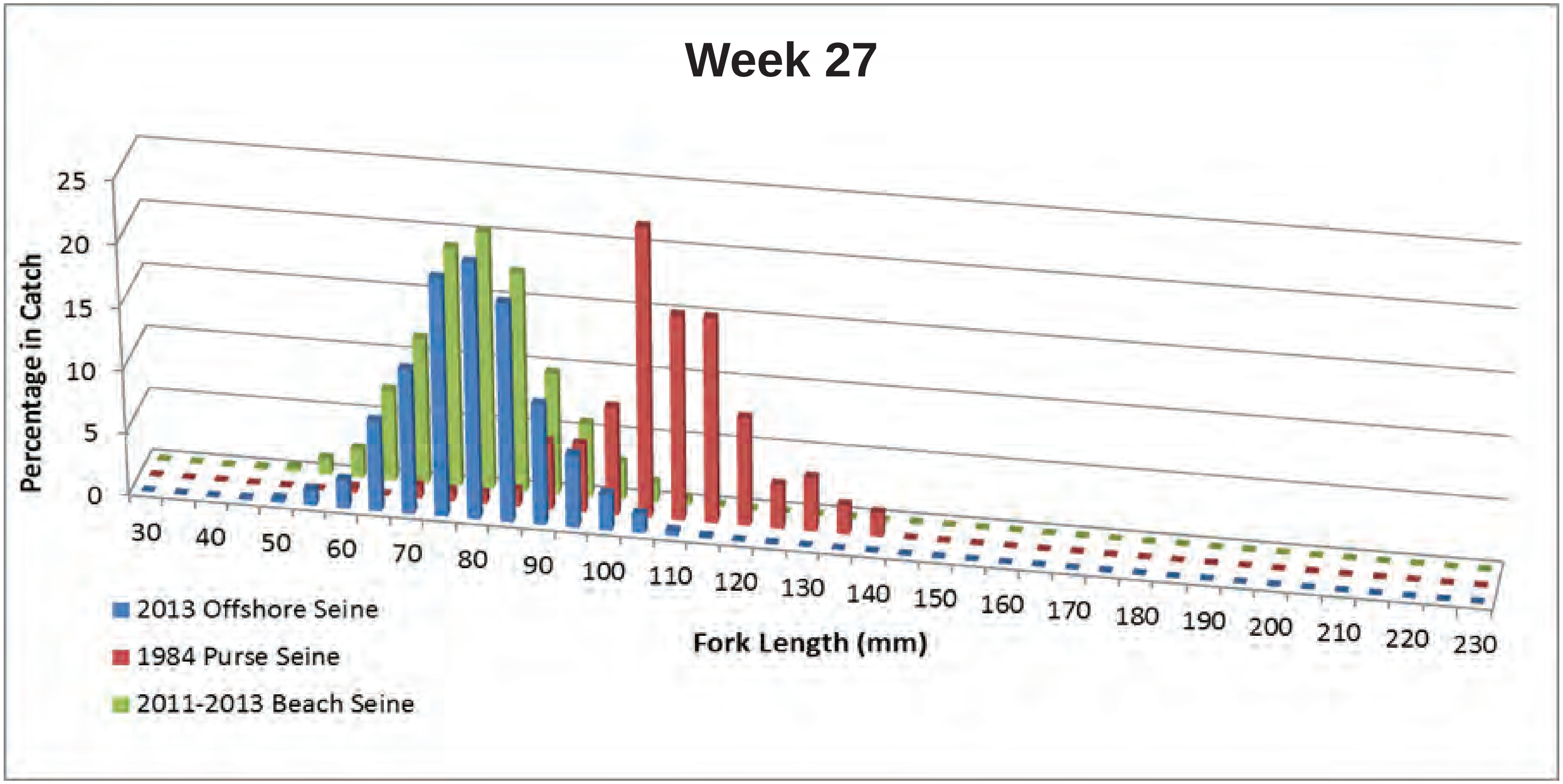


Comparing Lengths of Fish Captured by Beach Seining, Purse Seining, and Historical Fyke-Netting



Night Purse Seining – 1983-1984
Night (mostly) Fyke Netting – 1985-1994
Day Beach Seining – 2011-2013

Comparing Lengths of Fish Captured by Beach Seining, Purse Seining, and Historical Fyke-Netting



Night Purse Seining – 1984
Day Offshore Seining – 2013
Day Beach Seining – 2011-2013

Mean Fork Length at Tagging of Beach-Seined Fish, 2011-2013, Contrasted with Those Captured in Fyke Nets, 1980s and 1990s

	Mean Chinook Fork Length (mm) in Weekly Catches									
Week Ending	**6/17**	**6/24**	**7/1**	**7/8**	**7/15**	**7/22**	**7/29**	**8/5**	**8/12**	**8/19**
Fyke-net	92	104	107	109	111	111	117	120	124	130
Beach Seine	71	73	75	79	71	80	NS*	NS*	NS*	NS*

*NS indicates no sampling on those dates.

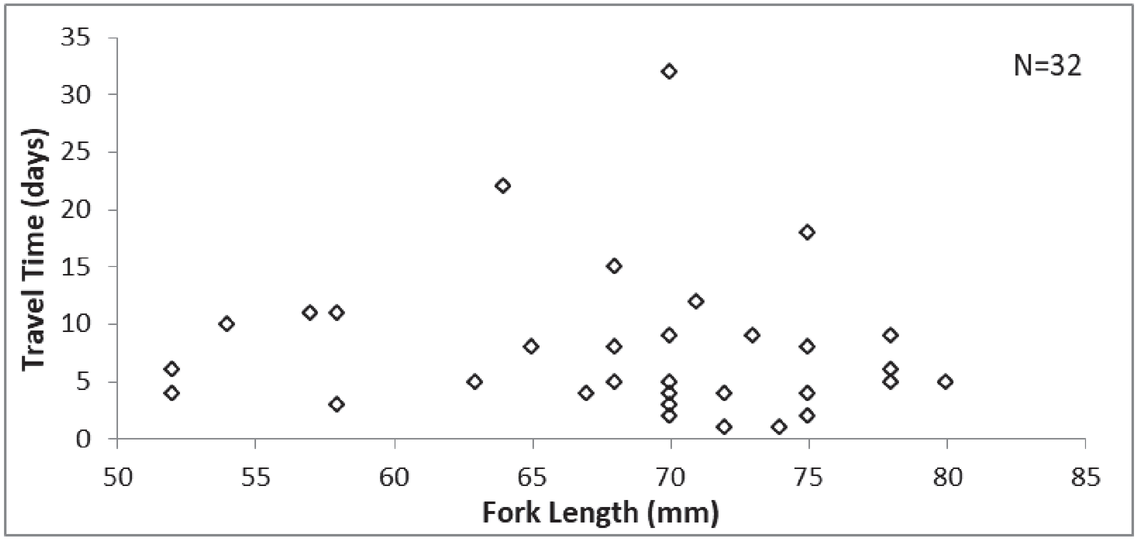
Travel Times for CTCR-Tagged Fish Detected at Both WEJ and RRJ in 2017 and 2018

		Travel Time (days)			
Capture Site	**Mark Length (mm)**	**Release to WEJ**	**WEJ to RRJ**	**Release to RRJ**	**Proportion RR**
Gebber's	52	4	38	42	0.90
Gebber's	54	10	28	38	0.74
Gebber's	68	5	18	23	0.78
Gebber's	70	5	2	7	0.29
Gebber's	72	4	1	5	0.20
Gebber's	72	1	5	6	0.83
Washburn	75	4	14	18	0.78

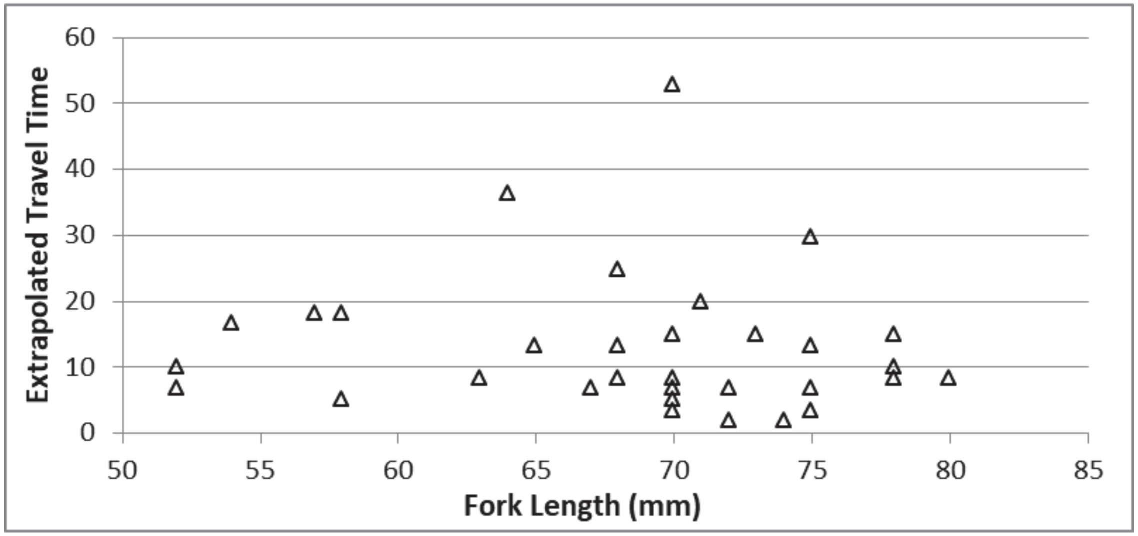
Average = 0.65

Travel Time by Length for CTCR-Tagged Fish Detected at WEJ in 2017 and 2018, and Extrapolated RRJ Travel Times

WEJ Detections

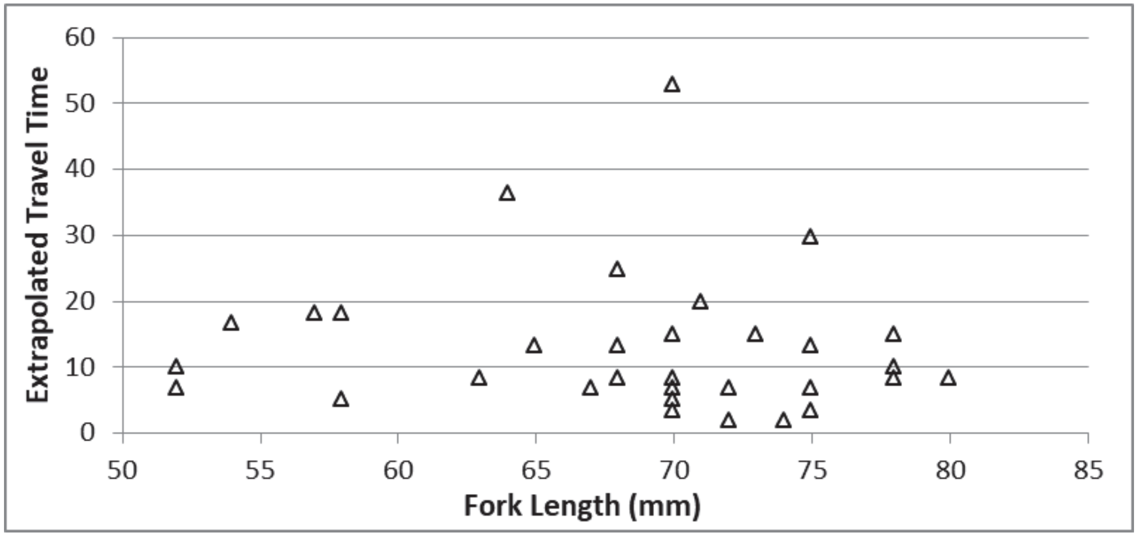


Extrapolated RRJ Travel Time

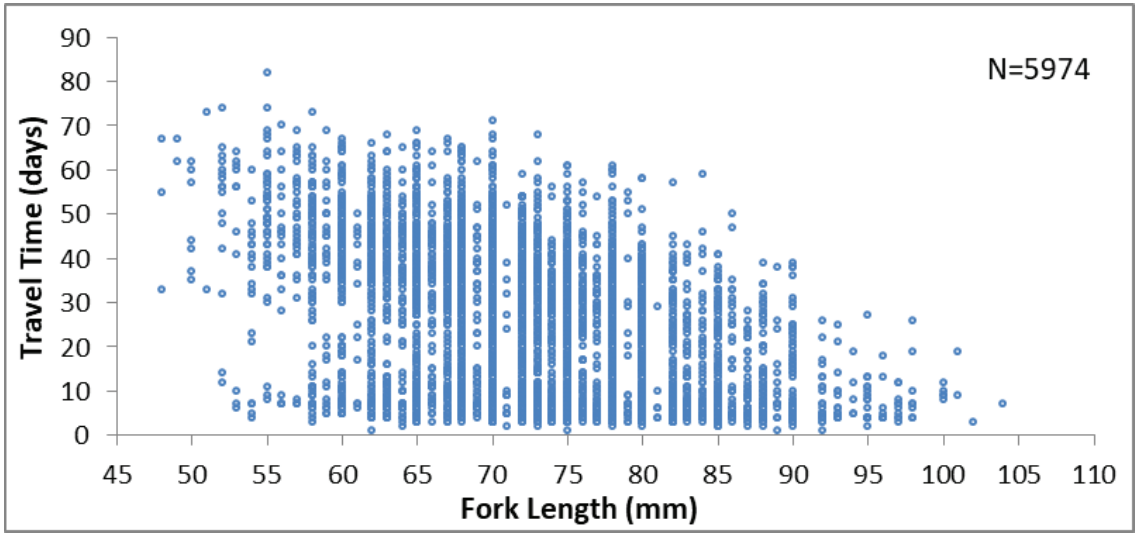


Travel Time by Length for CTCR-Tagged Fish Detected at WEJ Contrasted with Those Detected at RRJ in 2017 and 2018

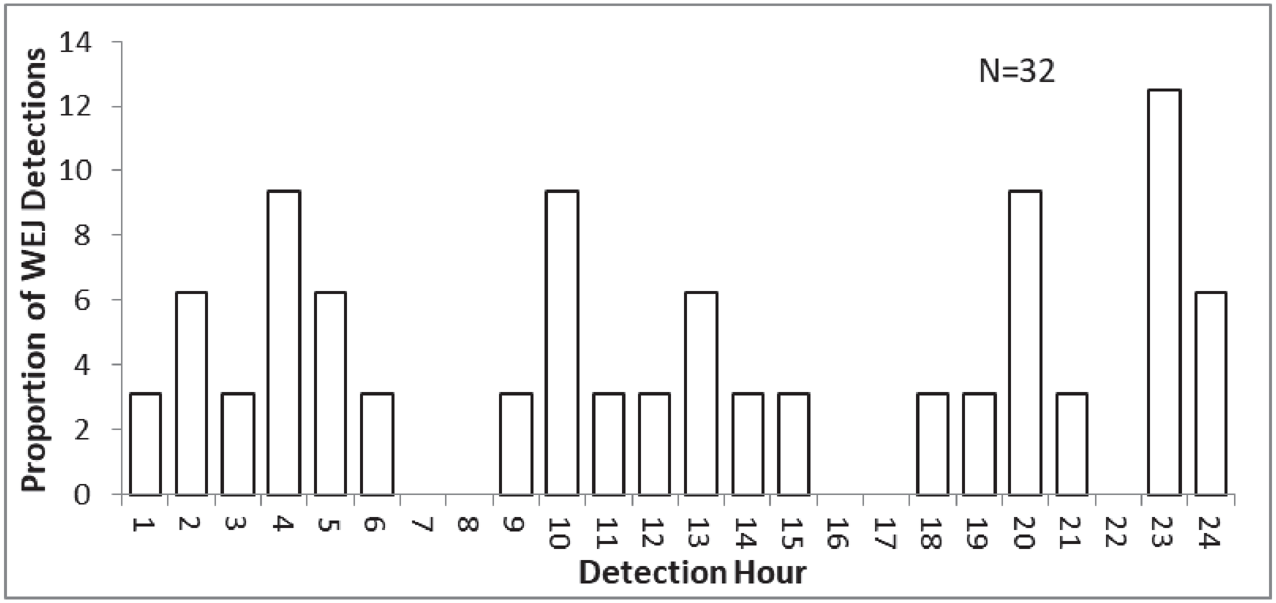
RRJ Extrapolated Travel Times from WEJ Detections

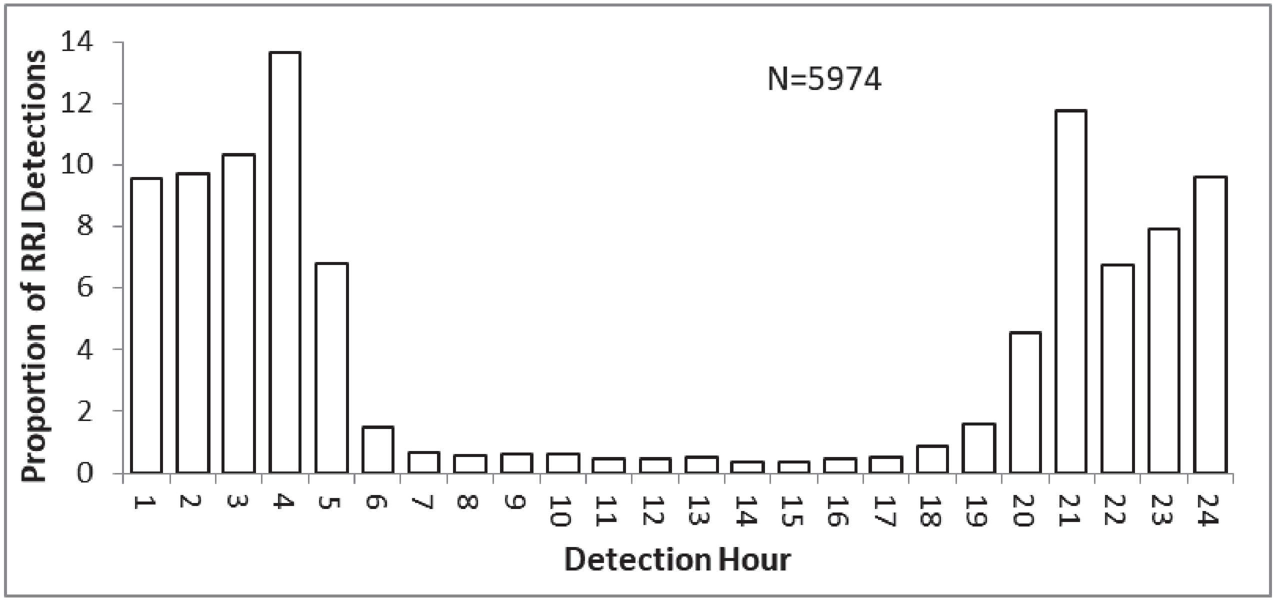


All RRJ Detections

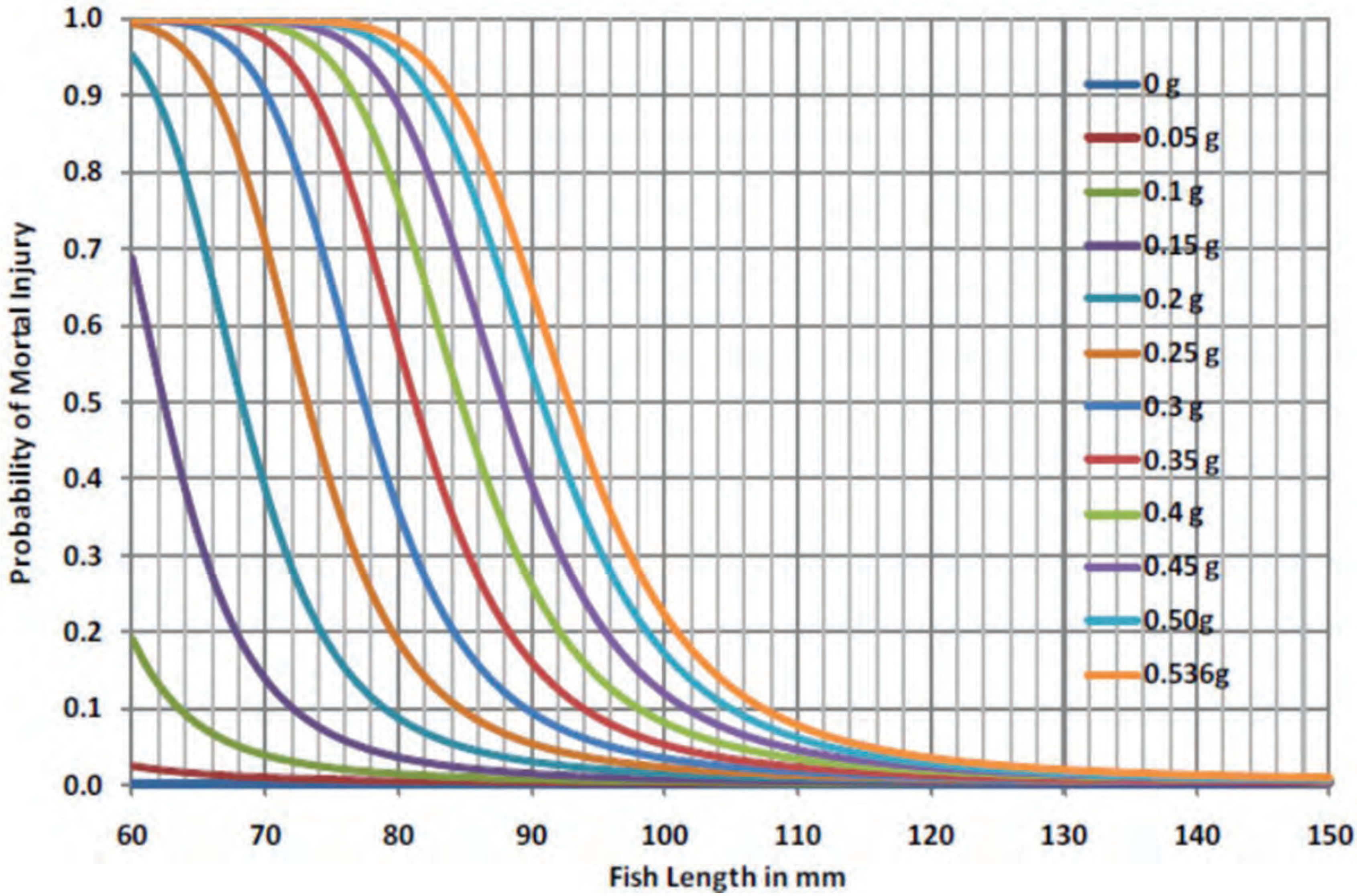


Detection Times for CTCR-Tagged Fish Detected at WEJ Contrasted with Those Detected at RRJ in 2017 and 2018





Fish Mortal Injury Index Given Various Transmitter Weights, Under Pressure Changes Simulating Turbine Passage Events



Carlson, T. J., and M. J. Myjak. 2010. Juvenile Salmon Acoustic Telemetry System transmitter downsize assessment. PNNL-19366.

Conclusions

- Subyearling Chinook are abundant and available to beach seining from early-May through mid-July, but difficult to capture by mid-July
- Nearly all subyearlings are too small to PIT tag in May, and nearly all are large enough to tag by the end of July—if you can still catch them!
- Seining captures Chinook <40 mm even into late June, and <45 mm even the third week of July
- The mean size of subs passing Wells Dam exceeds 100 mm by late June, increasing to 130 mm by the third week of August
- The mean size of subs in beach-seine catches is relatively stable from mid-June to late-July, between 70-80 mm
- Beach seining sampled the smaller half of the subyearling size range available from late-May through August
- Subyearlings exhibit a continuum of migration timing, with passage at downstream projects occurring from spring until at least termination of bypass operations in mid-November—few detected as yearlings

Conclusions Continued

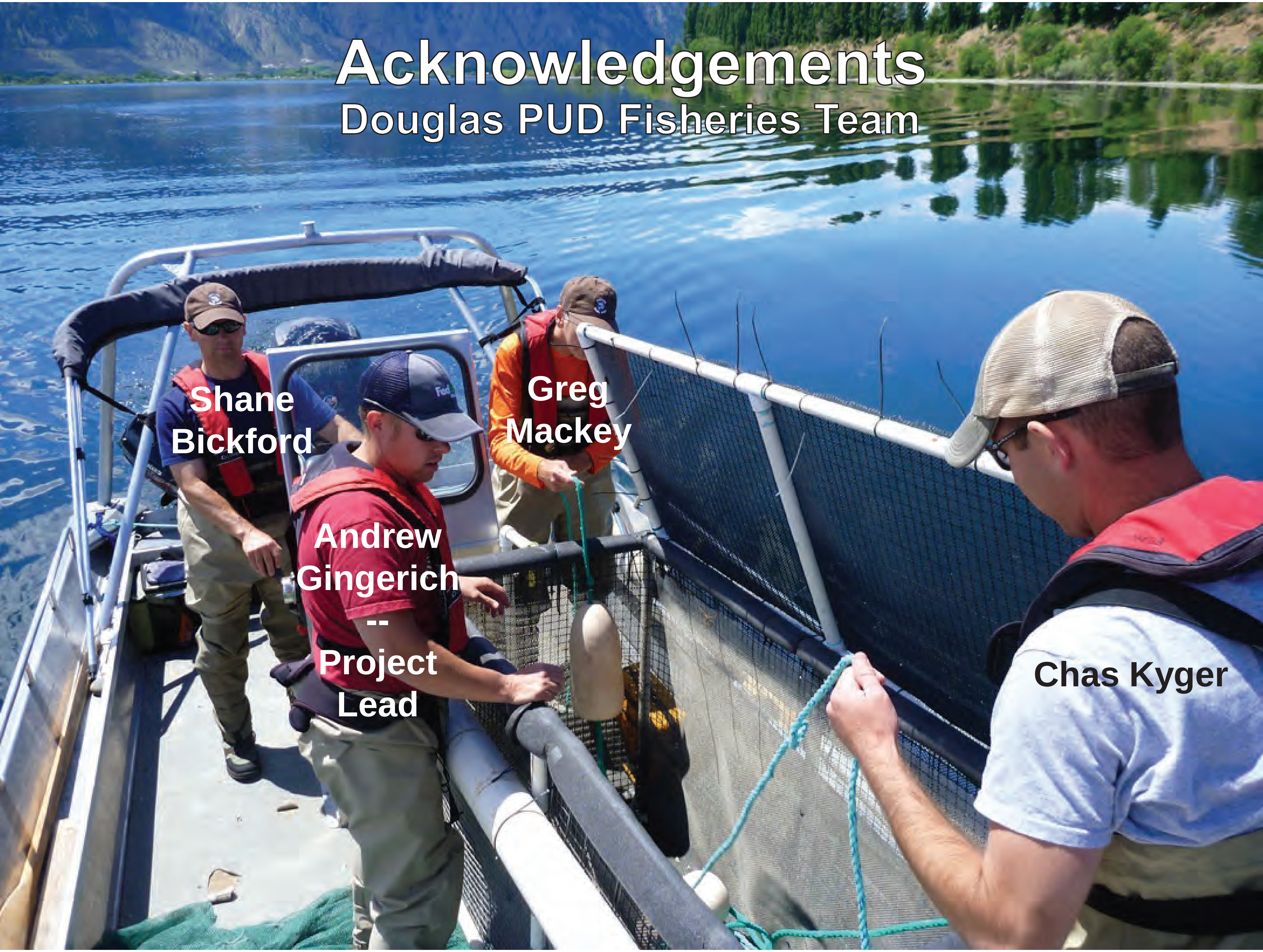
- Generally, larger fish had faster and less variable mean travel times to Rocky Reach than smaller fish, over all three years
- We can lump subyearlings into two categories of emigration behavior:
  i. relatively rapidly emigrating fish (travel time to RRJ of 20 days or less) encompassing the full size range of detected fish; and,
  ii. rearing fish comprising the smaller two-thirds of detected fish
- The distinction between these two classes varies between years and within sampling periods in each year, with generally more residents in early tag groups, and more rapid emigrants in late tag groups
- Larger fish had a much greater detection probability at downstream dams than smaller fish
- For study fish that returned as adults, larger individuals at tagging were more likely to return, indicating that greater survival for larger juveniles was the likely basis for their greater detection probability

Conclusions Continued

- The two emigration categories were equally represented in returning adults; thus, neither strategy provided a survival advantage
- We could not identify a size threshold that distinguished active migrants from rearing individuals
- The length of residence time in Wells Reservoir prior to recapture was a good indicator of the length of travel time to RRJ after re-release
- Fish exhibited short-term post-tagging reductions in growth rate, but this effect was not size-dependent, indicating it was a function of the capture and tagging process rather than of tag burden
- We were unable to PIT tag a representative sample of the run at large because fish were too small, and we couldn't catch the largest fish
- At least 16% of PIT-tagged fish emigrate too slowly to utilize the JSATS tag (battery life), and 95% are too small for that tag
- The battery life of the ELAT is presently insufficient for most study fish, and the ELAT is too large for the fish we couldn't PIT tag.

Conclusions Continued

- A traditional study of this population would violate several assumptions of the single- and paired-release study model:
  1. Can't tag a representative sample (many fish too small)
  2. Even the PIT tag disproportionately affects survival probability in small individuals
  3. Not all individuals have the same probability of survival to the end of the reach
  4. Treatment and control groups would experience unequal river and passage conditions in common reaches
- The ELAT currently under development by PNNL holds promise…
- Even if the ELAT battery life improves to match that of the current JSATS, the residence time of 16% of our tagged study fish would exceed that, we still couldn't tag a representative sample of the population, and the mathematical obstacles posed by highly variable and unpredictable emigration/residency behavior have no solution.


Acknowledgements
Douglas PUD Fisheries Team
Shane Bickford
Greg Mackey
Andrew Gingerich -- Project Lead
Chas Kyger

Acknowledgements – Continued:

Douglas PUD: Dick Weinstein, Wayne Marsh, Scott Kreiter, Jim McGee, Mary Mayo, Beau Patterson, and the late Darrin Sexton

Biomark, Inc: Ryan Richmond – Biological Project Lead, Scott McCutcheon, Dave Thompson, Heath Hopkins, Phillip Vincent, Jerry Moore, Mike Zobott, Jerek Richardson, Ana Gabica, and Trevor Sato

Washington Department of Fish and Wildlife – Twisp Field Office: Charlie Snow, Charles Frady, Dave Grundy, Pat Hale, Evan Haug, Randy Johnson, Jeff Kingsbury, Sean Kramer, Chas Lawson, Drew Pearson, Alex Repp, Mark Sorel, Mark Tuttle, Mike Vaughan, Katie Weber, Jake Wicken, and Matt Young

Questions?

FINAL

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Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: July 24, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Larissa Rohrbach and Kristi Geris

Re: Final Minutes of the June 25, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, June 25, 2019, from 10:00 a.m. to 11:45 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C). *(Note: Keller provided the review of subyearling sampled at RRJSF by email following the meeting on June 25, 2019, as distributed to the HCP Coordinating Committees by Larissa Rohrbach that same day.)*
- Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item I-C).
- Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).
- Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item I-C).
- The following action items pertain to the Decision Item whether to approve Douglas PUD's request not to tag with coded wire tags (CWTs) the component of brood year (BY) 2018 summer Chinook salmon raised at Wells Hatchery that will be used for the 2020 Survival Verification Study (2020 Survival Study) because they will be tagged with PIT-tags and

adipose clipped (Item II-A) (*Note: This Decision Item will be brought forward to the July 23, 2019 meeting agenda*):

- Tom Kahler will inform the HCP Coordinating Committees of the planned dates in July when CWT tagging will occur. *(Note: Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Larissa Rohrbach the following day.)*
- Tom Kahler will respond to Keely Murdoch's initial questions about the effects of a decision not to tag with CWTs the 2020 Survival Study fish on the following:
  - Monitoring and evaluation studies
  - Estimates of smolt-to-adult ratios (SARs)
  - The collection of harvest information
- Chad Jackson will determine whether there are concerns associated with not coded wire tagging the study fish from an ocean harvest standpoint.
- Larissa Rohrbach will distribute draft meeting minutes from this agenda item to Kirk Truscott and Scott Carlon following the meeting for their immediate consideration. *(Note: Rohrbach emailed a draft of the relevant minutes on June 26, 2019, to Truscott and Carlon, Cc Tom Kahler, John Ferguson, and Kristi Geris.)*
- HCP Coordinating Committees representatives will email their own or their Hatchery Committees representative's comments and questions to Larissa Rohrbach for distribution by next Wednesday July 3, 2019. *(Note: Per Tom Kahler's email on June 26, 2019, a CWT tagging date in August allows the issue to be brought to the HCP Hatchery Committees in the regular monthly meeting on July 17, 2019.)*
- The HCP Coordinating Committees will vote on whether to approve Douglas PUD's request via email or at the next meeting depending on when a decision is needed for CWT tagging operations. *(Note: Tom Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Larissa Rohrbach the following day.)*

- Lance Keller will provide an update by email on the performance of the new Rocky Reach Dam C3 Unit Chesterton seals by Friday, June 28, 2019 (Item III-A).
- Larissa Rohrbach will distribute by email the acoustic tag specifications sheets shared by Lance Keller following today's meeting (Item IV-A). *(Note: Keller provided the specifications sheets by email following the meeting on June 25, 2019, as distributed to the HCP Coordinating Committees by Rohrbach that same day.)*
- Lance Keller will provide additional information on the change in ATS Inc. acoustic tag weights with different battery types (Item IV-A).
- The HCP Coordinating Committees meeting on July 23, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019, and is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, July 23, 2019 (Item I-A).

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No additions or changes were requested.

Kirk Truscott was unable to attend today's meeting and has asked for additional time to consider the decision item "2020 Survival Verification Study – Coded Wire Tags." Note that after discussion in the meeting, the members determined that additional time was needed to understand implications of the decision, so the vote was delayed (see summary of Item II-A).

Ferguson reminded the HCP Coordinating Committees that comments on the *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* are due to Tom Kahler by July 23, 2019.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft May 28, 2019 meeting minutes. Larissa Rohrbach reviewed one comment and incorporated all comments and revisions received from members of the Committees into the revised minutes. HCP Coordinating Committees members present approved the May 28, 2019 meeting minutes, as revised. Jim Craig was absent from the May 28 meeting, so he abstained from voting to approve the minutes. Scott Carlon provided his vote to approve the minutes by email to Rohrbach and John Ferguson on May 17, 2019.

Ferguson provided a status update on the 2019 Columbia River sockeye return. He said this information pertains to a potential desire to revisit the decision made by the Wells HCP Coordinating Committee on May 28,2019, to approve the Columbia River Inter-Tribal Fish Commission's annual request to tag sockeye salmon at Wells Dam in 2019, with the caveat that approval of the tagging will be reviewed again if low flow and warm water migration conditions develop. Ferguson said the 10-year average through June 23 is 117,556; this year's count as of June 23, 2019, is 22,894. Ferguson said sockeye abundance could be low this year (approximately one-fifth of the 10-year average) or could be late due to river conditions.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on May 28, 2019, and follow-up discussions, were as follows. *(Note: Italicized text corresponds to agenda items from the meeting on May 28, 2019):*

- *Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item II-C).*
  Keller provided the results of his analysis via email following the meeting, as distributed to the HCP Coordinating Committees by Larissa Rohrbach that same day. Keller said the fish count trends are similar between the subyearling Chinook salmon index sample counts at the RRJSF (bypass) and counts of PIT-tagged subyearling Chinook salmon detected at the Rocky Reach Dam Juvenile Surface Collector (RRJ) site. Keller said that the subyearling count at the bypass begins 3 days earlier than at the RRJ. He said more fish passage occurred at night, which aligns with observations made at other sites. He said the question is whether sampling is occurring at the right time. Keller said that he posed the question to fish passage statistician Dr. John Skalski who provided the expert opinion that as long as sampling is carried out at the same time of day and same days of the year every year, the obligation to observe fish presence or absence according to HCP obligations has been met.
- *Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item II-C).*
  This action item will be carried forward.

- *Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item II-C).*
  This action item will be discussed during today's meeting and will also be carried forward.
- *Anchor QEA, LLC, will contact Jim Craig to obtain U.S. Fish and Wildlife Service (USFWS) approval of the updated HCP Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Subcommittee email distribution lists (Item III-A).*
  Kristi Geris emailed Craig with this request following the meeting on May 28, 2019, and Craig provided USFWS's approval of the lists via email on May 29, 2019, as distributed to the HCP Coordinating Committees by Geris that same day.
- *The HCP Coordinating Committees will begin discussing the necessity and significance of the data behind the Columbia River Inter-Tribal Fish Commission's (CRITFC's) annual request to tag sockeye salmon at Wells Dam during the HCP Coordinating Committees meeting in December 2019 (Item IV-A).*
  Kristi Geris added this to the agenda for December 2019.
- *Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item IV-B).*
  Tom Kahler said a memorandum is currently being drafted and he may be able to present findings in July. This action item will be carried forward.

II. Douglas PUD

A. DECISION: 2020 Survival Verification Study – Coded Wire Tags (Tom Kahler)

Tom Kahler sent information supporting the request for a decision via email, as distributed by Kristi Geris on June 14, 2019. The email stated the following:

"In 2009, the HCP Parties approved a request by Douglas PUD to not coded wire tag study fish for the 2010 Survival Verification Study because 100 percent of those fish would be PIT tagged and ad-clipped. Douglas PUD made that request to not CWT study fish to avoid any negative cumulative effects of multiple tags/marks on their survival. As we near the date for ad-clipping and CWT tagging for the BY 2018 summer Chinook yearlings at Wells Hatchery, Douglas PUD again requests to not CWT the component of the Wells yearling summer Chinook that will serve as study fish for the 2020 Survival Verification Study.

Specifically, with the approval of the Wells Coordinating Committee, Douglas PUD would not CWT 110,000 of the 320,000 (release target) yearling summer Chinook from BY 2018, and instead, those

110,000 fish not tagged with CWTs would be PIT tagged. Those 110,000 fish would be ad-clipped this summer (when the remainder of the BY 2018 yearlings are CWT'd and ad-clipped), then PIT tagged in November. The 110,000 number of PIT-tagged fish is a conservative tagging rate to ensure the availability of at least 100,000 PIT-tagged study fish for the study in April and May 2020, accounting for the in-hatchery mortality rate of PIT-tagged study fish between tagging and release in 2010."

Kahler said that in preparations for the previous 2010 summer Chinook Survival Verification Study (2010 Survival Study), a decision was made not to tag those study fish with CWTs in addition to the PIT tags used for the 2010 Survival Study. Kahler said Douglas PUD had not asked for a similar change to the CWT tagging approach for Wells Hatchery summer Chinook salmon when developing this 2020 study. He said that when working through the bioprogramming issues, they realized in the 2010 Survival Study that Douglas PUD had elected not to tag study fish with CWTs to minimize handling stress and effects of multiple tags. Douglas PUD decided to bring this proposed change to the Wells HCP Coordinating Committee this June as a decision item because CWT tagging would need to occur in July.

Douglas PUD proposes that out of 320,000 Wells Hatchery program yearling summer Chinook salmon that normally receive a CWT and are adipose fin-clipped, the 110,000 designated as 2020 Survival Study fish would be PIT tagged and adipose fin-clipped but would not receive a CWT. Fish would still be available for harvest because of the adipose fin clip.

Keely Murdoch had questions about the proposed change to tagging. Murdoch asked if the fish designated for the 2020 Survival Study would be part of the actual hatchery production or in addition to the normal production. Kahler responded that they would be part of the normal Wells Hatchery production but that in 2010 the Survival Study fish were in addition to the normal hatchery production. Kahler said this is an important difference between the decision made for the 2010 Survival Study and the proposal for the 2020 Survival Study. Murdoch asked if there are any hatchery monitoring and evaluation programs that could be compromised by the use and interrogation of PIT tags instead of CWTs. She asked if SAR estimations that depend on CWT counts could be compromised, noting that in her observation SARs estimated using CWTs differ from SAR estimates made with PIT tags detections due to differences in redetection efficiency. Murdoch also asked if there is any place where these fish would normally be interrogated for CWTs but not for PIT tags, for instance in creel surveys, and if so, would some redetections be miscounted, or harvest information missed? Jim Craig said the USFWS does scan for PIT tags during carcass surveys. Andrew Gingerich asked if Chad Jackson knew whether there are any areas where CWTs are normally interrogated, but PIT tags are not. Jackson said the one concern may be whether the reduction in coded wire tagged fish released would affect ocean surveys or ocean harvest data collection. John Ferguson asked if SARs are calculated using CWT counts. Murdock said yes, CWTs are collected in spawning surveys and broodstock collection. Kahler said for Wells Hatchery summer yearling Chinook salmon, CWTs are the only source of data for calculating SARs except for the PIT tags used in the 2010 study.

Craig asked if this proposal has been brought to the HCP Hatchery Committees. Kahler said no because the Hatchery Committees did not meet this month. Kahler said this topic was discussed in the HCP Hatchery Committees in 2009 for the previous 2010 Survival Study where more time was available to discuss the tagging prior to making a decision. Kahler read from the May 2009 HCP Hatchery Committees minutes to review the approach taken in 2010. Kahler said the same questions came up but that the proposal was approved after discussion.

Ferguson said the proposal to mark Wells Hatchery program fish with a PIT tag instead of a CWT for the 2020 Survival Study is different from the approach used to rear and tag additional fish for 2010 Survival Study. Ferguson said there are questions that require further consideration and the consensus is that the Wells HCP Coordinating Committee is not prepared to vote on the decision in today's meeting.

The following action items were outlined to further the discussion via email, which should lead to a decision prior to CWT tagging operations at Wells Hatchery *(Note: This Decision Item will be brought forward to the July 23, 2019 meeting agenda)*:

- Kahler will inform the HCP Coordinating Committees of the planned dates in July when CWT tagging will occur. *(Note: Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Larissa Rohrbach the following day.)*
- Kahler will respond to Keely Murdoch's initial questions about the effects of a decision not to tag with CWTs the 2020 Survival Study fish on the following:
  - Monitoring and evaluation studies
  - Estimates of SARs
  - The collection of harvest information
- Jackson will determine whether there are concerns associated with not coded wire tagging the study fish from an ocean harvest standpoint.
- Rohrbach will distribute draft meeting minutes from this agenda item to Kirk Truscott and Scott Carlon following the meeting for their immediate consideration. *(Note: Rohrbach emailed a draft of the relevant minutes on June 26, 2019, to Truscott and Carlon, Cc Kahler, Ferguson and Geris.)*
- HCP Coordinating Committees representatives will email their own or their Hatchery Committees representative's comments and questions to Rohrbach for distribution by next Wednesday July 3, 2019. *(Note: Per Kahler's email on June 26, 2019, a CWT tagging date in August allows the issue to be brought to the HCP Hatchery Committees in the regular monthly meeting on July 17, 2019.)*

- The HCP Coordinating Committees will vote on whether to approve Douglas PUD's request via email or at the next meeting depending on when a decision is needed for CWT tagging operations. *(Note: Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Rohrbach the following day.)*

B. Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report (Tom Kahler)

The draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019, and is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, July 23, 2019.

Kahler asked whether representatives had any questions regarding the content of the report. Keely Murdoch asked for clarification on differences in migration behavior between Snake River subyearling Chinook salmon and Upper Columbia River subyearling Chinook salmon, information that was initially provided in the associated presentation that was given in the May 28, 2019 meeting.

Kahler said that in the Snake River, the Chinook salmon are fall-run Chinook salmon that are already in the migrant stage and are larger by the time the juveniles migrate through the lower Snake River hydroprojects as subyearlings. In contrast, Chinook salmon from the Okanogan and Methow rivers or Rocky Reach tributaries are passing through reservoirs at a very small size; they are essentially swim-up fry. To give an idea of the size of the subyearlings in the Snake River, 99% of the size distribution can be tagged with a Juvenile Salmon Acoustic Technology System (JSATS) tag to evaluate passage through the Snake River projects, even though the minimum fish length for tagging is 95 mm (fork length).

John Ferguson asked what the survival rate requirement is for the Snake River hydroprojects. Kahler said they don't have a "project" (tailrace-to-tailrace) survival rate requirement for individual hydroprojects like they do for the mid-Columbia PUD projects. Instead, they have a dam-passage (forebay-to-tailrace) survival standard of 96%. It was noted that the survival standard is for yearlings, and the survival standard for subyearlings in the FCRPS is lower: 93% dam-passage survival.

Murdoch asked for confirmation that the mid-Columbia HCPs do not have that same requirement, and Kahler answered that is correct. Kahler said the main point to emphasize is that in the Upper and Mid-Columbia, biologists are trying to study fry, whereas in the Snake River they are studying the migrant life stage.

No other questions about the draft report were asked in the meeting. Ferguson concluded the agenda item by reminding the HCP Coordinating Committees that the 60-day review period is ongoing and ends on July 23, 2019.

III. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said work continues on Turbine Unit C1. He said the unit has been disassembled to the point that the trunnion bushings are revealed. He said the project is still on the same timeline for completion as previously discussed. The disassembly will allow for the replacement of the trunnion seals to avoid the problem with seals that has occurred with Turbine Unit C3.

Keller said new engineered Chesterton seals for Turbine Unit C3 are on site at Rocky Reach Dam. He said the seals have been engineered for the site and are undergoing testing to determine if they are performing as designed. He said testing began last week. Keller said he would provide an update on performance of the Chesterton seals by end of week. Keller said Chelan PUD will continue to explore the blade block option for Turbine Unit C3, as well. He said there will be engineers from Italy on site next week. He said that even if the seals work, hydraulically locking the blades may be pursued as an additional control option.

Keller said there are additional seals en route from Voith (a hydroproject manufacturer) for Turbine Unit C3 that could also be installed and tested.

Keller said that at the end of September or early October, Turbine Unit C9 will also be coming on line. Keller said that Chelan PUD has never conducted commissioning of two turbine units simultaneously. Keller said because of this conflict he will inquire whether the schedule for bringing C1 online may shift earlier. He said either way, the return of Turbine Unit C1 to service will occur outside the 2019 juvenile passage season.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Chelan PUD continues to modernize Turbine Unit B4. Keller said some parts have caused delayed (the rotor poles and hydraulic power unit) but Chelan PUD does not expect the schedule for project completion to be delayed. Keller said Turbine Unit B4 is scheduled to come online in the fourth quarter of 2019.

Keller said the operating ring that sits on top of the wicket gates associated with Turbine Unit B4 will be repaired and retained to avoid schedule delays. The rings on the other units will be modernized and replaced first. There is no critical need to change the operating ring on B4 immediately so it will be modernized after the other units. The head cover unit for B4 will also be replaced.

IV. Joint HCP Coordinating Committees and PRCC

A. Subyearling Chinook Salmon Studies (All)

John Ferguson welcomed Peter Graf (Grant PUD) who joined the discussion of approaches to subyearling Chinook salmon studies.

Lance Keller reviewed the availability of current acoustic tag technology to illustrate improvements that have been made since the last review in 2016. Keller distributed specifications sheets for current tag types and made comparisons to tags that were discussed in 2016 (acoustic tag specifications sheets were emailed by Keller and distributed by Larissa Rohrbach following the meeting, see Attachment B).

JSATS AMT by Lotek

In 2016 the JSATS AMT by Lotek was the smallest tag offered by the company. It weighed 0.28 gram in air and had a 25-day battery life using a 5-second ping rate (model number L-AMT-1.416). The specific information for this tag is still current, as the tag has not changed since 2016.

Chelan PUD uses a 3-second ping rate for higher resolution in the immediate proximity of their hydroprojects. A higher ping rate provides more detections and higher accuracy in the location of the last detection. Andrew Gingrich said there is better detection probability, but shorter tag life associated with the higher ping rate. Keller said yes. Ferguson asked what tag lifespan is needed. Keller said it is ideal to have a tag that has adequate tag life to ensure detection throughout the project area, as well as the downstream detection arrays. Keller said this is easily achieved with spring migrants (that move downstream rapidly and are sure to out-migrate), but not ideal for use in subyearlings that could possibly residualize in the reservoirs. Gingerich said the fish does not even have to residualize, it just has to take 15-20 days to move downstream, which it looks like many subyearlings do.

Keely Murdoch said if you were catching run-of-river fish in the Juvenile Bypass System at Rocky Reach Dam you would have a higher propensity to capture actively migrating fish of an appropriate size. Murdoch asked whether there are any subyearling hatchery releases upstream of Rocky Reach Dam. Keller said yes, from Chief Joseph Hatchery and Wells Fish Hatchery. Keller said in late May you see a pulse of hatchery-origin subyearling Chinook salmon that causes Chelan PUD to initiate the spill program, while the wild subyearlings begin outmigrating later into June.

Murdoch asked whether there is any PIT-tag data that could be used to observe migration rate. Tom Kahler said they have been PIT tagging fish at Wells Fish Hatchery to support the Comparative Survival Study fish. Keller said using PIT-tagged hatchery fish would lead to an assumption that the migration rate of the hatchery fish represents the whole population. Murdoch said there are similar assumptions made in other cases. Keller said Chelan PUD tags fish that are run-of-river; as long as size and health criteria are met, fish are tagged and regardless of their origin. Keller said it is obvious when hatchery subyearlings arrive in May and wild-origin summer fish arrive later. Keller said the timing of the wild fish is not very predictable and depends on environmental conditions. Murdoch asked if there are any studies that are tagging wild fish. Kahler said there are some in the Methow and Okanogan rivers, and the Colville Confederated Tribes continue tagging in Wells Reservoir. Graf said some fish are tagged in the Entiat River screw trap. Graf said that for the previous subyearling summit held in 2016, he analyzed PIT-tag data coming from the Entiat River. Graf said some subyearlings come out of the Entiat River and go through Rocky Reach Dam quickly, then have a long delay downstream of Rocky Reach Dam; some go straight to McNary Dam and some take a year to get to McNary Dam. Graf said Tom Desgroseillier (USFWS) may have carried on that work. Kahler emailed presentations from the June 2016 subyearling workshop by Graf (*Comparing the Migration Patterns of Yearling Spring Chinook and Subyearling Summer Chinook Salmon Through the Mainstem Columbia River Using Available PIT-Tag Data*) and Desgroseillier (*Life-History of Subyearling Chinook Migrants from the Entiat River*), as distributed by Rohrbach that same day.

Vemco-HTI Tag

Keller said the next tag to discuss is the Vemco-HTI tag. He noted that Vemco and HTI have merged and that HTI's parent company Amirix has been purchased by InnovaSea, a company focused on aquaculture. Keller said the 307-kilohertz tag is 0.3 gram in air, can be detected on Vemco or HTI receiver systems, and the battery life is 45 to 90 days (it is closer to 45 days with a 3-second ping rate). Keller said the finished product will be more complete (requiring less steps for the user) than in the past. Keller said the size is slightly smaller than in the past (Vemco was previously using a 0.5- to 0.65-gram tag in 2011, which was still the best available tag in 2016). Graf asked if the batteries are different or if they are all from technology developed at Pacific Northwest National Laboratory (PNNL). Gingerich said PNNL will do the research and development of tags, and then after a year or so, hand off the specifications to the manufacturers who then mass produce the tags. Ferguson said the batteries would likely be manufactured by a battery manufacturer.

ATS JSATS SS300 Acoustic Micro Transmitter

Keller introduced the next tag, the ATS JSATS SS300 acoustic micro transmitter. Keller said it has multiple ping rates; the battery lasts 23 days using the 3-second ping rate. More battery life requires the larger tag size and additional batteries. In 2016 the tag weight was 0.34 gram in air, now it is 0.3 gram, and the battery life is the same. Gingerich said this is the tag that has been used by U.S. Army Corps of Engineers exclusively on lower Columbia River studies.

Ferguson asked what the body burden recommendations are, approximately 5%? Keller said yes and noted a recent PNNL presentation that showed injury from barotrauma associated with passing through hydroelectric turbines increased with an increase in tag size/tag burden. Keller noted that there is a broad range in body size for subyearlings. Gingerich said for reference, a 0.3-gram tag is similar in weight to 3 PIT tags.

Murdoch asked how much heavier a tag would be with additional batteries. Keller said it is probably quite a bit bigger since the battery is a large proportion of the tag. Murdoch asked if tag shape has an effect on barotrauma. Keller said no, not to his knowledge. Ferguson said not barotrauma, but tag shape affects incision size and extrusion rate. Gingerich said barotrauma had to do with how much air has to be brought into the swim bladder to compensate for the tag burden. Kahler said the observations with barotrauma were tag extrusion, viscera extrusion, and swim bladder rupture. Ferguson said this has to do with the air bladder being larger already and putting pressure on viscera when the air in the bladder expands as the fish passes through low pressure areas below turbine unit blades.

ATS SS400 Acoustic Transmitter

Keller said the ATS SS400 acoustic transmitter is the "injectable tag" developed by PNNL. Keller said it does require a large needle compared to PIT tags, so the standard practice is still to create an incision. Gingerich asked if there were sutures. Kahler said no sutures are necessary. Keller said a 3-second ping rate would have a 48-day tag life, and it weighs 0.216 gram in air. Keller, Graf, and Kahler saw the tag in person and said it is obviously bulkier than a PIT tag. Keller said that even with a 48-day tag life, there is still the issue with non-migrants influencing passage statistics. Graf said ATS Inc. is still recommending not tagging fish less than 95 millimeters (mm) in length, which is no different than the ATS SS300. Keller said yes, this is not an improvement regarding being able to tag smaller fish, but there is not a need for sutures and there is less tag burden, which is a major improvement to the tagging process. Keller said that with high water temperatures there is always increased stress and disease problems with holding and tagging fish. Murdoch asked for further information on tag weight with additional batteries from ATS Inc. Keller said he would ask ATS Inc. for that information.

Eel/Lamprey Acoustic Tag (ELAT)

Ferguson asked about the Eel/Lamprey Acoustic Tag (ELAT). Keller said they did see the ELAT in-person as well, but it is not commercially available at this time. Keller has reached out to Ryan Harnish for more information. Kahler said it has a 40-day life with a 5-second ping rate. Gingerich roughly estimated that the tag burden would be 2% to 3% for a 95-mm-size fish.

Ferguson asked for any additional questions; no others were posed in the meeting. Ferguson asked what the next steps should be for conveying information in preparation for survival studies. Keller suggested a presentation be given in July by Dr. John Skalski to understand whether there is a statistical model that can be created from the best available data. This allows the Rock Island and

Rocky Reach HCP Coordinating Committees time to draft a statement of agreement (SOA) in August (the current SOA that maintains Rock Island and Rocky Reach subyearling Chinook salmon in Phase III [Additional Juvenile Studies] status expires in late September).

B. HCP Tributary Committees Dispute Update (All)

John Ferguson said the formal dispute has been retracted by Steve Parker (Yakama Nation) at Ferguson's request, allowing the Policy Committee time to convene a meeting to discuss the topic informally. Ferguson asked Keely Murdoch to thank Steve Parker for withdrawing the formal dispute. He said the Policy Committee discussion of the Tributary Committees' issues will be on July 9 in the Chelan PUD offices. Tom Kahler will represent Douglas PUD as the Policy Committee representative. Richie Graves (National Marine Fisheries Service) will attend by phone. Ferguson will issue a simple agenda later this week for the meeting. Ferguson said the idea is to have a straightforward and open discussion of the issues.

Ferguson asked if there were any questions; Murdoch asked if a step to bring the issue to the HCP Coordinating Committees was skipped because of time. Ferguson said that retracting the formal dispute allows the Policy Committee to take the time to set a meeting date when all parties can attend and that is not being driven by the schedule established by the HCP. He indicated the HCP Coordinating Committees have discussed the dispute issues and made it clear they would be unable to reach a consensus position and would in all likelihood pass the dispute along to the Policy Committee. He said retracting the formal dispute allowed for all parties to meet in July. He said meeting informally does get to the intent of getting the Policy Committee together to discuss these issues because the Tributary Committee cannot reach a consensus on some funding or land ownership decisions at this time. Ferguson said the Yakama Nation issue paper will be presented as the main agenda item at the Policy Committee meeting. Ferguson said a goal will be to determine whether the Policy Committee can provide guidance to the Tributary Committees on how they should be operating. The Policy Committee may require only one meeting or they may require more. Ferguson said this uncertainty around the time needed requires more flexibility for ongoing discussion and led to the request to retract the formal dispute at this time.

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on July 23, 2019, to be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington.

The August 27 and September 24, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A List of Attendees

Attachment B Acoustic Tag Specifications

Attachment A
List of Attendees

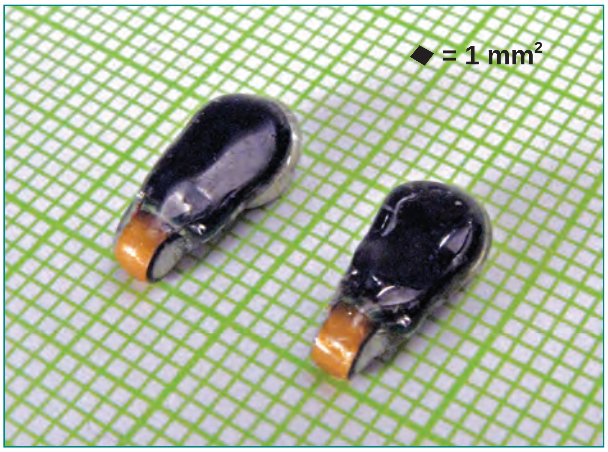
Name	Organization
John Ferguson	Anchor QEA, LLC
Larissa Rohrbach	Anchor QEA, LLC
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Peter Graf¨	Grant PUD

Notes:
- * Denotes HCP Coordinating Committees member or alternate
- † Joined by phone
- ¨ Joined for the joint HCP Coordinating Committees and PRCC portion of the meeting

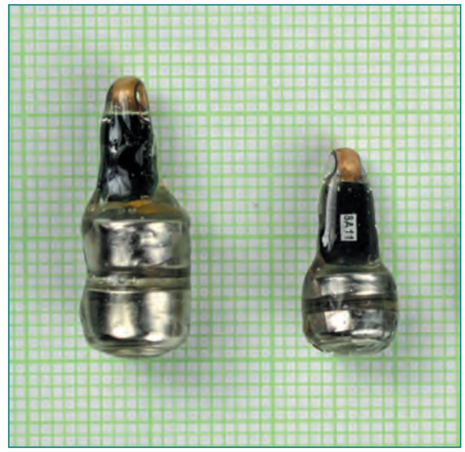
Freshwater & Marine
Acoustic

JSATS AMT

Juvenile Salmon Acoustic Telemetry System
Acoustic Micro Transmitter



L-AMT-1.416 *L -AMT-1.421*



L-AMT-8.2 *L -AMT-5.2*

The Lotek JSATS AMT – Juvenile Salmon Acoustic Telemetry System Acoustic Micro Transmitter – was developed to satisfy the research and regulatory requirements for monitoring juvenile salmon in the Columbia River Basin. The transmitter's small size and relatively long operational life permits tracking of sub-yearlings throughout their natural environment while minimizing impact upon them.

The Lotek JSATS AMT transmitter is compatible with JSATS receiving systems and utilizes a Binary Phase-Shift Keying (BPSK) coding system that allows for tens of thousands of unique IDs on a single acoustic frequency. Each transmission consists of an ID and check sum delivered in less than one millisecond thereby minimizing the probability of mis-identification or interference from code collision.

Key Features

- Small size and light weight (0.28g) - suitable for small fish and sub-yearling applications
- Over 65,000 unique Ids - embedded check sum reduces error rate
- Sub-millisecond ID message length provides long life and reduced "code collision" rate
- Used for autonomous monitoring presence/absence
- Used for wireless positioning in 2D via Lotek UMAP positioning system
- Now available as JCART combined acoustic/radio transmitter compatible with SRX (400/600/800/DL) radio receivers and WHS 4000 acoustic receivers

JSATS AMT

Specifications

Lotek JSATS AMT Juvenile Salmon Acoustic Telemetry System Acoustic Micro-Transmitter						
TAG MODEL	Physical Specifications		Calculated Life (days)* (with given transmission period-seconds)			
	Size (mm)	Dry Weight (g)	2s	5s	10s	20s
L- AMT-1.416	10.7 x 5.4 x 3.1	0.28	10	25	48	87
L- AMT-1.421	11.1 x 5.5 x 3.7	0.32	15	38	72	131
L-AMT-5.1 B	5 x 7 x 13	0.6	39	95	180	327
L-AMT-5.2	7 x 7 x 16	1.1	81	189	341	568
L-AMT-8.2	9 x 23	3.5	218	508	914	1522
L-AMT-14-12	14 x 45	8.0	429	1009	1837	3114

** Calculated life represents expected or average life*
Warranty Life is 80% of calculated life
Maximum warranty life is three (3) years
Minimum signal strength is +158 dB (re 1 uP @ 1 meter)
Transmitters that do not meet the warranty life during normal use will be replaced

Product specifications provided herein are subject to change as a result of ongoing product development. Please contact your Lotek sales representative for current specifications.
Product specifications tolerance +/- 5%.

Surface Roughness:	Smooth and devoid of sharp edges or protrusions
Coating:	Parylene-C (25 microns min. thickness) or alternate field proven encapsulation
Biocompatibility:	Biologically inert coating
Shape:	See photographs
Transmitter frequency:	416.7 kHz ± 0.05%
Transmitter power:	Typical source level of +158 dB (re: uPa @ 1 meter)
Pulse Repitition Interval (PRI):	Factory configurable - 1 second minimum / 1 second increments
ID Message encoding:	31-bits, BPSK, with format as follows: 1. 7-bit Barker code (ox72) 2. 16-bit tag ID code (0x0000 – 0xFFFF) 3. 8-bit cyclic redundancy check (CRC), (oxFF)
ID Message length:	744 microseconds
Number of possible tag ID codes:	65,536
On/off switch:	Non-contact acoustic trigger device, i.e. no exposed wires; tags are fully encap-sulated when delivered.
Transmitter label:	Discernable 4-character hex-code representing the 16-bit tag ID code (0xFFFF)

Prior to delivery, 100% of all transmitters are tested for adherence to dimensional and dry weight specifications, acoustic source level, code sequence and transmit interval.

Shipment of AMT:

Transmitters are separated in the shipping box using shock absorbing high density anti-static foam.

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L0315- 003

Tel: 905-836-6680
Fax: 905-836-6455
Web: www.lotek.com
Email: biotelemetry@lotek.com

V3 307 kHz Coded Transmitters

VEMCO's miniature coded transmitters open up a new world for small fresh and salt water species research

Smaller Fish, More Species

Weighing just 0.3 grams and measuring 15 mm in length, the V3 tag is the smallest of VEMCO's line of miniature coded transmitters. The V3 enables researchers to track and monitor smaller fish and a broader range of species than ever before!

Why a Higher Frequency?

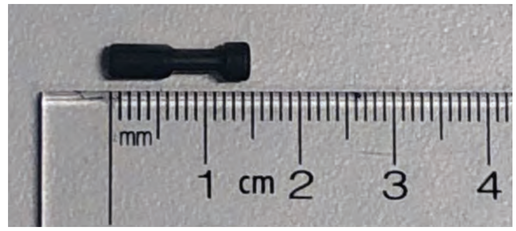
The V3, operating at 307 kHz, is designed to work well in fresh water. This frequency enabled VEMCO to develop a lightweight tag that allows researchers to track a large number of fish in a small space. Researchers can now tag and release many more fish simultaneously due to the detection capabilities of our new tag transmission sytems.

Compatible Receivers

The V3 works with VEMCO's new High Residence HR3 Receiver, as well as HTI 290-Series Receivers and 395 Data Loggers. The HR3 can be deployed remotely, or cabled for real-time detections, and can be programmed to detect either HR or HTI coding schemes, or both schemes alternating.

High Residence (HR)

HR represents a more aggressive transmission system that offers the ability to detect many more tagged animals at once. Each HR ID code is embedded in each short ping transmitted by the tag. This allows the HR3 receiver to detect many IDs in a short period of time.



Benefits of HTI Coding

The HTI coding structure provides researchers with high performance in noisy and reflective environments. Alternating HTI and HR coding schemes provide researchers with interesting study possibilities that previously weren't possible, in a tag designed for very small fish. The HTI coding (i.e. the ability to vary pulse widths and signal types, etc.) in the V3 tag also allows for cross-compatibility with HTI equipment.

HR3 Receiver

The new HR3 receiver is capable of very precise signal timing, which makes the HR3 ideal for anyone interested in accurate spatial 2D/3D positioning with sub-meter resolution. Many tagged animals can be tracked in a short period of or have their movements tracked as they move quickly through acoustic gates (i.e. river survival study). Using a VR100 and VHTx-307 hydrophone, HR3 receivers can be communicated with, to query things such as tilt, pressure (depth), temperature, battery usage, memory used, and detection count.

Advantages of VEMCO's 307 kHz Product Line

- Two transmission systems (HR and HTI) in one tag provides flexibility for study designs and research objectives
- Real time monitoring of HR and HTI tags (HR3s and HTI 290-series receivers)
- HR and HTI transmission systems available in all 307 kHz tag models
- Able to transmit HR, HTI, or both signals alternating

High Residence (HR) **and HTI transmission** systems offer new ways of detecting your tagged animals!

Tel: (902) 450-1700
Fax: (902) 450-1704

www.vemco.com

Programmable ON/OFF

The V3, as with all VEMCO transmitters, is available with programming options that allow users to take greater advantage of fish behaviour over the life of their tags. In order to control the characteristics of their tags, users have the option of using up to four programming steps to define the tags transmission: Status (ON/OFF), time interval, nominal delay, and transmission type (HR / HTI / Alternating).

This is an example of how V3 tag programming options can be utilized to provide a staged release tag behaviour.

Interval	Status	Time	Power (H)	Nominal Delay (sec)
Step 1	ON	1 hour	H	30
Step 2	OFF	7 days		
Step 3	ON	70 days	H	10

When finished, LOOP back to Step 3.

Step 1: The tag is programmed to start with a nominal delay setting of 30 seconds for a period of 1 day. This allows a researcher to activate a tag and have it transmit for 1 day during the surgical implantation phase of the study.

Step 2: The tag is programmed to turn OFF for a period of 9 days. In order to conserve battery life while the animals recover from surgery, the tags are switched to the OFF status since the location of the animals is known.

Step 3: The tag is programmed to turn ON with a nominal delay setting of 60 seconds for a period of 45 days. This allows a researcher to release and track the animals during a 45 day migration period through a given study area.

Step 4: The tag is programmed to stay ON with a nominal delay setting of 180 seconds for a period of 15 days. This allows a researcher the ability to track the animals for 15 days during what might be a more residency type setting. Note the Loop control setting is set to Step 4 thus keeping the tag in the ON status until the tag reaches its battery end of life.

VEMCO Tag Activator (VTA)

The VTA is a handheld device that enables users to quickly and easily activate 307 kHz transmitters.

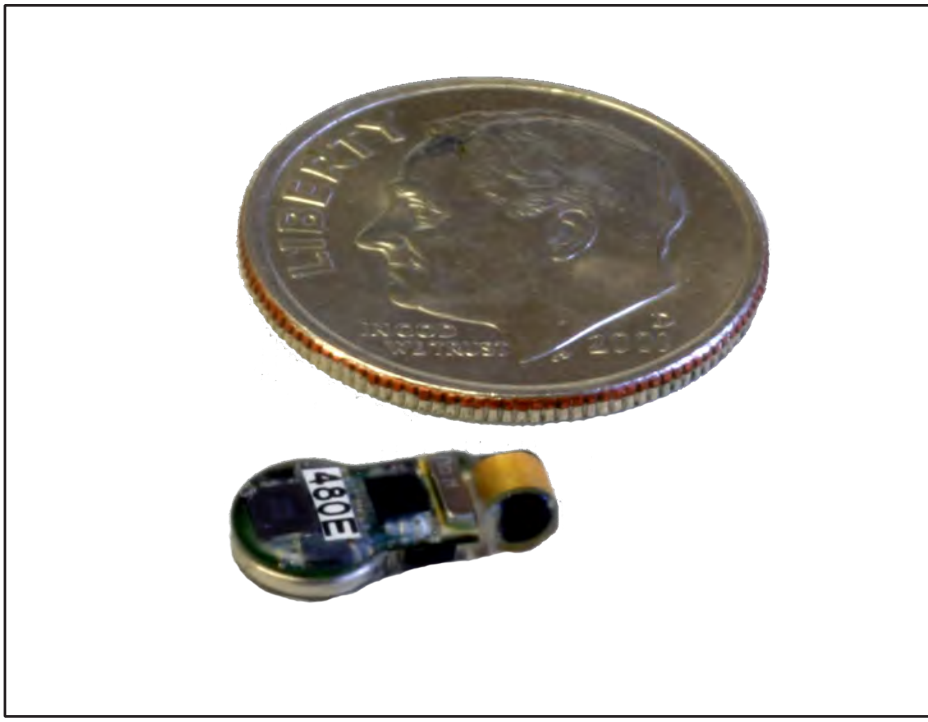
Contact Us!

Please consult with VEMCO if you are considering 307 kHz products. We can help you fine tune your study design and programming options!

Attachment B

ATS SS300 Acoustic Micro Transmitter

World's Most Reliable Transmitters and Tracking Systems



The New Third Generation model SS300 Acoustic Tag is Significantly Smaller in Size Without Sacrificing Life or Signal Strength.

The Juvenile Salmonid Acoustic Telemetry System (JSATS) was developed by the Army Corps of Engineers and its partners to study fish behavior in freshwater and marine environments. ATS has been manufacturing large numbers (more than 10,000 tags per year) of acoustic micro transmitters (AMT's) for the JSATS program since 2007. Through our innovative designs, the JSATS transmitter has significantly decreased in size, increased in power output, and become easier to deploy in the field. We've achieved these improvements while still offering another ATS trademark - low cost!

The JSATS system uses a binary phase shift keyed (BPSK) code pulse to achieve a code set of over 65,000 individual ID's. The pulse rate interval (PRI), code ID, and duty cycling (sleep/delayed activation) are user configurable through the use of the highly portable ATS Pinger Dish. The pulse train contains a 7-bit Barker code, 16-bit tag ID code, and 8-bit cyclic redundancy check (CRC). The message is only 744 milliseconds in length, so the short on-time saves power and reduces signal collisions as compared to other standard timing code sets on the market.

ATS manufactures JSATS transmitters using strict process control procedures and part traceability, so you can be assured that you will receive a reliable product.

- **Part of a complete Tracking System includes Tags, Tag Programmer, and Receiving Equipment**
- **Smallest Acoustic Tag Available that meets Life and Output Requirements of the JSATS Program**
- **User Configurable**
- **Model SS300**
  - **Weighs 300 mg**
  - **Size 10.7 x 5.0 x 2.8 mm**

World's Most Reliable Transmitters and Tracking Systems

TRANSMITTERS
RECEIVERS
GPS SYSTEMS
ANTENNA SYSTEMS
CODED ID SYSTEMS
CONSULTING

ADVANCED TELEMETRY SYSTEMS
470 FIRST AVE NW · ISANTI, MN 55040
sales@atstrack.com · www.atstrack.com
763-444-9267

ATS SS300 Acoustic Micro Transmitter

PHYSICAL

SS300

- Size: 10.7 mm long x 5.0 mm wide x 2.8 mm high
- Weight, dry: 300 mg; heavier depending on battery used
- Expected life:

Battery Type	Interval (sec)	Expected run time (days)
337	3	23
	5	37
	10	68
379	3	45
	5	73
	10	136
377	3	79
	5	128
	10	238

GENERAL

- Code set: 65,536 individual BPSK codes
- Frequency: 416.7 kHz ± 0.5%
- Power output, typical: +156 dB re: 1uPa @ 1 meter
- Biocompatible coating: Parylene C, 25 micron thickness
- Pulse rate interval (PRI): Factory or user configurable with Pinger Dish
- On/off: Acoustic coded with Pinger Dish
- Label: 4 place alphanumeric code ID
- Code ID: Factory or user configurable with Pinger Dish
- Duty cycling: Factory or user configurable with Pinger Dish

ATS Pinger Dish III

The ATS Pinger Dish III is designed to be an inexpensive, field-portable unit to activate and deactivate AMT's (acoustic micro-tags). When a tag is activated in the pinger dish, the integrated display shows the tag frequency, code ID, CRC (cyclical redundancy check) and the PRI (pulse rate interval).

The improved model III features a more durable and robust design, making high volume field operations easier and more efficient. Decoding algorithms have been improved, and the programming control signal is now four times stronger than the previous model, making communications between tag and reader highly reliable. Pulse rate interval resolution displayed on the screen has increased from 0.01 to 0.001 seconds, and the LCD display size has increased from 2 lines x 16 characters, to 4 lines x 16 characters.

The dish operates on 12 VDC, and is powered by an included converter that utilizes 120 VAC. Connecting the Pinger Dish III to a PC via a RS232 serial cable allows the PRI, code ID, and duty cycling parameters to be user configurable.

The included Sonic Tag Integrator software may be used on the PC side to control tag activation, and to create a database of activation and tagging activities.

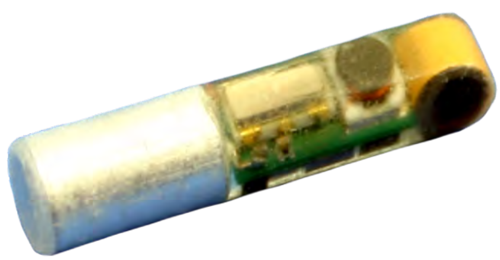
WARRANTY

- One year parts and labor on materials and workmanship

Attachment B

ATS SS400 Acoustic Transmitter

World's Most Reliable Transmitters and Tracking Systems



The New Fourth Generation model SS400 Acoustic Tag allows for easy insertion into the fish, and is JSATS compatible.

The Juvenile Salmonid Acoustic Telemetry System (JSATS) was developed by the Army Corps of Engineers and its partners to study fish behavior in freshwater and marine environments. ATS has been the acoustic micro transmitter (AMT's) supplier for the JSATS program since 2007. The cylindrical form factor used in this design allows you to more quickly insert the tag into the fish, which will save time and expense during fish tagging operations and improve survival.

The JSATS system uses a binary phase shift keyed (BPSK) code pulse to achieve a code set of over 65,000 individual ID's. The pulse rate interval (PRI), code ID, and duty cycling (sleep/delayed activation) are user configurable through the use of the highly portable ATS Pinger Dish. The pulse train contains a 7-bit Barker code, 16-bit tag ID code, and 8-bit cyclic redundancy check (CRC). The message is only 744 milliseconds in length, so the short on-time saves power and reduces signal collisions as compared to other standard timing code sets on the market.

ATS manufactures JSATS transmitters using strict process control procedures and part traceability, so you can be assured that you will receive a reliable product.

- **Part of a complete Tracking System includes Tags, Tag Programmer, and Receiving Equipment**
- **Cylindrical form factor allows tag to be quickly inserted into fishes body cavity**
- **Smallest acoustic tag available that meets life and output requirements of the JSATS Program**
- **User activated and configurable using the portable Pinger Dish**
- **Model SS400**
    - **Weighs 216 mg**
    - **Size 15.0 x 3.38 mm**

World's Most Reliable Transmitters and Tracking Systems

TRANSMITTERS
RECEIVERS
GPS SYSTEMS
ANTENNA SYSTEMS
CODED ID SYSTEMS
CONSULTING

ATS
ADVANCED TELEMETRY SYSTEMS
470 FIRST AVE NW · ISANTI, MN 55040
sales@atstrack.com · www.atstrack.com
763-444-9267

ATS SS400 Acoustic Transmitter

PHYSICAL

SS400

- Size: 15.0 mm long x 3.4 mm diameter
- Weight, dry: 216 mg; heavier depending on battery used
- Expected life:

Battery Type	Interval (sec)	Expected run time (days)
BR306	3	48
	5	71
	10	111
Battery Type	**Interval (sec)**	**Expected run time (days)**
379 (2)	3	108
	5	159
	10	247
Battery Type	**Interval (sec)**	**Expected run time (days)**
377 (2)	3	188
	5	279
	10	432

GENERAL

- Code set: 65,536 individual BPSK codes
- Frequency: 416.7 kHz ± 0.5%
- Power output, typical: +156 dB re: 1uPa @ 1 meter
- Biocompatible coating: Parylene C, 25 micron thickness
- Pulse rate interval (PRI): Factory or user configurable with Pinger Dish
- On/off: Acoustic coded with Pinger Dish
- Label: 4 place alphanumeric code ID
- Code ID: Factory or user configurable with Pinger Dish
- Duty cycling: Factory or user configurable with Pinger Dish
- Temperature: 0 to 31° C

ATS Pinger Dish IV

The ATS Pinger Dish IV is designed to be an inexpensive, field-portable unit to activate and deactivate AMT's (acoustic micro-tags). When a tag is activated in the pinger dish, the integrated display shows the tag frequency, code ID, CRC (cyclical redundancy check) and the PRI (pulse rate interval).

The model IV features a durable and robust design, making high volume field operations easy and efficient. With specialized decoding algorithms and a high energy programming control signal, communications between tag and reader are highly reliable. The display uses a large 16 character by 3 line LCD for easy readability.

The dish operates on 12 VDC, and is powered by an included converter that utilizes 120 VAC. Connecting the Pinger Dish IV to a PC via a RS232 serial cable allows the PRI, code ID, temperature, and duty cycling parameters to be user configurable.

The included Sonic Tag Integrator software may be used on the PC side to control tag activation, and to create a database of activation and tagging activities.

WARRANTY

- One year parts and labor on materials and workmanship

FINAL

1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: August 28, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the July 23, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, July 23, 2019, from 10:00 a.m. to 1:45 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- HCP Coordinating Committees representatives will prepare technical questions and considerations concerning the feasibility of conducting subyearling Chinook salmon studies with the current information and technology available to date, for discussion with Drs. Rebecca Buchanan and John Skalski (University of Washington [UW], Columbia Basin Research) during the HCP Coordinating Committees meeting on August 27, 2019 (Item I-A).
- Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item II-C).
- Douglas PUD will review available passive integrated transponder (PIT)-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item II-C).
- Kirk Truscott will submit Colville Confederated Tribes (CCT) comments on the draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* to Tom Kahler by Friday, July 26, 2019 (Item V-B).
- The HCP Coordinating Committees meeting on August 27, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item VII-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The draft *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019; Douglas PUD will request approval of the report during the HCP Coordinating Committees meeting on August 27, 2019 (Item V-B).

Finalized Documents

- There are no documents that have been recently finalized.

I. Joint HCP Coordinating Committees and PRCC

A. Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies – 2019 (Rebecca Buchanan)

The presentation titled, *Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies – 2019* (Attachment B) was distributed to the HCP Coordinating Committees by Kristi Geris on July 20, 2019.

Slides 1 to 2

Dr. Rebecca Buchanan said there have been no significant developments in statistical analyses for estimating reach survival of subyearling Chinook salmon; however, there have been some new developments for estimating at-dam passage survival. Buchanan said this presentation will include a refresher on the requirements and assumptions for a paired release-recapture design, a review of studies, and study recommendations.

Slides 3 to 4

Buchanan said project survival can be estimated using a paired release-recapture design, based on the Cormack-Jolly-Seber (CJS) model, which requires control and treatment releases and a minimum of two downstream detection sites. She said detection arrays need to be placed at the upstream end of one pool and at the downstream end of the next pool. She said arrays in the tailrace of a dam need to be far enough downstream to avoid detecting dead fish in the immediate tailrace (which results in a positive bias) and far enough downstream that fish in both releases have completed expressed short-term handling effects, but not too far that fish in Release 1 (R_1) are exhibiting tagger effects or tag burden effects (negative bias). She said an estimate (S_1) of the probability of survival from R_1 to the first detection site (dashed line labeled P_1 and P_2)[1] and an estimate (S_2) of the

[1] Where P_1 is the probability of tag detection at the first detection site for a fish from R_1, conditional on the tag being present at the detection site (i.e., "detection probability"); and P_2 is the probability of tag detection at the first detection site for a fish from R_2, conditional on the tag being present at the detection site.

probability of survival from Release 2 (R_2) to the first detection site are calculated. She said the last reach parameter estimates the joint probability of: 1) surviving from the first detection site to the second detection site; and 2) being detected on the second detection site, conditional on having survived to the first detection site, for fish from R_1 (λ_1) and R_2 (λ_2). She said the ratio of the estimated survival for one release ($\hat{S}_1$) to the other release ($\hat{S}_2$) equals the estimated project survival ($\hat{S}_{\text{Project}}$). She said if the detection arrays are placed as described, the short-term handling effects for $\hat{S}_1$ and $\hat{S}_2$ should be the same and will cancel out.

John Ferguson asked about additional rules or recommendations for placement of the first and second detection arrays. Buchanan said for each respective tailrace location, one must consider how far dead fish are drifting downstream. She said studies conducted in mainstem rivers place arrays anywhere from 25 to 50 river kilometers (rkm) downstream of the dam. She said, however, the arrays cannot be located too far downstream where fish from R_1 are exhibiting tag burden effects. She said additionally, arrays in the tailrace should be placed far enough downstream where there is complete mixing of fish from the different releases. She said two downstream arrays are the minimum design requirements, but more than two are needed to test the assumptions. She said 8 to 10 arrays are ideal.

Kirk Truscott said it seems placing arrays farther downstream would result in less issues with dead fish and short-term handling effects and tagging more fish might address issues with overall lower survival to downstream detection sites. He said more PIT tags might not be an issue; however, the cost of additional acoustic tags might be an issue. Buchanan agreed tag and receiver costs can be a factor in these studies. She noted that PIT-tag studies do not estimate project survival because those studies examine juvenile bypass system to juvenile bypass system and not tailrace to tailrace. Truscott said PIT-tag studies still examine a ratio. Buchanan agreed but explained that the detection locations for PIT-tag studies (juvenile bypass system) do not exactly align with the project and will always include some survival from the previous project. She said in this presentation, she will always be referring to acoustic tags. *(Note: Buchanan later indicated that upon further consideration, she agrees with Truscott that the ratio from PIT tags can be used to estimate project survival, provided that the model assumptions are met.)*

Slide 5

Buchanan said this is the list of assumptions common to all paired-release model studies. She said one cannot adjust for an assumption at the time of data analysis; therefore, it is important to think about these assumptions when designing a study.

Slides 6 to 7

Buchanan said each assumption includes considerations, as well as actions to take to prevent from violating the assumption or to determine how much in violation one is with the assumption. She reviewed considerations and actions for *Assumption #1: Test fish representative of population of inference*. She noted that good documentation of fish selection is key to defend against criticisms, and she reviewed histograms that compare fish lengths of acoustic-tagged subyearling study fish with run-of-the-river (ROR) fish.

Truscott asked if fish are not the healthiest but are representative of the run, is it really representative to remove injured fish from the study? He asked further, how does one not bias the study results unless the same quality of fish are included in each release group? Lance Keller agreed and said it can also be difficult to design a study to make sure the results are due to project effects and not a function of hatchery effects. Truscott said because the evaluation is based on a ratio, it seems this bias can be removed so long as there is equality between the release groups. Buchanan agreed if poor-quality fish are represented in both release groups this will cancel out. She said if a hatchery population is what one wants to make inference to, these fish need to be included in the sample and project survival will be estimated for this population. *(Note: Buchanan later indicated, upon further consideration, that the effects of using poor-quality fish will cancel out only if those effects are expressed equally between the upstream and downstream release groups. If the effects are expressed more in the upstream release group [e.g., stronger tag burden effects among poor quality fish], then the estimate of project passage survival will be negatively biased [for higher quality fish] even if both releases have the same proportion of poor-quality fish [i.e., representative sampling]. Both releases should have the same distribution of fish condition.)*

Slides 8 to 9

Buchanan reviewed considerations and actions for *Assumption #2: Test conditions representative of conditions of interest*. She said, for example, an unusually high-water year or drought year would not be representative of normal conditions and would not be ideal for a study.

Truscott said the HCPs stipulate conducting a validation study every 10 years, which limits the options to 1 year. Tom Kahler added, however, that validation studies consider a multiyear average, and Keller said a flow duration curve is also applied to each individual study included in a 3-year survival average.

Slide 10

Buchanan reviewed considerations and actions for *Assumption #3: Release sizes known exactly*. She emphasized the importance of scanning tags before release and also scanning recovered shed tags.

She said if fish are assigned to the wrong release group this will negatively impact the survival estimate.

Slide 11

Buchanan reviewed considerations and actions for *Assumption #4: Detection events correctly coded*. She said to differentiate true detections from false positive detections arising from ambient noise or tag collisions, one needs to implement a signal processing program. She said UW has a software program for processing data based upon Juvenile Salmon Acoustic Telemetry System (JSATS) and other tags. She said the program analyzes the number of tag pings and intervals. She said the program is complicated to implement.

Truscott asked how studies differentiate between alive and dead fish. Buchanan said there are filters for data implanted by the researcher; for example, those based on assumed behavioral differences or a statistical process based on movement behavior. Truscott asked if there is a difference in the tag signal. Buchanan said not generally; however, tag manufacturers have developed predation tags that ping differently when the tag comes in contact with stomach acid.

Slide 12

Buchanan reviewed considerations and actions for *Assumption #5: Fate of each fish independent*. She noted that tag collision is fairly uncommon with JSATS tags. She also recommended not positioning a receiver array directly downstream of a release location.

Slide 13

Buchanan reviewed considerations and actions for *Assumption #6: Prior detection history has no effect on subsequent survival and detection*. She said this consideration came out of bird banding studies where one must re-handle a bird to read the band, which might affect subsequent survival. She said the thought was the same with fish although less of an issue for acoustic tags, which do not require re-handling to detect fish. She said one can test for violations of this assumption using tests developed by Burnham et al. (1987)[2]; however, because acoustic tags have high detection probabilities these tests are not useful in this case. The Burnham tests are necessary for PIT-tag studies. She said to avoid violations of this assumption, researchers should think about the placement of the receivers. She said for example, if two detection sites are located upstream and downstream from each other and do not span the entire migratory channel, fish detected at the upstream site will have a different detection probability compared to the downstream site. She said this type of scenario results in biased detection probability (generally negative bias) and biased

[2] Burnham, K. P., D. R. Anderson, G. C. White, C. Brownie, and K. H. Pollack (1987). Design and analysis methods for fish survival experiments based on release-recapture. American Fisheries Society Monograph 5.

survival (positive bias). She said nothing can be done to correct this in the statistical analysis so this needs to be considered and addressed when designing the study.

Slides 14 to 15

Buchanan reviewed considerations and actions for *Assumption #7: All fish have same survival and detection probabilities*. She said the CJS model is generally robust to violations of this assumption. The robustness of the model to failures of this assumption can be tested by conducting a simulation study. She said in the example on slide 15, the study used a single release with two detection sites and survival was estimated through one reach (S_1). She said the single release was broken into two groups of equal size (Group 1 and Group 2 each with 10,000 fish), and the study simulated datasets under different scenarios to determine similarities or differences between groups. She said then an estimate of survival (or expected survival) [$E(\hat{S})$] and average of all datasets (or actual survival) ($\hat{\hat{S}}$) were calculated. She said in each case, the expected survival and actual survival were really close. She noted the low detection probabilities (p_1) ranging from 0.10 to 0.20, which she said is applicable to PIT-tag studies.

Ferguson asked what the lambda (λ) represents, and Buchanan said this represents the joint probability of: 1) surviving from the first detection site to the second detection site; and 2) being detected on the second detection site, conditional on having survived to the first detection site.

Peter Graf (Grant PUD) asked if there is a short-term receiver outage does this invalidate the data? Buchanan said this depends on how long the outage is relative to the duration of the detection period. She said, for example, a 2-hour outage over a 2-week detection period is not a big deal; however, a 2-hour outage over a 24-hour detection period might be more significant. She said one consideration is the λ parameter cannot be too small or this can lead to bias in the survival estimate.

Slide 16

Buchanan reviewed considerations and actions for *Assumption #8: Releases share same survival processes in reaches in common*. She reviewed the paired release-recapture model for estimating project passage survival. She said the first release (R_1) provides an estimate of the joint probability (S_1) of surviving through the project and through the tailrace to the first detection site and must be adjusted for survival from the tailrace to the detection site in order to give project passage survival. She said the second release (R_2) provides an estimate of the probability of survival from the tailrace to the first detection site (S_2). She said if fish from the two releases have the same probability of survival from the tailrace to the first detection site, then the ratio of the survival probabilities estimated from the two releases (S_1/S_2) is project passage survival. She said if the two releases do not have the same probability of survival between the tailrace and the detection site, then the ratio will be biased for project passage survival. She said one possible reason fish from the two releases might not have common survival in the common reach is if the fish are experiencing different environmental conditions when the fish are in the reach. She said to avoid this, the release timings should be staggered so that the downstream fish are released during the time when fish from the upstream release are expected to be passing through that reach.

Truscott said, for example, a study is targeting 80% of all migrants and those migrants are experiencing different flow regimes over the migration period, or the majority of fish pass in the first 30% of the migration period. He asked what exactly should the releases mimic? Buchanan said with the ratio this does sometimes make a difference. She suggested calculating a season-wide estimate that pools the releases across the season or take a weighted average of release-specific estimates. She said both should have the same results in expectation. Truscott said it seems if the bulk of fish pass during a specific period this would result in a different estimate compared to taking an average. Keller said the important thing is to align the release and migration timing. He said, for example, sockeye salmon below Wells Dam take 18 hours on average to reach Rocky Reach Dam and so long as the releases in the tailrace are at the same time across the entire study these factors should tease out.

Graf said these survival studies want the final results to be representative of the run at large, and he asked if this means the releases need to be weighted more? Buchanan said this is a good question and she is unsure, but she believes U.S. Army Corps of Engineers (USACE) studies pooled data across releases through time (R_1 and R_2 were pooled across the season). She said for PIT-tag survival studies, data were pooled on a daily basis.

Kahler said Douglas PUD has reported treatment and control releases within each replicate separately as a single release. He said survival was reported for: 1) pooled Okanogan and Methow releases (treatment); and 2) tailrace releases, for each replicate. He said survival for each pooled release treatment was divided by the survival for the control release for each replicate, and then the overall average survival was weighted.

Truscott asked how to calculate an estimate based on high survival when there is a low abundance of ROR fish. Buchanan replied: by taking a representative sample of the run through time, weighted more to the times when most fish are migrating. Keely Murdoch said she recalls having pre-planned releases fixed through time. Kahler agreed and said because it is unknown how the migration will turn out. Truscott asked then, if this would be a valid study? Murdoch also asked if the migration is normally distributed and releases are equal, but at the peak of migration there is higher or lower survival, will this bias the results? Kahler said for every release group there was an average travel time with travel-time distributions that overlapped with the distributions from other release groups, essentially a mass of fish from all releases that combined at one point. He said it would not be possible to implement an in-season tailoring of the releases to match the run, because one cannot tell where you are in the distribution at any point in time until the run is over. Keller suggested monitoring survival on a weekly basis and said it is not uncommon to see a decrease in survival on the front end and back end of the migration. He said from a predator saturation perspective, a lot of ROR fish are present in the middle of a juvenile outmigration compared to the beginning and the end. Buchanan suggested comparing study dates to run timing (e.g., slide 9). She said this would be a post-hoc analysis, but it would be based on historical averages. She said the curve on slide 9 is fairly well-representative and if the study is conducted too early or too late the sample size would have undue weight.

<u>Slide 17</u>

Buchanan continued discussing *Assumption #8: Releases share same survival processes in reaches in common*. She said when study fish are released in the river channel there is concern about releasing the fish in an area of high or low mortality, which can result in a positive or negative bias to the estimate. She said this can be assessed by comparing survival to a downstream site for each release across the river channel. She said in the example on slide 17, there is no strong evidence of a mortality hotspot.

<u>Slide 18</u>

Buchanan continued discussing *Assumption #8: Releases share same survival processes in reaches in common*. She said these plots examine the distribution of arrival timing. She said the hope here is for the peaks of the curves to align (for the modes to align).

<u>Slide 19</u>

Buchanan reviewed considerations and actions for *Assumption #9: Fish either migrate downriver or die*. She said if a fish does not appear at the end of a reach the model cannot distinguish between whether the fish died or did not migrate. She said if residualization occurs (i.e., migration delay past the end of the study), the estimate of project survival will be biased. She said actions to address this concern include using only active migrants and obtaining residualization-corrected estimates. She said the latter can be done through mobile surveys or an augmented acoustic-tag study design (extra receivers). She noted this cannot be done with PIT-tag studies because mobile tracking cannot be used with residualized PIT-tagged fish. She said even with good detection rates the problem is in interpreting the data.

<u>Slide 20</u>

Buchanan reviewed considerations and actions for *Assumption #10: No tag failure*. She emphasized the importance of testing tag life concurrent with the study. She said some tags lose battery life on the shelf or the tag can accidently be turned on during shipping. She said in one study, by the time tagging came along, these tags had only 4 days of battery life instead of 24 or more days. She said the only way to salvage a year of study is to conduct a tag-life study concurrent with the tagging and release of test fish and tell the manufacturer what is wrong so the vendor can fix the problem and send new tags.

Slide 21

Buchanan continued discussing *Assumption #10: No tag failure*. She said on the left graph, the black markers show the time of tag failure, which fit the tag-life curve really well. She said the average tag-life is 24 days. She said on the right, a tag-life curve was compared to tag detection times, particularly to the arrival distribution of tags at detection sites. She said each curve represents the cumulative arrival timing of tags at different detection sites. She said for a study you want the arrival to occur before the tag expires. She said if a lot of tags arrive dead (23 days or more in this case) this cannot be corrected, but a smaller amount can be corrected.

Graf asked how to determine whether a fish arrived past 24 days. Buchanan said if the fish arrives on Day 28, there is little likelihood for detection because the tag is probably dead. She said, however, if a fish arrives on Day 23, there is a 50% chance of detecting the fish based on available tags. She said if a lot of fish are arriving late, this indicates a problem. She said a tag-life adjustment can be applied if fish are arriving at the shoulder. Graf asked if the curve is assuming all tags are detected. Buchanan said the curve assumes the observed tags are representative of travel times.

Graf asked if the tag-life adjustment applies with a unimodal distribution of arrival times or does this only work with a uniform distribution of migration time. Buchanan said the tag-life correction factor is based on the average travel time for fish in a release group. She said if the average time is not a good representation, then the tag-life correction factor is not good either. She said a correction factor can be applied to a bimodal distribution, but it would have a large standard error.

Slide 22

Buchanan continued discussing *Assumption #10: No tag failure*. She reviewed each bullet on slide 22. Ferguson asked about tag lots. Buchanan explained that the tag lot indicates what day or group a tag is made on. She said some vendors do not send this information and then tags are assumed to be from one lot. She said different lots can have different ping rates or settings, which require a different tag-life study. Sample size for the tag-life study should be from 50 to 100 tags per tag lot.

Slide 23

Buchanan reviewed considerations and actions for *Assumption #11: No handling or tag effects that could distort survival studies*. She said tag-burden effects can get worse over time. She said Dr. John Skalski calls this the “backpack effect,” where over time, the burden of the tag on the test fish gets heavier (i.e., the fish gets fatigued by the burden over time). Buchanan said the best solution is to avoid tagger effects altogether by using well-trained surgeons and consistent tagging teams.

Slide 24

Buchanan continued discussing *Assumption #11: No handling or tag effects that could distort survival studies*. She said this graph shows estimates of common survival; specifically, it shows survival from a common starting point and moving downstream. She said in this example, the cumulative survival decreases as fish move downstream and the problem here is one release is decreasing more than the other, which is an indication of tag burden effect or tagger effect. She suggested creating this type of plot for each tagger, and if the upstream release for a tagger shows a steeper decline in cumulative survival than the composite upstream release, then the fish tagged by that tagger should be removed from the study, otherwise it will be bias the study results.

Slide 25

Buchanan continued discussing *Assumption #11: No handling or tag effects that could distort survival studies*. She said in this case, Tagger A always tags 20% of fish, Tagger B always tags 40%, and Tagger C always tags 30%. She noted these amounts are not the same, but they are consistent with the same tagger team (i.e., stable tagger team throughout entire season).

Slide 26

Buchanan continued discussing *Assumption #11: No handling or tag effects that could distort survival studies*. She said this graph demonstrates a tag burden effect where the cumulative survival is plotted for different releases. She noted the difference in the slopes of the curves moving downstream. She said on the right, the cumulative survival for the black line is decreasing more than the others, which indicates tag burden effects, where the black line represents the farthest upstream release. This means that fish from the farthest release upstream should not be used to estimate survival far downstream.

Slides 27 to 30

Buchanan said the next few slides consider estimating residualization in subyearling studies using single release and paired-release models. She said there are three possible fates for fish: 1) migrate and survive; 2) stop migrating and survive; or 3) die. She said the probability of migrating and surviving can be estimated using a single release CJS model [$\phi =$ Prob(migrating & surviving)]. She said the estimate from the CJS model is a product of the combination of migrating and surviving (= $\Psi \cdot S_{\text{MIG}}$). She said the probability of residualizing and surviving [$\delta =$ Prob(residualizing & surviving)] is $(1 - \Psi) \cdot S_{\text{RES}}$. She said, however, one cannot separate the probability of residualizing (Ψ) from the probability of surviving (S_{MIG} for migraters and for S_{RES} residualizers).

Ferguson asked if there have been studies to estimate residualization. Buchanan said there have been studies to estimate delta (δ), but not of actual residualizing. She said UW conducted a study in the Lower Monumental Dam pool and Grant PUD also conducted a study to estimate delta (δ). Graf said the study conducted by Grant PUD used arrays (rather than mobile tracking) and did not work well. Buchanan said the Lower Monumental Dam study also used fixed site detections in the reservoir, but the data structure did not allow separating the probability of residualizing from the probability of surviving. She said the study was able to get an overall estimate of phi (ϕ) and delta (δ) and total survival ($S = \phi + \delta$). She noted that both δ and S are time dependent.

Buchanan said one can attempt to estimate the joint probability of residualizing and surviving (δ) by either conducting at least two mobile surveys or using detections from a dense array of acoustic receivers to obtain an estimate of the abundance of tagged fish ($\widehat{N}$) still in a study reach and alive at the end of the migration period or study. She said the study design would need to have rules to differentiate between alive and dead fish or have nodes.

Slides 31 to 35

Buchanan said a paired-release CJS model isolates estimated project survival in the absence of residualization by calculating the ratio of survival estimates from two groups. She said if there is residualization, the model estimates the joint probability of migrating and surviving through the project ($\Psi_1 S_{MIG,1}$) similar to a single release model, but she also pointed out that only a paired-release model accounts for short-term handling effects and mortality between the tailrace and the detection site. She said if test fish residualize, this results in a negative bias in the project survival estimator. She said this model also assumes both releases have the same probability of migrating through the second reach, which may or may not be the case. She said ultimately, the model assumptions may not be realistic. She said taking the ratio of total survival from the two releases does not help because nothing cancels out in the ratio of total survival estimates resulting in no useful interpretation. One option is to use only active migrants ($\Psi = 1$).

Truscott said, as he has stated before, he does not agree with the HCPs' stipulation to only study active migrants. He said to only study active migrants is not an accurate representation of project-level effects. He asked, for example, if fish are collected at Rocky Reach Dam and randomly assigned to R_1 or R_2, will the probability of residualizing be different or equal if this is calculated by comparing ratios? Buchanan said the assumption is the probability of residualizing will be the same between two releases and if this is the case, the project survival estimate will still be of the joint probability of migrating and surviving. She said regarding compliance standards, if the standards are not met there is no way to determine if this is because the fish died or residualized. Truscott said if there is equal probability of residualizing, the assumption is the larger release group will have a higher probability of residualizing. Buchanan said not necessarily. Graf said the probability of residualizing will be the same in the two releases and will cancel out of the ratio. He said this is the same with sick fish. He said there are still the same proportion of sick fish and this does not cancel out the effect of sick fish, but it cancels out the bias. Truscott said if the overall survival is 50% and there is a 5% difference between R_1 and R_2, the PUD mitigation would be 5%. Graf said it is not the difference, it is a ratio. He said the 50% value includes the fish that residualize. Murdoch said if the study uses ROR fish that residualize this is part of the effect. She said if active migrants residualize the assumption is these fish would have residualized anyway. She said if residualizing is natural to this group of fish this is the proportion the study is trying to represent. Buchanan agreed but said this is not an estimate of pure survival; rather, it is the product of two things, migrating and surviving. She said the paired release is not going to include the survival of fish that residualized and cannot only estimate survival; therefore, if the survival standard is not met, the study cannot determine if this is because the fish died or residualized. She said the issue is how to apply the analyses to the standard.

Keller said fish from R_1 and R_2 have two different distances in order to migrate through the study area based on their release location. He said fish from R_1 have more time to manifest residualization, and he asked if the assumption is saying fish from R_1 and R_2 have equal probability of residualizing? Buchanan clarified the assumption only applies to the common reach (i.e., between the tailrace and the first detection site). Keller said, so residualization before a common reach is a bias. Buchanan said the bias for project survival is relative to survival for active migrants. If the two releases have the same probability of residualizing and surviving in the common reach, then the project passage estimate will be biased for true migrant survival in the project but will be unbiased for the joint probability of migrating and surviving through the project. She said one would need to conduct a mobile survey to get at residualizing and she reminded the HCP Coordinating Committees that there need to be rules during these surveys to differentiate live versus dead fish. Kahler asked how to distinguish between foraging and a predator? Buchanan said if the fish is really just foraging this may be a problem. She suggested considering how long the tag has been in one location. She said if a tag is stationary one can assume the fish is dead. She said even if there is evidence of residualizing, these fish cannot be used to get an adjusted estimate of project survival. She said the analysis methods account for non-detection under the modeling assumptions, but low detection probabilities introduce imprecision in the estimate and can introduce bias if detection probabilities are low enough. Graf agreed and added that if psi (Ψ) does not equal one this will negatively bias the survival estimate when the study is under the assumption that two groups have the same probability of migrating in a shared region. He said if there are different probabilities of migrating there will be bias in one or another direction depending on the psi (Ψ) from one group.

Slides 36 to 38

Buchanan said the next few slides review USACE subyearling Chinook salmon studies. She reviewed the survival requirements in the Federal Columbia River Power System (FCRPS), noting that FCRPS survival standards are different from those in the HCPs in that FCRPS standards refer to a different metric (dam passage survival), have different standards for subyearlings compared to yearlings, and have more rigorous precision standards. She said studies in the FCRPS use a virtual/paired-release design (or "viper" [ViPRe]) to estimate survival through a dam. She said fish are released upstream of a dam (R_1) where the fish have a chance to express handling and tagging effects and distribute naturally across the river channel. She said a three-dimensional (3D) array of receivers is used to define when and where a fish arrives at the dam and define a virtual release group (V_1). She said the study can estimate resident time in the forebay, route of passage, and survival based on the last known location of the fish. She said receivers should not be located in the tailrace to avoid detecting dead fish and suggested moving the receivers downstream about 20 to 50 rkm. She said the design calculates an adjusted estimate of survival from V_1 by calculating the probability of survival through the tailrace. She said the design cannot use only one release to compare to V_1 because this compares new fish to old fish. She said instead, a paired-release (R_2 and R_3) provides an estimate of surviving between the dam and the first detection site (marked P_{11} on slide 38). The paired release is used to adjust the estimate of survival from V_1 to get an estimate of dam passage survival.

Slide 39

Buchanan reviewed estimates of dam passage survival of subyearling Chinook salmon for seven FCRPS dams. She said the largest and smallest values are bolded to clearly show the range. She noted that the smallest value is about 91% at Little Goose Dam in 2013 and the largest is about 98% at Lower Monumental Dam in 2012. She said the overall average, about 94%, is noted at the bottom of the table. She said the HCPs stipulate 93% project passage. She said if Grant, Chelan, and Douglas PUDs' dam passage is similar to these FCRPS dam passage values for subyearlings, meeting 93% project passage for subyearlings might be challenging.

Slide 40

Buchanan reviewed an example of a release–recapture design for studying subyearling Chinook salmon in the mainstem in 2012. She said the goal of the study was to estimate dam passage survival. She said this study was conducted at consecutive dams which means it could be implemented efficiently with only 9 releases instead of 12 releases. She said this study design could also estimate project survival by comparing tailrace releases in consecutive tailraces. She said this design still included probabilities of migrating and surviving, which are potentially negatively biased for survival.

Slide 41

Buchanan reviewed acoustic-tagged, paired-survival estimates from various years of study at FCRPS projects. She noted a low of 67% at John Day Dam in 2014, to a high of 96% at McNary and Bonneville dams in 2012. She also noted the McNary Dam study was a mid-reservoir release. She said the average project survival was only 86% and it is not clear if this was due to mortality in the reservoir or to the possibility of residualizing in the reservoir. She said dam passage estimates are unbiased for residualizing because subyearlings do not residualize during dam passage.

Slides 42 to 44

Buchanan reviewed a 2007 acoustic tag study estimating subyearling Chinook salmon survival through the Lower Monumental Dam reservoir. She said fish were released in the Little Goose Dam tailrace. She said the initial release was defined based on fixed site acoustic receivers in the reservoir (virtual release). She said survival was monitored from the virtual release site through the reservoir. She said this was repeated for seven groups. She said fixed site nodes were used to estimate the abundance of residualizing fish at the end of each 8-week sampling period.

Buchanan said slide 44 shows estimates for the weekly release groups and pooled results for study totals. She said the light gray in the plot shows the probability of migration and survival. She noted there is little variability between release groups. She said the white in the plot shows the probability of delay (residualizing) and surviving, which increased toward the end of the study. She said the black in the plot shows the probability of mortality, which could represent a mortality as a migrant or mortality as a residualizer. She said the results for the probability of residualizing and surviving (white bars) and for mortality (black bars) are time dependent; however, the plot is not showing the level of time-dependency. She said the pie chart shows the combined results over the season for the probability of migrating, surviving, and delay in weighted averages. She said migration and delay combined is about 47%, and she noted there is quite a bit of mortality. She also noted that these data only represent the portion of the reservoir where receivers were located.

Buchanan said Grant PUD conducted a similar study but did not have as much residualization. Graf said there was a bit of loss; however, this could not be attributed to death or residualization. He said regarding dam survival, Grant PUD conducted studies in the same years and had similar numbers.

Truscott said both dam passage and survival studies were conducted with taggable-sized subyearlings, and he asked if there are fry in the Rocky Reach Dam bypass. Keller said there are, and Truscott said this is another issue. Truscott said these designs are not studying survival of a population; rather, they only study taggable-sized fish.

Slides 45 to 47

Buchanan reviewed subyearling PIT-tag survival results from Priest Rapids Fish Hatchery to McNary Dam. She said for joint probability of migration and survival, the estimates ranged from 46% in 2004 to 85% in 2016 and averaged 66%. Graf said the study fish were all fall Chinook salmon and there was no evidence of residualizing. Buchanan noted that these estimates are far from meeting the HCP standard. Graf noted that the study area is a long reach. Truscott recalled work conducted by Geoff

McMichael (Mainstem Fish Research) on natural subyearlings. Truscott said survival was also really low for McMichael, about 30%. Graf agreed and said McMichael and Ryan Harnish (Pacific Northwest National Laboratory) acoustically tagged wild fish and identified two mortality hot spots at the mouth of the Yakima River and in the McNary Dam forebay.

Buchanan reviewed subyearling Chinook salmon PIT-tag survival results from Lower Granite Dam to McNary Dam. She noted that these fish came from Lyons Ferry Fish Hatchery and were released upstream of Lower Granite Dam. She said the reach from Lower Granite Dam to McNary Dam is through four projects, so taking the fourth root of the survival to McNary Dam gives a per project survival ($\sqrt[4]{S}$). She said these results were considerably higher ranging from 84% to 98% and averaging 91%. She said, however, this still does not meet the HCP project compliance standard.

Slides 48 to 52

Buchanan said project survival (S_{MIG}) is not separately estimable. She said what is estimable is: 1) joint probability of migration and survival ($\phi = \Psi \cdot S_{\mathrm{MIG}}$); or 2) total survival ($\phi + \delta$), which is time dependent. She said phi (ϕ) can be estimated using a pair-release design; however, phi (ϕ) can only be estimated under perhaps unrealistic assumptions. She said, therefore, a statistical solution to subyearling Chinook salmon residualization may not exist. She then reviewed subyearling study design recommendations if one did want to attempt to study the estimable parameters and how one might attempt to estimate residualization.

Ferguson asked if a study design follows all of these recommendations, could the results potentially address the survival standard as stipulated in the HCPs? Buchanan clarified that there is still no statistical solution to address the survival standard as stipulated in the HCPs. She said there is still no way to tease out the desired parameters. She said what can be done is calculating an estimate of migration and survival, which can be maximized as far as the migration component can go by using actively migrating fish. She said there may still be a negative bias for actual survival itself if some fish are residualizing. She said if one conducts a study, the recommendation is to use a paired-release design bearing in mind the estimates will not necessarily be an unbiased estimate of survival because even with active migrants some study fish may still residualize. Graf also noted that subyearlings are really small earlier in the season and may be less likely to be active migrants. Buchanan agreed and said this is another issue.

Buchanan said one option is to instead estimate dam passage survival, which is presumably estimable based on USACE studies. She said instead of a paired-release design downstream of the tailrace (ViPRe design), a virtual release/dead fish correction (or ViRDCt) design puts receivers in the tailrace and releases dead fish with tags to estimate the probability of dead fish traveling downstream. She said this design, which releases fish at the dam, was tested at Lower Granite Dam in

2018. She said the results were comparable to the ViPRe design. She said there are advantages to the ViRDCt design; however, the results are not applicable to the HCP criteria.

Slides 53 to 55

Buchanan reviewed ideal study timing and spacing. She said regarding timing, consider an ideal tag-life based on what needs to occur during the tag-life and program the tags to last this long. She said detection of all tags needs to occur before the tag fails and a residualizing survey also needs to be conducted before a tag dies. She said when considering spacing of detection arrays, if the first detection site is too far downstream there may be an increasing expression of "backpack effect," and if the site is not far enough downstream this will result in false positives from detections of dead fish and unequal expression of handling effects. She said the graph on slide 55 shows the survival of two releases through space. She said the cumulative survival declines as fish travel farther. She said to look for a lack of parallelism, which would indicate tag burden effects and is likely to occur more towards the right side; the curves on slide 55 are parallel.

Slides 55 to 57

Buchanan reviewed a summary about the residualization issue. She suggested having nodes in place to conduct a post-study abundance survey. She said one can estimate migrating and surviving (ϕ) and not migrating and surviving (δ). She said using active migrants gets a design closest to 1 as possible ($\Psi_1 \approx 1$, $\Psi_2 \approx 1$). She noted that phi to phi ($\frac{\hat{\phi}_1}{\hat{\phi}_2}$) will estimate the joint probability of migrating and surviving through the project ($\Psi_1 S_{MIG,1}$) but assumes the probability of migrating is the same for two groups through a common reach. She said one option is to estimate total survival using the ratio of phi estimates and the estimate of residualization and survival from the project reservoir ($\hat{\delta}_{11}$).

Buchanan said alternatively, one can study dam passage survival to avoid the residualization issue. Murdoch asked if instead of just dam passage survival, can a study be set up to study both dam and total survival? She recognized this is still not the same as project survival, but the data could be useful to inform dam and total survival. Buchanan said yes, this is possible and said this is kind of what was being studied in the USACE studies, only those designs did not use in-reservoir nodes so there were no estimates of residualizing populations or total survival in the project. She said rather, these studies used the ViPRe design and consecutive dams to estimate the probability of migrating and surviving through the projects. She said one question to ask when considering a study design is, can one interpret the complement in a useful way? She asked, what does "1 – whatever is being estimated" mean? Murdoch said if one knows project survival and total survival, this would provide an idea of how big of an issue residuals and mortalities are outside of a project. Buchanan said the experience Grant PUD had makes her hesitant, i.e., they found that fish were not getting past the project and there was no evidence of residualizing. She questioned whether this was because the fish residualized and died before the post-study survey or died before residualizing? Murdoch said this would still provide an estimate of project survival, and Buchanan said but not an unbiased estimate of survival. Murdoch said one would still know dam survival and know how that parameter performed. She said if there is a big difference between total and dam survival this would indicate a problem with residualizing and mortalities. Buchanan said if there is not a big difference, then this raises a question when interpreting project performance because one cannot distinguish between residualization and mortality. Murdoch agreed but said this might provide the best information available.

Murdoch asked how much do projects and reservoirs affect residualization and the mortality of fish displaying different life histories? Kahler said at this point, there is no way to distinguish from what would happen without the project being present.

Discussion

Truscott said considering there are fry (or 40-millimeter fish) at Rocky Reach Dam, which are active migrants that cannot be tagged, this means there is no way to tag an accurate representation of the population. Graf said the issue is not that a study cannot be done; rather, with the current information and technology, there will be someone who is unsatisfied with the study (e.g., the sample is not representative, the study duration is too short, and unknowns about the tags, among other things). Truscott agreed and said there needs to be an understanding that a study cannot be perfect and the reason for studying subyearlings is to have something more tangible.

Buchanan said even if a smaller fish can be tagged and as much as these fish may be less likely to migrate, the interpretation issue will be bigger. She said if the results indicate that survival is high, this is fine; however, if results are low, then why? She questioned if low results are a project effect or tag effect? Truscott also noted that subyearlings are emigrating and rearing at the same time but moving downstream slower compared to yearlings, and he asked how to classify an active versus non-active migrant?

HCP Coordinating Committees and PRCC representatives thanked Buchanan for sharing the presentation.

Ferguson asked, given the information shared during today's meeting, if Chelan PUD plans to request approval of another 3-year Statement of Agreement (SOA) during the next HCP Coordinating Committees meeting on August 27, 2019? Keller said he did not hear anything today to change Chelan PUD's view expressed during recent meetings and he believes an SOA is the next logical step. He said, however, Chelan PUD does not want to draft an SOA if the Rock Island and Rocky Reach HCP Coordinating Committees desire additional discussion. He recalled Chelan PUD's proposal to draft a reboot of the last SOA, including retaining the quarterly check-in language to capture changes or new opportunities at estimating project survival for subyearlings. Truscott asked when the current SOA expires, and Keller said September 29, 2019. Truscott suggested having another discussion on this topic before voting on an SOA. Murdoch agreed and said it seems there may be parameters that can be measured and could be useful. Keller agreed further discussion could be useful.

HCP Coordinating Committees representatives will prepare technical questions and considerations concerning the feasibility of conducting subyearling Chinook salmon studies with the current information and technology available to date, for discussion with Buchanan and Skalski during the HCP Coordinating Committees meeting on August 27, 2019.

II. Welcome

A. Review Agenda (John Ferguson)

John Ferguson excused Peter Graf and Tom Skiles (Columbia River Inter-Tribal Fish Commission) and welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No additions or changes were requested.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft June 25, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. HCP Coordinating Committees members present approved the June 25, 2019 meeting minutes, as revised. National Marine Fisheries Service (NMFS) and the CCT abstained, because NMFS and CCT representatives were not present during the June 25, 2019 meeting. *(Note: Chad Jackson provided Washington Department of Fish and Wildlife's [WDFW's] approval of the minutes via email on July 22, 2019.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on June 25, 2019, and follow-up discussions, were as follows. *(Note: Italicized text corresponds to agenda items from the meeting on June 25, 2019):*

- *Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining* *continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).*

Keller provided the review of subyearling sampled at RRJSF by email following the meeting on June 25, 2019, as distributed to the HCP Coordinating Committees by Larissa Rohrbach that same day.

- *Kirk Truscott will contact Lance Keller to further discuss options to increase attraction flow through the cul-de-sac area in the Rocky Reach Dam forebay (near Turbine Units C1, C2, and C3) while Turbine Units C1 and C3 are offline for maintenance (Item I-C).*

  Keller said Turbine Unit C3 is back in operation, which closes this action item.
- *Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).*

  This action item will be discussed during today's meeting and will also be carried forward.
- *Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item I-C).*

  Tom Kahler said the PIT-tag data from the Methow Fish Hatchery and Twisp River releases have only recently been uploaded, and have not yet been analyzed. This action item will be carried forward.
- *The following action items pertain to the Decision Item whether to approve Douglas PUD's request not to tag with coded wire tags (CWTs) the component of brood year (BY) 2018 summer Chinook salmon raised at Wells Hatchery that will be used for the 2020 Survival Verification Study (2020 Survival Study) because they will be tagged with PIT-tags and adipose clipped (Item II-A) (Note: This Decision Item will be brought forward to the July 23, 2019 meeting agenda):*
  - *Tom Kahler will inform the HCP Coordinating Committees of the planned dates in July when CWT tagging will occur. (Note: Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Larissa Rohrbach the following day.)*
  - *Tom Kahler will respond to Keely Murdoch's initial questions about the effects of a decision not to tag with CWTs the 2020 Survival Study fish on the following:*
    - *Monitoring and evaluation studies*
    - *Estimates of smolt-to-adult ratios (SARs)*
    - *The collection of harvest information*
  - *Chad Jackson will determine whether there are concerns associated with not coded wire tagging the study fish from an ocean harvest standpoint.*
  - *Larissa Rohrbach will distribute draft meeting minutes from this agenda item to Kirk Truscott and Scott Carlon following the meeting for their immediate consideration. (Note:*

Rohrbach emailed a draft of the relevant minutes on June 26, 2019, to Truscott and Carlon, Cc Tom Kahler, John Ferguson, and Kristi Geris.)

- *HCP Coordinating Committees representatives will email their own or their Hatchery Committees representative's comments and questions to Larissa Rohrbach for distribution by next Wednesday July 3, 2019. (Note: Per Tom Kahler's email on June 26, 2019, a CWT tagging date in August allows the issue to be brought to the HCP Hatchery Committees in the regular monthly meeting on July 17, 2019.)*
- *The HCP Coordinating Committees will vote on whether to approve Douglas PUD's request via email or at the next meeting depending on when a decision is needed for CWT tagging operations. (Note: Tom Kahler stated via email on June 26, 2019, that CWT tagging will occur in August, as distributed by Larissa Rohrbach the following day.)*

This action item will be discussed during today's meeting.

- *Lance Keller will provide an update by email on the performance of the new Rocky Reach Dam C3 Unit Chesterton seals by Friday, June 28, 2019 (Item III-A).*
  Keller provided an update on July 19, 2019, which Kristi Geris distributed to the HCP Coordinating Committees on July 20, 2019.
- *Larissa Rohrbach will distribute by email the acoustic tag specifications sheets shared by Lance Keller following today's meeting (Item IV-A).*
  Keller provided the specifications sheets following the meeting on June 25, 2019, which Larissa Rohrbach distributed to the HCP Coordinating Committees that same day.
- *Lance Keller will provide additional information on the change in ATS Inc. acoustic tag weights with different battery types (Item IV-A).*
  Keller provided this information on July 22, 2019, which Kristi Geris distributed to the HCP Coordinating Committees that same day.

III. HCP Hatchery and Tributary Committees Update

A. HCP Hatchery and Tributary Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on July 16, 2019:

- *Lower Derby Fish Passage Project:* The Rock Island HCP Tributary Committee received a time extension request from Cascade Columbia Fisheries Enhancement Group (CCFEG). Because of a delay in completing final designs, CCFEG requested a time extension from December 1, 2019 to December 15, 2020. After discussion, the Rock Island HCP Tributary Committee agreed to the time extension.
- *General Salmon Habitat Program Proposals:* The HCP Tributary Committees received 13 proposals, including 12 cost shares with the Salmon Recovery Funding Board (SRFB). Before

evaluating the projects, the HCP Tributary Committees identified the unallocated balance within each Plan Species Account. In total, there is just under $10.5 million available to fund projects. As a result, the HCP Tributary Committees evaluated 13 proposals, including the 12 cost shares with SRFB, and six of the proposals were funded by the Rock Island HCP Tributary Committee at a cost totaling $1.2 million. By comparison, the total request was for $1.7 million in cost shares, with a total cost of $11 million. The proposal that was not a cost share was from WDFW for the 2019 Eightmile Creek Fisheries Assessment Project. The purpose of the project is to identify fish abundance, stream flows, and water temperatures to guide permitting and selection of a brook trout removal strategy for Eightmile Creek, a tributary to the Chewuch River. The HCP Tributary Committees were unable to make a funding decision and asked the sponsor to provide additional information and a revised budget, which does not include genetic analysis of brook trout and bull trout (non-Plan Species).

- *HCP Policy Committees Guidance:* Hillman said John Ferguson will discuss this topic, but in general, the HCP Tributary Committees were pleased with the guidance provided by the HCP Policy Committees.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on August 8, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on July 17, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Goat Wall Acclimation Site Performance Update (joint):* The Yakama Nation (YN) provided a presentation on the performance of the spring Chinook salmon Goat Wall Acclimation Site, which is located on the Upper Methow River. Since using the site (2017), the YN has released between 25,000 to 30,000 spring Chinook salmon smolts from the site. Spring Chinook salmon survival within the acclimation pond has ranged from 98.0% to 99.9%. Smolt survival and travel times to McNary Dam are similar to those reported for Methow Fish Hatchery spring Chinook salmon.
- *Egg Treatment Study (joint):* Douglas PUD provided results from their study to evaluate the effects of salt, hydrogen peroxide, and formalin in controlling saprolegnia fugus infections on summer Chinook salmon eggs during incubation. The study found no difference among treatments and a control group. This result may have been because there is a low level of pathogens at the Methow Fish Hatchery where the study was conducted. Douglas PUD proposed to conduct a similar study at Wells Fish Hatchery where the incidence of saprolegnia may be higher.

- *Outplanting Spring Chinook Adults in the Chewuch River (joint):* Because of the low escapement of spring Chinook salmon to the Methow River basin, it is unlikely that spring Chinook salmon adults will be outplanted into the Chewuch River this year. This is a planned study to examine outplanting as an alternative to acclimation. Once escapements allow the study to be conducted, fish will be outplanted in areas where spring Chinook salmon are absent within the Chewuch River.
- *Wenatchee Spring Chinook Salmon Broodstock Collection (joint):* Sufficient broodstock has been collected for the Wenatchee spring Chinook salmon programs. However, most of the broodstock collected consist of hatchery fish. Therefore, crews are trying to collect more natural-origin fish for the programs.
- *NMFS Consultation (joint):* NMFS is completing their Finding of No Significant Impact for the Steelhead and Summer Chinook Salmon Environmental Assessments. Permits are currently going through internal review and hopefully will be signed soon.
- *Wells Summer Chinook Salmon Tagging for the 2020 Survival Study (Wells):* Douglas PUD informed the Wells HCP Hatchery Committee that the Wells HCP Coordinating Committee intends to conduct the 10-year check-in study using yearling summer Chinook salmon in 2020. The 110,000 summer Chinook salmon used for the survival study will be part of the Wells Fish Hatchery yearling summer Chinook salmon production. To reduce tagging and handling effects, Douglas PUD proposed to tag the survival-study fish with only PIT tags and adipose fin clips, but no CWTs. The Wells HCP Coordinating Committee asked the Wells HCP Hatchery Committee if there are any issues with the proposed tagging plan. For monitoring purposes and harvest evaluations, the Wells HCP Hatchery Committee recommended that all fish be tagged with CWTs. Those fish used for the survival study could receive a code different from the rest of the production fish. Thus, all Wells Fish Hatchery yearling summer Chinook salmon will be adipose clipped and CWT tagged. Those used for the survival study will also be PIT tagged.
- *2019 Hatchery Monitoring and Evaluation (M&E) Implementation Plan (Wells):* The Wells HCP Hatchery Committee reviewed and approved the 2019 Hatchery M&E Implementation Plan.
- *Expanded Wells Summer Chinook Salmon Production for the Southern Resident Killer Whale Population (Wells):* WDFW is preparing a proposal that will allow extra production of summer Chinook salmon at the Wells Fish Hatchery. The extra production is intended to benefit the Southern Resident Killer Whale population. The Wells HCP Hatchery Committee will evaluate the proposal to determine if the extra production will affect HCP production.
- *HCP Policy Committees Guidance (Wells, Rock Island/Rocky Reach):* Hillman shared with the HCP Hatchery Committees the guidance provided by the HCP Policy Committees to evaluate all decision items based on biological and technical merits, feasibility, and cost. Hillman said the HCP Hatchery Committees were not as pleased with this guidance, based on issues with

the *US v. Oregon* process. Kirk Truscott clarified the direction from the HCP Policy Committees was to evaluate a proposal based on technical merit, which does not mean to make or not make a funding decision. He said the decision is whether the project is fundable and if there is a policy issue the decision to fund is an HCP Policy Committees decision. *(Note: The HCP Policy Committees direction was not intended to take decision-making away from the technical committees, but to provide those committees an option besides a dispute whenever a policy issue interferes with decision making.)*

- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on August 21, 2019.

IV. All

A. HCP Tributary Committees Dispute Update (John Ferguson)

John Ferguson said the HCP Policy Committees convened an in-person meeting on July 9, 2019. He said there was good discussion and development of four action items. He said there was good progress in terms of isolating issues to those that are within and outside the HCPs. He said guidance was developed for the HCP Tributary, Hatchery, and Coordinating Committees. He said there was discussion and agreement about the successful implementation of the HCPs to date and a shared desire to continue this trend. He said the HCP Policy Committees agreed it would be beneficial to meet more often, perhaps annually around the time when the HCP annual reports are complete, to review the past year's activities and current topics. Tom Kahler and Kirk Truscott, who also attended the in-person meeting on July 9, 2019, said they had nothing further to add.

Ferguson reviewed the action items from the HCP Policy Committees meeting on July 9, 2019, as follows:

- Steve Parker (YN HCP Policy Committees Representative) and Cody Desautel (CCT Natural Resources Director) will discuss with their respective policy staff about convening the YN and CCT Tribal Councils to discuss potential paths forward for the Scaffold Camp Acquisition #2 Project, including third-party ownership.
- Tracy Hillman (HCP Tributary and Hatchery Committees Chairman) will communicate HCP Policy Committees guidance to the HCP Tributary and Hatchery Committees to base funding decisions on technical merit, and to notify respective HCP Coordinating and Policy Committees representatives of any potential policy issues needing to be addressed in those forums.
- Steve Parker and Cody Desautel will discuss with their respective policy staff about convening the YN and CCT Tribal Councils to: 1) attend a joint meeting and presentation by Chelan PUD, Douglas PUD, and YN and CCT HCP technical representatives about the function of the HCPs; and 2) provide guidance on land ownership issues that might impact implementation of the HCPs.

- HCP Policy Committees representatives will each discuss with their respective HCP Tributary and Hatchery Committees representatives the option of abstaining in lieu of a disapproval vote to preserve a policy position.

Ferguson said two of the action items concern land ownership issues, which the HCP Policy Committees spent a lot of time discussing. He said regarding the first action item, the HCP Tributary Committees meeting minutes from July 16, 2019, indicate that the YN purchased the Scaffold Camp property; therefore, this action item is a moot point.

V. Douglas PUD

A. DECISION: 2020 Survival Verification Study – Coded Wire Tags (Tom Kahler)

Tom Kahler said the Wells HCP Hatchery Committee recommended that all fish be CWT tagged and Douglas PUD agrees this recommendation can be incorporated into the study; therefore, this is no longer an HCP Decision Item.

B. Wells Project Subyearling Chinook Life-History Study 2011–2013 Draft Final Report (Tom Kahler)

The draft *Wells Project Subyearling Chinook Life-History Study 2011–2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019, and is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, July 23, 2019. Kahler said he wanted to provide an opportunity for the Wells HCP Coordinating Committee to ask final questions, and if the Committee has no questions or comments Douglas PUD can make a few editorial corrections, finalize, and distribute. Kirk Truscott said he will submit CCT comments on the draft report by Friday, July 26, 2019.

Douglas PUD will request approval of the report during the HCP Coordinating Committees meeting on August 27, 2019.

VI. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said Rocky Reach Dam mechanics are moving forward with the trunnion seal repair in Turbine Unit C1, with the unit being returned to service after the 2019 juvenile bypass season. He said there is a conflict in scheduling for the recommissioning of Turbine Units C9 and C1. He said crews have never conducted concurrent unit commissioning and he does not believe there are plans to try to do so. He said currently, he is unsure which unit will be prioritized.

Keller said Turbine Unit C3 was returned to service on July 17, 2019. He said he provided an update on Turbine Unit C3 on July 19, 2019, which Kristi Geris distributed to the HCP Coordinating Committees on July 20, 2019. Keller apologized for not providing an update by June 28, 2019, per his action item from the HCP Coordinating Committees meeting on June 25, 2019; however, he said the unit was tested and re-tested because there was direction from the senior team to continue to pursue both the new seals and hydraulically locking the blades into place as options, which caused a brief delay in the schedule. He said currently, the unit is operating with the Chesterton seals installed and everything is running fine with no observations of anything out of the ordinary. He said there are plans to remove Turbine Unit C3 out of service periodically to reassess the performance of the new seals; however, he is unsure about the schedule for this. He said the outage will likely be weeks and not months. He said he reviewed bypass counts pre- and post-outage for Turbine Unit C3 and there was no evidence of any change in the index counts. Kirk Truscott asked if Chelan PUD plans to include these data and dates in a report, and Keller said he will, and these data are also available on DART.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said work continues to move forward on Turbine Unit B4. He recalled that parts needed to repair the unit (the rotor poles and hydraulic power unit) have been delayed and now the rotor spider is also delayed. He said the return to service date of fourth quarter of 2019 is still accurate.

VII. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on August 27, 2019, to be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington.

The September 24 and October 22, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VIII. List of Attachments

Attachment A	List of Attendees
Attachment B	*Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies – 2019*

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Rebecca Buchanan	University of Washington, Columbia Basin Research
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Patrick Verhey*†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes
Peter Graf¨	Grant PUD
Tom Skiles¨	Columbia River Inter-Tribal Fish Commission

Notes:
- * Denotes HCP Coordinating Committees member or alternate
- † Joined by phone
- †† Joined by phone for the HCP Tributary and Hatchery Committees Update
- ¨ Joined for the joint HCP Coordinating Committees and PRCC portion of the meeting

Attachment B

Considerations in the Design & Analysis of Subyearling Chinook Salmon Survival Compliance Studies – 2019

John R. Skalski, Rebecca A. Buchanan
University of Washington
School of Aquatic & Fishery Sciences

Outline

I. Paired release–recapture design
- Minimal requirements
- Model assumptions

II. Estimating residualization in subyearling Chinook salmon

III. Overview of USACE subyearling studies
- Virtual/paired-release design
  - Dam passage survival estimates
- *Post hoc* paired-release design
  - Project passage survival estimates

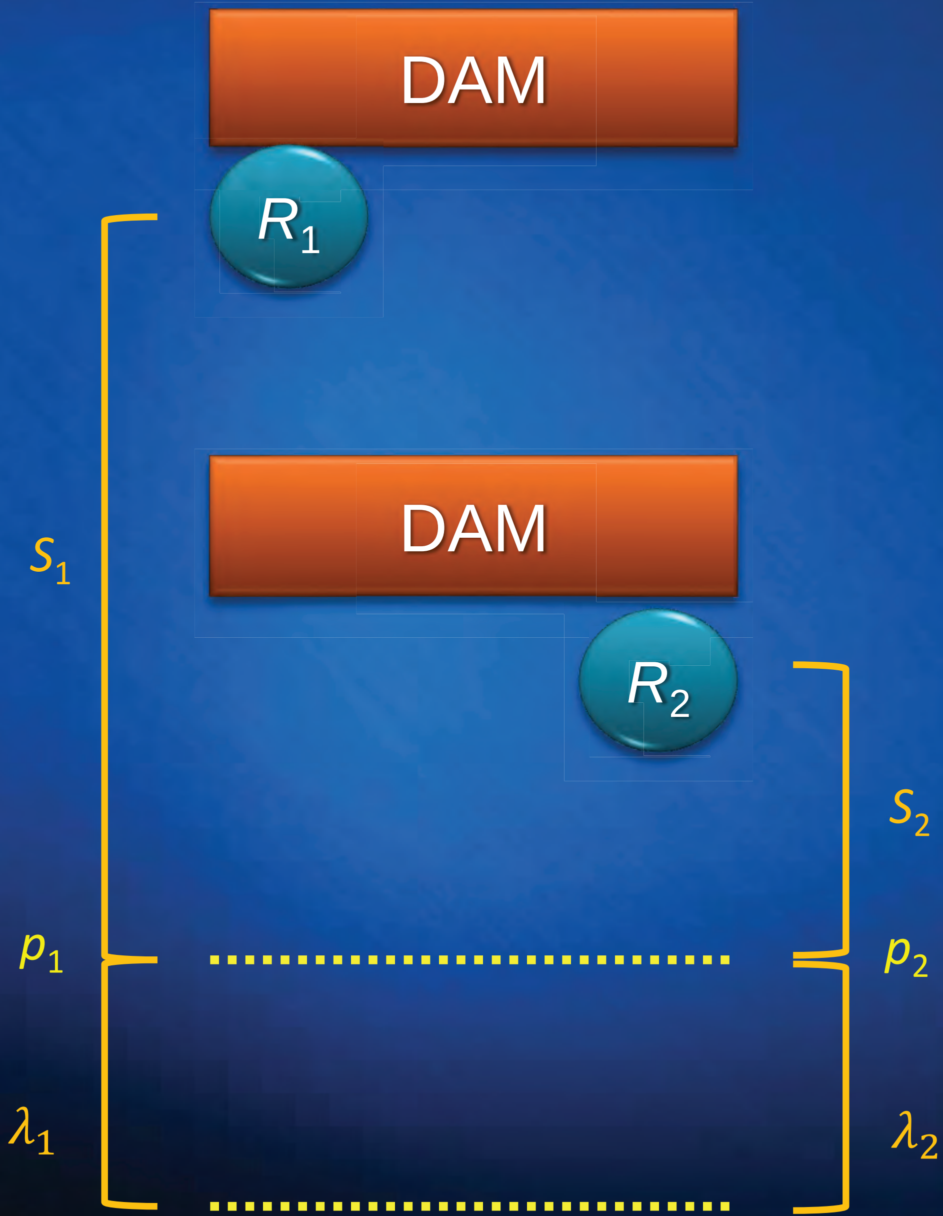
IV. Lower Monumental 2007 subyearling study

V. PIT-tag reach survival estimates

VI. Study recommendations

I. Paired Release–Recapture Design

Paired Release–Recapture Design: Estimation of Project Passage Survival



$$\hat{S}_{\text{Project}} = \frac{\hat{S}_1}{\hat{S}_2}$$

- Requirements
  - Control and treatment releases
  - Minimum of 2 downstream detection locations

Assumptions of Paired-Release Model

1. Test fish representative of population of inference
2. Test conditions representative of conditions of interest
3. Release sizes known exactly
4. Detection events correctly coded
5. Fate of each fish independent
6. Prior detection history has no effect on subsequent survival and detection
7. All fish have the same survival and detection probabilities.
8. Releases share same survival processes in reaches of common passage
9. Fish either migrate downriver or die
10. No tag failure
11. No handing or tag effects that could distort survival estimates

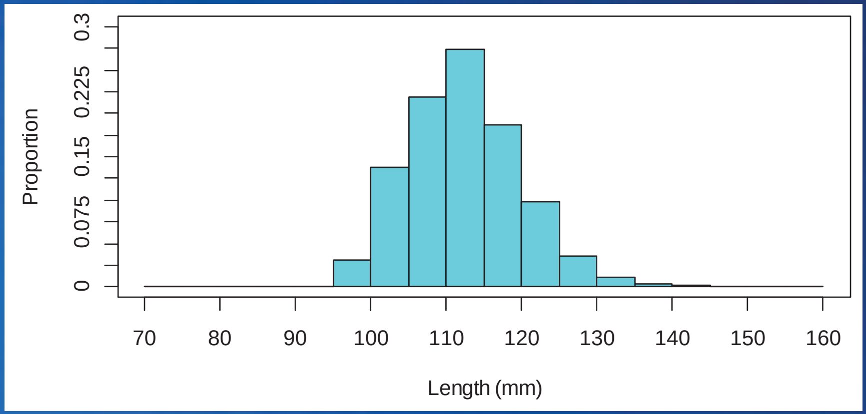
Assumption #1: Test fish representative of population of inference

- Considerations:
  - Wild vs. hatchery composition
  - Size distribution
  - Fish condition
- Actions:
  - Representative sampling of ROR fish
  - Limitations on minimum size for tagging (e.g., 95 mm with acoustic tag, potentially smaller with injectable tags)
    - Comparison of tagged and source fish
  - *A priori* rules on fish selection
    - % descaling
    - Injury
    - Document fish selected and rejected

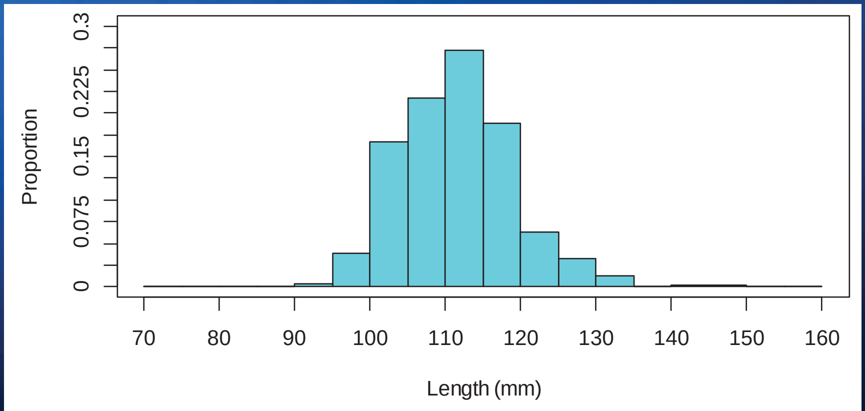
Assumption #1 (Continued)

Comparison of acoustic-tagged subyearlings with ROR fish, e.g., The Dalles, 2012

a. Tagged



b. ROR via FPC

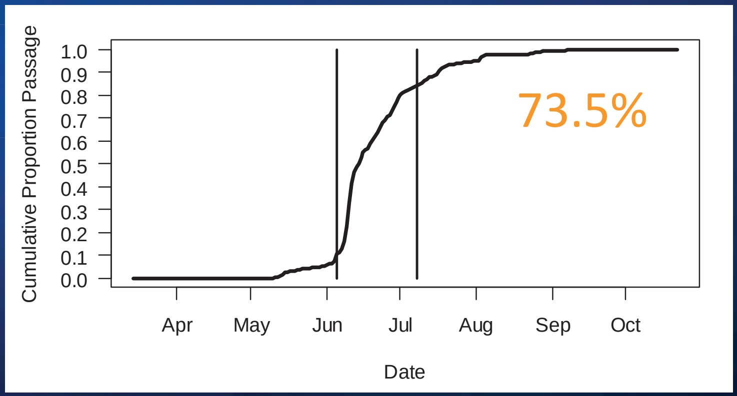


Assumption #2: Test conditions representative of conditions of interest

- Considerations:
  - Dam operations
    - Spill program
    - Juvenile bypass system operations
    - Powerhouse operation
  - Ambient conditions
    - River flows
  - Outmigration season timing
    - Release throughout outmigration
  - Diel patterns

Assumption #2 (continued)

- Actions:
  - Control dam operations
  - Selection of test years
    - Representative:
      - E.g., middle 90% of historical river discharges
    - Hydraulic diversity:
      - E.g., replicate studies at least 5% difference in hydraulic patterns
    - Monitor run timing:
      - Report % of run covered by study, e.g., LMN, 2013
      - Handling/tagging stops when water temperature > 18°C



Assumption #3: Release sizes known exactly

- Considerations:
  - Prerelease tag loss and/or failure
  - Tagged fish assigned to wrong release group
- Actions:
  - QA/QC procedures
    - Scan tags before release
    - Search for shed tags

Assumption #4: Detection events correctly coded

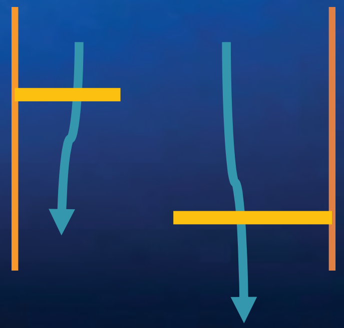
- Considerations:
  - Tag ID misidentification
  - Differentiating actual tag signals from ambient noise
  - Differentiating predation from alive detection events
- Actions:
  - Rigid signal processing criteria to avoid false-positive signals

Assumption #5: Fate of each fish independent

- Considerations:
  - Death of one fish does not affect the fate of another fish
  - Detection of one fish does not affect the detection of another fish
- Actions:
  - Assumption necessary to construct statistical models
  - Receivers capable of detecting many 10s of fish simultaneously

Assumption #6: Prior detection history has no effect on subsequent survival & detection

- Considerations:
  - Detection and rehandling could affect subsequent survival and detection
- Actions:
  - Acoustic tags do not require rehandling for detection
  - No post-detection bypass mortality as in PIT tags
  - Burnham et al. (1987) tests 2 and 3
    - Not useful because of high detection probabilities
  - Avoid poor receiver placement, e.g.,



Assumption #7: All fish have same survival and detection probabilities

- Concerns:
  - Heterogeneity in survival likely exists between fish
  - Route of dam passage may affect survival and detections
- Actions:
  - CJS model totally robust to heterogeneity in survival, e.g., estimates average survival
  - At high detection probabilities, CJS model also robust to heterogeneity in detections

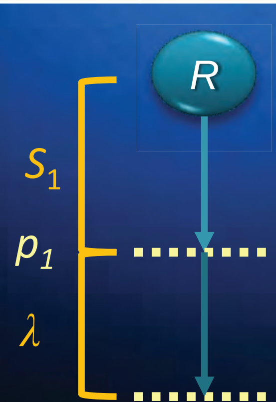
Simulation Study – Model Robustness

Assumption: All fish have equal probability of survival and detection

- Single release: Composed of 50% Group 1 and 50% Group 2 @10,000 fish/group

Scenario		Group 1			Group 2				
S_1	p_1	S_1	p_1	λ	S_1	p_1	λ	$E(\hat{S})$	$\hat{\hat{S}}$
same	same	0.90	0.20	0.18	0.90	0.20	0.18	0.90	0.901
diff	same	0.90	0.20	0.18	0.80	0.20	0.18	0.85	0.851
same	diff	0.90	0.20	0.18	0.90	0.10	0.18	0.90	0.901
diff	diff	0.90	0.20	0.18	0.80	0.10	0.18	0.85	0.851
diff	diff	0.90	0.10	0.18	0.80	0.20	0.18	0.85	0.851

Scenario

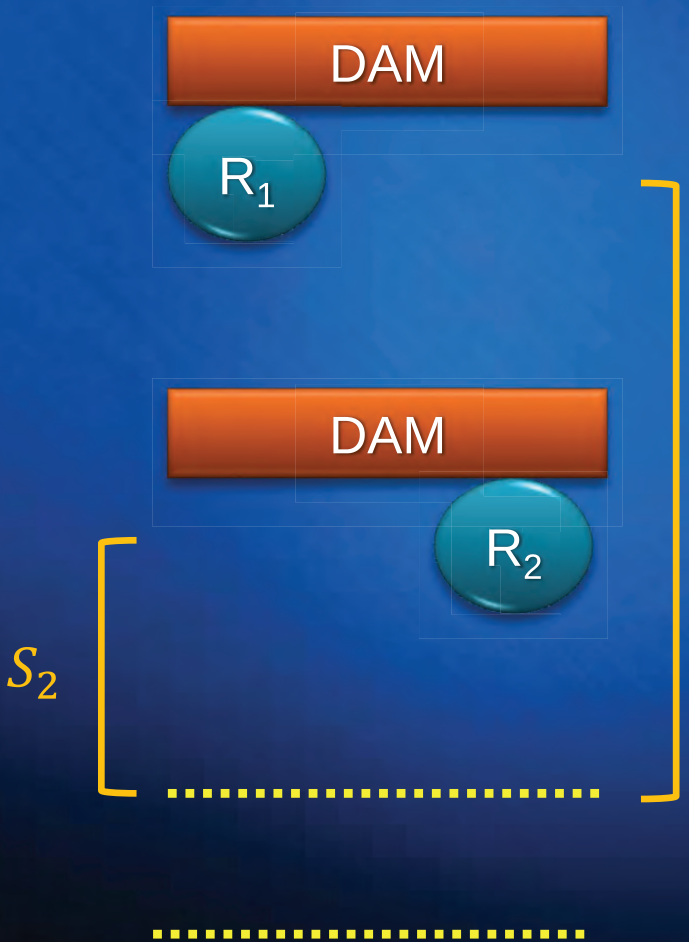


- Model fully robust to unequal survival
- Model quite robust to unequal detection

Assumption #8: Releases share same survival processes in reaches in common

- Concern:
  - Necessary assumption to partition out project survival

$$\hat{S}_{\mathrm{Proj}} = \frac{\hat{S}_1}{\hat{S}_2} \to \frac{S_{\mathrm{Proj}} \cdot \cancel{S_2}}{\cancel{S_2}} = S_{\mathrm{Proj}}$$

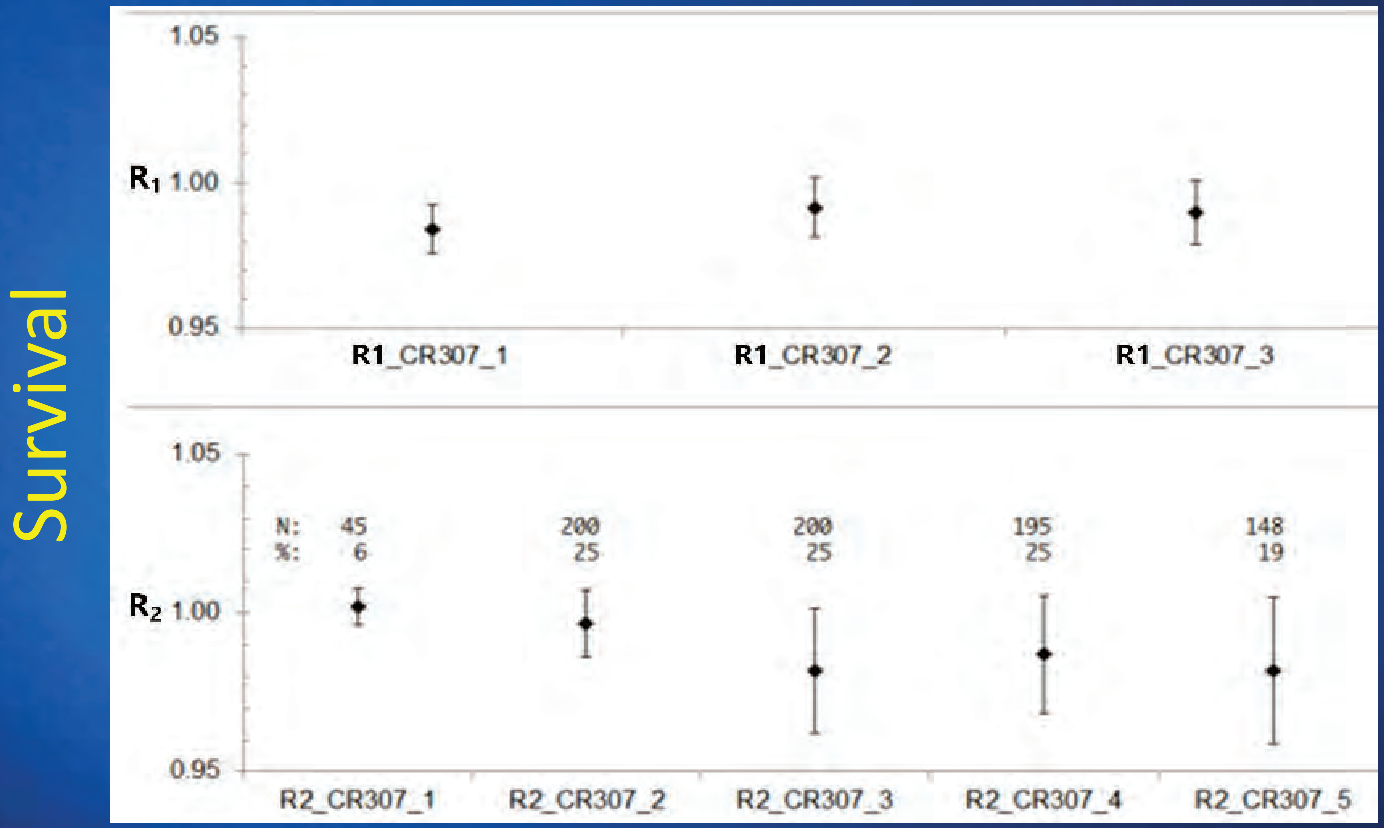


$S_1 = S_{\mathrm{Proj}} \cdot S_2$

- Actions:
  - Stagger release times to facilitate downstream mixing
  - Distribute R_2 releases to mimic R_1 passage

Assumption #8 (continued)

- Examine spatial pattern of R_1 and R_2 survivals
  - E.g., The Dalles Dam, 2012



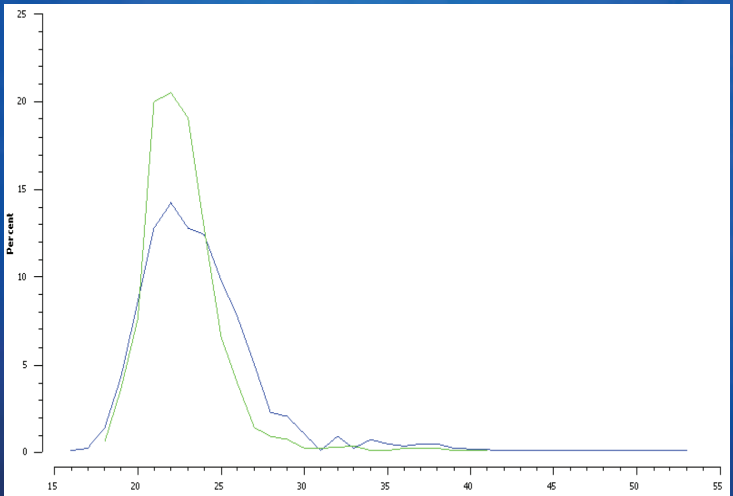
Release site – across river channel

  - Look for mortality "hot spots" at R_2 release locations across river

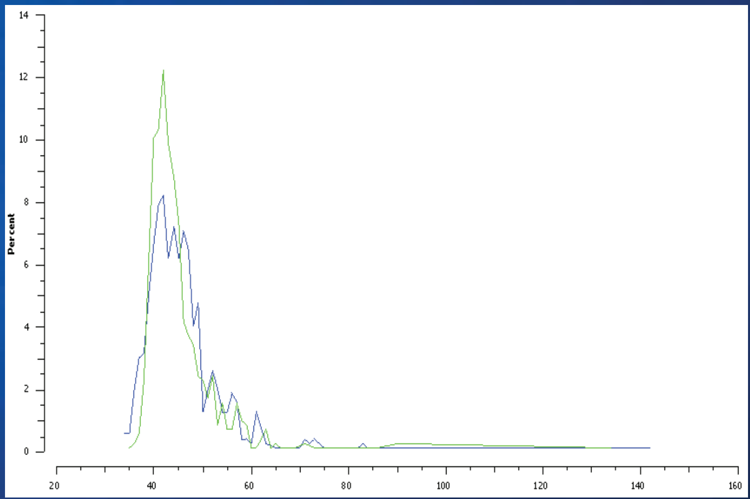
Assumption #8 (continued)

- Examine downstream mixing plots
  - E.g., The Dalles Dam, 2012

Rkm 234



Rkm 156



Arrival Time (Hours)

R_1 R_2

Assumption #9: Fish either migrate downriver or die

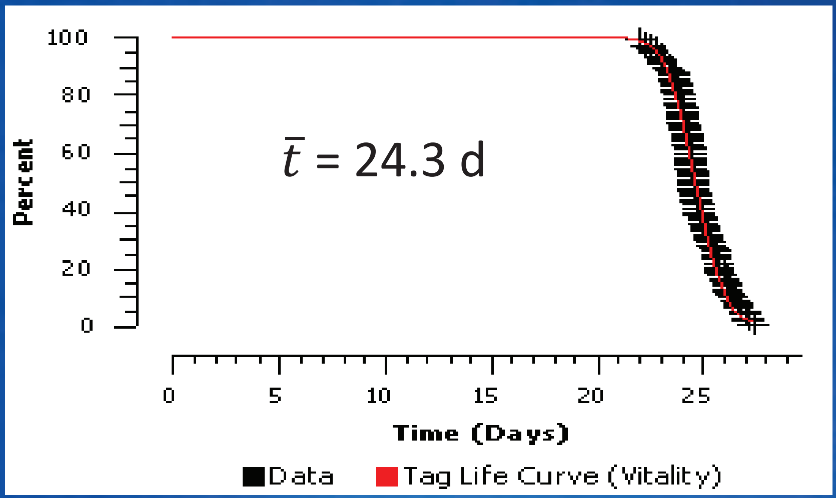
- Concerns:
  - The CJS model estimates "perceived survival," the joint probability of a fish migrating and surviving through a reach
  - $\hat{S}_{\text{Project}}$ will be biased if residualization occurs
- Actions:
  - Use only active migrants
    - Collected in bypass system
    - Conduct studies before high water temperatures
  - Obtain residualization-corrected survival estimates
    - Augmented acoustic-tag study design
    - PIT-tag study design generally incapable of estimating residualization
    - Nevertheless, problem is interpretation

Assumption #10: No tag failure

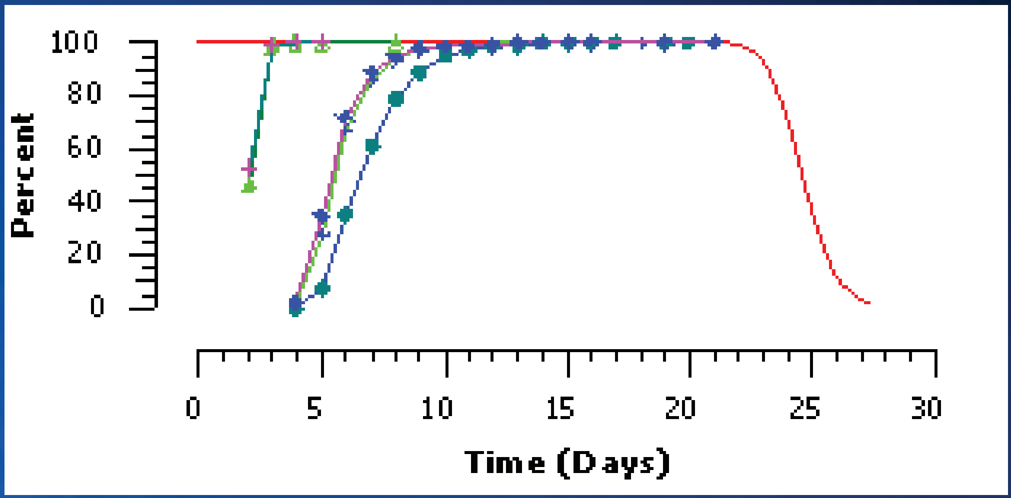
- Concerns:
  - The CJS model estimates the joint probability of the fish and the tag being "alive"
  - Premature tag failure will negatively bias survival estimates
- Actions:
  - Conduct tag-life studies
  - Use Program ATLAS to provide tag-life-adjusted survival estimates

Assumption #10 (continued)

Estimation of tag-life curve



Assure tag life adequate for study



E.g., John Day Dam, 2014

Assumption #10 (continued)

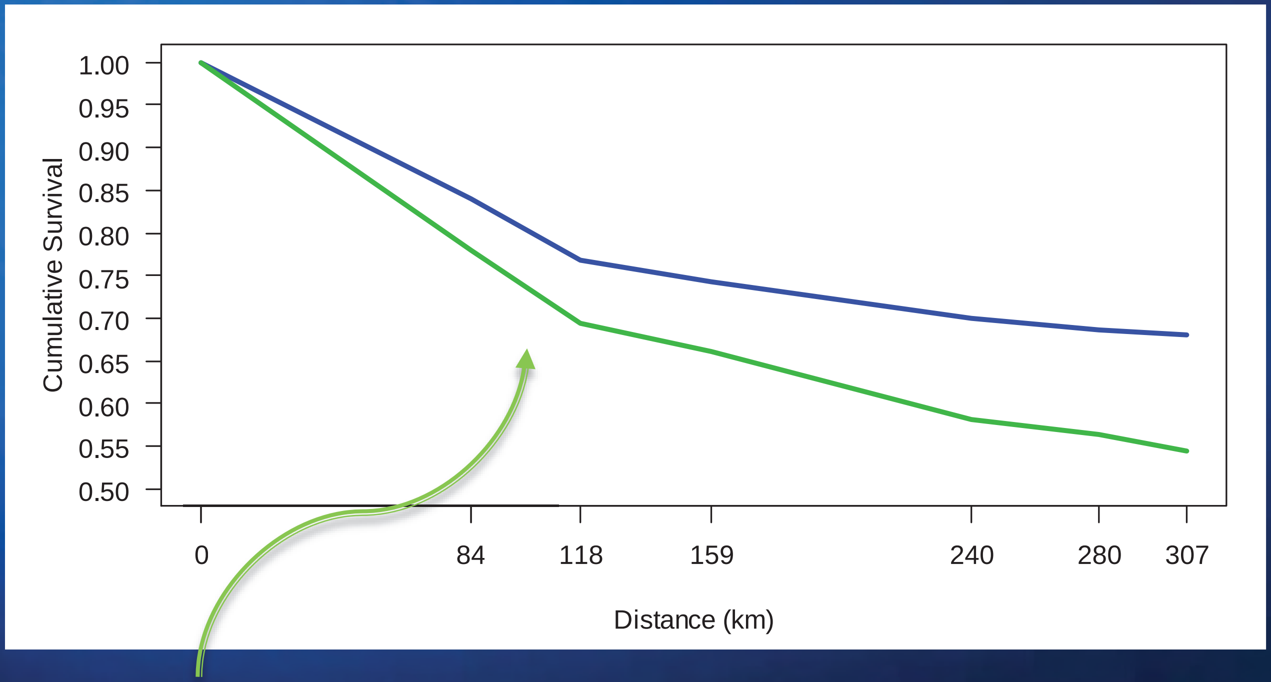
- Tag-life study recommendations:
  - Separate tag-life study for each unique tag lot
  - Monitor tags continuously from onset to complete tag failure
  - Monitor in ambient water (i.e., battery life function of temperature)
  - Sample size: $50 \leq n \leq 100$ per tag lot

Assumption #11: No handling or tag effects that could distort survival studies

- Concerns:
  - Tagger effects could occur
  - Tag-burden effects could exist
  - Both tagger and tag-burden effects are time dependent and can bias $\hat{S}_{\text{Project}}$ downward
- Actions:
  - Rigorous surgeon training, testing, and in-season monitoring
    - Eliminate releases by bad taggers
  - Balance tagger effort across releases
  - Need multiple taggers to identify a problem

Assumption #11 (continued)

- Tagger effects are time and distance dependent
  - R_1 release will be affected more than R_2 release
  - Negatively bias $\hat{S}_{\text{Project}}$



The further the distance traveled, the worse the survival

Assumption #11 (continued)

- Balance tagger effort across releases to minimize any undetected effects

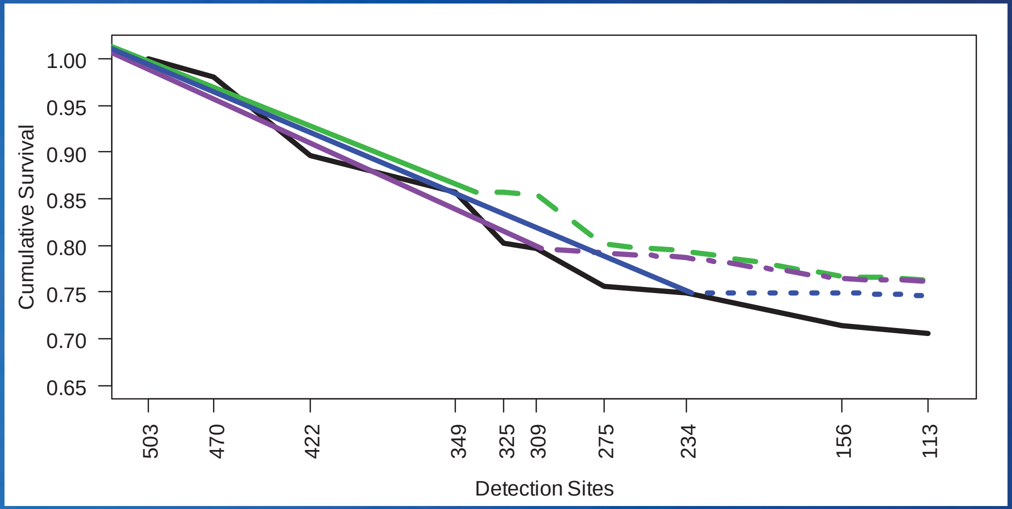
	Tagger		
	A	B	C
R_1	20%	40%	30%
R_2	20%	40%	30%

- Also balance tagger effort across season

	Week			
Tagger	1	2	3	4
A	20%	20%	20%	20%
B	40%	40%	40%	40%
C	30%	30%	30%	30%

Assumption #11 (continued)

- Tag burden effect
  - E.g., McNary, John Day, The Dalles, Bonneville 2012



Found tag burden effect for subyearlings that migrated through 4 projects but not for subyearlings that migrated through ≤3 projects

II. Estimating Residualization in Subyearling Studies

A. Single Release

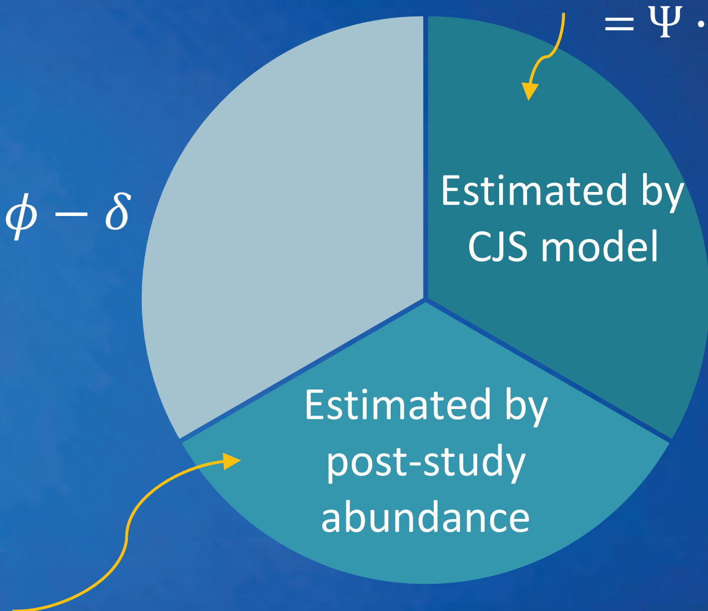
B. Paired Release

A. Single Release

- Partitioning the fate of subyearlings

$\phi = \text{Prob (migrating \& surviving)}$
$= \Psi \cdot S_{\text{MIG}}$

Prob (death) $= 1 - \phi - \delta$



$\delta = \text{Prob(residualizing \& surviving)}$
$= (1 - \Psi) \cdot S_{\text{RES}}$

Overall survival: $S = \phi + \delta$

$$= (\Psi) S_{\text{MIG}} + (1 - \Psi) S_{\text{RES}}$$

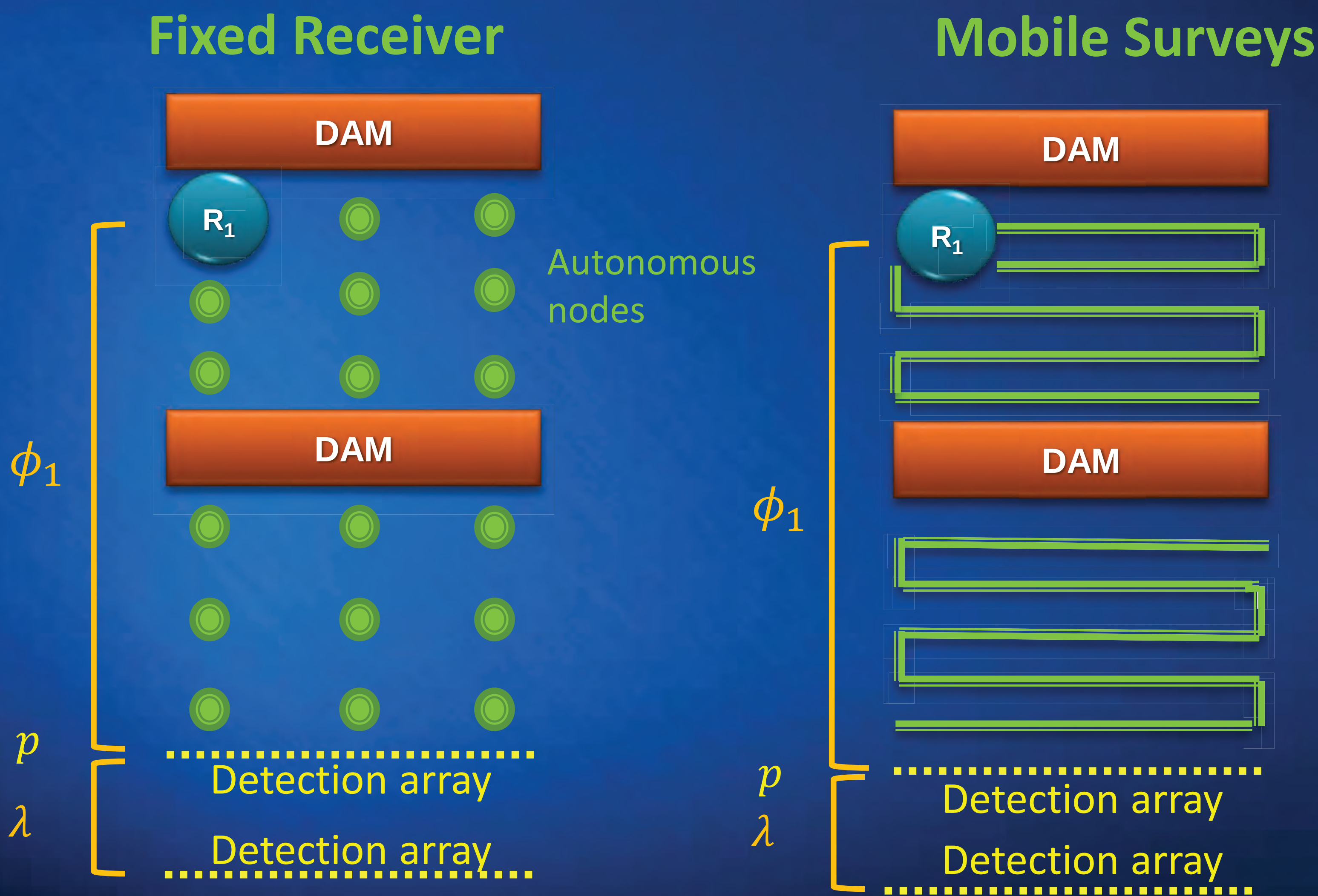
Partitioning Fate (continued)

- Joint probability of migrating and surviving estimable
$$\phi = \Psi \cdot S_{\mathrm{MIG}}$$
- Joint probability of <u>not</u> migrating and surviving estimable
$$\delta = (1 - \Psi) \cdot S_{\mathrm{RES}}$$
- Overall survival estimable
$$S = \Psi \cdot S_{\mathrm{MIG}} + (1 - \Psi) S_{\mathrm{RES}}$$
- Note separate estimates of $\hat{S}_{\mathrm{MIG}}$, $\hat{S}_{\mathrm{RES}}$, and $\widehat{\Psi}$ are not available

Estimating Residualization

$$\hat{\delta} = \frac{\hat{N}}{R_1}$$

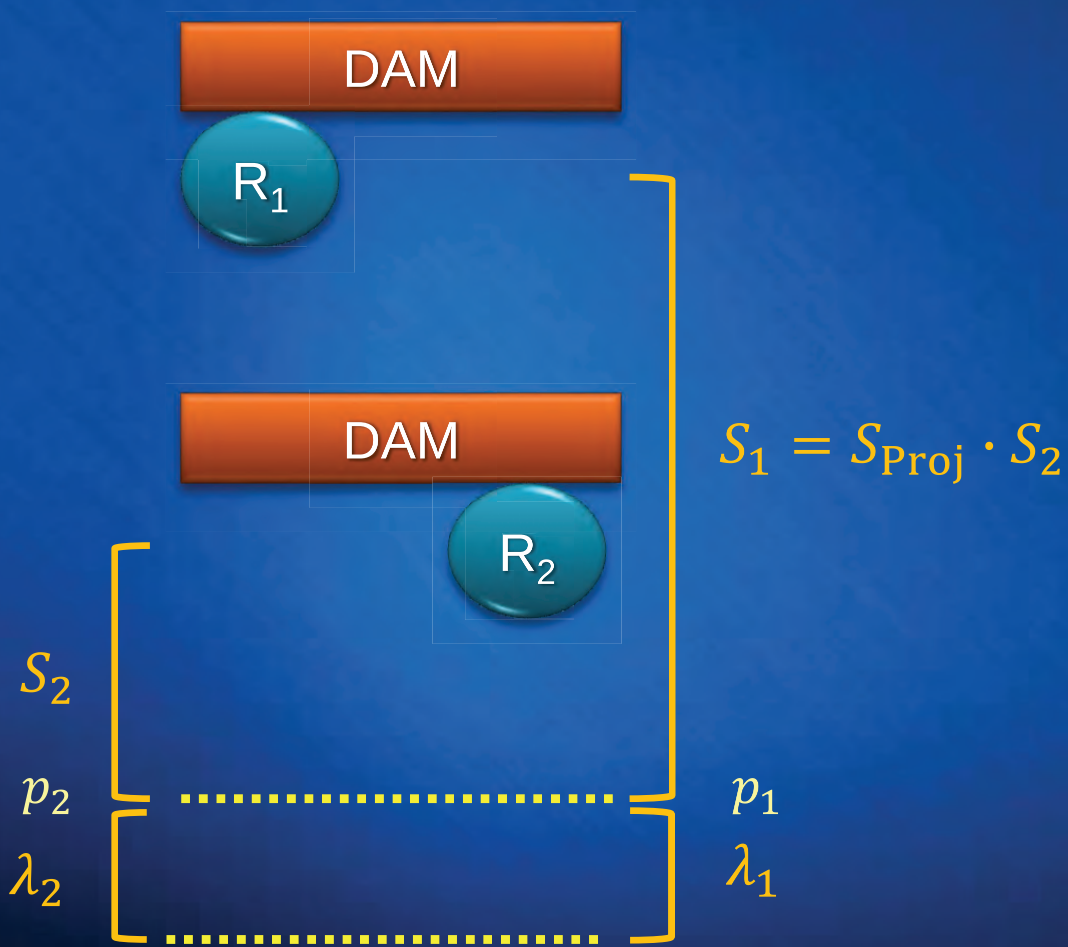
- Augmented designs to estimate residualization



- Must conduct minimum of two surveys to estimated residualized fish abundance just prior to end of study, δ

B. Paired Release

- Statistical model – No residualization



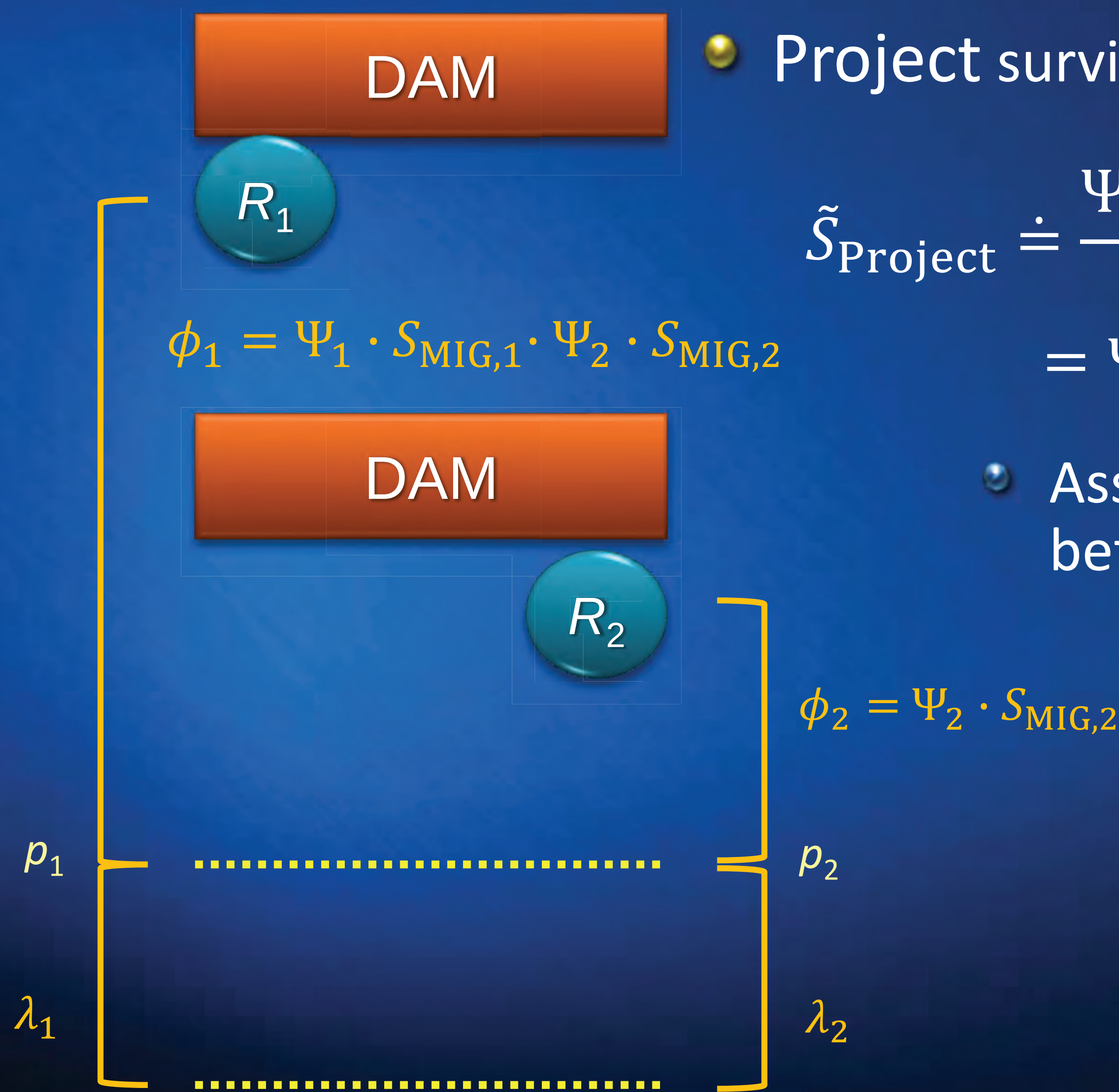
- Project passage survival estimated by

$$\hat{S}_{\text{Project}} = \frac{\hat{S}_1}{\hat{S}_2}$$

where

$$E\left(\hat{S}_{\text{Proj}}\right) \doteq \frac{S_{\text{Proj}} \cdot \cancel{S_2}}{\cancel{S_2}} = S_{\text{Proj}}$$

Paired Release with Residualization



- Project survival

$$\tilde{S}_{\text{Project}} \doteq \frac{\Psi_1 S_{\text{MIG},1} \cdot \Psi_2 S_{\text{MIG},2}}{\Psi_2 S_{\text{MIG},2}}$$

$$= \Psi_1 S_{\text{MIG},1}$$

  - Assumes common Ψ_2 between releases

Paired Release with Residualization (continued)

- Under ideal conditions/assumptions, can estimate only the joint probability of migrating and surviving through project ($\Psi_1 S_{\text{MIG},1}$)
- Model assumptions may be unrealistic
  - Both releases must have same residualization probability in the second reach
- Basing assessment on ratio of total survivals:

$$\frac{\hat{S}_{\text{Total},1}}{\hat{S}_{\text{Total},2}} = \frac{\hat{\phi}_1 + \hat{\delta}_1}{\hat{\phi}_2 + \hat{\delta}_2}$$

  - Very convoluted interpretation and not useful approach

Ratio of Total Survival Estimates

$$\frac{\phi_1 + \delta_1}{\phi_2 + \delta_2} = \frac{\Psi_1 S_{\mathrm{MIG},1}\left(\Psi_2 S_{\mathrm{MIG},2} + (1-\Psi_2) S_{\mathrm{RES},2}\right) + (1-\Psi_1) S_{\mathrm{RES},1}}{\left(\Psi_2 S_{\mathrm{MIG},2} + (1-\Psi_2) S_{\mathrm{RES},2}\right)}$$

No useful simplification or interpretation

Residualization and Paired Releases

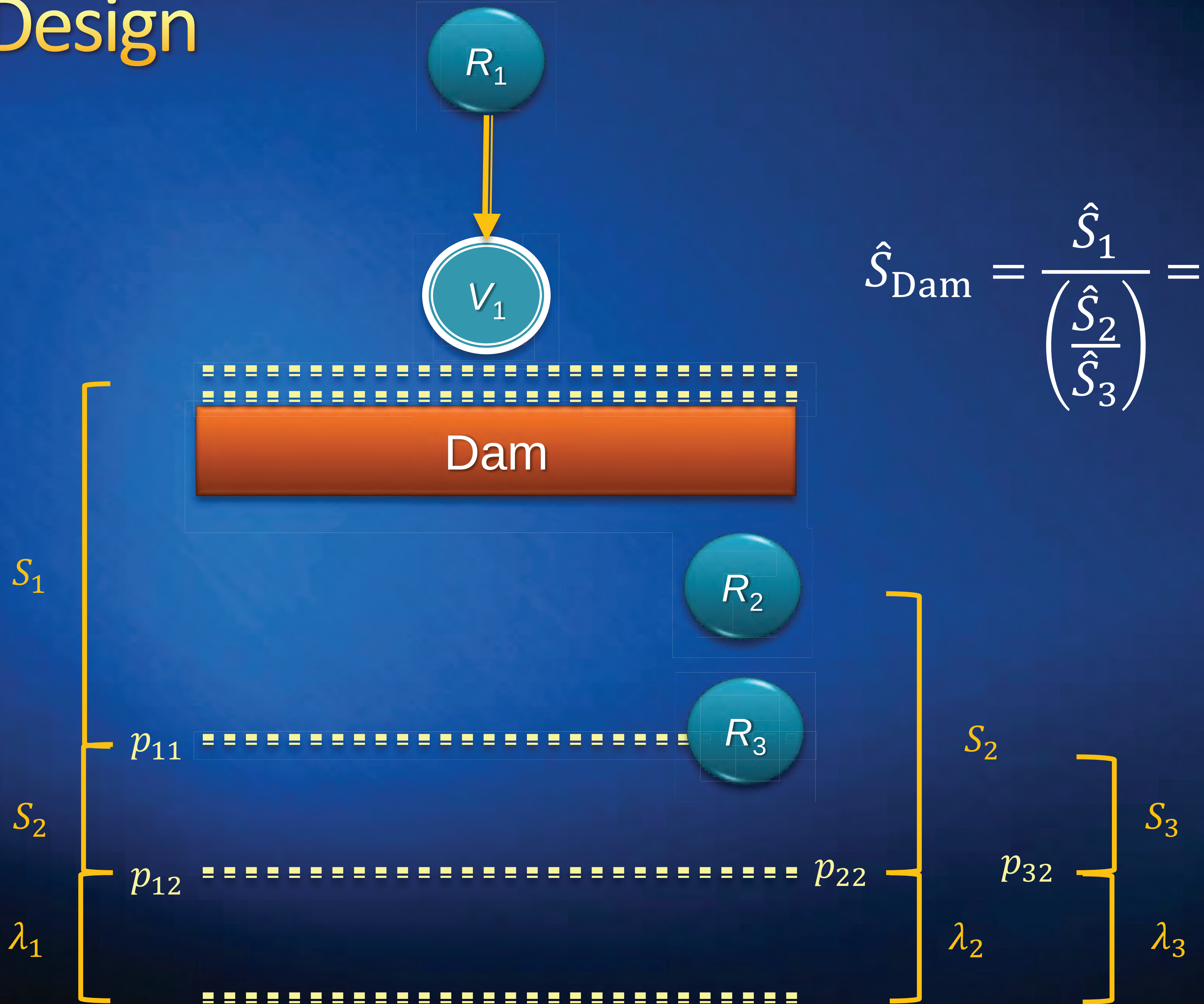
- Estimating total survival not helpful
- Use CJS model to estimate ΨS
- Use active migrants (i.e., $\Psi = 1$)
  - Allows direct estimation of S
- Use in-reservoir surveys to confirm assumption of no residualization

III. Overview of USACE Subyearling Studies

Survival Requirements in FCRPS

- Estimate dam passage survival defined as survival from dam face to tailrace mixing zone
- Survival standards
  - Yearling Chinook salmon and steelhead: $\hat{S} \geq 0.96$
  - Subyearling Chinook salmon: $\hat{S} \geq 0.93$
- Precision standard
  - $\widehat{\mathrm{SE}}\left(\hat{S}\right) \leq 0.015$
- Two consecutive successful trials per fish stock
- Hydraulic conditions
  - Representative
  - Diverse

Overview of the Virtual/Paired-Release Design



$$\hat{S}_{\text{Dam}} = \frac{\hat{S}_1}{\left(\frac{\hat{S}_2}{\hat{S}_3}\right)} = \frac{\hat{S}_1 \cdot \hat{S}_3}{\hat{S}_2}$$

Estimates of Dam Passage Survival of Subyearling Chinook Salmon

Dam	Year	$\hat{\hat{S}}$
Bonneville	2012	0.9739 (0.0069)
John Day	2012	0.9414 (0.0031)
	2014	0.9169 (0.0061)
The Dalles	2010	0.9404 (0.0091)
	2012	0.9469 (0.0059)
McNary	2012	0.9747 (0.0114)
	2014	0.9239 (0.0180)
Lower Monumental	2012	**0.9789 (0.0079)**
	2013	0.9297 (0.0105)
Little Goose	2012	0.9508 (0.0097)
	2013	**0.9076 (0.0139)**
Lower Granite	2018	0.9422 (0.0217)
		$\hat{\hat{S}}$ = 0.9439

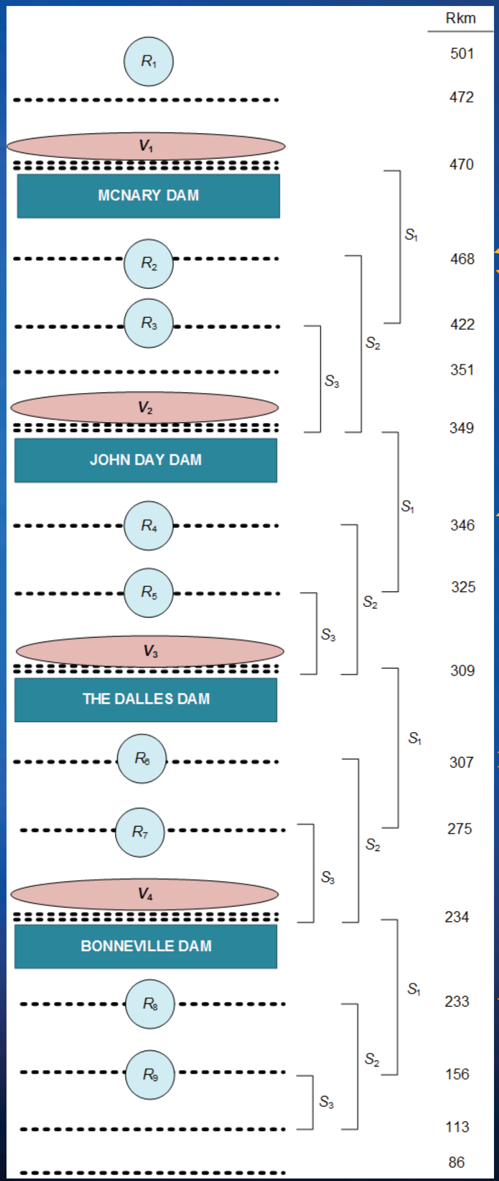
USACE – Acoustic-tag Studies ----Tag weights (in air): 0.430 g (2010), 0.304-0.346 g (2012-14), 0.216 g (2018)

Release–Recapture Design for Study of Subyearling Chinook Salmon

Example: 2012

Mainstem Study

Estimates of Project Passage Survival



$\hat{S}_{\mathrm{MCN}}$

$\hat{S}_{\mathrm{JDA}}$

$\hat{S}_{\mathrm{TDA}}$

$\hat{S}_{\mathrm{BON}}$

Subyearling Chinook Salmon: Acoustic-Tagged Paired-Survival Estimates

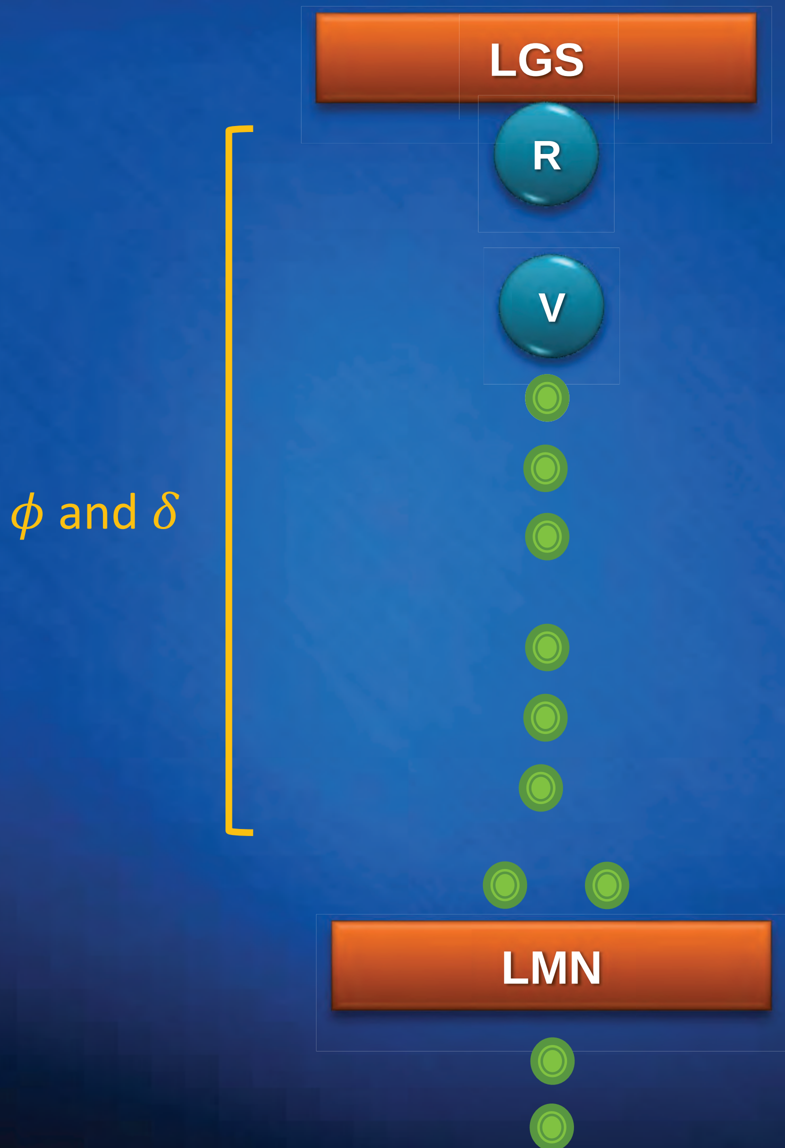
Year	Project	Release Sites	Paired Survival	Water Year
2014	McNary*	CR503, 468	0.9037 (0.0170)	Normal +
	John Day	CR468, 346	0.6748 (0.1110)	
2013	Little Goose*	SR133,122	0.7905 (0.0132)	Normal –
	Lower Monumental	SR112, 065	0.7685 (0.0129)	
2012	McNary*	CR503, 468	0.9667 (0.0112)	High
	John Day	CR468, 346	0.8354 (0.0085)	
	The Dalles	CR346, 307	0.9397 (0.0094)	
	Bonneville	CR307, 233	0.9655 (0.0074)	
	Little Goose*	SR133, 112	0.8804 (0.0095)	
	Lower Monumental	SR112, 065	0.8723 (0.0107)	
			$\hat{\bar{S}} = 0.8595$	

*Only a fraction of reservoir incorporated

IV. Example: Lower Monumental 2007 Subyearling Acoustic-Tag Study

- Objectives:
  - Estimate subyearling Chinook salmon survival in the LMN pool
  - Determine extent of residualization
  - Characterize residualization pattern over season

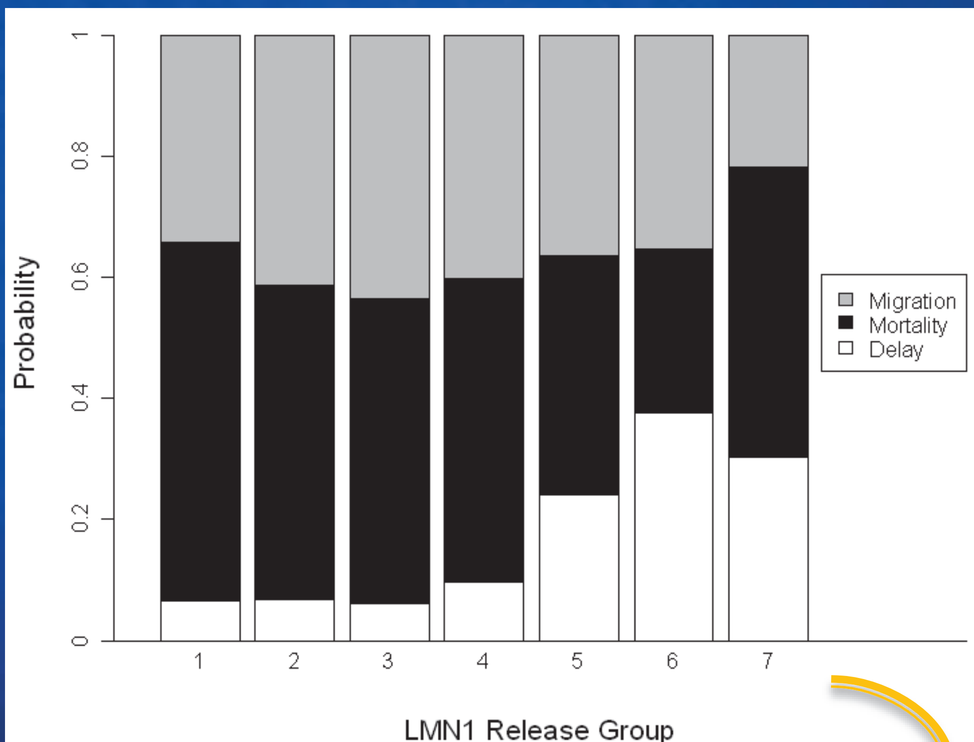
Release–Recapture Design



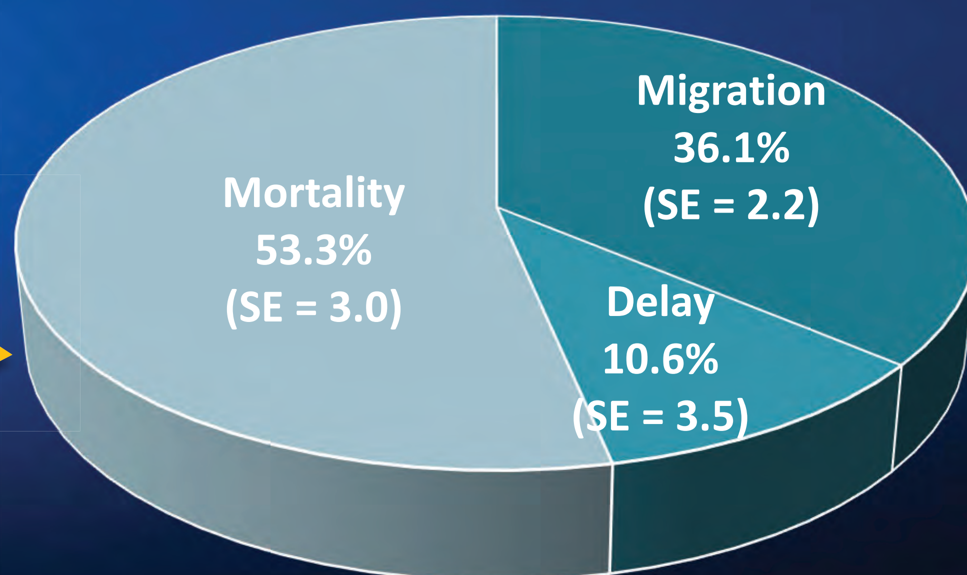
- 7 weekly virtual release groups, 1 August – 19 Sept, 2007
- 8-week sampling period for each release group
- Residualization surveys occurred last 2 days of sampling periods
  - Lincoln Index estimate of residualized fish abundance

Pooling Fate Across Release Groups

Release-Specific Reservoir Fates



Study-Wide Result



V. Subyearling Chinook Salmon PIT-Tag Survival Results

Example: PIT-tagged Subyearlings

Priest Rapids Hatchery to McNary

- Joint probability of migration and survival: ϕ

Year	$\hat{S}$	$SE(\hat{S})$
2013	0.668	0.023
2014	0.626	0.015
2015	0.783	0.049
2016	**0.847**	0.039
2017	0.532	0.018
2018	0.521	0.024

Year	$\hat{S}$	$SE(\hat{S})$
2000	0.676	0.046
2001	0.748	0.025
2002	0.695	0.036
2003	0.632	0.022
2004	**0.460**	0.024
2005	0.652	0.038
2006	0.680	0.049
2007	0.690	0.063
2008	0.702	0.080
2009	0.622	0.057
2010	0.614	0.061
2011	0.804	0.124
2012	0.612	0.020

$$\hat{\hat{S}} = 0.661$$

Example: PIT-Tagged Subyearlings

$\sqrt[4]{S}$ - Lyons Ferry Hatchery: Lower Granite to McNary

Year	$\hat{S}$	$SE(\hat{S})$
2006	0.917	0.0012
2008	0.947	0.006
2009	0.922	0.005
2010	0.970	0.007
2011	**0.981**	0.005
2012	0.928	0.025
2013	0.912	0.016
2014	0.934	0.022
2015	0.849	0.035
2016	**0.845**	0.017
2017	0.857	0.016
2018	0.911	0.016
	$\hat{\hat{S}}$ = 0.914	

VI. Subyearling Study Design Recommendations

Recommendations

- Desirable parameter S_{MIG} not separately estimable
- What is estimable:
  - $\phi = \Psi \cdot S_{\mathrm{MIG}}$ = joint probability of migration and survival

  or

  - $\phi + \delta$ = total survival, which is time dependent
- Paired release can only estimate ϕ under perhaps unrealistic assumptions
- Therefore, statistical solution to subyearling residualization may not exist

Recommendations (continued)

- Instead, use active migrants during early summer when water temperatures are acceptable (i.e., <18°C)
- Use paired-release design
- Minimum of 2 downstream detection sites
  - >2 are required to test assumptions
- Detection sites far enough downriver to allow both releases to express post-release handing effects
- Multiple well-trained surgeons
  - Balance effort temporally and spatially
- Tag-life study, $n \geq 50$ per tag lot

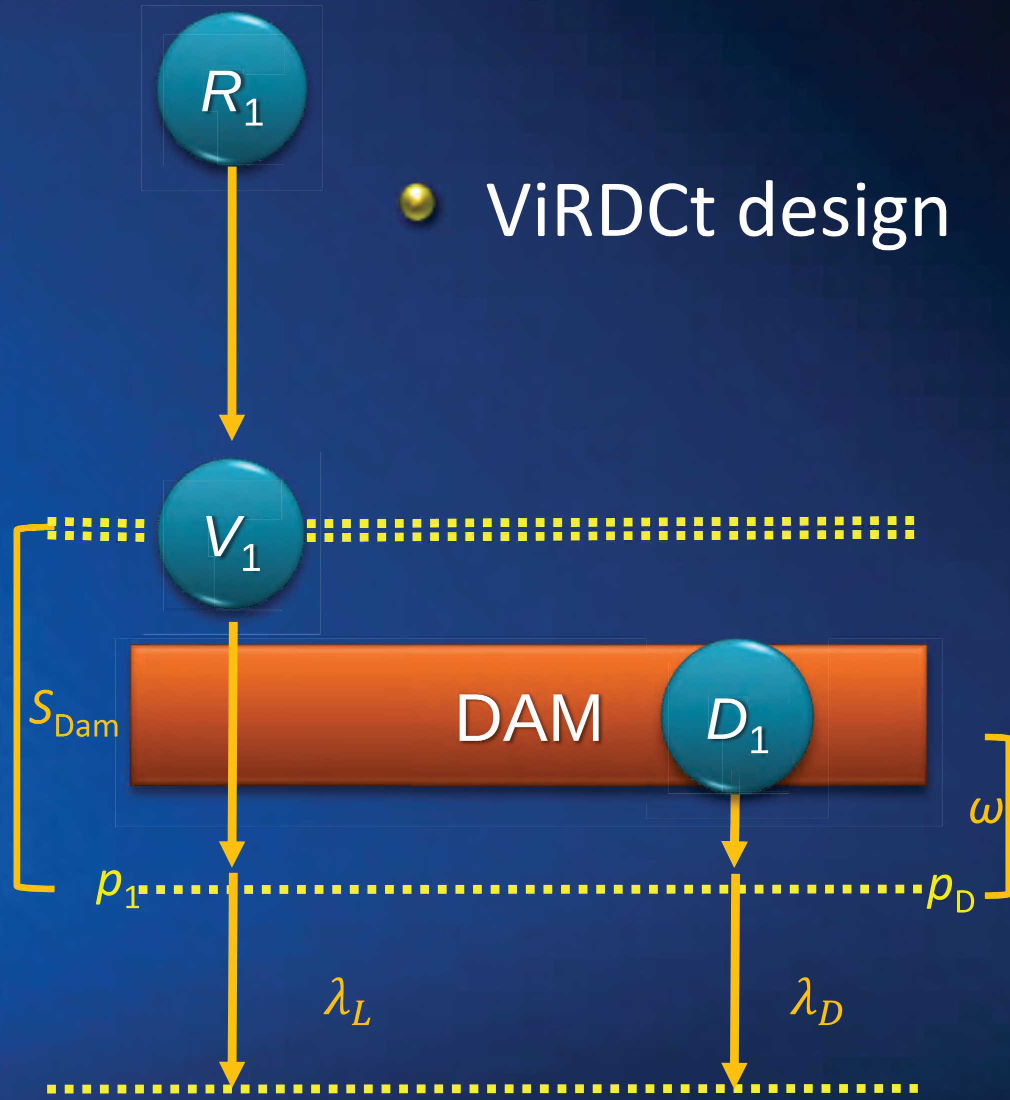
Recommendations (continued)

- Use within-reservoir surveys to ensure residualization rates are minimal
  - Mobile or fixed location
  - If mobile, repeat 2–3 times at end of study before tag life becomes a problem
  - Tag-life long enough to allow active migrants to exit study and still detect residualized fish
- PIT-tag studies incapable of estimating residualization between dams
- Expect project survival estimates to be lower than yearling Chinook salmon and steelhead
  - Fish size
  - Residualization
- Adjust release sizes for lower anticipated survival estimates

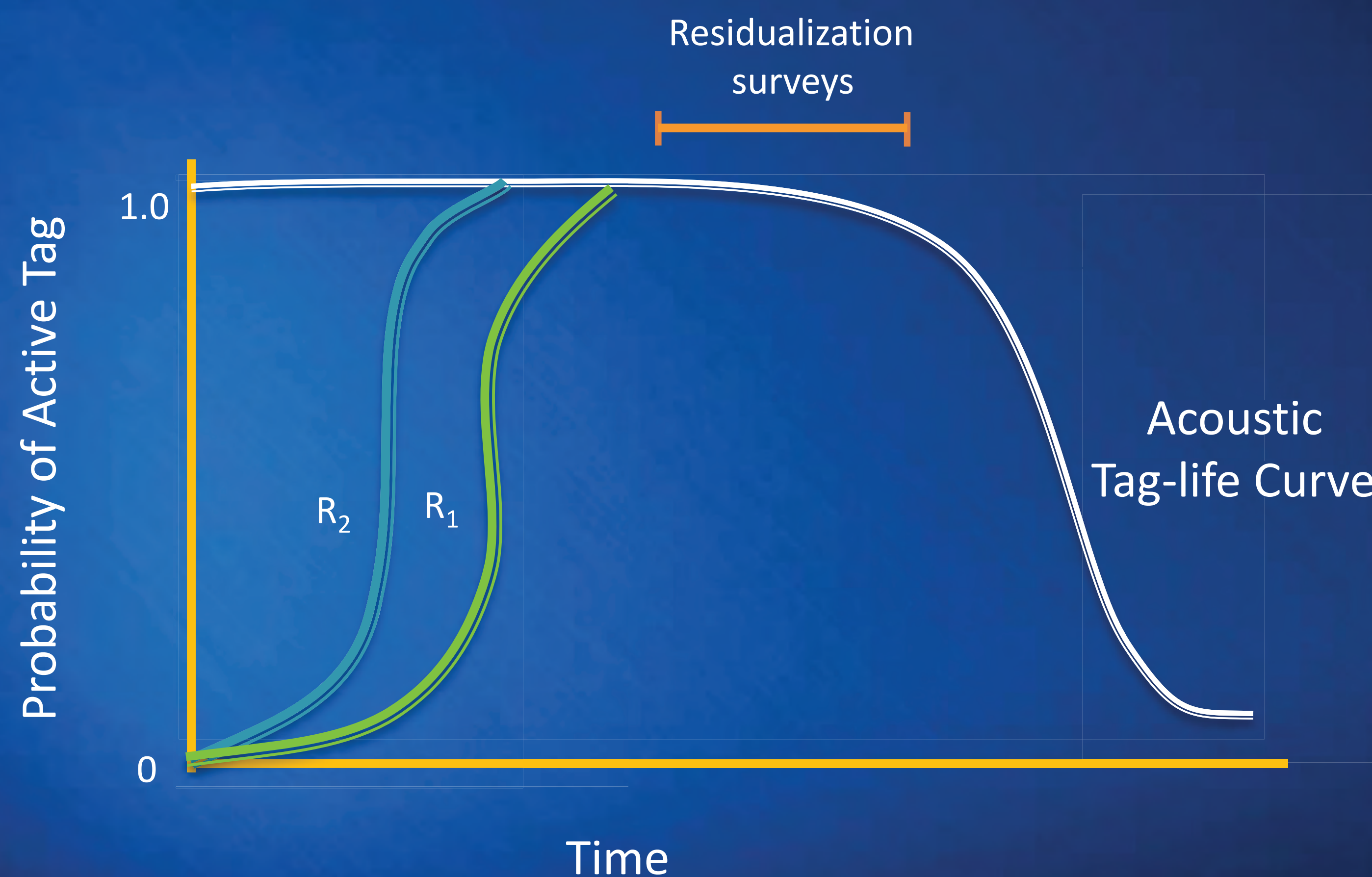
Recommendations (continued)

- Alternative: Estimate dam passage survival
- Paradigm shift: dam passage survival vs project survival
- Pros:
  - Robust to residualization (assume no residualization during dam passage)
  - Existing methods: Virtual Release/Dead Fish Correction (ViRDCt design)
  - Smaller sample sizes than for project survival
- Cons:
  - Not applicable to existing criteria
- NMFS: dam passage survival ≥ 0.93 for subyearlings in FCRPS

- ViRDCt design



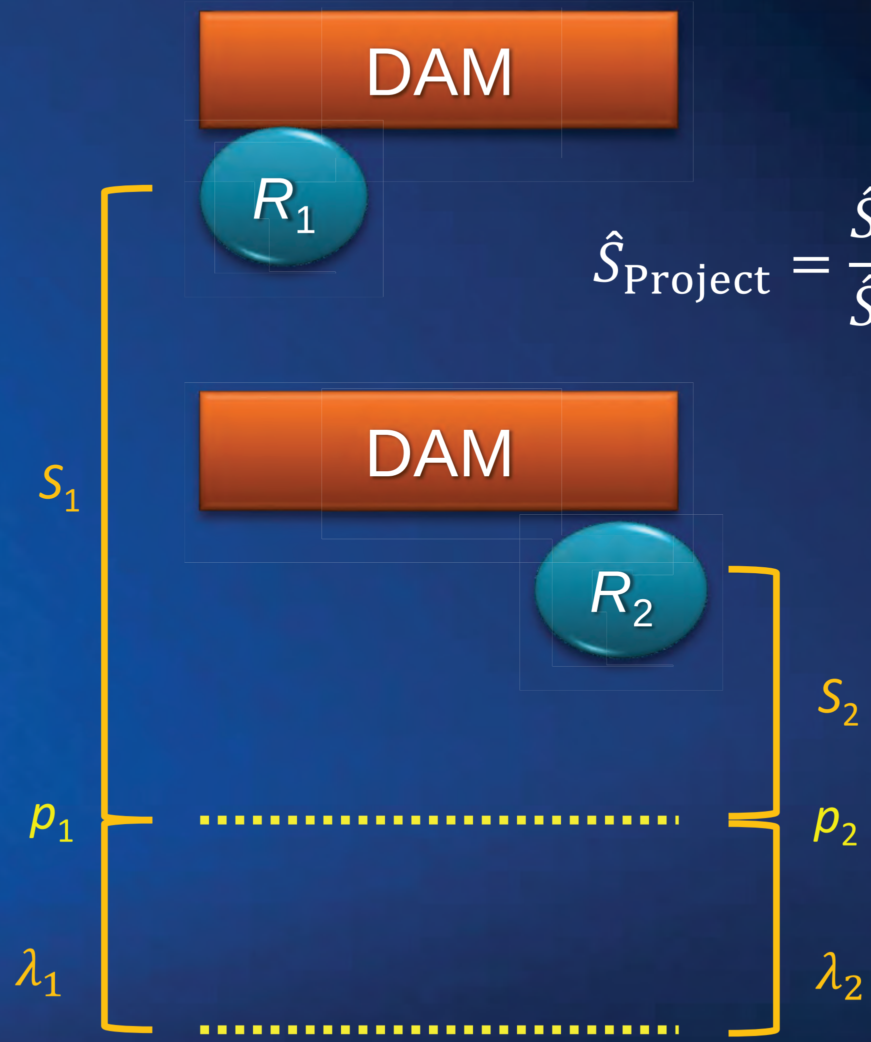
Idealized Study Timing



Idealized Study Spacing

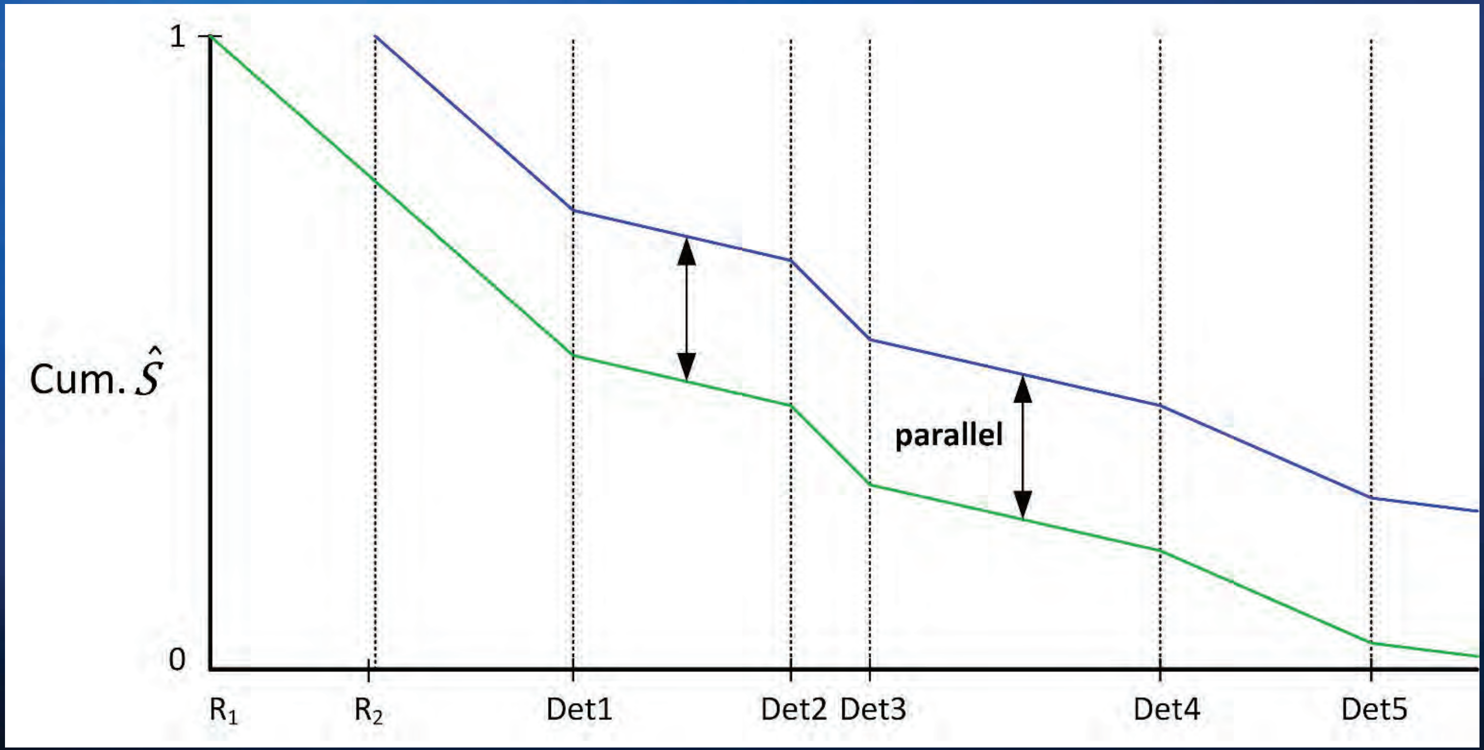
- If reach 1 is too long
  - "Backpack effect": increasing expression of tag burden effect
- If reach 2 is too short
  - False positive detections (mortalities from dam passage)
  - Unequal expression of handling effects
- Tag burden, unequal handling effects → $\hat{S}_{\text{Proj}}$ is negatively biased
- False positive detections → $\hat{S}_{\text{Proj}}$ is positively biased

$$\hat{S}_{\text{Project}} = \frac{\hat{S}_1}{\hat{S}_2}$$

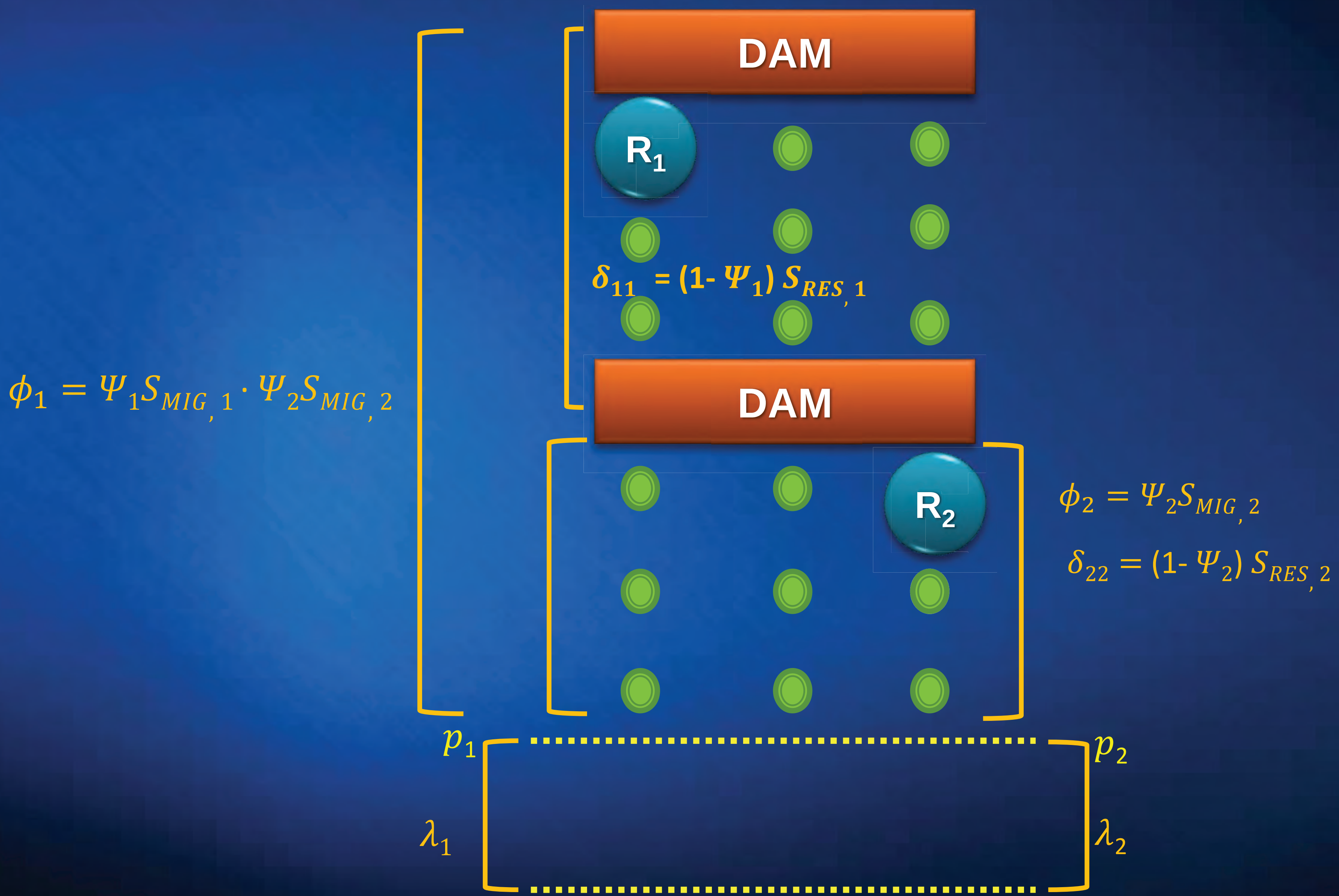


Idealized Study Spacing (continued)

- Negative bias in project survival: not bad if meet standard
- Diagnosis of tag burden effects
  - Compare cumulative survival from paired releases
  - Identify departure from parallel curves



Residualization



Residualization (Continued): Options

1. Use active migrants: $\Psi_1 \approx 1, \Psi_2 \approx 1$

2. Use ratio of release-specific CJS estimates (if common Ψ_2):

$$\frac{\hat{\phi}_1}{\hat{\phi}_2} \approx \frac{\Psi_1 S_{MIG,1} \cancel{\Psi_2 S_{MIG,2}}}{\cancel{\Psi_2 S_{MIG,2}}} = \Psi_1 S_{MIG,1}$$

3. Estimate total survival:

$$\frac{\hat{\phi}_1}{\hat{\phi}_2} + \hat{\delta}_{11} \approx \Psi_1 \, S_{MIG,1} + (1 - \Psi_1) S_{RES,1}$$

4. Paradigm shift → dam passage survival

FINAL

1201 3rd Avenue, Suite 2600
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206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: September 24, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the August 27, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, August 27, 2019, from 10:00 a.m. to 12:45 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).
- Douglas PUD will review available passive integrated transponder (PIT)-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item I-C).
- Kirk Truscott will submit Colville Confederated Tribes (CCT) comments on the *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* to Tom Kahler (Item I-C).
- Lance Keller will update Keely Murdoch on subyearling discussions to date, including Chelan PUD's plan to request approval of a renewed Statement of Agreement (SOA) during the HCP Coordinating Committees meeting on September 24, 2019, that maintains subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for the Rock Island and Rocky Reach projects for up to 3 years (Item III-B). *(Note: Keller discussed this topic with Murdoch, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.)*
- Lance Keller will distribute to the HCP Coordinating Committees a draft SOA, maintaining subyearling Chinook salmon in the Rock Island and Rocky Reach projects in Phase III (Additional Juvenile Studies) for up to 3 years, for vote during the HCP Coordinating Committees meeting on September 24, 2019 (Item III-B). *(Note: Keller provided a draft SOA to Kristi Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Lance Keller will distribute to the HCP Coordinating Committees results from the Rocky Reach Dam Turbine Unit C3 Chesterton seal tests once they become available (Item IV-A). *(Note:*

Keller provided an update on the Chesterton seal tests to Kristi Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)

- Lance Keller will explain to Keely Murdoch Chelan PUD's request to begin the 2019/2020 annual ladder maintenance work period at Rocky Reach Dam on December 16, 2019, which is 2.5 weeks earlier than usual, to allow more time to complete required work, and request that Murdoch provide the Yakama Nation's (YN's) approval of the request to the Rocky Reach HCP Coordinating Committee via email (Item IV-D). *(Note: Keller discussed this topic with Murdoch and the YN agreed to Chelan PUD's request, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.)*
- The HCP Coordinating Committees meeting on September 24, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item VI-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- Rocky Reach HCP Coordinating Committee representatives present agreed to Chelan PUD's request to begin the 2019/2020 ladder maintenance outage at Rocky Reach Dam 2.5 weeks earlier than usual to allow more time to complete required work, contingent on approval by the YN. Rather than beginning work during the first week in January (per usual), maintenance work will begin on December 16, 2019 (Item IV-D). *(Note: Keely Murdoch provided the YN's agreement to Chelan PUD's request via email on September 3, 2019, as distributed to the HCP Coordinating Committees by Kristi Geris that same day.)*

Review Items

- The *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019.
- The *Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018* was distributed to the HCP Coordinating Committees by Kristi Geris on September 10, 2019 and is available for a 30-day review with edits and comments due to Lance Keller by October 10, 2019.
- A draft SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to three years* was distributed to the HCP Coordinating Committees by Kristi Geris on September 19, 2019 (Item III-B).

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No additions or changes were requested from HCP Coordinating Committees members. Ferguson added an update on the HCP Policy Committees draft July 9, 2019 meeting minutes.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft July 23, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Geris said Dr. Rebecca Buchanan (University of Washington [UW], Columbia Basin Research) also reviewed and commented on the draft minutes. Lance Keller requested one additional edit under the subyearling presentation discussion, slide 16, where he commented that from a predator saturation perspective, a lot of run-of-the-river fish are present "in the middle of a juvenile outmigration compared to the beginning and the end." This edit was incorporated, and HCP Coordinating Committees members present approved the July 23, 2019 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on July 23, 2019, and follow-up discussions, were as follows. *(Note: Italicized text corresponds to agenda items from the meeting on July 23, 2019):*

- *HCP Coordinating Committees representatives will prepare technical questions and considerations concerning the feasibility of conducting subyearling Chinook salmon studies with the current information and technology available to date, for discussion with Drs. Rebecca Buchanan and John Skalski (UW, Columbia Basin Research) during the HCP Coordinating Committees meeting on August 27, 2019 (Item I-A).*
  This will be discussed during today's meeting.
- *Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item II-C).*
  This will be discussed during today's meeting and will be carried forward.

- *Douglas PUD will review available PIT-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item II-C).*
  Tom Kahler said these data are still under internal review. This action item will be carried forward.
- *Kirk Truscott will submit CCT comments on the Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report to Tom Kahler by Friday, July 26, 2019 (Item V-B).*
  Truscott said this effort is still ongoing and Kahler said it is not critical to finalize this report right away. This action item will be carried forward.

II. HCP Hatchery and Tributary Committees Update

A. HCP Hatchery and Tributary Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on August 8, 2019:

- *Cottonwood Flats Connection Project Presentation:* Chelan County Natural Resources Department provided an update on the status of the Cottonwood Flats Connection project on the Entiat River. The County described three design alternatives for the project. The Rocky Reach HCP Tributary Committee, which funded a portion of this project, supported a 240-cubic feet per second (cfs) connection to the floodplain (i.e., the floodplain will be activated when flows in the Entiat River are at 240 cfs or greater). The Rocky Reach HCP Tributary Committee also recommended the construction of a short “feeder” channel that will direct flows onto the floodplain. The sponsor, engineers, and the landowner are currently evaluating the Committee’s recommendation. Hillman said more information is expected in September when there will hopefully be resolution on a design.
- *Okanagan River Restoration Monitoring Presentation:* The Okanagan Nation Alliance (ONA) presented results from monitoring enhancement actions implemented on the Okanagan River in Canada, some of which were funded by the HCP Tributary Committees. ONA documented increased abundance and distribution of Chinook salmon and rainbow/steelhead; increases in large wood; positive responses in channel morphology, fish habitat, riparian vegetation and wildlife; increases in macroinvertebrate diversity and richness; and a reduction in coverage of macrophytes (especially Eurasian milfoil). In addition, spawning habitat has increased along with egg-to-fry survival rates. Hillman said these positive results suggest the enhancement efforts are working. John Ferguson asked if these results are provided in a report, and Hillman said they are in annual reports.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on September 12, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on August 21, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Relative Reproductive Success Timeline (joint):* Washington Department of Fish and Wildlife (WDFW) provided the HCP Hatchery Committees with a memorandum clarifying the extension of the Wenatchee spring Chinook salmon relative reproductive study. The last year of sampling DNA from natural-origin adult Chinook salmon at Tumwater Dam will be 2023.
- *Egg Treatment Study (joint):* Douglas PUD provided a study plan that will evaluate the effects of salt, hydrogen peroxide, and elemental copper in controlling saprolegnia infection of summer Chinook salmon eggs during incubation at Wells Fish Hatchery. The pilot study will begin this fall.
- *Update Genetics Section of the Hatchery Monitoring and Evaluation (M&E) Plan (joint):* The HCP Hatchery Committees reviewed edits made to the genetics section of the Hatchery M&E Plan. Revisions were made based on recommendations provided by the Genetics Monitoring Panel. Members will finalize and approve the edits during the HCP Hatchery Committees meeting on September 18, 2019.
- *Broodstock Collection Protocols (joint):* The HCP Hatchery Committees are beginning the process of updating the Broodstock Collection Protocols. Over the next few months, the HCP Hatchery Committees will identify any significant changes that need to be made to the protocols and will identify members who will lead the writeup of certain sections of the protocols.
- *National Marine Fisheries Service (NMFS) Consultation (joint):* NMFS is in the process of signing the Steelhead and Summer Chinook Salmon permits. The permits will then go to the permittees for signature.
- *Expanded Wells Summer Chinook Production for the Southern Resident Killer Whale Population (Wells):* WDFW prepared a proposal that will allow extra production of subyearling summer Chinook salmon at Wells Fish Hatchery. The extra production is intended to benefit the Southern Resident Killer Whale population. The Wells HCP Hatchery Committee is currently evaluating the proposal to determine whether the extra production will affect HCP production. Ferguson asked how much extra production is being discussed, and Kirk Truscott said a half-million fish. Tom Kahler said the extra production will be reared in the large dirt ponds and the question is whether there is adequate incubation space. Ferguson asked about

funding, and Chad Jackson said this effort is being conducted under a contract between WDFW and Douglas PUD, which is passing through funds from the Washington legislature. Ferguson asked if there are any other logistical issues. Jackson said WDFW is currently navigating through various Endangered Species Act permits alongside several other hatcheries that are also planning extra production for orcas. Truscott noted that there are contingency plans in place in case permits get hung up, so these fish will go somewhere other than into the ground. Jackson said Douglas PUD's contingency plan is Banks Lake. Kahler also noted if other hatcheries are battling columnaris issues, there may be a need for extra fish from Wells Fish Hatchery.

- *Draft 2020 Rock Island and Rocky Reach M&E Implementation Plan (Rock Island/Rocky Reach):* Chelan PUD provided the draft 2020 Rock Island and Rocky Reach M&E Implementation Plan for review. The Rock Island and Rocky Reach HCP Hatchery Committees are currently reviewing the draft implementation plan and will discuss and vote on the plan during the HCP Hatchery Committees meeting on September 18, 2019.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on September 18, 2019.

III. Subyearling Studies

A. Brainstorming Session (All)

John Ferguson recalled the HCP Coordinating Committees convening a subyearling workshop in 2016, and then the subsequent Chelan PUD subyearling phase designation SOA, which is now about to expire, and the subyearling presentation provided by Dr. Rebecca Buchanan during the HCP Coordinating Committees meeting on July 23, 2019. Ferguson said based on Buchanan's presentation, in terms of survival models, project survival is still not separately estimable which is the same situation as 3 years ago. He said the question remains, where to go from here, and the HCP Coordinating Committees agreed further discussion was needed this month.

Ferguson said Keely Murdoch provided an email summarizing the Yakama Nation's (YN's) stance on subyearling studies, which was distributed to the HCP Coordinating Committees by Kristi Geris on August 12, 2019. Ferguson said the email is consistent with what Murdoch expressed verbally during the HCP Coordinating Committees meeting on July 23, 2019, i.e., the YN is interested in conducting at-dam passage survival studies similar to what the U.S. Army Corp of Engineers (USACE) has been doing. Ferguson noted, however, that at-dam passage survival studies are not stipulated in the HCPs as a means for achieving Phase III (Standard Achieved), and if this is a path the HCP Coordinating Committees choose to go down this will not be a simple discussion because it is a departure from the Passage Survival Plans in the HCPs. He said this may even require HCP Policy Committees input because at-dam passage survival studies are only an interim measure in the HCPs for getting out of

Phase II (Additional Tools), and the HCPs do not include the flexibility to study just for the sake of studying. He said the HCP Coordinating Committees would need to carefully consider this approach.

Jim Craig questioned whether studying survival at the dam is a significant enough departure from the HCPs to be in conflict with the HCPs. Lance Keller pointed out that achieving the 95% dam passage survival standard does not lead to a change in phase designation from Phase III (Additional Juvenile Studies) to Phase III (Standard Achieved). Keller said the HCPs are designed to carry out actions to define a phase designation on a project scale that is subsequently used to identify mitigation targets.

Kirk Truscott said currently under the HCPs, there is a negotiated level of mitigation for all Plan Species. He said the question is, is this enough mitigation for species for which survival has not been measured? He said if the PUDs conduct at-dam survival studies and the results are less than the negotiated value, does mitigation need to increase? He said conversely, if the results are better (higher survival), does this mean the negotiated mitigation is too much or does it not apply because this is only at-dam survival. He said, while everyone wants to know if Plan Species are being under-mitigated, this is not a two-way street. He said the risk is entirely on the PUD side and he is unsure whether this is fair. He said further, only fish of taggable size are being mitigated for, based on the studies, which is not the entire population.

Keller said after the last HCP Coordinating Committees meeting on July 23, 2019, he went back internally and discussed what has been learned about spring species, how this effects operational changes (especially at Rock Island Dam), and what is known about passage routes. He said, for example, what if Chelan PUD conducts an at-dam survival study and results are higher than 95% survival for 20% spring spill. He asked, does this mean Chelan PUD could conduct a spill reduction similar to the additional studies conducted in 2007 to reduce fish spill at Rock Island Dam from 20% to 10% for spring Plan Species after Phase III (Standards Achieved) was designated in 2006.

Truscott said he is interested in a tagging option to incorporate all fish lengths, but there are none. He said fish are marked with Bismarck brown dye at screw traps, but this would not remain visible for the duration needed for a survival study. He said it may work for an at-dam survival study or at least in proximity to a project. He said another sample location would also be needed, like a bypass. Tom Kahler said it would be difficult to recapture enough fish to have statistically significant results. Truscott suggested conducting a mass marking effort to boost sample size. He said, for example, marking 50,000 to 75,000 fish of all sizes at the confluence of the Okanogan River. He caveated that the current sampling scheme at the Rocky Reach Juvenile Fish Bypass is not sufficient to recover an adequate sample size; therefore, operational changes would be needed at the bypass. Keller agreed there would be logistical issues to recover the fish. Ferguson asked if there is an option for in-reservoir collection? Truscott said this would be nearly impossible. He said a fixed location would be needed to operate all day. Keller said even then, there would be detectability issues. He said at Rocky Reach Dam, Chelan PUD has staffed the bypass continuously for 40-some days, 24 hours per day, with samples conducted at the top of each hour. He said there needs to be high detection probability to calculate a survival estimate and he questioned whether a study design could reasonably handle that many fish. He said even with a PIT-tag study, there needs to be additional downstream handling sites to improve detection probability. He also noted that detection probability at the Rock Island Dam Juvenile Bypass System is low.

Truscott said there are obvious difficulties in attempting to conduct an at-dam or project-level, population-at-large, study, and he has no suggestions on how to arrive at something more tangible. Jim Craig said additionally, there are unknowns about life histories, such as fish residing versus moving slowly. Truscott said it might be useful to discuss what constitutes an active migrant and suggested considering migrating birds as a reference point. Kahler said, however, there is a difference between migrating birds and migrating fish. He explained that migrating birds move volitionally through an air mass, versus a fish not swimming will still be passively transported through their native water. He said fish do not have a choice to avoid migrating unless the fish actively resists it. He said Tiffan et al (2018)[1], also referenced in Douglas PUD's *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report*, distinguished what is an active versus passive migrant for the purposes of their study. Kahler said their method considers the ratio of the velocity of the fish relative to the velocity of the current. He said a fish moving slower than the current is considered a passive migrant versus a fish moving faster than the current is identified as an active migrant. He said perhaps the HCP Coordinating Committees can develop something similar to this.

Kahler said he does not recall whether Tiffan et al (2018)[1] mentioned water particle transport time nor is he certain this transit time is the same timing non-swimming creatures experience, but when Chief Joseph Dam increases discharge, it takes only a few hours for a wave of water to reach Wells Dam; however, the actual water-particle transit-time is calculated differently and is between 1 and 2 days. He said he is unsure how this is calculated but this water transit time is recognized by the Washington State Department of Ecology. Keller said according to the operators, water transit time from Rocky Reach Dam to Rock Island Dam is 45 minutes. Truscott said considering this timing yearlings would be passive. Kahler said in the Douglas PUD survival study, release times at Pateros were intended to match with release times in the Wells Dam tailrace, and those releases linked up pretty well. Keller said in the Chelan PUD survival study, the test and control groups were released 24 hours apart and travel time was species dependent. He said, for example, sockeye salmon migrated through the Rocky Reach Reservoir faster than yearling Chinook salmon or steelhead.

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[1] Tiffan K. F., T. J. Kock, W. P. Connor, M. C. Richmond, and W. A. Perkins. 2018. Migratory behavior and physiological development as potential determinants of life history diversity in fall Chinook salmon in the Clearwater River. Transactions of the American Fisheries Society 147:400-413.

Truscott also noted that even though fish might be tailing (or moving tail-first), this does not necessarily mean the fish is not an active migrant.

Keller said additionally, the term "residualization" has been used a lot while discussing subyearling survival studies. He said this term is used a lot in the hatchery world to refer to a fish that chooses to not migrate and exhibits a life-history without an ocean component; however, when used in the context of natural-origin fish and survival studies it refers to a fish that will eventually out-migrate. Truscott agreed and added that, to residualize in the hatchery world refers to a reservoir-rearing life history. He said historically, there have been years with a fairly large amount of hatchery adult returns demonstrating this life history, but it has somewhat gone away over the past 6 to 8 years. Kahler agreed this life history has diminished.

Ferguson clarified that the term "active migrant" is not in the HCPs; rather, the HCPs only indicate "migrant." Truscott said active migrant is used in Douglas PUD's subyearling report and Keller said this term is also used in Buchanan's subyearling presentation. Chad Jackson said a survival study needs study fish that want to migrate. Kahler said for an acoustic tag study, according to Buchanan's subyearling presentation, any fish that does not migrate before the tag life expires is a residual fish.

Keller recalled in 2011, a similar situation of not being able to evaluate subyearlings, so Chelan PUD provided a presentation on what was known about subyearlings, including a review of metrics such as carrying capacity, productivity, and limiting factors. He said this provided confidence to the HCP Coordinating Committees that even though subyearling survival could not be studied, these data indicated the species was doing quite well. He suggested perhaps in lieu of a survival study, something similar can be done now, i.e., review these same metrics to determine if the species is in the same situation and doing okay. He recalled Tracy Hillman presented a productivity model for summer Chinook salmon in the Wenatchee and Methow river basins. He said ambient air temperature, relative snowpack, and pacific decadal oscillation were found to be the largest determining factors related to abundance. Truscott also recalled that the data indicated from an abundance and hatchery smolt-to-adult ratio standpoint, the population seemed to be on par or doing better than yearlings.

Truscott said he does not believe conducting an at-dam study will give the direction needed for a change in phase designation. Jackson agreed the technology is not quite there yet to conduct a project-level survival study, and he asked if more can be learned about the study species. He said maybe too much focus is on trying to fit a "square subyearling peg" into a "round (John) Skalski study" hole. Jackson recalled Murdoch mentioning otolith chemistry or perhaps other studies conducted on a good faith effort in order to get more information. Jackson suggested maybe convening a subgroup to brainstorm potential studies tailored just for subyearlings. He asked if hatchery surrogates could be used for a study. Ferguson said he would argue against a subgroup because each HCP Coordinating Committees representative needs to be a part of this discussion. Jackson agreed with this reasoning. Kahler said when developing a hatchery surrogate, the intent is to match the wild fish population; however, with subyearlings, it is unknown what time frame or location to match.

Truscott asked how did the USACE study immigration or survival studies on the Snake River with fall Chinook salmon? He recalled the studies were at-dam survival. Kahler said USACE acoustically tagged run-of-the-river fish collected at the projects. He said these fish were of sufficient size, at 95 millimeters tagging size, and only 1% of the fish captured were too small to tag. Truscott asked about fish size at Rocky Reach Dam, and Keller said there is definitely a fry component there (less than 40 millimeters). Keller said the average fish size changes on a daily basis. He said throughout a season, there is a first pulse of larger hatchery fish followed by an "unknown" component where the average fish length grows over time. Ferguson said Billy Connor (U.S. Fish and Wildlife Service) conducted a study on non-hatchery natural subyearling migrant reservoir-rearing life history, which was published in Transactions of the American Fisheries Society in 2005. Ferguson said NMFS also conducted early fish transportation studies which compared the study fish to in-river controls. Ferguson said the study fish faired really well because the fish were big, but the number of fish used in the study was small. He said these fish with a reservoir life history adapted to all environmental conditions. Kahler said Tiffan has also conducted a lot of work on this.

Truscott asked if there is any information the HCP Coordinating Committees have not yet reviewed toward another study design. He asked, what other studies can be conducted?

Keller recalled Chelan PUD's initial project survival study conducted on yearlings, which resulted in survival in the 80th percentile and subsequently remained in Phase I (Testing). He said Chelan PUD continued sockeye salmon studies under a Phase II (Additional Tools) designation and learned year-to-year how to boost survival. Truscott said eventually survival targets for these species were met for representative conditions. Keller agreed, but said there was a way to evaluate project survival for these species. He recalled that yearlings remained in Phase I (Testing) but studying sockeye salmon under Phase II (Additional Tools) showed that no spill and loading of the powerhouse improved survival. He said once it was determined improvements in sockeye salmon survival would also translate to and benefit yearling Chinook salmon, Chelan PUD reinitiated phase designation studies for yearling Chinook salmon under the new operations. He said for subyearlings, however, as Buchanan outlined, there is no way to define true survival.

Truscott asked if there is value in determining whether fish are really gone or just offshore somewhere in the reservoir? Kahler said Douglas PUD has observed subyearlings offshore in the Wells Reservoir. Keller said there is a lot of variability in the Rocky Reach Reservoir. He noted in 2011 and 2012, however, unknown subyearling components were detected at Rock Island Dam above the tagging size threshold but were gone about a week later. Kahler said historical fyke net data indicate those fish are migrating out of the reservoir through mid-August and peaking in early August, which is long after these fish can be captured by beach seine. Truscott suggested using a small purse seine, but then asked, what does this information do to improve our knowledge towards conducting a survival study? He said he is not certain this is what was intended by the phase designation "Additional Juvenile Studies." Ferguson said it seems "Additional Juvenile Studies" is generic language. Truscott said he does not want to keep postponing an actual study.

Keller said that although the current Chelan PUD subyearling SOA expires on September 29, 2019, Chelan PUD does not feel it is necessary to rush into another SOA. He said further, another SOA does not preclude continuing these discussions. He said Chelan PUD intends to revisit subyearling survival studies at least once per quarter, as an ongoing agenda item. Truscott said he would be supportive of renewing an SOA and understands the administrative reasoning for doing so.

Truscott asked if the PUDs would be interested in considering other studies of subyearlings, even if there is no clear link to informing a future survival study. He suggested, for example, studying what happens to these larger fish offshore in the reservoir in late-August and September. He added that learning something additional might end up helping design a future survival study. Jackson agreed and said building a knowledge base until technology becomes available might reveal another survival study design other than Skalski's design.

Ferguson said with true project survival off the table, the options seem to include behavioral studies, scale collection, otolith microchemistry, and acoustic tracking. He asked if there are other tools? Truscott said he is partial to active tag studies and monitoring scales from adults to obtain information on what is successful. He said he wants to know what these fish are doing in the reservoir. Ferguson noted the really good water quality in the reservoir. Kahler agreed and said the temperature are ideal for growth. He added that temperatures do not get too warm until late-August, which might be an impetus for fish to move out.

Ferguson asked about Dual-Frequency Identification Sonar (DIDSON) studies within the reservoir. He suggested establishing a sampling grid throughout the reservoir, similar to stock assessment surveys, to get at what is present and when. Kahler said this gets into the issue of how to distinguish targets. He said there are clouds of stickleback, chub, and peamouth, among other species. Keller agreed and said at the juvenile fish size it is difficult to distinguish species. Kahler said this is why Douglas PUD used fyke netting during the development and testing of the bypass system; it was needed to identify the species of fish observed in the hydroacoustic beams in the turbine and spillway intakes. He said until about mid-August, almost all objects identified as fish in the hydroacoustic sampling are salmonids, but in mid-August the young-of-year resident fish reach the same size as the salmonids. Keller said mobile surveys are also not as effective as a fully deployed array. He said

Chelan PUD conducts mobile surveys for white sturgeon and there are times when fish are present, but the gear cannot pick up a signal.

Truscott asked if the acoustic arrays deployed in the Wells and Rocky Reach reservoirs for white sturgeon are adequate for monitoring distribution of subyearlings? Keller said the white sturgeon arrays in the Rocky Reach Reservoir are setup to operate at a different frequency compared to a juvenile system. Kahler said the same is true for the Wells Reservoir, that the system would need to be rewired for juveniles. Keller said Chelan PUD would need to deploy entirely different equipment in the Rocky Reach Reservoir.

Truscott said it may turn out that behavioral data might contribute to a survival study, but he understands this may be a hard sell. Keller said, notably when a study moves from passive to active technology the base cost increases significantly. Ferguson asked about radio tags. Keller noted the external component (long antenna) and the need to install different detection equipment.

Keller said Chelan PUD appreciates the HCP Coordinating Committees thoughts and discussion on this topic. He said the Chelan PUD Natural Resources Department is tracking this closely and has full support of Chelan PUD General Manager, Steve Wright, who is very connected to the natural resources world.

Ferguson asked the HCP Coordinating Committees if there are questions for Buchanan and Skalski. No questions were expressed, and Kristi Geris notified Buchanan and Skalski that there were no further questions for them.

B. Questions and Answers with Drs. Rebecca Buchanan and John Skalski (All)

John Ferguson said the HCP Coordinating Committees had no further questions for Drs. Rebecca Buchanan and John Skalski.

Lance Keller said he will share today's discussions internally with Chelan PUD. Ferguson asked the Rock Island and Rocky Reach HCP Coordinating Committees representatives if everyone is ready to vote on a reboot of Chelan PUD's 3-year subyearling SOA during the next HCP Coordinating Committees meeting on September 24, 2019, and representatives present agreed on moving forward with a vote next month. Keller said the SOA will essentially be the same as the last SOA with a new date and quarterly check-ins on subyearlings.

Ferguson also suggested conducting additional research, for example, review of scale data. Keller said a review of scale data is already available. Tom Kahler agreed and said in 2016, Andrew Murdoch (WDFW) provided a stock assessment presentation, which looked at proportional contributions of the subyearling, reservoir-reared, and yearling life-history tactics, as evidenced in scales from natural-origin summer/fall Chinook salmon broodstock and carcasses. Keller read from the HCP Coordinating Committees June 22, 2016 meeting minutes, as follows:

> *He (Jeff Korth, WDFW retired) said despite these issues, subyearlings seem to have been able to adapt. He asked what happened in 2002, such that summer and fall Chinook salmon counts in the Mid-Columbia Basin have been on the rise. Kahler said it was harvest. He added that in 2002, there was a significant reduction in the Canadian harvest allocation. Truscott noted that the exploitation rate is still high.*

Keller said he will update Keely Murdoch on subyearling discussions to date, including Chelan PUD's plan to request approval of a renewed SOA during the HCP Coordinating Committees meeting on September 24, 2019, that maintains subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for the Rock Island and Rocky Reach projects for up to 3 years. *(Note: Keller discussed this topic with Murdoch, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.)*

Keller said he will also distribute to the HCP Coordinating Committees a draft SOA, maintaining subyearling Chinook salmon in the Rock Island and Rocky Reach projects in Phase III (Additional Juvenile Studies) for up to 3 years, for vote during the HCP Coordinating Committees meeting on September 24, 2019. *(Note: Keller provided a draft SOA to Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*

IV. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said Turbine Unit C1 continues to be plagued by delayed delivery of necessary components for repair from the vendors. He said currently, Rocky Reach Dam mechanics are waiting on the wicket gate servo control. He said repairs are still progressing in some areas but are delayed in others waiting on delivery of this key component. He said the return-to-service date has now slipped slightly to January 2020. He recalled the conflict in scheduling for the recommissioning of Turbine Units C9 and C1. He said crews have never conducted concurrent unit commissioning and do not plan to do so; therefore, Turbine Unit C1 must be operational no later than April 1, 2020. He said this return-to-service date also provides confidence for this unit to be online in time for the 2021 survival study.

Keller said Turbine Unit C3 is out-of-service today for a periodic evaluation of the new Chesterton seals. He said the last assessment occurred a few weeks ago and everything looked good. He said since the last assessment, crews have improved their ability to measure oil volumes when filling and draining the turbine hub. He said he will distribute results from the Rocky Reach Dam Turbine Unit

C3 Chesterton seal tests to the HCP Coordinating Committees once they become available. *(Note: Keller provided an update on the Chesterton seal tests to Kristi Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Turbine Unit B4 has also suffered a delay in delivery of the hydraulic power unit, which controls the oil pressure inside the unit. He said work is continuing on the unit and there is no delay in the repair schedule as of yet. He said crews are currently working on the discharge liner, which in some areas is ground down to a depth of 3 inches and then filled and ground smooth. He said crews are refilling these areas and prepping the surface to prevent re-cavitation. He said crews are learning a lot and gaining knowledge towards repairing Turbine Unit B1 after Turbine Unit B4 is complete.

Kirk Truscott asked, with these maintenance issues ongoing at both Rock Island and Rocky Reach dams, is there going to be a modified maintenance schedule so there are not these prolonged amounts of time of limited maintenance? He asked, is the plan to operate until it breaks or conduct more frequent maintenance to avoid complete breakdowns? John Ferguson said it seems this question assumes these issues are all maintenance-related; however, some of these issues are aging-related. Keller said some of the current issues are due to deferring maintenance to accommodate other needed work, and he does not believe this is the fashion in which Chelan PUD prefers to operate. He said other current issues, such as the design flaws discovered in Rocky Reach Dam Turbine Units C8 to C11, were not maintenance related.

C. 2019 Rock Island and Rocky Reach Fish Spill Update (Lance Keller)

Lance Keller said at Rocky Reach Dam, summer fish spill started on June 2, 2019, and ended on August 12, 2019. Keller said on August 12, 2019, the Columbia River Data Access in Real Time database (DART) estimated that 99.24% of the subyearling Chinook salmon outmigration had passed Rocky Reach Dam. He said as a double-check, Chelan PUD took the cumulative count divided by the number of days remaining in August and compared smolts-per-day to the bypass counts. He said when summer spill was shutdown, bypass counts were averaging 29 to 30 smolts per day. He said counts over the past 5 days averaged 7 smolts per day.

Keller said at Rock Island Dam, summer fish spill started on June 2, 2019, and ended on August 19, 2019. He said the criteria to end summer spill at Rock Island Dam were met early on; however, results of the double-check were very close to the daily bypass counts. He said Chelan PUD chose to take a conservative approach and waited to end spill until daily index counts dropped to an average of 15 smolts per day. He said immediately after shutting down spill daily counts dropped into single digits. He said since spill shutdown, average daily counts have been 5 smolts per day. He said DART estimated that 99.47% of the subyearling Chinook salmon outmigration had passed Rock Island Dam on August 19, 2019.

Keller said next, Thad Mosey (Chelan PUD) will draft the 2019 Rock Island and Rocky Reach Fish Spill Report and will present the results to the HCP Coordinating Committees during the September 24 or October 22, 2019 meetings.

D. 2019/2020 Rocky Reach Dam Adult Fishway Maintenance (Lance Keller)

Lance Keller said typically, adult fishway maintenance at Rocky Reach Dam is completed during the months of January and February each year. He said this year, Rocky Reach Dam mechanics asked Chelan PUD to request approval for an earlier outage to complete necessary work. He said the initial ask was for the entire month of December 2019, but this has been negotiated down to 2 weeks, which has been requested and approved in the past. He said work driving this request includes the recommissioning of Turbine Units C1 and C9. He said the Turbine Unit C9 commissioning might happen as early as December 2019, which requires a full mechanical crew and will occur on the heels of the Turbine Unit C1 commissioning. He said the refurbished wicket gates for Turbine Unit C9 are coming from a vendor in Spokane, Washington, are being sent 3 to 4 at a time, but that 1 to 2 gates are being sent back each time because the gates are not meeting tolerances or have bearing issues.

Keller said concurrently, tied to public power benefits, there are plans to improve the fish viewing windows. Public Power Benefits look for ways to use surplus energy sales to enhance local experiences for rate payers, with previous examples being free parking passes for local parks and free electric vehicle charging stations. He said currently, the windows are 4 feet above the ground and the new windows will stretch nearly from the floor to the ceiling, allowing smaller children to get eye-to-eye with fish ascending the Rocky Reach Dam adult fish ladder. He said the plan is requires cutting into the fishway, removing the existing windows, and re-installing and pressure-testing the new windows. He said the contractor is planning to complete this construction from January 1 to February 29, 2020.

Keller said lastly, this leaves one crew to complete the preventative, routine checklist, while the other crews complete the other tasks. He said this is a lot of work for one crew, but the additional 2 weeks will provide breathing room to complete all these maintenance activities and meet the water-up date of March 1, 2020.

John Ferguson summarized that the request is for an outage from December 16, 2019 to February 29, 2020. Keller added that if the work is completed early, the system will be watered up early, as well. He also clarified that Chelan PUD is not requesting agreement right now unless Rocky Reach HCP Coordinating Committee representatives are comfortable with voting right now. He said, however, Rocky Reach Dam mechanics would like to know if a schedule change is needed, sooner than later.

Kirk Truscott said there are not a lot of anadromous fish moving through the ladders during this time of year. He said he is unsure about Pacific lamprey. Keller said he is unsure whether Pacific lamprey would use the ladders for overwintering or for migration, but if encountered in the ladders during the fish rescues that accompany the dewatering of an adult fishway, these fish would be translocated upstream.

Rocky Reach HCP Coordinating Committee representatives present agreed to Chelan PUD's request to begin the 2019/2020 ladder maintenance outage at Rocky Reach Dam 2.5 weeks earlier than usual to allow more time to complete required work, contingent on approval by the YN. Rather than beginning work during the first week in January (per usual), maintenance work will begin on December 16, 2019. Keller said he will explain to Keely Murdoch Chelan PUD's request, and request that Murdoch provide the YN's approval of the request to the Rocky Reach HCP Coordinating Committee via email. *(Note: Keller discussed this topic with Murdoch and the YN agreed to Chelan PUD's request, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.)*

V. Douglas PUD

A. Wells Dam Bypass Update (Tom Kahler)

Tom Kahler said bypass operations at Wells Dam ended at midnight on August 19, 2019, per the operating plan and as distributed to the HCP Coordinating Committees by Kristi Geris that same day.

VI. HCP Administration

A. HCP Policy Committees July 9, 2019 meeting minutes (John Ferguson)

John Ferguson said edits and comments on the draft minutes are still being addressed by HCP Policy Committees representatives. He said once all edits are received, the revised minutes for approval will be distributed for a vote via email. He said he has not heard further discussion on this topic within the HCP Tributary Committees. He said there is an action item to convene the HCP Policy Committees in-person on an annual basis after completion of the HCP annual reports to touch base on activities and discussions over the past year.

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on September 24, 2019, to be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington.

The October 22 and November 26, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone for the HCP Tributary and Hatchery Committees Update

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: November 20, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the September 24, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, September 24, 2019, from 10:00 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Chelan PUD will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).
- Chelan PUD will review with U.S. Fish and Wildlife Service (USFWS) the Colville Confederated Tribes' (CCT's) revisions to the Statement of Agreement (SOA) titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years*, and will confirm with USFWS approval of the SOA with these revisions (Item III-A). *(Jim Craig provided USFWS approval of the CCT's edits and revised SOA via email on September 26, 2019.)*
- Anchor QEA, LLC, will add a subyearling Chinook salmon check-in agenda item for Chelan PUD on HCP Coordinating Committees meetings occurring in February, May, August, and November, to continue to evaluate or monitor study design, tag technology, and life history information on a quarterly basis to better understand future survival study feasibility by 2022, per the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years* (Item III-A). *(Note: Kristi Geris added this reoccurring item to HCP Coordinating Committees meeting agendas beginning in February 2020.)*
- Douglas PUD will revise the *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*, as discussed (Item IV-A). *(Note: Tom Kahler provided a revised draft document to Kristi Geris following the HCP Coordinating Committees meeting on September 24, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Wells HCP Coordinating Committee representatives will review the revised *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During*

April 2019 and will be prepared to discuss a path forward during the HCP Coordinating Committees meeting on October 22, 2019 (Item IV-A).

- Anchor QEA will coordinate with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) and Grant PUD regarding rescheduling the HCP Coordinating Committees and PRCC's meetings in November and December 2019 to accommodate the holidays (Item V-C). *(Note: Anchor QEA and Rohr coordinated rescheduled dates, as discussed.)*
- The HCP Coordinating Committees meeting on October 22, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-C).

Decision Summary

- Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years*, as revised (Item III-A). *(Jim Craig provided USFWS approval of the revised SOA via email on September 26, 2019.)*

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019.
- The *Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018* was distributed to the HCP Coordinating Committees by Kristi Geris on September 10, 2019, and is available for a 30-day review with edits and comments due to Lance Keller by October 10, 2019. Chelan PUD will request approval of this report during the HCP Coordinating Committees meeting on November 19, 2019.
- A *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* was distributed to the HCP Coordinating Committees by Tom Kahler during the HCP Coordinating Committees meeting on September 24, 2019, and a revised draft document was distributed to the HCP Coordinating Committees by Kristi Geris following the HCP Coordinating Committees meeting on September 24, 2019 (Item IV-A).

Finalized Documents

- The final SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years* was distributed to the HCP Coordinating Committees by Kristi Geris on October 7, 2019 (Item III-A).
- The Final 2017 Douglas PUD Pikeminnow Removal Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on October 22, 2019, as approved by the Wells HCP Coordinating Committee after no disapprovals were received prior to the 60-day review deadline on March 28, 2019.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Tom Kahler added a 3-year performance review of the HCP Coordinating Committees Chair
- Lance Keller removed the *Rock Island and Rocky Reach 2019 Fish Spill Season Report*
- Ferguson added a Yakama Nation (YN) HCP Tributary Committees representation designation

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft August 27, 2019 meeting minutes. John Ferguson said in the first revised draft minutes (distributed to the HCP Coordinating Committees by Kristi Geris on September 17, 2019), under the Subyearlings Studies discussion, Chelan PUD and Douglas PUD provided text clarifying the discussion about phase designations and at-dam passage survival studies. Ferguson said the text clarified that at-dam studies do lead to a phase designation (Phase III [Additional Juvenile Studies] or Phase II [Additional Tools]); however, at-dam studies do not lead to designation of Phase III (Standard Achieved) and thus a calculation for mitigation (i.e., do not lead to a calculated survival component for No Net Impact). Tom Kahler further explained that Douglas PUD did use at-dam passage calculations to get to Phase III (Additional Juvenile Studies) for subyearling Chinook salmon; however, the Wells Project will remain in this phase until a project-level survival study can be conducted. Kahler said if the HCP Coordinating Committees want to make at-dam studies a basis for hatchery compensation, this is not currently stipulated in the HCPs and would be a major change to the HCPs.

Geris said a second revised draft minutes were distributed on September 19, 2019, which included Chelan PUD responses to three outstanding comments, which are tracked in redline strikeout. The HCP Coordinating Committees reviewed these additional edits. Geris said all other comments and revisions received from members of the Committees were incorporated into the revised minutes.

The HCP Coordinating Committees members present approved the August 27, 2019 meeting minutes, as revised. The YN abstained, because a YN representative was not present during the August 27, 2019 meeting.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on August 27, 2019, and follow-up discussions, were as follows. *(Note: Italicized text corresponds to agenda items from the meeting on August 27, 2019):*

- *Lance Keller will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).*
  This will be discussed during today's meeting and will also be carried forward.
- *Douglas PUD will review available passive integrated transponder (PIT)-tag detection data from April 9 to April 30, 2019, covering the span of Wells Dam bypass non-compliance events for Turbine Units 1 to 4 and Bypass Bays 2 and 4, to identify possible impacts to fish passage and survival through the Wells Project (Item I-C).*
  This will be discussed during today's meeting.
- *Kirk Truscott will submit CCT comments on the Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report to Tom Kahler (Item I-C).*
  Kahler said Truscott provided CCT comments on the draft report prior to the HCP Coordinating Committees meeting on September 24, 2019. Kahler said he will review and address these comments.
- *Lance Keller will update Keely Murdoch on subyearling discussions to date, including Chelan PUD's plan to request approval of a renewed SOA during the HCP Coordinating Committees meeting on September 24, 2019, that maintains subyearling Chinook salmon in Phase III (Additional Juvenile Studies) for the Rock Island and Rocky Reach projects for up to 3 years (Item III-B).*
  Keller discussed this topic with Murdoch, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.
- *Lance Keller will distribute to the HCP Coordinating Committees a draft SOA, maintaining subyearling Chinook salmon in the Rock Island and Rocky Reach projects in Phase III (Additional Juvenile Studies) for up to 3 years, for vote during the HCP Coordinating Committees meeting on September 24, 2019 (Item III-B).*
  Keller provided a draft SOA to Kristi Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day.
- *Lance Keller will distribute to the HCP Coordinating Committees results from the Rocky Reach Dam Turbine Unit C3 Chesterton seal tests once they become available (Item IV-A).*

Keller provided an update on the Chesterton seal tests to Kristi Geris on September 19, 2019, which Geris distributed to the HCP Coordinating Committees that same day. Keller said he will also discuss this during today's meeting.

- *Lance Keller will explain to Keely Murdoch Chelan PUD's request to begin the 2019/2020 annual ladder maintenance work period at Rocky Reach Dam on December 16, 2019, which is 2.5 weeks earlier than usual, to allow more time to complete required work, and request that Murdoch provide the YN's approval of the request to the Rocky Reach HCP Coordinating Committee via email (Item IV-D).*
  Keller discussed this topic with Murdoch and the YN agreed to Chelan PUD's request, as described in an email distributed to the HCP Coordinating Committees by Kristi Geris on September 3, 2019.

II. HCP Hatchery and Tributary Committees Update

A. HCP Hatchery and Tributary Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on September 12, 2019:

- *Cottonwood Flats Connection Project Presentation:* Chelan County Natural Resources Department and their consultant (Natural Systems Design) provided an update on the status of the Cottonwood Flats Connection project on the Entiat River. This was a follow-up visit based on feedback provided to the sponsor from the Rocky Reach HCP Tributary Committee during the HCP Tributary Committees meeting on August 8, 2019. The Rocky Reach HCP Tributary Committee had supported the 240-cubic feet per second (cfs) connection (i.e., the floodplain will be activated when flows in the Entiat River are at 240 cfs or greater) but did not support the perennial alcove or the construction of a channel throughout the floodplain. Rather, the Rocky Reach HCP Tributary Committee recommended the construction of a short pilot channel to allow the river the opportunity to carve out a channel or channels on the floodplain. The sponsor and their consultant evaluated the recommendation from the Rocky Reach HCP Tributary Committee and determined it will create ponding on the floodplain and noted the uncertainty of flow paths forming on the floodplain. Given this information, the Rocky Reach HCP Tributary Committee recommended knocking down high points on the floodplain to help with flow-path development. In summary, the Rocky Reach HCP Tributary Committee recommended construction of the pilot channel and knocking down high points downgradient from the pilot channel to help with flow-path development. No channels other than the pilot channel will be constructed on the floodplain. The sponsor, their consultant, and the landowner (Chelan-Douglas Land Trust) agreed with this approach.

- *Evaluation of the Chair:* The HCP Tributary Committees conducted an evaluation of the HCP Tributary Committees Chair (Tracy Hillman). HCP Tributary Committees members indicated they were pleased with the Chair's performance and requested that Douglas PUD and Chelan PUD retain Hillman's services for another 3-year term. Hillman agreed to serve as the Chair for the Wells, Rocky Reach, and Rock Island HCP Tributary Committees for another 3 years.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on October 10, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on September 18, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Relative Reproductive Success Timeline (joint):* Washington Department of Fish and Wildlife (WDFW) provided the HCP Hatchery Committees with a revised memorandum clarifying the extension of the Wenatchee Spring Chinook Salmon Relative Reproductive Success Study. Importantly, the last year of sampling DNA from natural-origin Chinook salmon at Tumwater Dam will be 2023. The Rocky Reach and Rock Island HCP Hatchery Committees approved the memorandum.
- *Broodstock Collection Protocols (joint):* WDFW prepared a Broodstock Collection Protocols Development SOA. The SOA provides a timeline for developing the Broodstock Collection Protocols. The Wells, Rocky Reach, and Rock Island HCP Hatchery Committees approved the SOA. In addition, and consistent with the SOA, the HCP Hatchery Committees began the process of updating the Broodstock Collection Protocols. The HCP Hatchery Committees are currently identifying important issues to cover in the Broodstock Collection Protocols and identifying who will lead the writeup of certain sections of the protocols.
- *Update Genetics Section of the Hatchery Monitoring and Evaluation (M&E) Plan (joint):* The HCP Hatchery Committees reviewed edits made to the genetics section of the Hatchery M&E Plan. Revisions were made to the M&E Plan based on recommendations provided by the Genetics Monitoring Panel. HCP Hatchery Committees members continue to edit the genetics section of the report and will review additional revisions to the report during the HCP Hatchery Committees meeting on October 16, 2019.
- *Alternative Broodstock Composition and Mating Strategies (joint):* Douglas PUD provided a presentation that reviewed hatchery broodstock and mating practices for conservation programs. The intent is to collect broodstock and implement mating strategies within the hatcheries that minimize negative genetic effects. Here, the focus is on whether to include jacks in broodstock and mating strategies. Douglas PUD will provide a paper to the HCP Hatchery Committees describing the different strategies and their consequences. The HCP

Hatchery Committees will continue to evaluate broodstock collection and mating strategies for conservation programs.

- *National Marine Fisheries Service (NMFS) Consultation (joint):* NMFS has signed the steelhead and summer Chinook salmon permits. The permits are waiting to be signed by the permittees. John Ferguson asked about the duration of the permits and Tom Kahler replied, 10 years.
- *Expanded Wells Summer Chinook Production for the Southern Resident Killer Whale Population (Wells):* WDFW prepared a proposal that will allow extra production of subyearling summer Chinook salmon at Wells Fish Hatchery. The extra production is intended to benefit the Southern Resident Killer Whale population. Prior to the HCP Hatchery Committees meeting on September 18, 2019, the Wells HCP Hatchery Committee reviewed and approved the proposal allowing extra production of summer Chinook salmon at Wells Fish Hatchery. Ferguson asked what the next steps are in this process and if funding is already available. Chad Jackson said funding is available and contracting is in place. He said the several orca programs are currently working through permitting with NMFS and making sure these efforts are not impacting priority mitigation programs. He said at Wells Fish Hatchery, the eggs have not yet been collected.
- *2019 Egg Treatment Study (Wells):* Douglas PUD provided a study plan that will evaluate the effects of salt, hydrogen peroxide, and elemental copper in controlling saprolegnia infection of summer Chinook salmon eggs during incubation at Wells Fish Hatchery. The Wells HCP Hatchery Committee approved the pilot study, which will begin this fall 2019.
- *Draft 2020 Rock Island and Rocky Reach M&E Implementation Plan (Rock Island/Rocky Reach):* Chelan PUD provided the Rock Island and Rocky Reach HCP Hatchery Committees with the Draft 2020 Rock Island and Rocky Reach M&E Implementation Plan, which was approved by both committees.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on October 16, 2019, which is when Hillman said he expects the HCP Hatchery Committees Chair evaluation results will be discussed.

III. Chelan PUD

A. DECISION: Rock Island and Rocky Reach Subyearling Chinook Salmon SOA (Lance Keller)

Lance Keller said a draft SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years* was distributed to the HCP Coordinating Committees by Kristi Geris on September 19, 2019. Keller said the draft SOA is updated from the version approved in 2016, as discussed during the HCP Coordinating Committees meeting on August 27, 2019. He said this includes date changes, an addition to the Agreement Statement to review study designs on a quarterly basis, and updating text in the Background to make it current. He recalled reviewing study designs on a quarterly basis was discussed under the former SOA; however, now this language is actually included in the SOA.

Kirk Truscott suggested the following edits *(note: edits are shown in underlined and strikeout text)*:

Section	Proposed Text
Agreement Statement	The Rock Island and Rocky Reach HCP Coordinating Committees (CC) were presented data regarding the requirements of statistical survival models, tag technology, and life-history attributes for subyearling summer Chinook project survival studies in the Mid-Columbia, and agree that valid juvenile project survival measurements are not currently feasible.
Background	Current statistical survival models cannot calculate project survival as they are currently unable to address ~~active and non-active migrants~~ variable juvenile migration characteristics.
Background	These factors, in combination with ~~yet unknown proportions of migrant vs. non-migrant juvenile fish in~~ variable juvenile migration characteristics within the population remain impediments to project survival estimations for subyearling Chinook.

Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years*, as revised. John Ferguson said Jim Craig provided USFWS approval of the draft SOA via email on September 19, 2019. Keller said he will review Truscott's revisions to the SOA with Craig and will confirm USFWS still approves the SOA with these revisions. *(Craig provided USFWS approval of the CCT's edits and revised SOA via email on September 26, 2019.)*

Ferguson asked about timing for the quarterly updates and suggested starting in February 2020 since the HCP Coordinating Committees just discussed this topic in detail. Keller also suggested including the month of November as one of the quarterly updates because this is when U.S. Army Corps of Engineers holds their annual Anadromous Fish Evaluation Program, which often presents on the latest technology and studies. Ferguson said Anchor QEA will add a subyearling Chinook salmon check-in agenda item for Chelan PUD on HCP Coordinating Committees meetings occurring in February, May, August, and November, to continue to evaluate or monitor study design, tag technology, and life history information on a quarterly basis to better understand future survival study feasibility by 2022, per the SOA titled *Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years*. *(Note: Geris added this reoccurring item to HCP Coordinating Committees meeting agendas beginning in February 2020.)*

The final SOA was distributed to the HCP Coordinating Committees by Geris on October 7, 2019.

B. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said there are no new updates on Rocky Reach Dam Turbine Unit C1.

Keller said an update on the Rocky Reach Dam Turbine Unit C3 Chesterton seal tests was distributed to the HCP Coordinating Committees by Kristi Geris on September 19, 2019. Keller said Turbine Unit C3 was removed from service on August 26, 2019. He said the unit was dewatered to inspect the hub. He said two blade seals were found to have small oil leaks. He said upon draining the oil from the turbine hub, approximately 24 ounces of water was found. He said engineers indicated that these systems are designed to be able to function with a little water in the hub, and also noted that 24 ounces of water in the approximately 2,000 gallons of oil removed from the hub is a very small and acceptable amount of water to be found in the turbine hub. He recalled that crews also now have an improved ability to measure oil volumes when filling and draining the turbine hub, using what is called a "totalizer." He said another new set of trunnion seals, manufactured as a second option in the event that the initial set of Chesterton seals failed, were also installed in the two blades. He said these seals are similar to the Chesterton seals and are also equipped with an o-ring to wipe the seal surface. He said these additional seals were installed, mechanics conducted a pressure test, moved the blades back and forth, and no leakage was observed. He said crews returned Turbine Unit C3 to service on September 6, 2019, and periodic removal from service events are planned to conduct similar inspections.

John Ferguson asked if the successes in repairing Turbine Unit C3 will now be applied to the other units, or is Chelan PUD still researching other repair options? Keller said he is unsure of a definite plan. He said all of the engineering work on hydraulically locking the blades into place via a governor control is still on the shelf and he is unsure of that status. He said as of now, there has been good success with the two seal options, with the second design seemingly performing even better than the first.

C. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said there are no new updates on Rock Island Dam Turbine Unit B4. He said work on the draft tube continues to move forward and Chelan PUD is still struggling with the delivery of needed replacement parts to the site.

IV. Douglas PUD

A. Wells Dam Bypass Analysis of Probable Impacts of April 2019 Non-Compliance Events (Tom Kahler)

Tom Kahler distributed hard copies of a *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* (Attachment B), which Kristi Geris distributed electronically to the HCP Coordinating Committees following their meeting on September 24, 2019.

Kahler noted that Appendix A (listed under Methods on page 1 of Attachment B) refers to the initial document provided to the HCP Coordinating Committees, which summarized Wells Dam bypass operations in April 2019 (titled, *Summary of Wells Dam Bypass Operations in April 2019*, distributed to the HCP Coordinating Committees by Geris on May 10, 2019).

Kahler said he developed a formula (Equation 1, Attachment B) to estimate the additional mortality that may have resulted from the Wells Dam bypass system not operating during a portion of April 2019. He said Equation 1 includes several parameters, which attempt to capture estimated passage timing for the different Plan Species spring emigrants, different non-compliance dates and times, and probable passage routes (Attachment B).

Kahler said Figures 1, 2, and 3 of Attachment B show coho salmon (Figure 1), steelhead (Figure 2), and yearling Chinook salmon (Figure 3) PIT-tag detections at the Rocky Reach Juvenile Fish Bypass System adjusted to represent Wells Dam passage dates based on estimated travel times (left y-axis). He said these figures also show the proportion of each day during which bypass operations were out of compliance (right y-axis and y_i in Equation 1). He said sockeye salmon and subyearling Chinook salmon passage dates at Wells Dam had no overlap with the bypass non-compliance dates. He noted for coho salmon, the earliest four migrants overlapped with dates when the bypass was out of compliance. He said because there are no time stamps for passage events at Wells Dam and these dates are back calculated based on travel time to Rocky Reach Dam, there is no way to confirm whether these fish passed Wells Dam during hours when the bypass was non-compliant. He said conservatively, the results assume these four fish passed during the hours when the bypass was not operating.

Kahler said fish are attracted to the face of Wells Dam by the discharge through turbine units since the bulk of the discharge through the dam is via operating turbines, and the idea of the bypass system is to have those fish that approach the dam pass via modified spillways located above turbine intakes. With 10 turbines at Wells Dam, Equation 1 assumes there is equal probability (0.1) a fish will encounter the dam at any one of these turbines. He said records are available showing which turbine units were operating during the non-compliance dates and times; however, parsing out passage routes and mortality rates gets complicated because we do not know what time a fish actually passed Wells Dam. To simplify the estimation of impacts, we assumed that a fish estimated to have passed Wells Dam on a date of non-compliant bypass operations could have passed at any time, and we multiplied the proportion of fish calculated to have passed on that date (x_i in Equation 1) by the proportion of that date during which bypass operations were non-compliant (y_i in Equation 1).

Kahler said the parameter $P(b_i)$ in Equation 1 represents the probability of a fish encountering the dam at a non-compliant bypass unit. He said, $P[t_i]$ in Equation 1 is the probability that the fish encountering the dam at a non-compliant bypass will pass via a turbine located below a bypass spillway. Andrew Gingerich added that a fish passing via a turbine route does not mean the fish dies. Kahler said this is correct; in fact, smolts survive turbine passage at high rates.

Kahler said Equation 1 sums all daily calculations of proportions of additional mortality for each date on which bypass operations were non-compliant to generate a total additional mortality as a proportion of detected emigrants (Estimated Additional Mortality, or *A* in Equation 1). Table 1 (Attachment B) shows those sums for each Plan Species. He said the Adjusted Survival Rate is the Estimated Additional Mortality subtracted from the measured survival value 0.9630. He said the Current Mitigation Rate is the rate established by the multi-year average of all of the survival studies for yearling spring migrants (or 7% for those Plan Species in Phase III [Additional Juvenile Studies]), and the Adjusted Mitigation Rate was calculated by adding the Estimated Additional Mortality to the Current Mitigation Rate. He said multiplying the Estimated Additional Mortality for each Plan Species by the total number of that species released or naturally produced above Wells Dam results in an estimate of the number of that species potentially affected by the non-compliant bypass operations (assuming that the distribution of emigration timing for the tagged fish used in the estimation represents the timing distribution for the run at-large). Gingerich noted a few errors in Table 1.

Keely Murdoch asked how the survival rate was calculated for estimating additional mortality resulting from increased turbine passage. Kahler said the baseline rate under normal bypass operations was determined via bypass studies that calculated an estimated weighted average bypass efficiency of 92% (or 0.92) for yearling spring migrants translating to a 0.08 probability of turbine passage. The estimate of additional mortality is calculated as the probability of turbine passage under non-compliant bypass operations minus the probability under normal bypass operations (0.08). That difference is multiplied by an average probability of turbine-passage mortality from studies at multiple projects, because we do not have a value specifically for Wells Dam. Murdoch asked if this calculation is based on immediate mortality or also includes latent mortality. Kahler said these data are based off of survival studies, which only consider immediate mortality within the study reaches.

Murdoch asked how these non-compliance dates compare to release dates for hatchery spring Chinook salmon (springers). She said in Figure 3, it is likely the increasing numbers represent hatchery springers and those passing earlier are wild-origin springers. She said she is interested in understanding how these non-compliance dates might have affected wild versus hatchery fish. Kahler said among the approximately 19,000 yearling Chinook salmon shown in Figure 3, he believes almost all fish were hatchery-origin; however, the migration timing of untagged fish is unknown.

Murdoch suggested acknowledging these estimates are for hatchery fish only and effects to wild fish cannot be assessed. *(Note: after the meeting Kahler provided a revised version of Attachment B that included estimated additional mortality [0.0016] for 71 wild spring Chinook salmon included within combined sample of yearling Chinook salmon.)*

Kirk Truscott said Equation 1 assumes equal probability for a fish to pass via any turbine, but he asked if Douglas PUD has data on what proportion of fish pass through different turbines based on fyke net data? Kahler said the fyke-netting effort did not sample every passage route at once as would have been necessary to determine horizontal distribution of fish passage. He said, however, if turbine discharge is what attracts fish to approach the dam at a particular location, and a turbine unit is not running, fish would be attracted to other passage options.

John Ferguson asked about next steps. Kahler asked whether the Wells HCP Coordinating Committee is satisfied with this approach or if there are other ideas to quantify Estimated Additional Mortality. Truscott said the CCT would like time to further review the document. Gingerich suggested adding language to the document to address Murdoch's comments about the scope being limited to PIT-tagged hatchery-origin fish. Chad Jackson also suggested correcting the errors in Table 1. Murdoch said it would also be helpful to parse out springers from summer Chinook salmon (summers) in Table 1. Gingerich said typically, yearling summers are released later. Murdoch agreed and said one could assume all late detections are summers. Kahler noted that summers have different travel times, which will affect the calculations. *(Note: During the meeting, Kahler provided Estimated Additional Mortality numbers parsed out for springers and summers [0.0019], springers only [0.0022], and summers only [0.00098]; however, he noted in a revised version of Attachment B that the estimated additional mortality for wild spring Chinook salmon [0.0016] was lower than the estimate for combined yearling Chinook salmon [0.0019].)*

Truscott noted in Figures 1, 2, and 3, no single day has more than 6% to 7% proportion of emigrants passing Wells Dam (left y-axis). He said with most hatchery releases occurring on or around April 15, these values seem low. He said he would expect a larger proportion on several of these days. Kahler said releases out of the Methow and Twisp rivers were late this year. Gingerich said historically during low-water years, releases out of the Twisp River were postponed in hopes of having more water and turbid conditions in the river when the fish are released to provide additional cover for out-migrating fish and reduce losses to predation. He said there was a drought in the Methow River this year and perhaps fish were held longer for this reason.

Kahler said Douglas PUD will revise the *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*, as discussed. *(Note: Kahler provided a revised draft document to Geris following the HCP Coordinating Committees meeting on September 24, 2019, which Geris distributed to the HCP Coordinating Committees that same day.)*

Wells HCP Coordinating Committee representatives will review the revised *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* and will be prepared to discuss a path forward during the HCP Coordinating Committees meeting on October 22, 2019.

V. HCP Administration

A. YN HCP Tributary Committees Representation Designation (John Ferguson)

John Ferguson said a YN HCP Tributary Committees Representation Designation letter was received on September 23, 2019 and was distributed to the HCP Coordinating Committees by Kristi Geris prior to the HCP Coordinating Committees meeting on September 24, 2019. Ferguson said the letter designates Brandon Rogers as the YN HCP Tributary Committees Representative (formerly Lee Carlson) and designates Hans Smith as the YN HCP Tributary Committees Alternate (formerly Rogers).

B. 3-Year Performance Review of the HCP Coordinating Committees Chair (Tom Kahler)

Tom Kahler recalled there is an HCP requirement to review the performance of each HCP Committee Chair every 3 years. Kahler said initially, the HCP Committees conducted this review in person; however, in all subsequent years they have been satisfied conducting this review via email. Kahler said a poll was distributed via email inquiring about the performance of both the Chair and Anchor QEA services as a whole. Kahler said HCP Coordinating Committees representatives provided positive feedback and agreed to retain John Ferguson and Anchor QEA for another 3 years.

C. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on October 22, 2019, to be held in person at the Grant PUD Wenatchee office in Wenatchee, Washington.

John Ferguson suggested starting discussions about possibly rescheduling the HCP Coordinating Committees meetings in November and December 2019 to accommodate the holidays. The HCP Coordinating Committees discussed moving the dates, including possible conflicts with the HCP Hatchery Committees meetings and coordinating with the PRCC meetings. The following changes were suggested:

Regular Date/Time	Proposed Date/Time
HCP Coordinating Committees meeting on November 26, 2019, 10:00 a.m. to 2:00 p.m.	HCP Coordinating Committees meeting on November 19, 2019, 9:00 a.m. to 12:00 p.m.
PRCC meeting on November 27, 2019	PRCC meeting on November 19, 2019, 1:00 p.m. to 5:00 p.m.
HCP Coordinating Committees meeting on December 24, 2019, 10:00 a.m. to 2:00 p.m.	HCP Coordinating Committees meeting on December 17, 2019, 9:00 a.m. to 12:00 p.m.
PRCC meeting on December 25, 2019	PRCC meeting on December 17, 2019, 1:00 p.m. to NLT 5:00 p.m.

Ferguson also noted that the HCP Coordinating Committees meetings in November and December 2019 may be convened via conference call or canceled pending agenda items (to be determined). Kristi Geris said Anchor QEA will coordinate with Denny Rohr and Grant PUD regarding rescheduling the HCP Coordinating Committees and PRCC's meetings in November and December 2019 to accommodate the holidays. *(Note: Geris contacted Rohr and based on discussions with the PRCC, the HCP Coordinating Committees meeting on November 19, 2019, was changed to 1:00 p.m. to 5:00 p.m. to be held at the Wanapum Dam Hydro Office Building, and the HCP Coordinating Committees meeting on December 17, 2019, remained from 9:00 a.m. to 12:00 p.m. to be held at the Grant PUD Wenatchee office.)*

VI. List of Attachments

Attachment A List of Attendees
Attachment B *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Chad Jackson*	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019

September 24, 2019

Background

From the Wells Project survival studies conducted to date, the four-year mean mortality rate through the Wells Project is 0.037, or 3.7 percent for "yearling spring migrants" (yearling Chinook, yearling coho, and steelhead smolts). This low rate of mortality is achieved because most emigrants pass Wells Dam via the bypass system, and bypass passage survival is effectively 100 percent. As the culmination of multiple years of bypass development and testing, Skalski et al. (1996) estimated the weighted mean bypass efficiency for emigrating steelhead smolts and yearling Chinook at 0.92, or 92 percent. In other words, 92 percent of steelhead smolts and yearling Chinook pass through Wells dam via the bypass, rather than the turbines.

Deviation from normal bypass operations that results in the operation of turbines without the normal operation of adjacent bypass facilities could increase the rate of turbine passage for those fish encountering the dam at the location of the affected bypass facilities. Such an increase in turbine passage could increase the mortality rate of fish passing during periods of non-compliant bypass operations.

Methods

During April of 2019, a series of events over several days resulted in multiple hours of bypass operations that deviated from normal bypass operations at Wells Dam (detailed in Appendix A). To estimate the additional mortality that may have resulted from the non-compliant operations for each plan species during April, 2019, we developed the following formula (Equation 1):

$$A = \sum_{i=1}^{n}(((x_i y_i \cdot P(b_i) \cdot P(t_i)) - (x_i y_i \cdot P(b_i) \cdot 0.08)) \cdot 0.1) \qquad \text{Equation 1}$$

Where:

A = Additional mortality (as a proportion of detected emigrants for each Plan Species) due to bypass non-compliance.

x_i = The number of detections on date *i*, divided by the total number of detections on all dates.

y_i = The proportion of date *i* affected by non-compliant bypass operations (number of non-compliant hours divided by 24 hours).

$P(b_i)$ = The probability of encountering the dam at an affected bypass on date *i*, which is a function of fish distribution across the project, turbine operation, and bypass-gate opening and barrier presence and configuration.

$P(ti)$ = The probability of turbine passage at an affected bypass on date *i*, which also is a function of turbine operation and bypass-gate opening and barrier presence and configuration.

0.08 = A constant; the weighted mean value of the probability of turbine passage for "yearling Chinook and steelhead" during normal bypass operations (i.e., 1 - bypass efficiency [0.92] = 0.08), as established during bypass testing (from Skalski et al. 1996).

0.1 = A constant; a reasonable value for the mortality rate experienced during passage of juvenile salmonids through Kaplan turbines such as those installed at the Wells Project, which typically ranges from 0.05 to 0.15 (from multiple studies at multiple projects).

Equation 1 calculates a total sum of the estimated additional mortality proportions resulting from the increased turbine passage that occurred on each date that bypass operations did not comply with the *2019 Bypass Operating Plan*, approved by the Wells HCP Coordinating Committee. The resultant sum is the proportion of additional mortality (beyond that under normal operations) of the total number of emigrating fish detected at the Rocky Reach Juvenile Bypass PIT-tag detection system (PTAGIS Site Code RRJ) for the 2019 juvenile emigration, calculated individually for each of the following Plan Species: yearling Chinook, subyearling Chinook, steelhead, coho, and sockeye.

We established Wells Dam passage dates by subtracting a Wells Dam-to-RRJ travel time from RRJ detection-event dates. We queried PTAGIS for juveniles detected at RRJ and also detected at WEJ (PTAGIS Site Code for the Wells Bypass Juvenile Sampling Array). Too few fish were detected at both facilities in 2019 to allow for a calculation of 2019 WEJ-RRJ travel time for each category of emigrants. Therefore, we used the combined data from all dual-detection events from 2016-2019 to generate WEJ-RRJ travel times. For Chinook and steelhead, data distributions had single modes but were right skewed, rendering the arithmetic mean a poor measure of central tendency for both. However, in both cases, the medians closely approximated the modes and harmonic means. Therefore, we used the median travel times for both steelhead smolts (2 days) and yearling Chinook (3 days), to back-calculate Wells passage dates. For coho smolts, the travel-time distribution was multimodal, and sample size was small; but, the median equaled the mean (5 days). Without enough PIT-tag-detection data with which to calculate WEJ-RRJ travel times for sockeye smolts, we used the mean travel time from the Wells tailrace to Rocky Reach Dam (1 day) generated by Chelan PUD from three years of survival studies (2007-2009) for the Rocky Reach project.

Because we estimated the passage date at Wells Dam, we could not match up actual passage times with the hours of non-compliant bypass operations on any given date. Thus, we could only assume the overlap of fish passage and non-compliant operation when a fish was estimated to pass on a given date, and this likely overestimated actual exposure to non-compliant bypass conditions since non-compliant operations never lasted all day (range: 1 to 18 hours).

We matched up the Wells passage-date distributions with the dates of non-compliant bypass operations, and found that all sockeye smolts and subyearling Chinook passed Wells Dam after those dates. For yearling Chinook, steelhead, and coho smolts, we applied Equation 1 for those dates on which passage events coincided with non-compliant bypass operations to generate the joint probability of additional mortality. Assuming that the distributions of passage events at Wells Dam, estimated from PIT-tag detections at RRJ, represents the runs at-large for yearling Chinook and coho, and steelhead smolts, we applied our estimates of additional mortality to the runs at-large for those Plan Species.

Results and Discussion

For coho yearlings, only 4 of 4,102 detected emigrants passed Wells on days when bypass operations were not compliant (Figure 1). In contrast, 11.9 percent of 15,861 steelhead smolts and 14.5 percent of 19,861 Chinook yearlings passed during non-compliant bypass operations (Figures 2 and 3, respectively). Despite that level of overlap, since the probability of increased turbine passage at the affected bypass bay(s) is the joint probability of multiple events, as expressed in Equation 1, the estimated additional mortality resulting from increased turbine passage is low. For each Plan Species, Table 1 lists the estimates of the proportional increased mortality and the resultant project survival from subtracting that increased mortality from the four-year project survival estimate from previous survival studies.

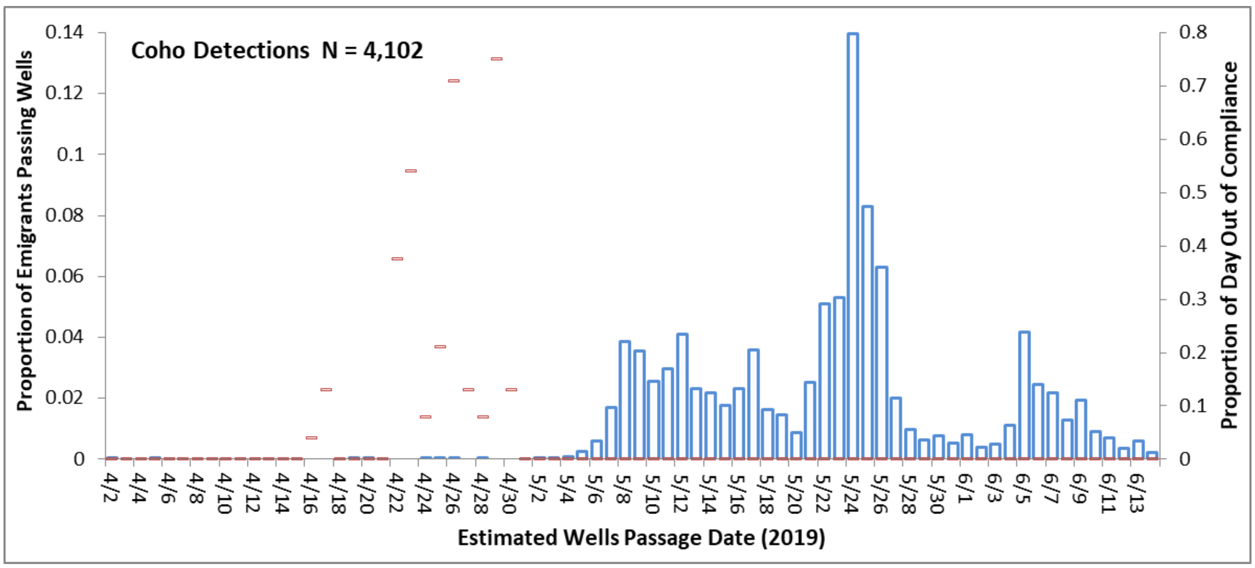

Figure 1. Yearling coho passage distribution at Wells Dam by date (left y-axis) as estimated by detection of PIT-tagged coho at RRJ. The proportion of coho emigrants on a given date (x_i in Equation 1) is represented by blue bars. The proportion of each day (right y-axis) during which bypass operations were out of compliance (y_i in Equation 1) is represented by red rectangles.

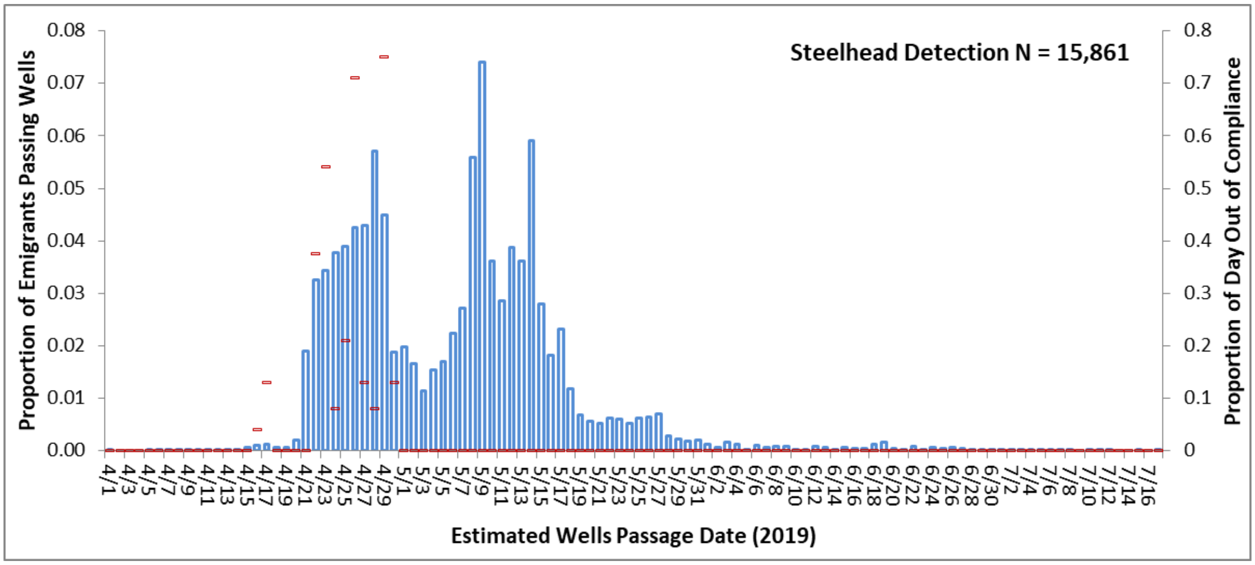

Figure 2. Steelhead smolt passage distribution at Wells Dam by date (left y-axis) as estimated by detection of PIT-tagged steelhead smolts at RRJ. The proportion of steelhead emigrants on a given date (x_i in Equation 1) is represented by blue bars. The proportion of each day (right y-axis) during which bypass operations were out of compliance (y_i in Equation 1) is represented by red rectangles.

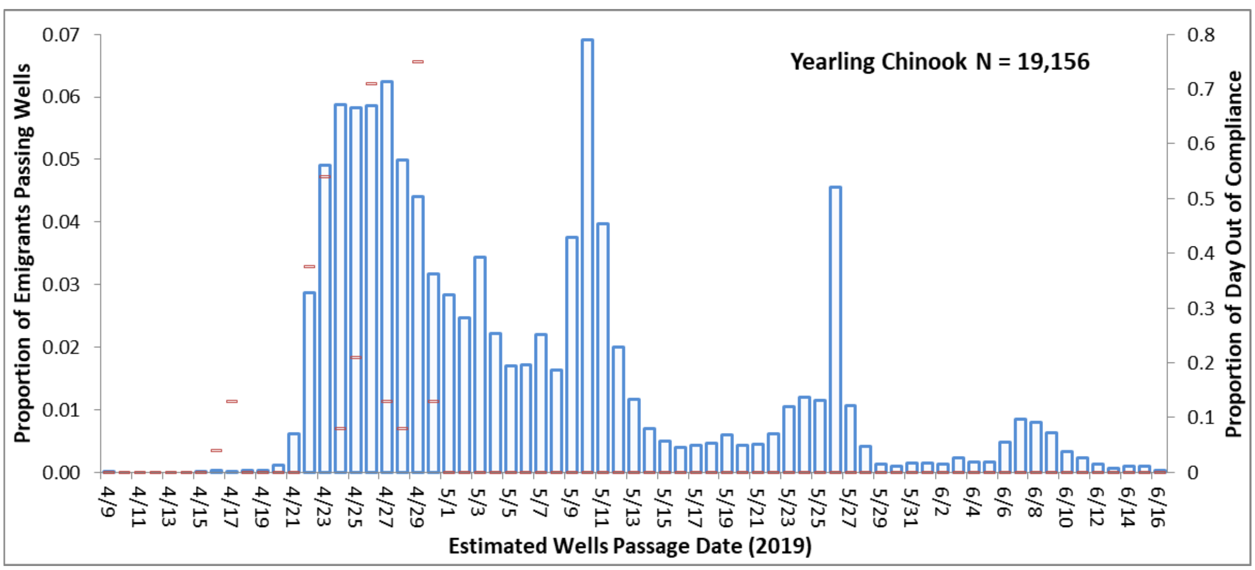

Figure 3. Yearling Chinook passage distribution at Wells Dam by date (left y-axis) as estimated by detection of PIT-tagged Chinook emigrants at RRJ. The proportion of Chinook emigrants on a given date (x_i in Equation 1) is represented by blue bars. The proportion of each day (right y-axis) during which bypass operations were out of compliance (y_i in Equation 1) is represented by red rectangles.

Table 1. "Estimated Additional Mortality" for each HCP Plan Species resulting from non-compliant bypass operations at the Wells Project during April 2019, as estimated by Equation 1. "Adjusted Survival Rate" is the Estimated Additional Mortality subtracted from the four-year-average survival value, 0.9630, for yearling spring migrants. "Current Mitigation Rate" is the hatchery production rate established for each Plan Species according to the current phase designations. "Adjusted Mitigation Rate" is the mitigation rate that would be necessary to compensate for the Estimated Additional Mortality, calculated by adding the latter to the Current mitigation rate.

Plan Species	Estimated Additional Mortality	Adjusted Survival Rate	Current Mitigation Rate	Adjusted Mitigation Rate
Sockeye	0	NA	7%	NA
Subyearling Chinook	0	NA	7%	NA
Coho	0.000003	0.962997	3.7%	3.70003%
Steelhead	0.0003	0.9627	3.7%	3.703%
Yearling Chinook	0.0019	0.9611	3.7%	3.719%

References

Skalski, J.R., G.E. Johnson, C.M. Sullivan, E. Kudera, M.W. Erho. 1996. Statistical evaluation of turbine bypass efficiency at Wells Dam on the Columbia River, Washington. *Canadian Journal of Fisheries and Aquatic Sciences* 53: 2188-2198.

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Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees Date: December 17, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the November 19, 2019 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Wanapum Dam Hydro Office Building in Grant County, Washington, on Tuesday, November 19, 2019, from 1:00 p.m. to 4:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Chelan PUD will continue providing Rocky Reach Dam and Rock Island Dam turbine unit maintenance updates as information becomes available (Item I-C). *(Note: these agenda items will be reoccurring until repairs are complete.)*
- Chelan PUD will determine the reason behind omitting data from 1979 to 1982 from the original Grand Coulee flow duration curves dataset (1929 to 1978 and 1983 to 2001; Item III-A).
- Anchor QEA, LLC, will contact Chad Jackson regarding Washington Department of Fish and Wildlife (WDFW) approval of the *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*, as revised (Item V-B). *(Note: Kristi Geris emailed Jackson on November 20, 2019, with this request and Jackson provided WDFW approval of the document via email on November 22, 2019.)*
- The HCP Coordinating Committees meeting on December 17, 2019, will be held at 9:00 a.m. (instead of 10:00 a.m.), in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item VI-B).

Decision Summary

- Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the *Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018* (Item IV-A). *(Note: Chad Jackson provided WDFW approval of the draft report via email on November 12, 2019.)*
- Wells HCP Coordinating Committee representatives present approved the *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*, as revised (Item V-B). *(Note: Chad Jackson provided WDFW approval of the document via email on November 22, 2019.)*

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The *Wells Project Subyearling Chinook Life-History Study 2011-2013 Draft Final Report* was distributed to the HCP Coordinating Committees by Kristi Geris on May 24, 2019.
- The *Chelan PUD Rocky Reach and Rock Island HCPs Draft 2019 Fish Spill Report* was distributed to the HCP Coordinating Committees by Kristi Geris on November 19, 2019. Chelan PUD will request approval of the report during the HCP Coordinating Committees meeting on December 17, 2019 (Item IV-B).
- The Passage-Dates Analysis portion of the 2019 Wells Dam Post-Season Bypass Report was distributed to the HCP Coordinating Committees by Kristi Geris on November 19, 2019, and the 2019 Wells Dam Post-Season Bypass Report was distributed on December 5, 2019. Douglas PUD will request approval of the 2019 Wells Dam Post-Season Bypass Report and Passage-Dates Analysis during the HCP Coordinating Committees meeting on December 17, 2019 (Item V-A).
- The draft Statement of Agreement (SOA), *Regarding the Updated Flow-Duration Curves for the Wells Hydroelectric Project For Establishing Representative Environmental Conditions*, was distributed to the HCP Coordinating Committees by Kristi Geris on December 5, 2019. Douglas PUD will request approval of the draft SOA during the HCP Coordinating Committees meeting on December 17, 2019 (Item III-A).
- The draft SOAs, *Updated Flow Duration Curves for the Rock Island Project for Establishing Representative Flow Conditions* and *Updated Flow Duration Curves for the Rocky Reach Project for Establishing Representative Flow Conditions*, were distributed to the HCP Coordinating Committees by Kristi Geris on December 6, 2019. Chelan PUD will request approval of the draft SOAs during the HCP Coordinating Committees meeting on December 17, 2019 (Item III-A).

Finalized Documents

- The final *Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* was distributed to the HCP Coordinating Committees by Kristi Geris on November 22, 2019 (Item IV-B).

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No additions or changes were requested.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft September 24, 2019 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. HCP Coordinating Committees members present approved the September 24, 2019 meeting minutes, as revised. The U.S. Fish and Wildlife Service (USFWS) abstained, because a USFWS representative was not present during the September 24, 2019 meeting. *(Chad Jackson provided WDFW approval of the revised minutes via email on November 12, 2019.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on September 24, 2019, and follow-up discussions, were as follows. *(Note: Italicized text corresponds to agenda items from the meeting on September 24, 2019):*

- *Chelan PUD will provide updates about the repair of Rocky Reach Dam Turbine Unit C1 and Turbine Unit C3 to the HCP Coordinating Committees as soon as additional information becomes available (Item I-C).*
  This action item will be discussed during today's meeting and will also be carried forward.
- *Chelan PUD will review with USFWS the Colville Confederated Tribes' (CCT's) revisions to the SOA titled Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years and will confirm with USFWS approval of the SOA with these revisions (Item III-A).*
  Jim Craig provided USFWS approval of the CCT's edits and revised SOA via email on September 26, 2019.
- *Anchor QEA, LLC, will add a subyearling Chinook salmon check-in agenda item for Chelan PUD on HCP Coordinating Committees meetings occurring in February, May, August, and November, to continue to evaluate or monitor study design, tag technology, and life history information on a quarterly basis to better understand future survival study feasibility by 2022, per the SOA titled Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to Three Years (Item III-A).*
  Kristi Geris added this reoccurring item to HCP Coordinating Committees meeting agendas beginning in February 2020.

- *Douglas PUD will revise the Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019, as discussed (Item IV-A).*
  Tom Kahler provided a revised draft document to Kristi Geris following the HCP Coordinating Committees meeting on September 24, 2019, which Geris distributed to the HCP Coordinating Committees that same day.
- *Wells HCP Coordinating Committee representatives will review the revised Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019 and will be prepared to discuss a path forward during the HCP Coordinating Committees meeting on October 22, 2019 (Item IV-A).*
  This will be discussed during today's meeting.
- Anchor QEA will coordinate with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) and Grant PUD regarding rescheduling the HCP Coordinating Committees and PRCC's meetings in November and December 2019 to accommodate the holidays (Item V-C).
  Anchor QEA and Rohr coordinated rescheduled dates, as discussed.

II. HCP Hatchery and Tributary Committees Update

A. HCP Hatchery and Tributary Committees Update (John Ferguson)

John Ferguson updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on October 16, 2019 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint," Wells HCP Hatchery Committee items are noted by "Wells," and Rock Island and Rocky Reach HCP Hatchery Committees items are noted by "Rock Island/Rocky Reach"*):

- *Update Genetics Section of the Hatchery Monitoring and Evaluation (M&E) Plan (joint):* The HCP Hatchery Committees reviewed and approved edits made to the genetics section of the Hatchery M&E Plan. Revisions were made to the M&E Plan based on recommendations provided by the Genetics Monitoring Panel. The HCP Hatchery Committees also discussed the spatial scale at which carcass data should be evaluated and concluded analyses will vary depending on the stock and species. At a minimum, all stocks will be evaluated at the historic reach scale. Analyses will determine and justify other scales of inference for each stock.
- *Improvement Feasibility at Eastbank Fish Hatchery for Wenatchee Summer Chinook Salmon SOA (joint):* Chelan PUD reported the ability to meet Wenatchee River Total Maximum Daily Load (TMDL) requirements for phosphorous discharged from hatchery production at the Dryden Acclimation Pond adjacent to the Wenatchee River. These requirements can be met

without implementing the 2016 SOA.[1] Therefore, the SOA is no longer needed to meet TMDL requirements at the Dryden Acclimation Pond.

- *Establishing Ranges Around Broodstock Collection Targets (joint):* Douglas PUD provided a presentation on *Managing Risk and Expectations in Broodstock Collection*. Douglas PUD described a modeling approach for determining the number of broodstock adults that would be required to meet juvenile production targets. The next step is to compare modeling results with the current method used to estimate broodstock collection targets.
- *Surplus Juvenile Spring Chinook Salmon Production (joint):* Douglas PUD indicated there are about 8,000 extra spring Chinook salmon eyed eggs at the Methow Fish Hatchery. Because the fecundity of 2019 broodstock was higher than expected, there are extra eyed eggs on station. The eyed eggs are from hatchery-origin eggs crossed with wild males. Members will see if the extra eyed eggs can be transferred to the Winthrop National Fish Hatchery or to the Chief Joseph Fish Hatchery.
- *Broodstock Collection Protocols (joint):* The HCP Hatchery Committees are in the process of updating the broodstock collection protocols. The HCP Hatchery Committees identified important issues to cover in the broodstock collection protocols and identified who will lead the writeup of certain sections of the protocols. Draft writeups are due to the HCP Hatchery Committees by the December meeting.
- *National Marine Fisheries Service (NMFS) Consultation (joint):* NMFS has signed the Steelhead and Summer Chinook Salmon permits. The permits are waiting to be signed by the permittees.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on November 20, 2019.

Ferguson updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on November 14, 2019:

- *Sugar Levee Ground Water Evaluation Project:* Methow Salmon Recovery Foundation is the sponsor of this project and the purpose is to evaluate groundwater levels and flow paths within the floodplain disconnected by the Sugar Levee along the Methow River between river miles 41 and 44. Results from this work will inform opportunities to reconnect the floodplain and relic side channels affected by levee development. The total cost of the project was $5,404. The sponsor requested $2,940 from HCP Plan Species Account Funds. The Wells HCP Tributary Committee elected to contribute $2,940 to the project.

[1] Rock Island and Rocky Reach HCP SOA titled, *Improvement Feasibility at Eastbank Hatchery for Wenatchee Summer Chinook*, approved by the Rock Island and Rocky Reach HCP Hatchery Committees on February 17, 2016, and distributed on February 18, 2016.

- *Cottonwood Flats Project:* The HCP Tributary Committees received an update from the project sponsor (Chelan County Natural Resources Department) on the Cottonwood Flats Project. Previously, the HCP Tributary Committees recommended that the sponsor use a "Light Touch" approach to reconnect the floodplain with the Entiat River. The sponsor indicated a preference to move forward with the original design (or a slightly modified design) to more easily justify or guarantee certain outcomes if the original design is implemented (the original plan was to construct a side channel though the floodplain; the Light Touch approach is to construct a short pilot channel and let high flows develop flow paths through the floodplain). The sponsor believes the Light Touch approach carries less certainty of success and limits the ability to guarantee certain outcomes. It also represents a significant departure from what the Salmon Recovery Funding Board (SRFB) originally approved. The HCP Tributary Committees appreciated the sponsor's position and concerns; however, the HCP Tributary Committees believe Cottonwood Flats represents a rare and unique opportunity to test the Light Touch approach. The HCP Tributary Committees therefore recommended that the sponsor consider working through the amendment process with the SRFB. The HCP Tributary Committees believe the SRFB will find favor with a less expensive project that still allows floodplain reconnection at certain flows. Cottonwood Flats provides an excellent opportunity to evaluate reconnecting a large floodplain using a Light Touch approach.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on December 12, 2019.

III. Chelan PUD and Douglas PUD

A. Updated Flow Duration Curves (Lance Keller and Tom Kahler)

John Ferguson said flow duration curves are included in all three HCPs. He said the Rock Island and Rocky Reach HCPs stipulate updating the curves every 10 years, which Chelan PUD started doing in 2013 but then the Wanapum Dam incident occurred postponing the final updated curves. He said the Wells HCP only stipulates periodic review of the curves. He said Chelan PUD and Douglas PUD have been coordinating on this and Chelan PUD will present findings and proposals. He said the goal today is to have a good discussion. He said Chelan PUD and Douglas PUD will bring Chad Jackson up to speed after the meeting and hopefully the HCP Coordinating Committees will be ready to approve updated flow duration curves during the HCP Coordinating Committees meeting on December 17, 2019. Ferguson said this will capture the new curves in the 2019 administrative record and annual reports ahead of the next survival verification study in 2020.

Lance Keller said the Rock Island and Rocky Reach HCPs stipulate starting to update the original flow duration curves in 2013, which Chelan PUD did before the Wanapum Dam fracture. He said these curves are only really applicable while conducting project survival studies and the Wells and Rock Island projects completed and achieved survival study standards in 2010 and the Rocky Reach

Project did the same in 2011; therefore, updating these curves was postponed but with no negative impacts to the projects.

Keller said a presentation titled, *Wells, Rocky Reach, and Rock Island HCPs Update Representative Survival Study Flows* (Attachment B) was distributed to the HCP Coordinating Committees by Kristi Geris prior to the HCP Coordinating Committees meeting on November 19, 2019. Keller said he will first review the history of the flow duration curves and what the curves are utilized for. He said he will then address the questions asked of Chelan PUD by the HCP Coordinating Committees in 2013. He said lastly, he will present the proposals he and Tom Kahler have developed on how to best approach updating these curves for each HCP during the current review.

Slide 2 of Attachment B

Keller presented and read a quote directly from page 10 of the Rock Island HCP. He said this is the basis of the design and intent of the flow duration curves.

Slide 3 of Attachment B

Keller said the flow duration curves outline the bounds of a valid flow (from the 10th percentile mean flow to the 90th percentile mean flow) during the time frame in which a survival study is conducted (spring or summer). He said the original curves were constructed based on out-flows from Grand Coulee Dam. He said these same curves were applied to the Wells, Rocky Reach, and Rock Island projects. He said the spring study period extends from April 16 to May 31 and the summer study period from July 1 to August 15. He said in 2013, the intent was to integrate the last 10 years of flow data into the existing flow duration curves dataset, rank the flows, and develop new updated curves.

Kirk Truscott asked if bullets 1 and 2 are exact language from the HCPs. Keller said this might not be the exact language, but this is how the curves are constructed.

Slide 4 of Attachment B

Keller said the original dataset includes 69 years of flow data. He said flows are ranked starting from highest to lowest, percentiles are calculated, and lines are drawn at the 10th and 90th percentiles. He said these are the bounds for a valid survival verification study based on river flow for all HCPs during for spring timeframe. He said the 1929 to 1978 dataset is HYDSIM modeled flow data and the 1983 to 2001 dataset is based on observed flow data.

Ferguson asked why the gap in datasets (1979 to 1982), and Keller said he believes these years were omitted because river flow was abnormally high, but he is unsure. Keller said he knows the years were omitted on purpose for a reason and he will find out why.

Keely Murdoch said she understands Grand Coulee Dam is key in controlling flow in the Columbia River, but she asked if it is possible that enough water comes out of the Wenatchee, Entiat, and Methow rivers such that river flow is above the 90th percentile in the Rock Island Project but this is not the case in the Wells Project? Keller said as currently written, even though these survival studies are carried out at the local project level, Chelan PUD and Douglas PUD still use flow data from Grand Coulee Dam. He said to Murdoch's point, he and Kahler developed a slide discussing this local influence and what might be a good approach to close the gap.

Slide 5 of Attachment B

Keller said this is the original Grand Coulee flow duration curve for the spring timeframe, created using the data shown on slide 4. He said the red line represents the 10th and 90th percentiles. He said the upper bound of the curve is at about 205,000 cubic feet per second (205 kcfs) and the lower bounds is at about 100.5 kcfs.

Keller said the HCPs also include language about what can be done if a survival study falls within the 5% to 10% range and 90% to 95% range of the flow duration curve. He said if this occurs, the HCPs stipulate that the HCP Coordinating Committees are to rule whether to accept the study as valid and the ruling is not subject to dispute. Ferguson said this is another reason to use contemporary data.

Slides 6 and 7 of Attachment B

Keller said these slides show the original flow duration curve data table and graphed curve for the summer timeframe. He said the upper bound is at approximately 165 kcfs and lower bound is approximately 76 kcfs. He said something interesting to note about this dataset is the date range includes July 1 to August 15. He asked, if this dataset was meant to be applicable to subyearling survival studies, what about June? He said it is known that a large portion of hatchery subyearlings and some wild subyearlings arrive at the projects in June.

Slide 8 of Attachment B

Keller recalled in 2013, the HCP Coordinating Committees started discussing updating the curves. He said the HCP Coordinating Committees asked Chelan PUD to do two things with the original spring flow duration curve: 1) add 2002 to 2012 river flow data and identify new 10th and 90th percentiles; and 2) create a new curve using only 1983 to 2012 river flows, eliminating all HYDSIM modeled river flow from the curve.

Slides 9 and 10 of Attachment B

Keller said these are the updated spring curves, per the HCP Coordinating Committees requests in 2013. He said the curve with HYDSIM modeled flows included (slide 9) increased at the upper bound (from 205 kcfs to 296 kcfs) and at the lower bound, but not as much (from 100.5 kcfs to 103 kcfs). He said the curve with HYDSIM modeled data eliminated (slide 10) decreased at both ends (205 kcfs down to 181.6 kcfs and 100.5 kcfs down to 90 kcfs).

Jim Craig asked why not include data through 2018? Keller said these curves only address the requests made by the HCP Coordinating Committees in 2013. He said curves have been developed that include data through 2019, which will be presented in later slides.

Slide 11 of Attachment B

Keller said this slide shows the requests made by the HCP Coordinating Committees in 2013, for the original summer flow duration curve: 1) add 2002 to 2012 river flow data and identify new 10th and 90th percentiles; 2) create a new curve using only 1983 to 2012 river flows, which again, eliminates all HYDSIM modeled river flow from this curve; and 3) repeat the first two updates but include June river flows in the dataset.

Slides 12, 13, 14, and 15 of Attachment B

Keller said slide 12 shows the updated summer curve with HYDSIM modeled data, which increased at both ends (from 165 kcfs to 170.5 kcfs and 76 kcfs to 79.5 kcfs). He said slide 13 shows the same curve with June data, which increased quite a bit on both ends (from 165 kcfs to 290.7 kcfs and 76 kcfs to 104 kcfs). He said slide 14 shows the updated summer curve with no HYDSIM modeled data and no June data. He said this curve decreased at both ends (from 165 kcfs to 157 kcfs and 76 kcfs to 72.7 kcfs). He said slide 15 shows the updated summer curve with no HYDSIM modeled data but with June data. He said this curve increased at both ends (from 165 kcfs to 194 kcfs and 76 kcfs to 78.6 kcfs).

Keller said the slides to this point bring everyone up to speed on the 2013 requests.

Slide 16 of Attachment B

Keller said given how this topic was left in 2013, now would be the time for the HCP Coordinating Committees to choose the best representative Grand Coulee flow duration dataset. He asked if the modeled data should be included or not and should the summer dataset include June or not?

Keller said then Douglas PUD proposed considering project-specific curves that factor in localized snowpack or droughts.

Slide 17 of Attachment B

Keller said that he and Kahler started by compiling local flow data for the Wells, Rocky Reach, and Rock Island projects. Keller said how Grand Coulee Dam is operated is often unknown to Douglas and Chelan PUDs. He said, for example, it is unknown when Grand Coulee Dam is planning a hard draft and implementing reservoir constraints of Lake Roosevelt for drum gate maintenance. He said having a project-specific dataset will eliminate this uncertainty from the curves.

Murdoch said it seems what matters is that river flows are in the middle 80th percentile, and she asked if Chelan PUD or Douglas PUD conducted any analyses to determine how well-correlated project-specific curves are with the middle 80th percentile compared to the Grand Coulee curves. She asked if there are any examples where the Grand Coulee curves are within the middle 80th percentile and the project-specific curves are not. Keller said the overall summaries for the Rock Island Project, which include side flows from the Okanogan, Methow, Entiat, and Wenatchee rivers, showed an increased middle 80th percentile in some years. He said there were also years where the lower bounds did not differ much, but the upper bounds did, or vice versa.

Slide 18 of Attachment B

Keller said this is a new project-specific curve he constructed for the spring timeframe for the Rocky Reach Project using a 1990 to 2019 dataset, where the curve is based on a 30-data set. Keller said moving forward, using a rolling 30-year flow duration curve is something Chelan PUD and Douglas PUD hoped the HCP Coordinating Committees would consider. He said, for example, come 2029, the flow duration curves would add the most recent 10 years of data and the oldest 10 years of data would be removed. He said the curve based on 1990 to 2019 includes an upper bound of 223 kcfs and a lower bound of 104.5 kcfs. He said for a 30-year curve, two data points are outside the 10th to 90th percentiles and fall in the 0 to 10th percentiles and three data points fall in the 90th to 100th percentiles.

Ferguson asked if Keller can explain more about the selection of a 30-year curve versus, for example, a 40-year curve. Keller said considering how project operations have evolved in the upper Columbia River over the past 30 years, he believes 1990 is a good starting point. He said this results in a data set that is large enough to provide stable curves while incorporating flow variability among years but is not too large of a dataset and it relies on the most recent data. He said he likes the idea of maintaining a rolling 30-year curve to account for unforeseen changes in the Columbia River system. He said, for example, the Columbia River Treaty is not yet finalized, and climate change may have effects on river flow. Kahler said Chelan PUD and Douglas PUD also discussed decadal cycles. He said including only one or two decades did not seem adequate but including three decades provides variability by encompassing a broader range. He said the idea is to study representative conditions, and if the dataset is too compressed there is a higher likelihood conditions will fall outside the bounds. He said, conversely, if the dataset is too large this will not capture conditions happening right now. He said a rolling 30-year dataset will also help account for changes in climate over time.

Slide 19 of Attachment B

Keller said this is the summer curve for the Rocky Reach Project using the same 1990 to 2019 dataset. He noted that this curve already includes the month of June and a summer curve without June has not yet been developed. He said he figured the HCP Coordinating Committees would want June included and Chelan PUD believes if a subyearling study will be conducted one day, it could most likely start in the month of June.

Truscott asked why June 1 versus June 15 is used to start the summer timeframe. He asked, looking at the bypass data, what percentage of subyearlings pass early versus late. Keller said the percentages change annually; however, there is typically a pulse of hatchery fish that occurs early. He said shifting to June 15 would exclude these fish that annually migrate past the projects prior to June 15 and annually make up a considerable portion of the juvenile subyearling outmigration. Kahler said additionally, the spring timeframe includes April 16 to May 31, and it makes sense for the summer timeframe to follow right after, which it does by using June 1. Ferguson said if June 15 is used versus June 1, the upper bounds might change from 221 kcfs to 220 kcfs. Keller agreed and said the upper bounds would change but the lower bounds would not.

Slide 20 of Attachment B

Keller said this is the new spring curve for the Rock Island Project, which includes influence from the Wenatchee River. He said the upper bound did not change from the Rocky Reach Project, but the lower bound increased from 104.5 kcfs for the Rocky Reach Project to 111.7 kcfs for the Rock Island Project. He said this is an example of how project-specific curves can capture local influences.

Slide 21 of Attachment B

Keller said this is the new summer curve for the Rock Island Project. *(Note: the screen projection was not functioning properly, but the upper and lower bounds increased slightly compared to the Rocky Reach Project.)*

Slide 22 of Attachment B

Keller said this is the summer curve for the Wells Project using the same 30-year, 1990 to 2019, dataset and including the month of June. He said the upper bound is 215 kcfs and the lower bound is 101 kcfs.

Slide 23 of Attachment B

Keller said this is the new spring curve for the Wells Project.

Keller noted that there are different approaches to constructing flow duration curves. He said both Chelan PUD and Douglas PUD chose to use the average flows across a timeframe, rank the flows from highest to lowest, and draw a line at the 10th and 90th percentiles (i.e., these curves are not smoothed out).

Slide 24 of Attachment B

Keller said this is a second spring curve for the Wells Project. Kahler said he decided to create a second spring curve with an earlier start date of April 13 to encompass the start date of the scheduled 2020 survival verification study at the Wells Project (the Chelan PUD spring curves and first Wells Project spring curve use April 16 as the start date). He said the upper bound is basically the same and noted this should be reported as 218,218 cfs (not 218,480 cfs as shown). He said the lower bound decreases by about 1,400 cfs.

Discussion

Keller said Chelan PUD and Douglas PUD are interested in hearing what the HCP Coordinating Committees think about: 1) switching from the Grand Coulee flow duration curves to project-specific curves for the Wells, Rocky Reach, and Rock Island projects; 2) using a rolling 30-year dataset approach where in 10 years from now the most recent 10 years of data are added and the oldest 10 years of data are removed; and 3) including the month of June in the summer flow duration curves, since this is not stipulated in the HCPs.

Murdoch asked how project-specific curves would work for Chelan PUD where there might be slightly different curves for the Rock Island and Rocky Reach projects, but the survival study encompasses both projects. Keller said Chelan PUD conducts separate survival studies for each project, and he noted that Grant PUD combines projects.

Murdoch said her initial thought is project-specific curves seem the most logical; however, she also wonders what the authors of the HCPs were thinking when choosing to use Grand Coulee Dam for the flow duration curves. She asked if the goal was to find an average for the Columbia River as a whole, or to get at latent mortality, or something else? Ferguson suggested that Murdoch ask Steve Parker and Scott Carlon ask Ritchie Graves. Keller agreed the authors must have thought this through. Truscott said it may have been based on the duration of the dataset. Keller said Grand Coulee Dam does regulate overall flow in the Columbia River. Murdoch said, however, river flow is captured in the project-specific flows, and she asked how long it takes for water passing Grand Coulee Dam to reach Chelan PUD projects. Keller said he is unsure, but project-specific curves essentially true this up.

Murdoch said Chelan PUD and Douglas PUD make good points about the Columbia River Basin treaties and their potential influence on future river flows. Keller added that using a 30-year dataset will also preserve the data from the recent past. Truscott noted in most recent years, the mid-Columbia River has experienced a more rain-dominate freshet than a snow-dominate freshet.

Ferguson said the HCP Coordinating Committees are being asked to consider three topics, which involves changing what is stipulated in the HCPs, and, therefore, will necessitate one or possibly three SOAs. Truscott said he also sees a fourth topic, which is what constitutes normal flows for study validation. He said in his mind, normal river flow can be the timing of flow within each spring and summer timeframe. He said what if there is low or high river flow in early or late parts of each timeframe, but the study plan is based on average run-timing curves. He asked how to synchronize these together. He asked if river flow can be considered more finely than over a month-and-a-half timeframe. Keller said the flow duration curves are developed to be applicable to the best estimated time to conduct a survival study. He said when Chelan PUD conducted a survival study for yearling Chinook salmon in the Rocky Reach Project, fish were arriving early and with increased consistency before the start of the survival study. He said still, Chelan PUD waited to have high certainty there would be no gaps in meeting the tag quotas required for release replicates, and once the study started, that fish would continue arriving consistently for 30 to 35 days to tag the most representative run as possible. He said Chelan PUD believes this approach worked well based on a review of the Columbia River Data Access in Real Time database (DART). Truscott asked if river flow in the last 2 weeks in April was outside the 10th to 90th percentile range. Murdoch asked Truscott to clarify what he is asking, and Truscott said he is wondering if it is possible to consider river flows in smaller increments. Keller said he believes should river flows fall outside the 10th to 90th percentile, when examined on smaller increments, those flows would be incorporated into the evaluation of survival estimates, and the average project flow for the study would be compared to the respective flow duration curve. Kahler said the Douglas PUD 2010 survival study started with low river flows and a freshet did not occur until maybe about the third week into the study. He said right before starting the test, Douglas PUD came to the Wells HCP Coordinating Committee and asked if the study should go on because there was no freshet. He said the Wells HCP Coordinating Committee said to do it. Ferguson reminded the HCP Coordinating Committees about the 5th to 95th percentile range Keller had mentioned earlier, as also written in the HCPs (slide 5 of Attachment B). Ferguson said it seems there is a post-hoc interpretation of data where the HCP Coordinating Committees evaluate whether the study occurred in representative conditions and can be accepted as valid. Keller said given the curves are an average, it is expected that river flows could be above or below the curve at times when analyzed on a weekly or daily interval. He said this is expected with survival studies and the study plans are tailored to accommodate this.

Murdoch said regarding the SOAs, changing what is stipulated in the HCPs does raise a red flag for the Yakama Nation (YN). She recalled a couple of years ago, the YN made a strong position with Grant PUD that a higher level of attention is needed than just an SOA at the technical level to change what is written in the Salmon and Steelhead Settlement Agreement. She said this may just involve a discussion with policy staff and creative language in the SOA with an expiration date so as to not permanently change the HCPs, but something more needs to be done. Keller said a 10-year expiration date would be appropriate since the curves need to be revisited every 10 years anyway. Kahler clarified that the Chelan PUD HCPs stipulate the curves will change, and the Wells HCP only stipulates the curves are subject to periodic review. Keller read from Section 13.24 of the Rock Island HCP:

> *"Starting as part of the 2013 comprehensive review, and every ten years thereafter, the Coordinating Committee shall update the flow duration curve and the river flow amounts contained in this definition."*

Therefore, the proposed considerations (and associated SOAs) will not change the language in the HCPs.

Truscott asked about the turbine hydraulic capacity at Rocky Reach Dam. Keller said under normal operations the capacity is about 208 to 210 kcfs. Truscott said if river flow exceeds the powerhouse capacity, involuntary spill might improve survival and then this number would be used for the next 10 years and into mitigation. Keller said Chelan PUD uses acoustic tags for survival studies so the last route of detection is known and fish passing via the spillway can be removed from the analysis. Truscott said Douglas PUD does not use acoustic tags, and he asked how the Wells Project accounts for improved survival from an anomalous year. Ferguson said this is addressed by the flow duration curve and the study fitting within the 10th to 90th percentile. Kahler said that Wells Dam has typically been a nine-unit plant and the hydraulic capacity is always under 180 kcfs. He said he recalls no involuntary spill during the survival study in 2010 under flow conditions that year, and although flow was low, it fit inside the flow duration curve, so the study was accepted. He added that this is just one data point on a multi-year average. Truscott said the same can be said on the lower bounds. He said a low flow year might have poorer survival. Keller said 2019 is on pace to be the third lowest water year since Rocky Reach Dam was constructed.

Keller reiterated Chelan PUD's proposal: 1) use project-specific curves for the Wells, Rocky Reach, and Rock Island projects; 2) use a rolling 30-year dataset; and 3) include June in the flow duration curve for the summer timeframe. Kahler said Douglas PUD is proposing the same.

Ferguson said the PUDs will bring WDFW up to speed on this topic prior to the December meeting. He asked that the HCP Coordinating Committees representatives think about this information and expect SOAs for approval during the HCP Coordinating Committees meeting on December 17, 2019.

The draft SOA, *Regarding the Updated Flow-Duration Curves for the Wells Hydroelectric Project For Establishing Representative Environmental Conditions*, was distributed to the HCP Coordinating Committees by Geris on December 5, 2019; and the draft SOAs, *Updated Flow Duration Curves for the Rock Island Project for Establishing Representative Flow Conditions* and *Updated Flow Duration Curves* *for the Rocky Reach Project for Establishing Representative Flow Conditions*, were distributed to the HCP Coordinating Committees by Geris on December 6, 2019.

IV. Chelan PUD

A. DECISION: Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018 (Lance Keller)

Lance Keller said the *Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018* was distributed to the HCP Coordinating Committees by Kristi Geris on September 10, 2019 and was available for a 30-day review with edits and comments due to Keller by October 10, 2019. Keller said no comments were received on the draft 2018 report. He said the draft 2019 report will be distributed to the HCP Coordinating Committees for review in early 2020. Keely Murdoch asked if any new data have surfaced that might suggest a change in approach for the program in future years. Keller said no, and so far these reports have shown no increase in fish encounters or fish size, which is good news. He said this effort includes angling using rod and reel and setlines, boat crews, deck crews, and input from the community via a fishing derby.

Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the *Northern Pikeminnow Predator Control Program, Rocky Reach and Rock Island Hydroelectric Projects, Draft Summary Report, 2018*. *(Chad Jackson provided WDFW approval of the draft report via email on November 12, 2019.)*

B. 2019 Rocky Reach and Rock Island Fish Spill Report (Lance Keller)

Lance Keller said the *Chelan PUD Rocky Reach and Rock Island HCPs Draft 2019 Fish Spill Report* (Attachment C) was distributed to the HCP Coordinating Committees by Kristi Geris prior to the HCP Coordinating Committees meeting on November 19, 2019. Keller said the report is in the same format as last year. He recalled that Thad Mosey (Chelan PUD) typically presents this report; however, he is unavailable today.

Keller said Rocky Reach Dam does not have a spring spill requirement. He said for summer spill at Rocky Reach Dam, the target species is subyearling Chinook salmon, with a summer spill target of 9% of the daily average river flow. He said spill was initiated on June 2 and terminated on August 12, 2019. He said Program RealTime estimated that 95% passage was achieved on July 28, 2019. He said retrospectively looking at Program RealTime for run coverage, 99.1% of the run was covered by August 12, 2019. He said the cumulative index count was 33,299 subyearlings over Rocky Reach Dam (as of August 31, 2019). Keller said Mosey did a good job on summer fish spill, hitting a spill percentage of 9.09%. Keller said of this fish spill, 0.07% was forced spill. He said average river flow at

Rocky Reach Dam was 100,417 cfs, average spill was 9,131 cfs, and there were 72 total days of spill. He said the graph for summer spill at Rocky Reach Dam shows a blue line for the daily index counts at the Rocky Reach Juvenile Sampling Facility (RRJSF) and a red line for percent spill for that day. He noted that the percent spill varies a bit, and he said this is affected by estimated outflow from Chief Joseph Dam and Grand Coulee Dam discharge. He explained that Chelan PUD must submit fish spill requests 2 to 5 days in advance and sometimes this estimate from Chief Joseph Dam changes. He said during a low flow year (such as 2019), an inaccurate flow estimate of 5 kcfs can result in a big difference. Keller said Mosey tracks how accurate the estimates are and bases his spill requests off of this. Keller said Mosey did a good job of maintaining spill volume across this time period. Keller said the graph on page 2 of Attachment C is the graph the HCP Coordinating Committees requested to be added to these spill reports. He said this graph shows, of the daily index counts at the RRJSF, what proportion of subyearlings are adipose (ad)-present. He said initially, hatchery fish dominated and there were very few ad-present fish, until the end of June 2019, and then ad-present fish dominated.

Keller said at Rock Island Dam, the spring spill target species include yearling Chinook salmon, steelhead, and sockeye salmon. He said the spring spill target is 10% of the daily average river flow. He said in 2019, the fish runs were late, and spill did not start until April 17, 2019, at 0001 hours, which is the deadline to start spring spill as stipulated in the Rock Island HCP. Keller said Mosey monitors the fish counts very carefully and there were minimal counts prior to April 17, 2019. Keller said on June 1, 2019, operators switched from 10% spring spill to 20% summer spill instantaneously. He said retrospectively looking at run coverage, spring and summer fish spill operations combined covered 99.7% of the yearling run, 99.9% of the steelhead run, and 98.5% of the sockeye salmon run. He said coverage for each species exceeded the 95% coverage target outlined in the Rock Island HCP. He said the cumulative index counts as of August 31, 2019, included 18,855 yearling Chinook salmon, 9,881 steelhead, and 7,416 sockeye salmon. He said the spring spill percentage from April 17 to June 1, 2019, was 11.67% including 10.03% requested fish spill and 1.64% forced spill beyond project capacity. He said the average river flow for the spring spill period was 128,137 cfs and average spill was 14,948 cfs. He said there were a total of 46 spill days. He described the color-coding of the graph for spring spill at Rock Island Dam and noted that the sockeye salmon run exhibited bimodal (and almost trimodal) peaks. Keely Murdoch asked if this might represent Osoyoos River versus Wenatchee River populations? Keller said he believes so, and there is a size difference between the two stocks and Wenatchee River sockeye salmon arrive earlier. He said in the past, spill has been initiated earlier due to Wenatchee River sockeye salmon arriving early.

Keller said for summer spill at Rock Island Dam, the target species is subyearlings with a goal of 20% spill of the daily average river flow. He said summer spill started on June 2 and was an instantaneous increase from 10% spring spill. He said summer spill ended at Rock Island Dam on August 19, 2019, at 2400 hours. He said Program RealTime estimated 95% passage was achieved on August 3, 2019.

He said as of August 19, 2019, spill operations covered 98.5% of the subyearling run. He said the cumulative index count was 11,876 subyearlings, and the summer spill percentage was 20.13% including 19.90% requested spill and 0.23% forced spill. He said average river flow was 101,744 cfs, average spill was 20,482 cfs, and then there is another graph for summer spill similar to Rocky Reach Dam. He said page 5 of Attachment C shows the subyearling ad-present proportions for Rock Island Dam. Murdoch asked why yearling Chinook salmon were not included on these ad-present graphs and Keller said because the HCP Coordinating Committees did not request to include yearlings on these graphs. Keller recalled that incorporating these graphs for subyearlings was a request from Kirk Truscott. Murdoch said she is particularly interested in the wild yearling spring Chinook salmon run coinciding with spill operations. Keller said Chelan PUD can add yearlings to these graphs. Murdoch said this is not necessary, she just wonders what proportion of wild versus hatchery springers are being covered by fish spill operations. She said the springers arriving early are likely wild but not in high enough numbers to trigger fish spill operations. Keller said Chelan PUD has records of which fish are ad-present or clipped; however, initiation of spill is based on species counts not origin counts. He added that one would need to make broad assumptions to attempt to get at Murdoch's question.

John Ferguson asked Murdoch how she would like to move forward and Murdoch suggested continuing discussing this topic within the HCP Coordinating Committees. Murdoch said understanding the idea is to protect fish with spill operations, she asked if the spill dates are adequate to protect wild spring Chinook salmon. Keller said this is hard to determine, but Chelan PUD does implement a spill program that was in use when phase designation survival studies were conducted and survival standards were achieved for Plan Species, and these were representative of both wild- and hatchery-origin juveniles. Ferguson summarized that Chelan PUD is operating in compliance with the HCPs and past survival studies but is there more information about wild springers that could be brought forward. Murdoch said she understands the HCPs focus on protecting what is in the river, which includes hatchery fish, but at the same time, it would be good to get at recovery. Truscott said one could determine a rough estimate of natural-origin fish through the process of elimination. He suggested examining yearling Chinook salmon for ad-clipped, coded wire tags, or passive integrated transponder (PIT) tags. He said some natural-origin fish may have a PIT tag from the screw traps, so this would require checking the tag codes against those data. Keller asked, however, if these data would change when spill is either turned on or off? He said the passage rate of juveniles at Powerhouse 2 most likely changes once spill is initiated since an additional passage route adjacent to Powerhouse 2 is now available, and the collection efficiency of the Powerhouse 2 bypass trap most likely changes as well and could compromise the ability to compare counts before and after the initiation of the spring fish spill program. He said downstream PIT detections cannot be used as neither the passage date nor the route of passage at Rock Island Dam is known unless the fish passed via the Powerhouse 2 bypass trap.

Keller said page 6 of Attachment C summarizes the historical counts at Rocky Reach Dam and Rock Island Dam. He noted that sampling efficiency at the two locations are different, and are therefore, not directly comparable.

Chelan PUD will request approval of the *Chelan PUD Rocky Reach and Rock Island HCPs Draft 2019 Fish Spill Report* during the HCP Coordinating Committees meeting on December 17, 2019.

C. Rocky Reach Dam Turbine Unit C1 and C3 Update (Lance Keller)

Lance Keller said mechanical staff are still waiting for parts for Turbine Unit C1 and with continued delays in recommissioning Turbine Unit C9, both schedules have been moved back. He said the return-to-service dates for Turbine Units C1 and C9 are now January 2020 and February 2020, respectively.

Keller said in October 2019, Turbine Unit C3 was taken offline for a 1-month check-up and mechanics discovered additional oil had been released from the unit. He said new seals were installed, the seals passed initial testing, and the unit was returned to service on October 11, 2019. He said when Turbine Unit C3 tailrace stoplogs were removed, mechanics observed small traces of oil in the tailrace and thought this was residual oil remaining from the unit work. He said mechanics took Turbine Unit C3 offline again, but the unit did not appear to be the source of the oil leak. He said Turbine Unit C2 was out-of-service that same morning to facilitate divers' cleaning of trashracks and then brought back online that same day. He said mechanics took Turbine Unit C2 offline again and observed oil in the tailrace; therefore, mechanics believe there is an issue with Turbine Unit C2, as well. Keller said mechanics believe trunnion seals are not the issue with Turbine Unit C2; rather, it may be a failure of the internal servo rod seal that allows the blade to change pitch. He said if this seal fails it can cause over-pressurization of the turbine hub. He said, however, mechanics had not yet been able to get into Turbine Unit C2 to investigate the issue because all of the crews and headgates were in use for Turbine Units C1 (repairs), C3 (seals), C7 (vibration issues), and C9 (repairs). He said since this time, additional testing was performed on Turbine Unit C3 to evaluate the internal servo rod seal, which the seals passed, and after about a 1-month outage, Turbine Unit C3 was finally returned to service on November 18, 2019. He said mechanics are performing daily monitoring of oil in Turbine Unit C3 with the understanding that if a fluctuation is observed the unit will be taken out of service.

Keller said Natural Resource staff are encouraging the mechanical staff to maintain the Turbine Unit C1 return-to-service date of February 2020, prior to the Rocky Reach Juvenile Fish Bypass System starting operations. He said the small units, Turbine Units C1 to C7, are designed the same with the same internal servo rod seals in all of them, as well as the same trunnion seals. He said the plan is to analyze these parts across the entire range of small units. He said Chelan PUD is also still working with the external consulting firm from Italy on developing a plan for block-loading the unit and operating it in this manner if needed in the future. He said Turbine Unit C2 will be out-of-service until headgates and crews become available and are able to assess the unit further. He said these headgates are the same gates used to isolate the attraction water to dewater the adult fish ladders for annual winter maintenance, which is scheduled to start in mid-December as approved by the Rocky Reach HCP Coordinating Committees (on August 27, 2019).

D. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said work continues to move forward on Turbine Unit B4. He recalled that Turbine Unit B4 is the first original small unit to be refurbished in Powerhouse 1. He said delays in the schedule have been caused by discovering that some parts were beyond refurbishment and needed replacement and delays in receiving the replacement parts. He said the original return-to-service date of early December 2019 has been updated to May 2020. He said Turbine Unit B4 is the first look into these original units and hopefully efficiencies can be gained and implemented on the remaining three units.

V. Douglas PUD

A. 2019 Wells Dam Post-Season Bypass Report and Passage-Dates Analysis (Tom Kahler)

Tom Kahler said the Passage-Dates Analysis portion of the 2019 Wells Dam Post-Season Bypass Report was distributed to the HCP Coordinating Committees by Kristi Geris prior to the HCP Coordinating Committees meeting on November 19, 2019. Kahler clarified that the Passage-Dates Analysis addresses how the Wells Project performed in terms of meeting compliance (i.e., the results), and the cover sheet to this document (or 2019 Wells Dam Post-Season Bypass Report) describes what operations were implemented during the year (e.g., when bypass barriers were pulled). Kahler said the results were distributed but the cover page is still undergoing internal review. *(Note: the 2019 Wells Dam Post-Season Bypass Report was distributed to the HCP Coordinating Committees by Geris on December 5, 2019.)*

Kahler said the Passage-Dates Analysis has been presented in the same format since 2011. He said a comparison of wild Chinook salmon was added in the last couple of years and then applied retrospectively back to 2012. He said one thing that is different this year is there were enough data to true up travel times. He recalled in past reports, mean travel times from the 2010 survival study were used to estimate passage dates. He said this year, travel times for steelhead, yearling Chinook salmon, and coho salmon were estimated using detections of fish that were PIT-tagged above Wells Dam and detected at both Wells and Rocky Reach dams. He said travel times for sockeye salmon were estimated using Chelan PUD acoustic tag study results of fish released in the Wells Dam tailrace and detected at Rocky Reach Dam. He said for subyearling Chinook salmon, there were too few detections at Wells and Rocky Reach dams; therefore, travel time for subyearlings was calculated by taking all subyearlings released above Wells Dam and detected at Rocky Reach Dam from 2011 to 2019 and splitting this travel time in half. He said travel times for steelhead, yearling Chinook salmon, coho and sockeye salmon, and subyearling Chinook salmon are presented in the appendix to the Passage-Dates Analysis.

Kahler said compliance in 2019 was good for both hatchery and wild fish. He said there was a late freshet this year and associated late movement of wild subyearling and yearling Chinook salmon, which aligned more closely with movement of the respective hatchery components compared to other years. He said Wells Dam bypass operations in 2019 provided 100% coverage for each Plan Species migration, except for coho salmon, which had 99.99% coverage. He noted that bypass operations were shut down several days after already achieving 95% passage for both hatchery and wild subyearling Chinook salmon. He said the closest this has been is 10 days after achieving 95% and has been as many as 35 days after. He noted for wild yearling Chinook salmon, bypass operations were initiated 6 days before 5% of the run passed Wells Dam. He said 2019 was a good year for fish passage at Wells Dam regardless of origin.

Kahler asked that the HCP Coordinating Committees contact him with questions. Douglas PUD will request approval of the 2019 Wells Dam Post-Season Bypass Report and Passage-Dates Analysis during the HCP Coordinating Committees meeting on December 17, 2019.

B. DECISION: Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019 (Tom Kahler)

Tom Kahler recalled that a *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* was distributed to the HCP Coordinating Committees by Kahler during the HCP Coordinating Committees meeting on September 24, 2019. Kahler said he received comments during the meeting, addressed these in the draft document, and a revised draft document was distributed to the HCP Coordinating Committees by Kristi Geris following the HCP Coordinating Committees meeting on September 24, 2019. Geris recalled that the Wells HCP Coordinating Committee had an action item to review the revised draft document and be prepared to discuss a path forward during the HCP Coordinating Committees meeting on October 22, 2019, which was canceled.

Wells HCP Coordinating Committees representatives present approved the *Draft Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019*, as revised. Anchor QEA, LLC, will contact Chad Jackson regarding WDFW approval of the revised draft document. *(Note: Geris emailed Jackson on November 20, 2019, with this request and Jackson provided WDFW approval of the document via email on November 22, 2019.)*

The final *Estimates of Additional Mortality Resulting from Non-Compliant Bypass Operations at Wells Dam During April 2019* was distributed to the HCP Coordinating Committees by Geris on November 22, 2019.

VI. HCP Administration

A. Final HCP Policy Committees July 9, 2019 Meeting Minutes (John Ferguson)

John Ferguson said the HCP Policy Committees approved the HCP Policy Committees July 9, 2019 meeting minutes, as revised. Kristi Geris added that the minutes were approved via email on September 25, 2019. Geris said the final minutes were distributed to each HCP Committee and Larissa Rohrbach (HCP Hatchery Committees Support Staff) incorporated the HCP Policy Committees guidance about funding criteria into the HCP Hatchery Committees protocols (i.e., to base funding decisions on technical merit, and notify respective HCP Policy Committees and HCP Coordinating Committees of any potential policy issues needing to be addressed in those forums). *(Note: The guidance from the HCP Policy Committees is also captured in the HCP Tributary Committees July 16, 2019 meeting minutes, the 2019 HCP annual reports, and in the HCP Tributary Committees' Operating Procedures)*.

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on December 17, 2019, to be held at 9:00 a.m. (instead of 10:00 a.m.), in-person at the Grant PUD Wenatchee office in Wenatchee, Washington.

The January 28 and February 25, 2020 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A List of Attendees
Attachment B *Wells, Rocky Reach, and Rock Island HCPs Update Representative Survival Study Flows*
Attachment C *Chelan PUD Rocky Reach and Rock Island HCPs Draft 2019 Fish Spill Report*

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Lance Keller*	Chelan PUD
Bill Towey	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
- * Denotes HCP Coordinating Committees member or alternate
- † Joined by phone

Wells, Rocky Reach and Rock Island HCPs

Update

Representative Survival Study Flows

HCP Valid Studies

"A valid study is one in which the study design, implementation, and criteria are determined to have been met by the Coordinating Committee, and one in which the study took place during Representative Flow Conditions and normal project operating conditions consistent with the approved study design."

“Representative Flow Conditions”

- Representative survival study flows bound the 10th percentile mean flow and the 90th percentile mean flow from Grand Coulee Dam (GCL) during the HCP survival study periods for spring and summer.

- Measured as mean daily out-flows from GCL during the spring and summer juvenile Plan Species study periods.

- HCP Spring Study Period: 16 April to 31 May

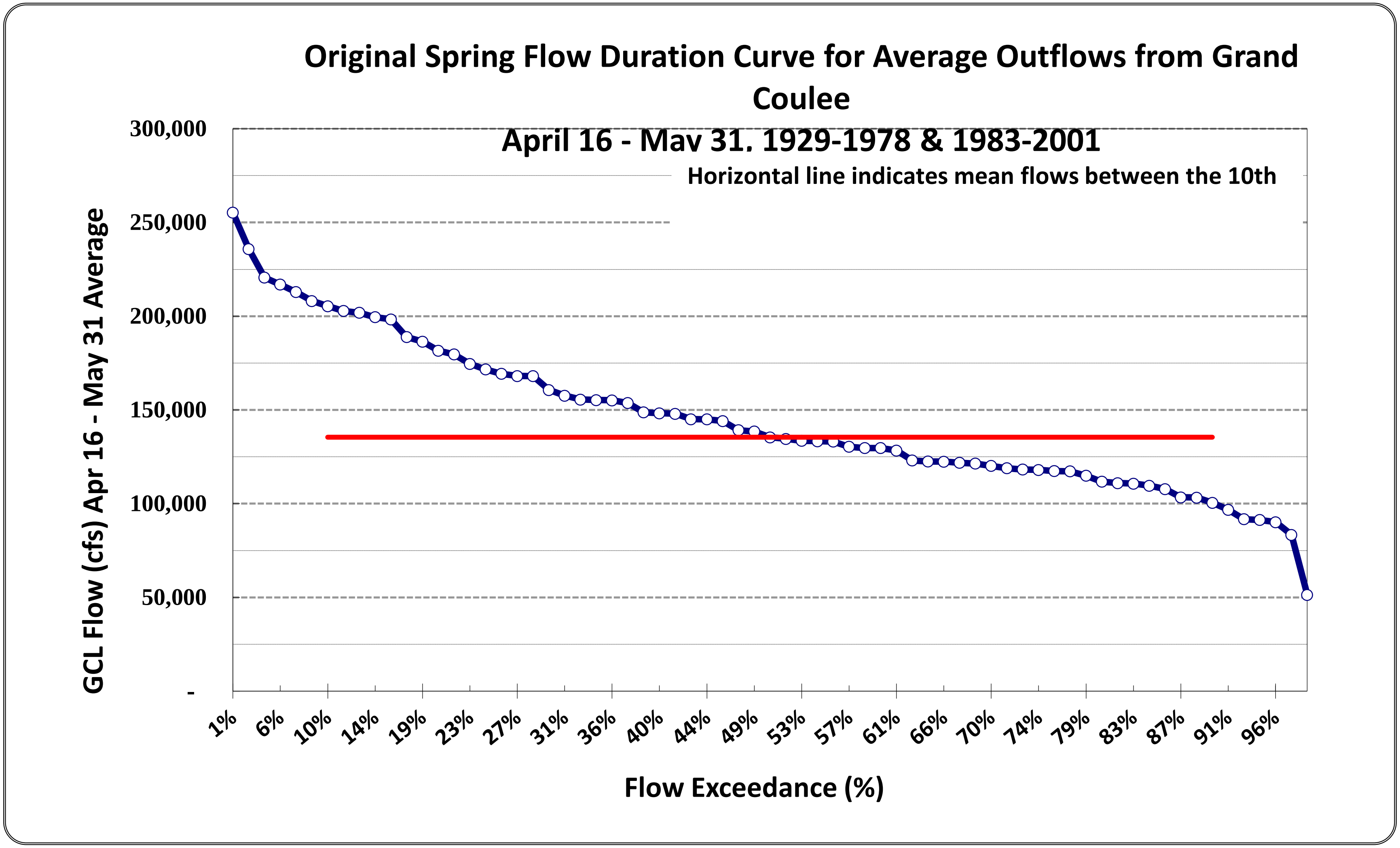
- HCP Summer Study Period: 1 July to 15 August

- HCP: “Update flow duration curves every 10 years with new flow data from GCL”

Original HCP Spring Valid Study Flows and Exceedance Percentiles

BPA Modeled Flow Data (1929-1978) and Actual Flow Data (1983-2001) from Grand Coulee Dam

Spring Flow Rank	Flow Percentile	April 16 – May 31 Mean Flows
1	1.4%	255,259
7	**10.0%**	**205,381**
18	25.7%	169,289
35	50.0%	135,423
53	75.7%	117,402
63	**90.0%**	**100,523**
69	98.6%	51,389

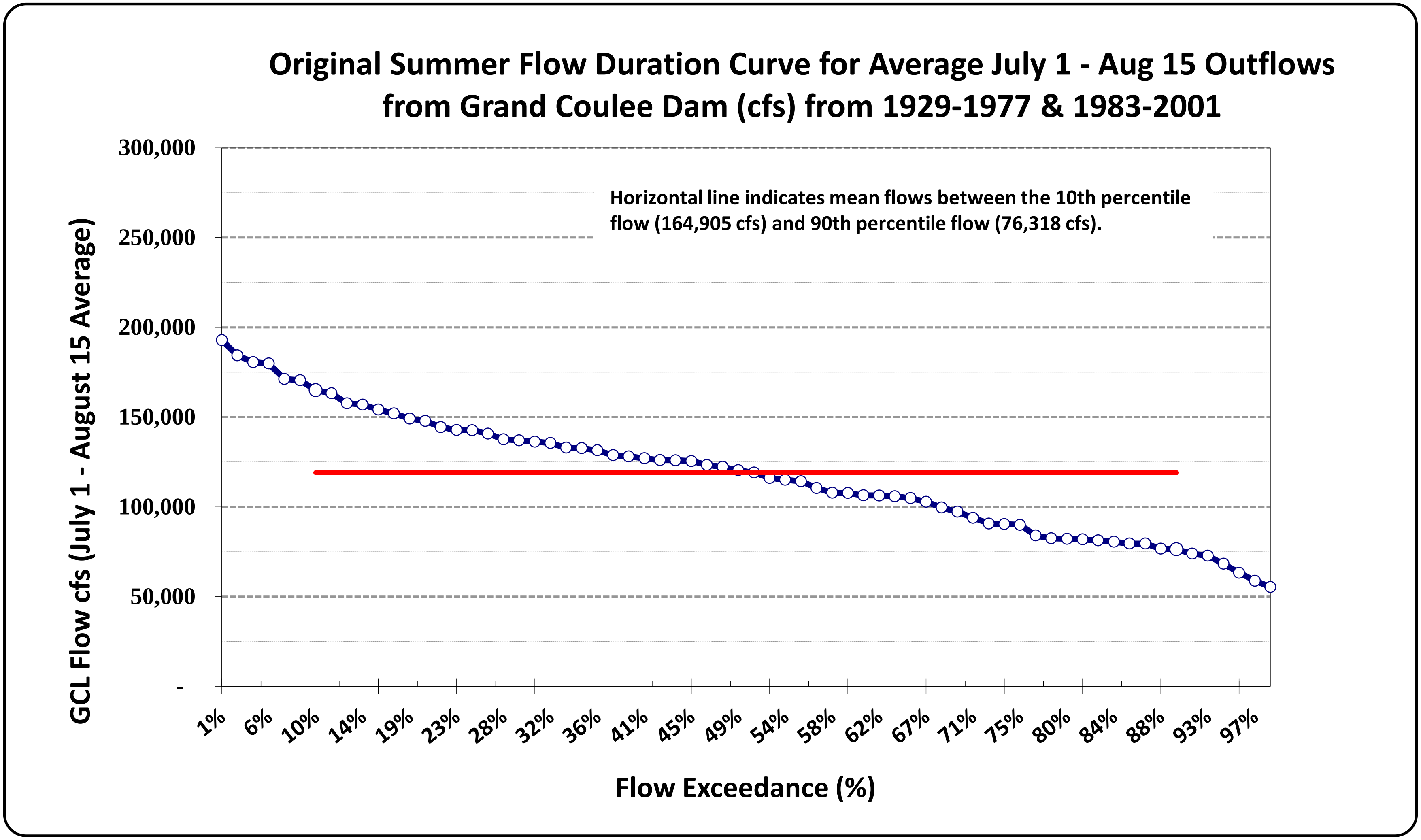


Original Spring Flow Duration Curve for Average Outflows from Grand Coulee
April 16 - Mav 31. 1929-1978 & 1983-2001
Horizontal line indicates mean flows between the 10th
300,000
250,000
200,000
150,000
100,000
50,000
-
GCL Flow (cfs) Apr 16 - May 31 Average
1%
6%
10%
14%
19%
23%
27%
31%
36%
40%
44%
49%
53%
57%
61%
66%
70%
74%
79%
83%
87%
91%
96%
Flow Exceedance (%)

Original Summer HCP Valid Study Flows and Exceedance Percentiles

BPA Modeled Flow Data (1929-1977) and Actual Flow Data (1983-2001) from Grand Coulee Dam

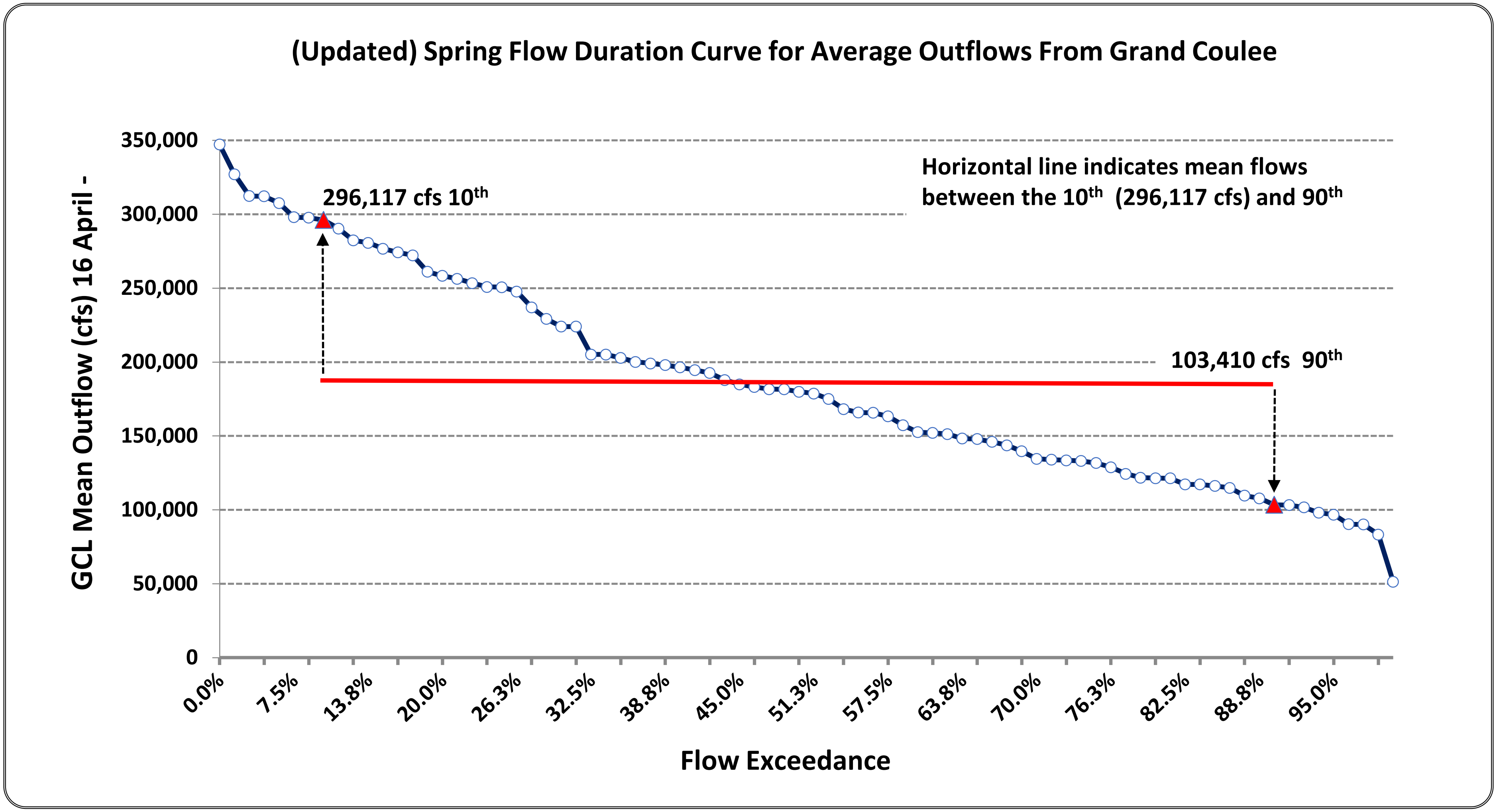
Summer Flow Rank	Flow Percentile	July 1 – August 15 Mean Flows
1	1.4%	192,888
7	**10.1%**	**164,905**
18	26.1%	140,831
35	50.7%	135,423
52	75.4%	90,010
62	**89.9%**	**76,318**
68	98.6%	55,388

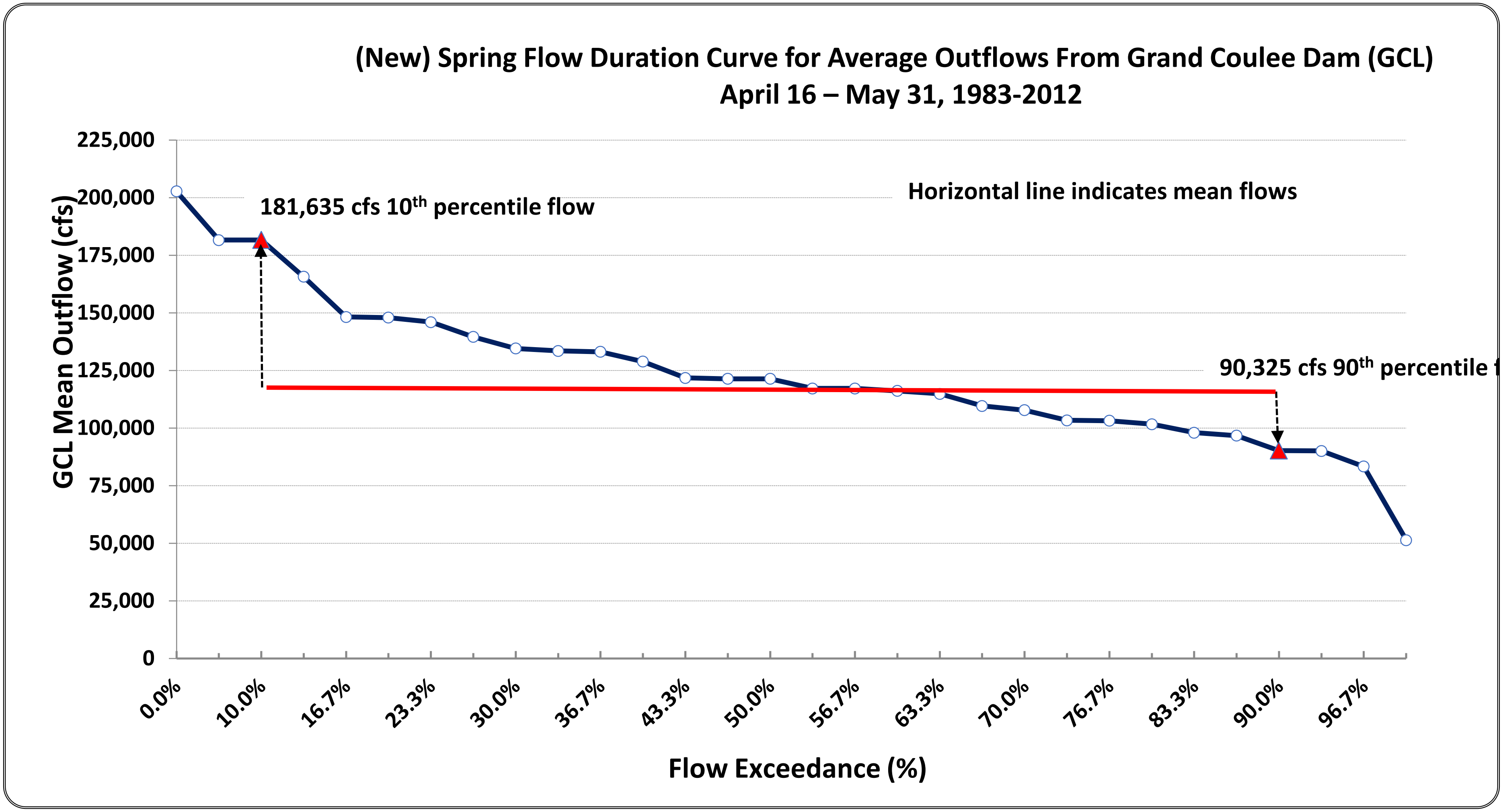

Original Summer Flow Duration Curve for Average July 1 - Aug 15 Outflows from Grand Coulee Dam (cfs) from 1929-1977 & 1983-2001
Horizontal line indicates mean flows between the 10th percentile flow (164,905 cfs) and 90th percentile flow (76,318 cfs).
GCL Flow cfs (July 1 - August 15 Average)
300,000
250,000
200,000
150,000
100,000
50,000
-
1%
6%
10%
14%
19%
23%
28%
32%
36%
41%
45%
49%
54%
58%
62%
67%
71%
75%
80%
84%
88%
93%
97%
Flow Exceedance (%)

HCP CC 2013:
Evaluate Spring Study Flows for Two Scenarios

1) Update the original flow duration curves by adding 2002-2012 flows, identify the new 10th and 90th percentile flows (HCPs 13.24 Appendix C, page 39).

2) Create new flow duration curves using *only* 1983 to 2012 flows, identify the new 10th and 90th percentile flows.


(Updated) Spring Flow Duration Curve for Average Outflows From Grand Coulee
Horizontal line indicates mean flows between the 10th (296,117 cfs) and 90th
296,117 cfs 10th
103,410 cfs 90th
GCL Mean Outflow (cfs) 16 April -
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0.0%
7.5%
13.8%
20.0%
26.3%
32.5%
38.8%
45.0%
51.3%
57.5%
63.8%
70.0%
76.3%
82.5%
88.8%
95.0%
Flow Exceedance

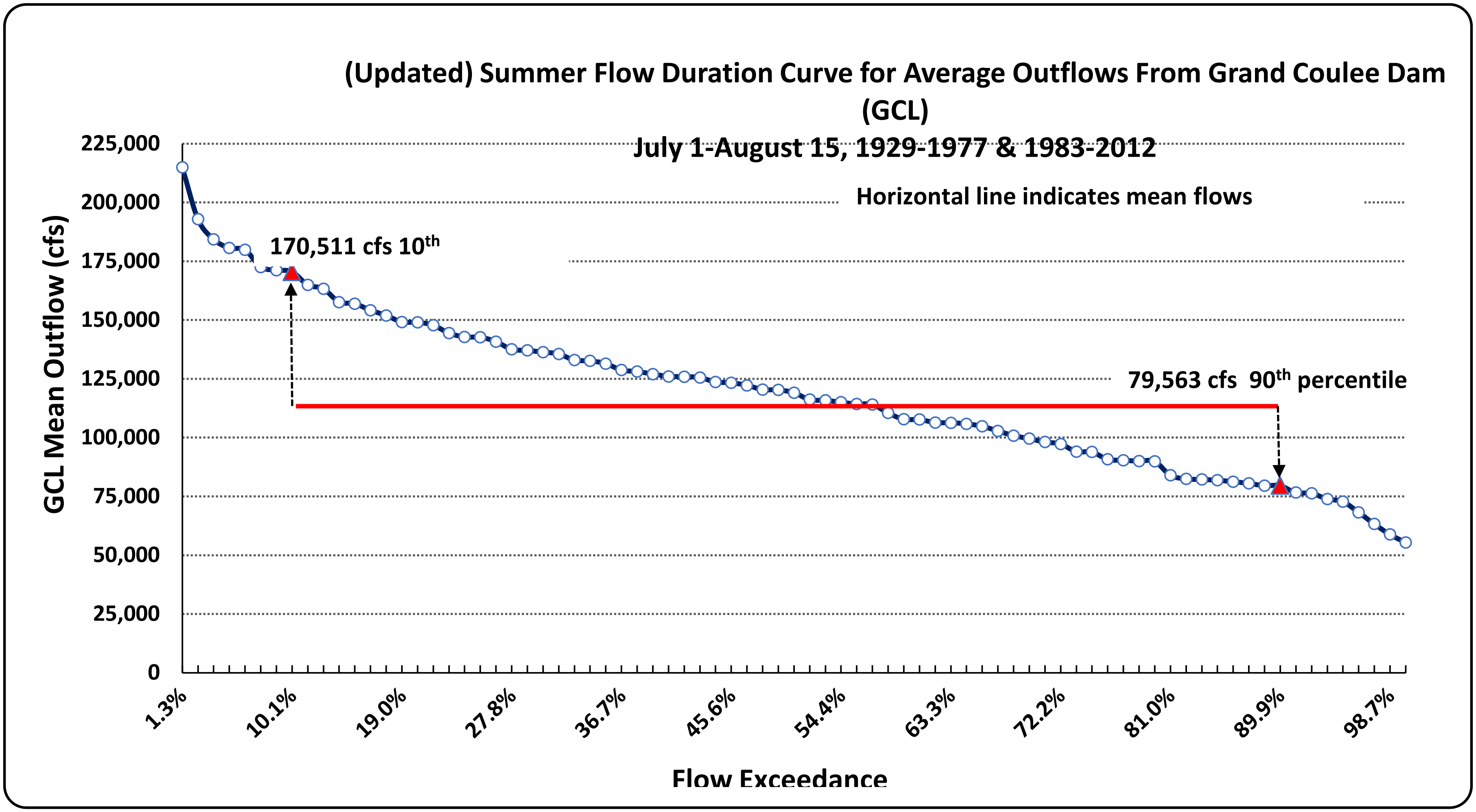

(New) Spring Flow Duration Curve for Average Outflows From Grand Coulee Dam (GCL)
April 16 – May 31, 1983-2012
GCL Mean Outflow (cfs)
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
181,635 cfs 10th percentile flow
Horizontal line indicates mean flows
90,325 cfs 90th percentile f
0.0%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
Flow Exceedance (%)

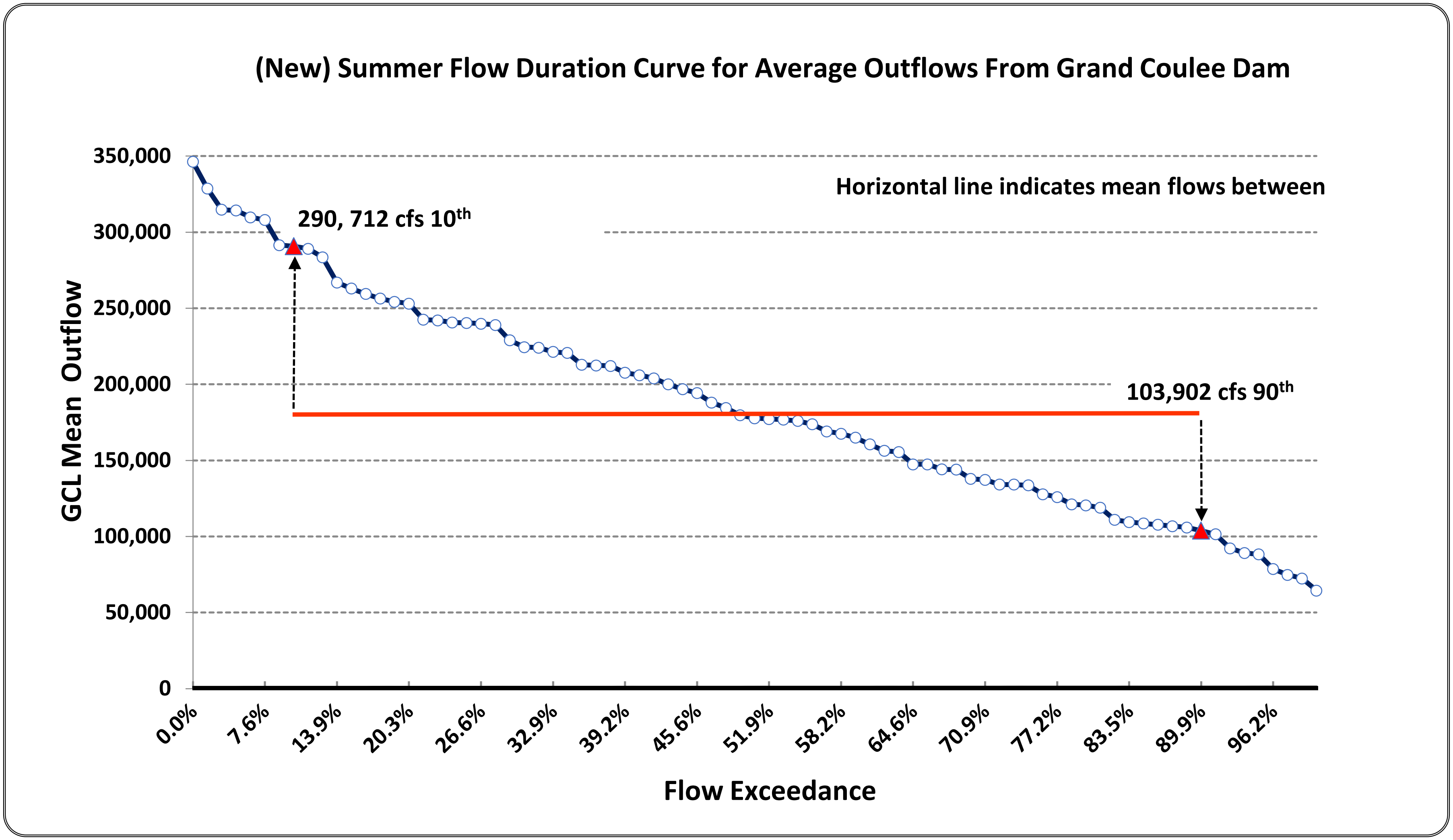
HCP CC 2013:
Evaluate Summer Study Flows for Four Scenarios

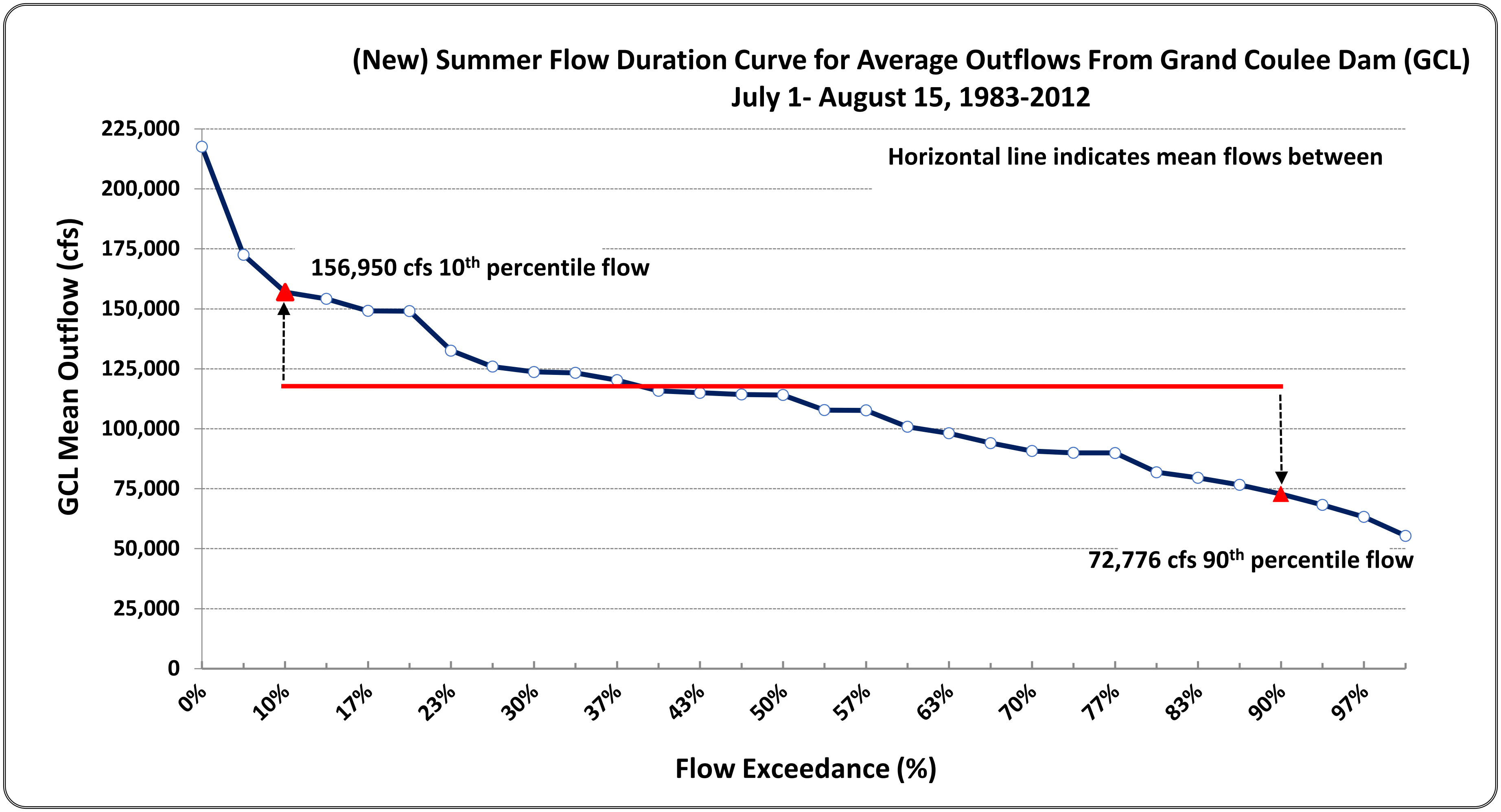
1) Update the flow duration curves by *adding* GCL flows from 2002-2012 to existing GCL flow data, identify the new 10^{th} and 90^{th} percentile flows (HCPs 13.24 Appendix C, page 39).

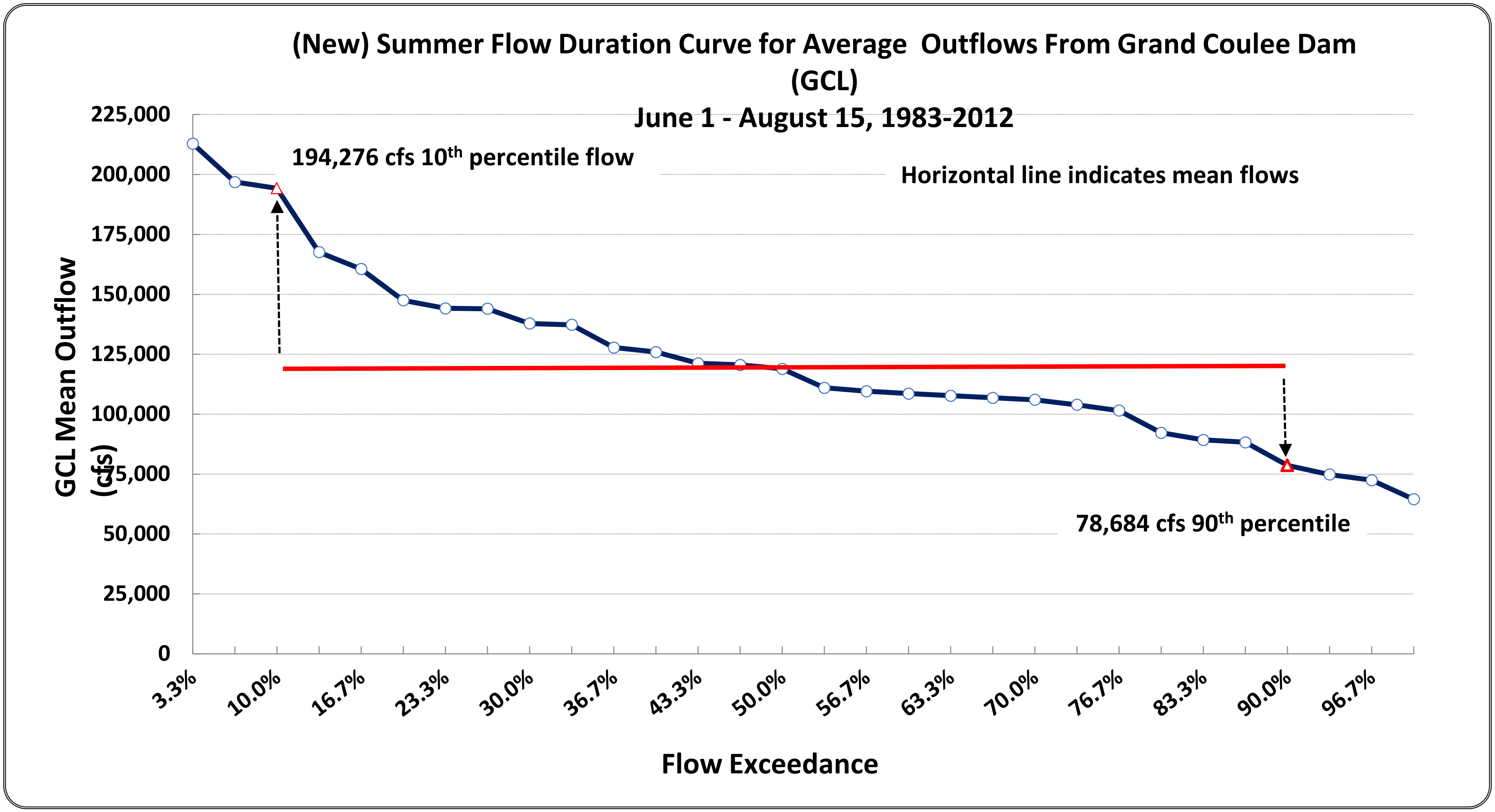
2) Create new flow duration curves using *only* GCL flows from 1983 to 2012, identify the new 10^{th} and 90^{th} percentile flows.

3) Re-evaluate the first two scenarios with 1983-2012 *June flows* in the flow data sets, identify the 10^{th} and 90^{th} percentile flows for both scenarios.


(Updated) Summer Flow Duration Curve for Average Outflows From Grand Coulee Dam (GCL)
July 1-August 15, 1929-1977 & 1983-2012
Horizontal line indicates mean flows
170,511 cfs 10th
79,563 cfs 90th percentile
GCL Mean Outflow (cfs)
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
1.3%
10.1%
19.0%
27.8%
36.7%
45.6%
54.4%
63.3%
72.2%
81.0%
89.9%
98.7%
Flow Exceedance


(New) Summer Flow Duration Curve for Average Outflows From Grand Coulee Dam
Horizontal line indicates mean flows between
290, 712 cfs 10th
103,902 cfs 90th
GCL Mean Outflow
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0.0%
7.6%
13.9%
20.3%
26.6%
32.9%
39.2%
45.6%
51.9%
58.2%
64.6%
70.9%
77.2%
83.5%
89.9%
96.2%
Flow Exceedance


(New) Summer Flow Duration Curve for Average Outflows From Grand Coulee Dam (GCL)
July 1- August 15, 1983-2012
Horizontal line indicates mean flows between
156,950 cfs 10th percentile flow
72,776 cfs 90th percentile flow
GCL Mean Outflow (cfs)
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0%
10%
17%
23%
30%
37%
43%
50%
57%
63%
70%
77%
83%
90%
97%
Flow Exceedance (%)


(New) Summer Flow Duration Curve for Average Outflows From Grand Coulee Dam (GCL)
June 1 - August 15, 1983-2012
194,276 cfs 10th percentile flow
Horizontal line indicates mean flows
78,684 cfs 90th percentile
GCL Mean Outflow (cfs)
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
3.3%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
Flow Exceedance

Choose Best Representative GCL Flow Data

<u>Spring Study Period</u>

- Update spring study flows using complete GCL flow data set (80 yrs)?
- Update spring study flows using GCL flow data set 1983-2012 (30 yrs)?

<u>Summer Study Period</u>

- Update summer study flows using GCL complete flow data set (79 yrs)?
- Update summer study flows using GCL flow data set 1983-2012 (30 yrs)?
- Include GCL June flows in the summer study period?

Or Use Project Specific Curves?

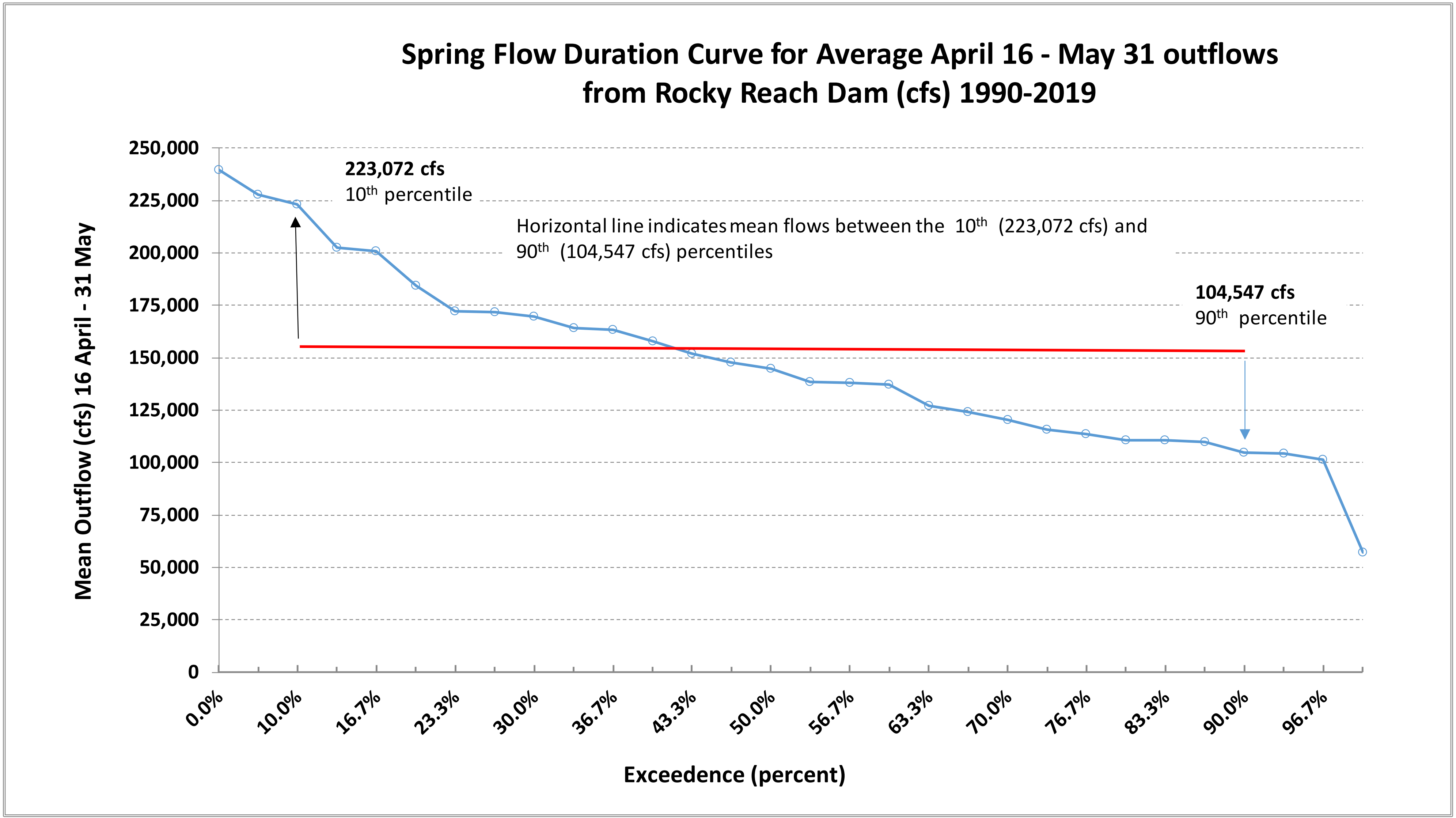
HCP Project Specific Flow Duration Curves

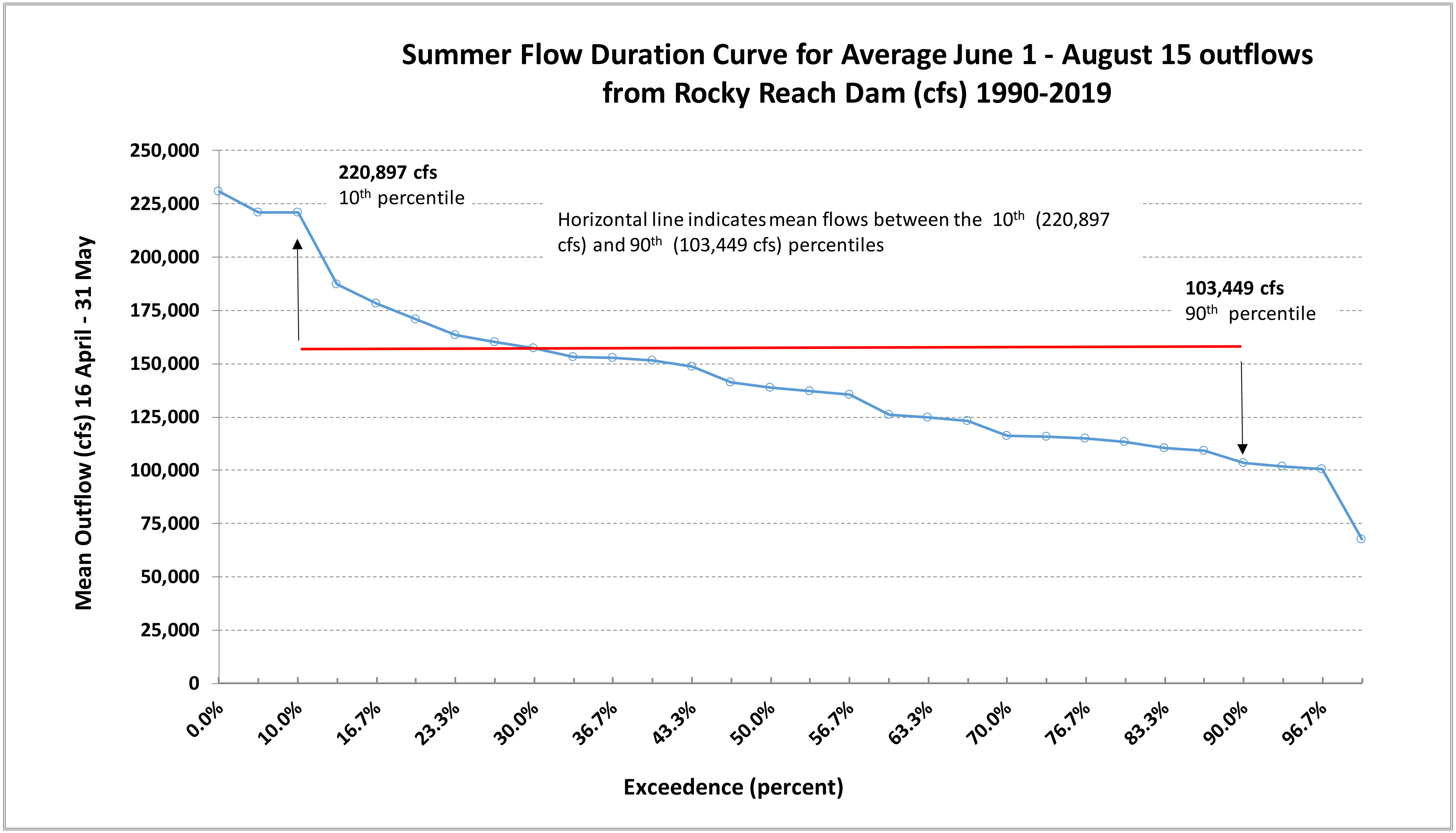
- Historical daily average flows are available for Wells, Rocky Reach, and Rock Island Projects

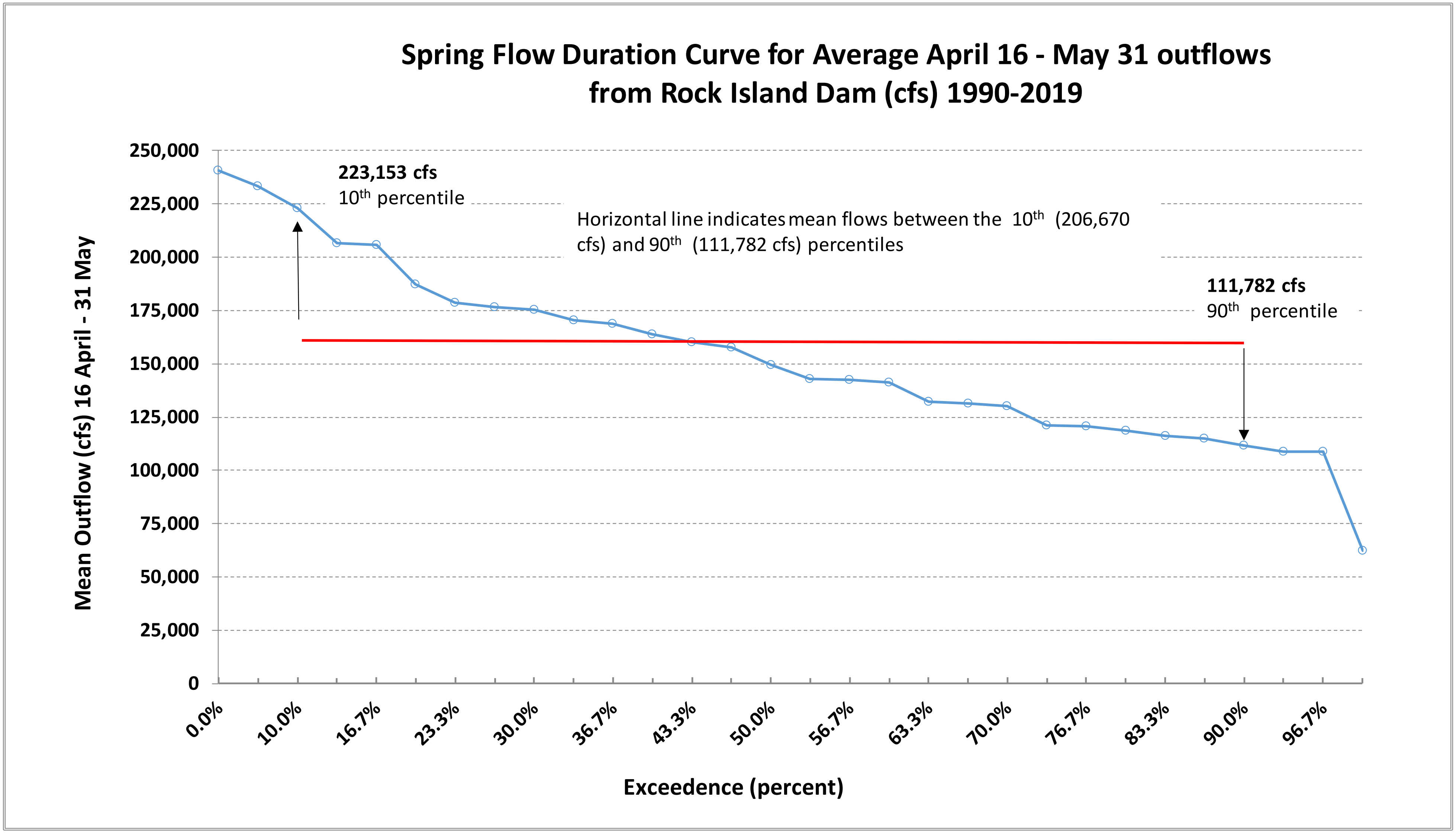
- Would include inflows from local tributaries upstream of HCP Projects

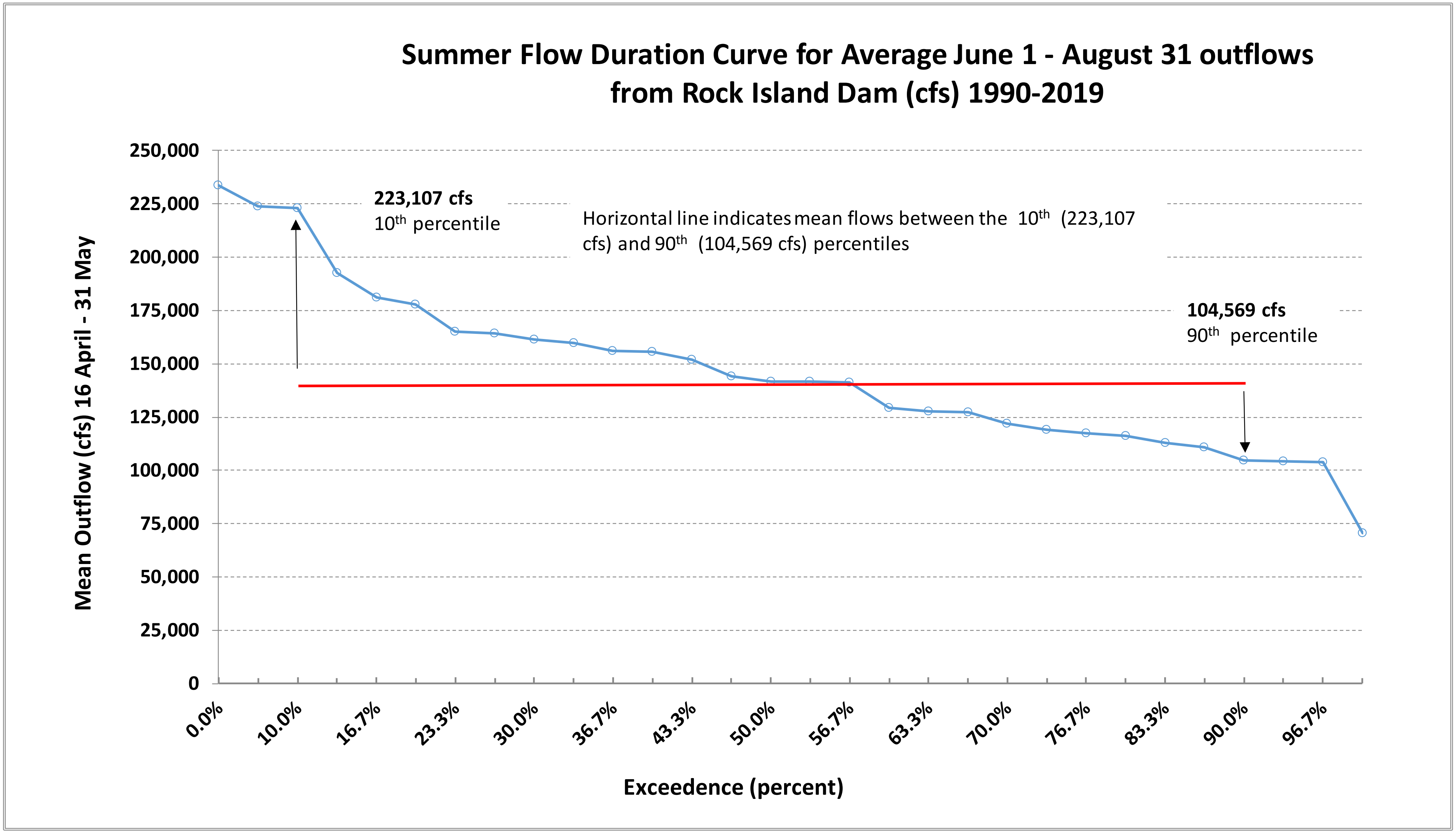
- Capture unique locally created flow events
  - Rain on snow event/early spring freshet
  - high flow/flood or drought conditions

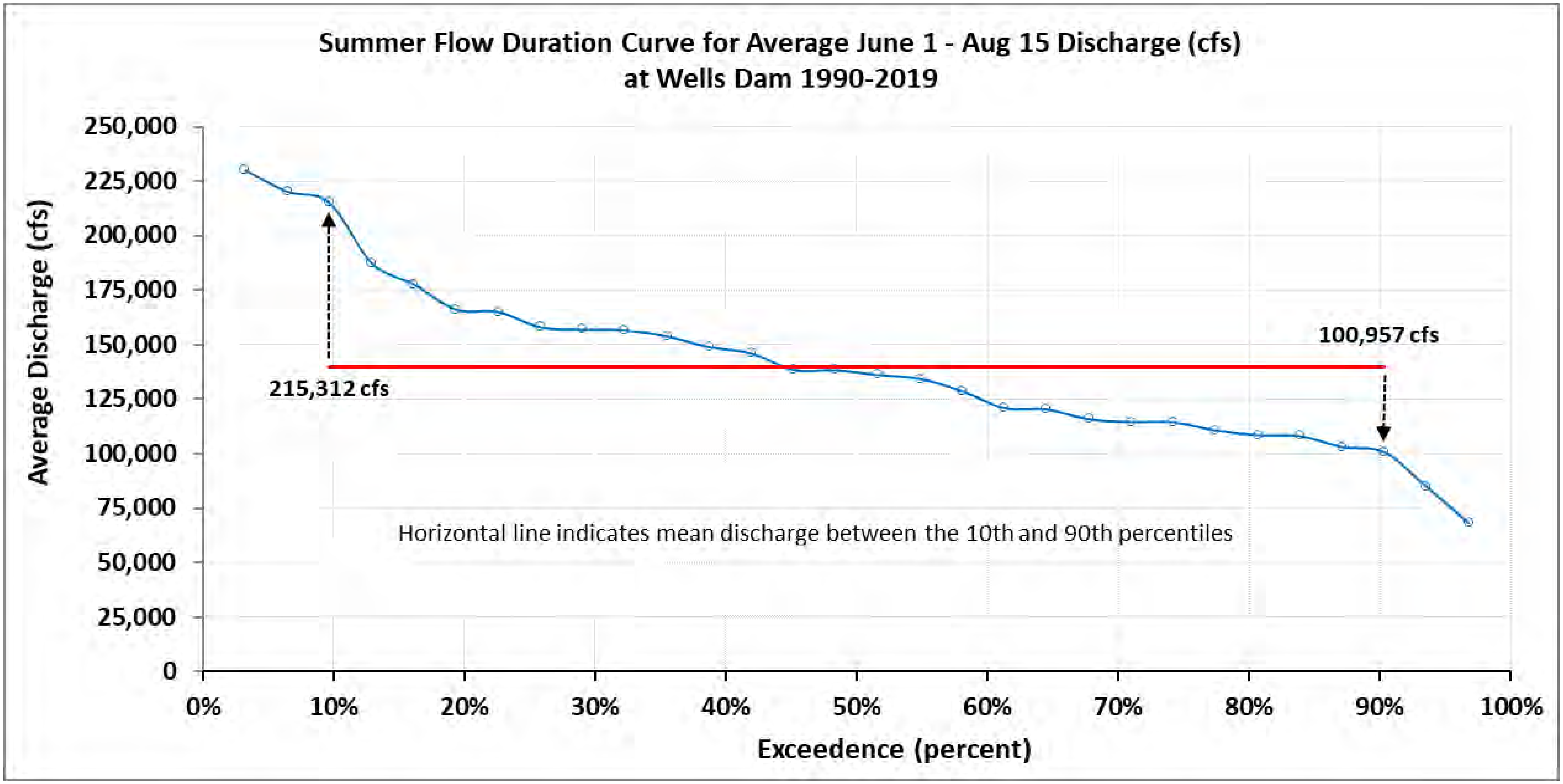
- Well understood project operations

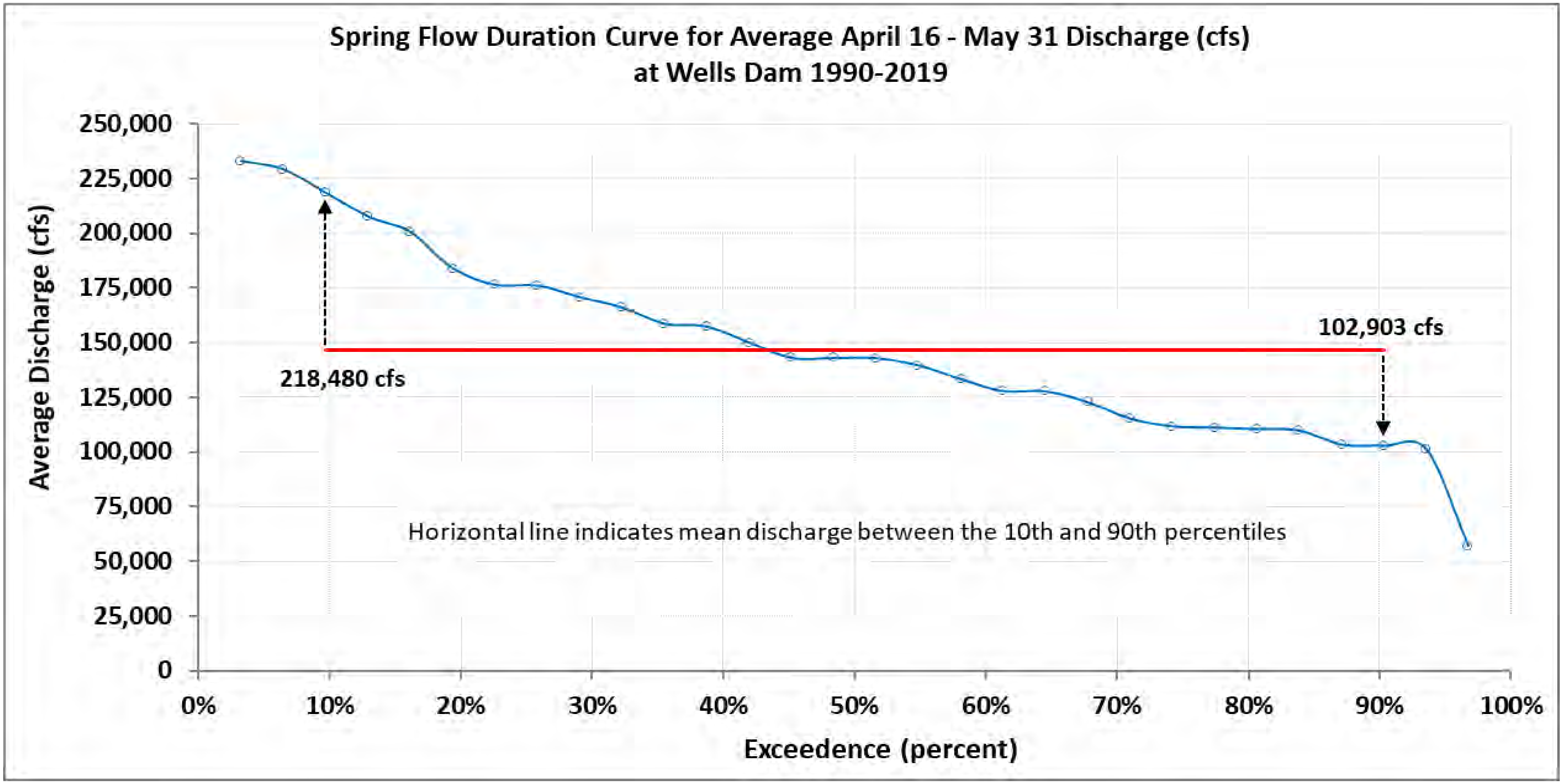

Spring Flow Duration Curve for Average April 16 - May 31 outflows from Rocky Reach Dam (cfs) 1990-2019
223,072 cfs
10th percentile
Horizontal line indicates mean flows between the 10th (223,072 cfs) and 90th (104,547 cfs) percentiles
104,547 cfs
90th percentile
Mean Outflow (cfs) 16 April - 31 May
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0.0%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
Exceedence (percent)

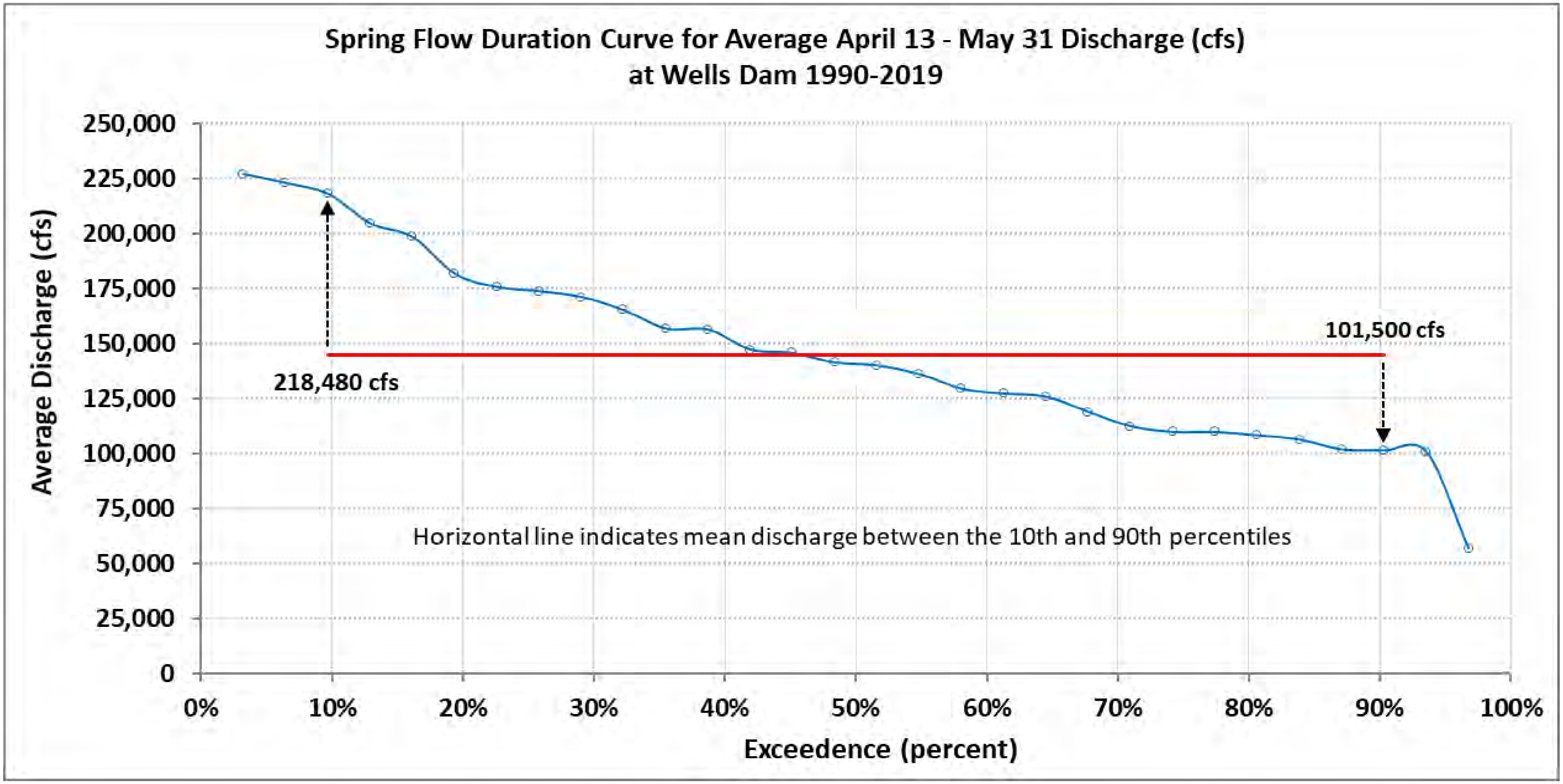

Summer Flow Duration Curve for Average June 1 - August 15 outflows from Rocky Reach Dam (cfs) 1990-2019
220,897 cfs
10th percentile
Horizontal line indicates mean flows between the 10th (220,897 cfs) and 90th (103,449 cfs) percentiles
103,449 cfs
90th percentile
Mean Outflow (cfs) 16 April - 31 May
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0.0%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
Exceedence (percent)


Spring Flow Duration Curve for Average April 16 - May 31 outflows from Rock Island Dam (cfs) 1990-2019
223,153 cfs
10th percentile
Horizontal line indicates mean flows between the 10th (206,670 cfs) and 90th (111,782 cfs) percentiles
111,782 cfs
90th percentile
Mean Outflow (cfs) 16 April - 31 May
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0.0%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
Exceedence (percent)


Summer Flow Duration Curve for Average June 1 - August 31 outflows from Rock Island Dam (cfs) 1990-2019
Mean Outflow (cfs) 16 April - 31 May
Exceedence (percent)
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0.0%
10.0%
16.7%
23.3%
30.0%
36.7%
43.3%
50.0%
56.7%
63.3%
70.0%
76.7%
83.3%
90.0%
96.7%
223,107 cfs
10th percentile
Horizontal line indicates mean flows between the 10th (223,107 cfs) and 90th (104,569 cfs) percentiles
104,569 cfs
90th percentile


Summer Flow Duration Curve for Average June 1 - Aug 15 Discharge (cfs)
at Wells Dam 1990-2019
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
Average Discharge (cfs)
215,312 cfs
100,957 cfs
Horizontal line indicates mean discharge between the 10th and 90th percentiles
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedence (percent)

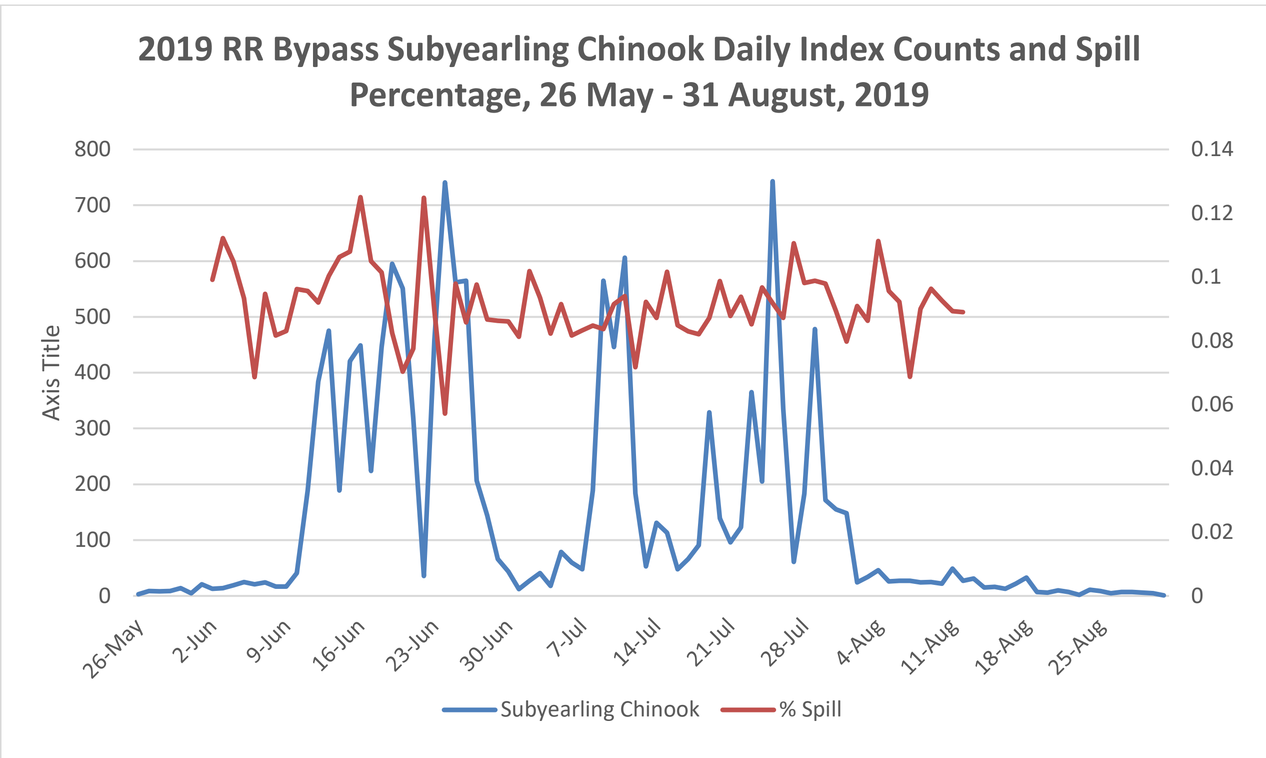

Spring Flow Duration Curve for Average April 16 - May 31 Discharge (cfs)
at Wells Dam 1990-2019
Average Discharge (cfs)
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedence (percent)
218,480 cfs
102,903 cfs
Horizontal line indicates mean discharge between the 10th and 90th percentiles

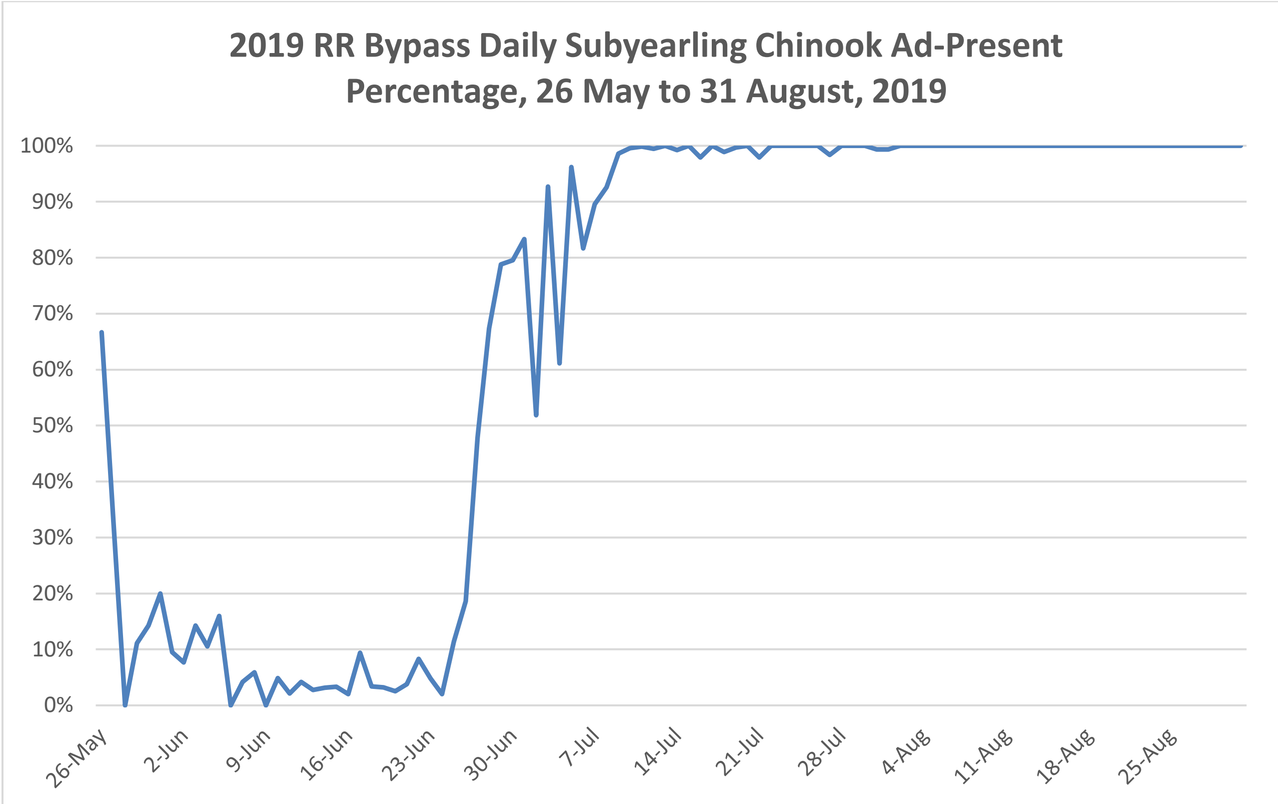

Spring Flow Duration Curve for Average April 13 - May 31 Discharge (cfs)
at Wells Dam 1990-2019
Average Discharge (cfs)
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedence (percent)
218,480 cfs
101,500 cfs
Horizontal line indicates mean discharge between the 10th and 90th percentiles

Chelan PUD
Rocky Reach and Rock Island HCPs
Draft 2019 Fish Spill Report

2019 ROCKY REACH
Summer Spill

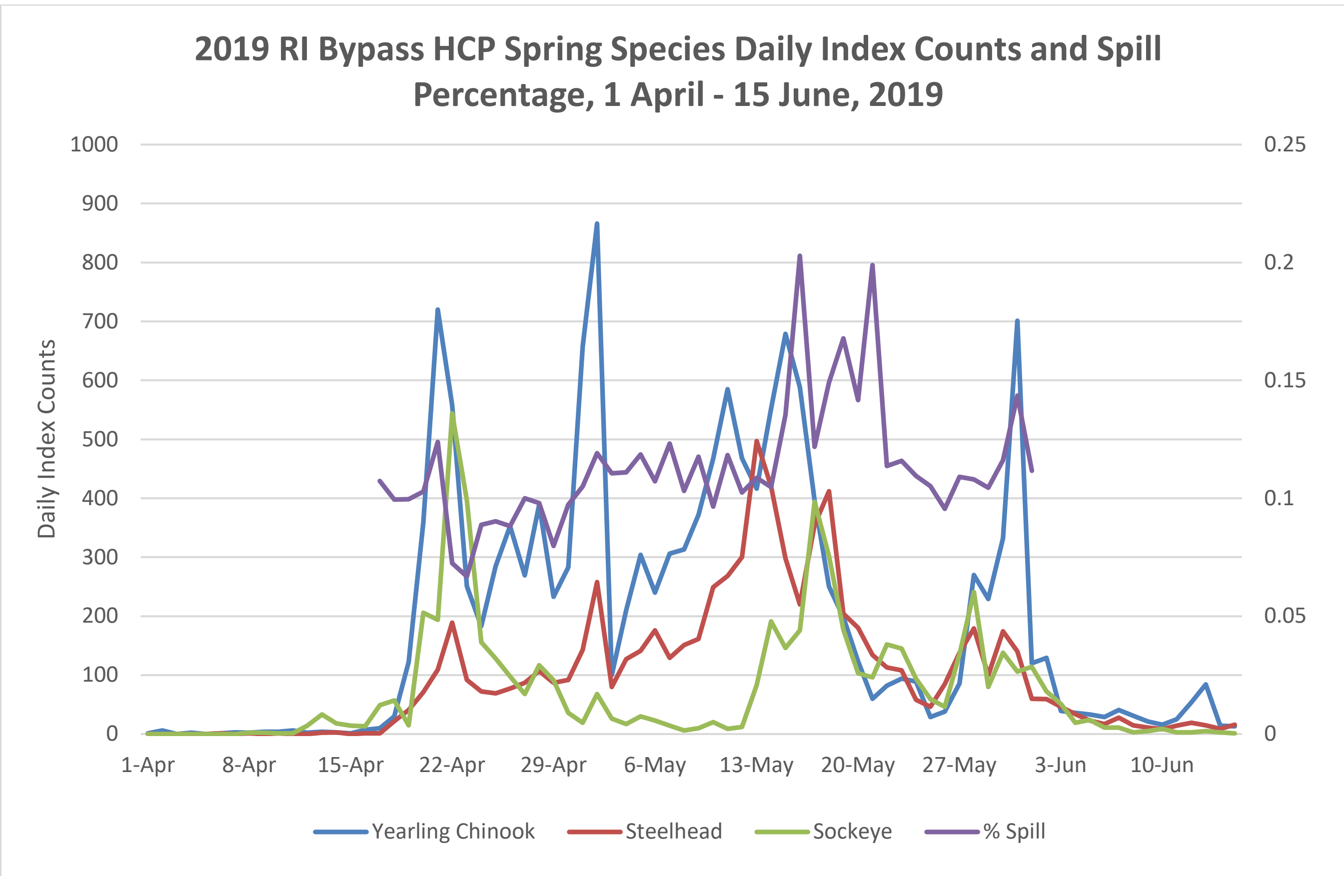
Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	2 June, 0001 hours
Spill stop date:	12 August, 2400 hours
95% Est. passage date:	28 July
Percent of run with spill:	99.1 % on 12 August (estimated as of 31 August)
Cumulative index count:	33,299 subyearling Chinook (as of 31 August)
Summer spill percentage:	9.09% (9.02% fish spill, plus 0.07% forced spill)
Avg river flow at RR:	100,417 cfs (2 June - 12 August)
Avg spill rate at RR:	9,131 cfs (2 June - 12 August)
Total spill days:	72




2019 RR Bypass Daily Subyearling Chinook Ad-Present Percentage, 26 May to 31 August, 2019
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
26-May
2-Jun
9-Jun
16-Jun
23-Jun
30-Jun
7-Jul
14-Jul
21-Jul
28-Jul
4-Aug
11-Aug
18-Aug
25-Aug

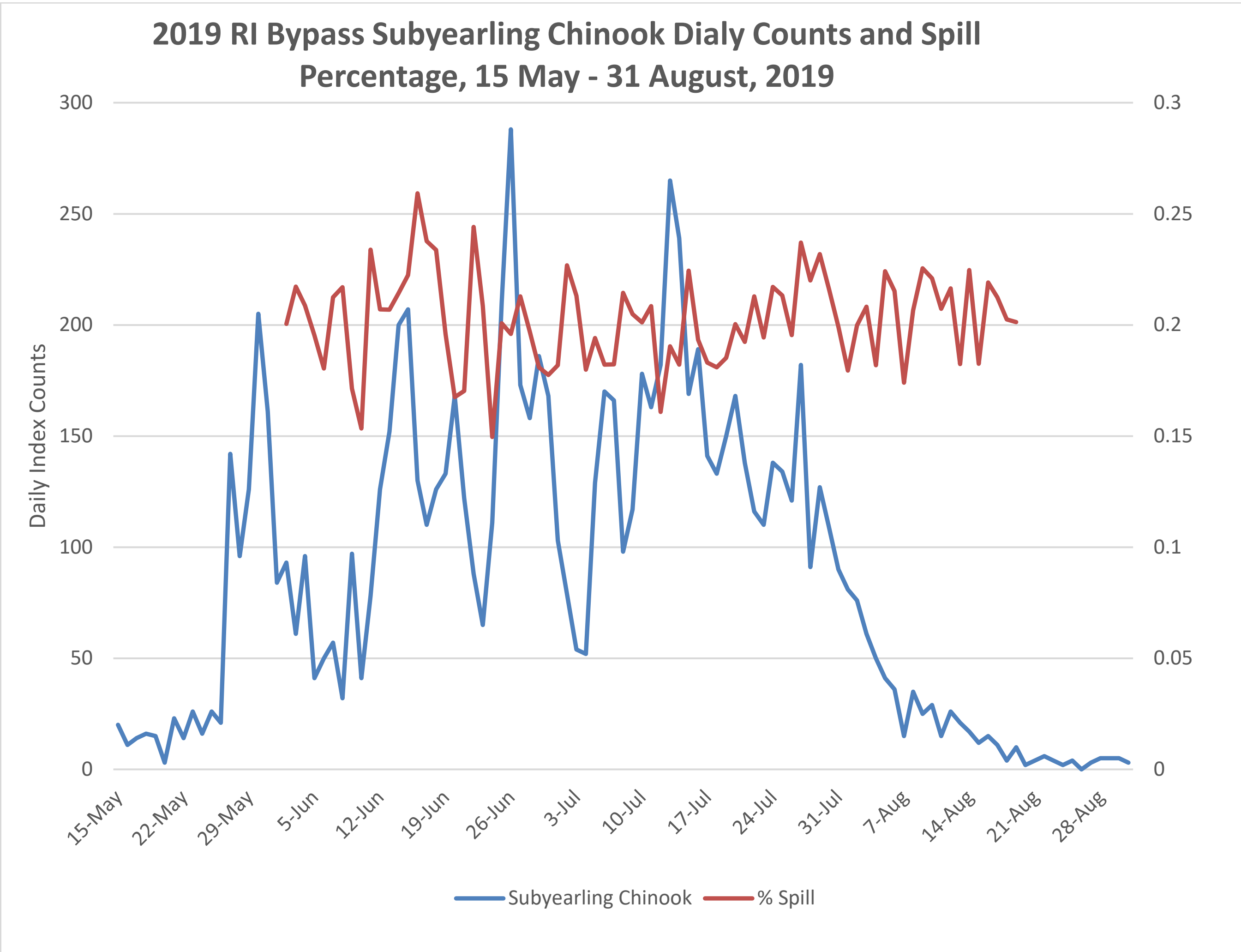
<u>2019 ROCK ISLAND</u>
Spring Spill

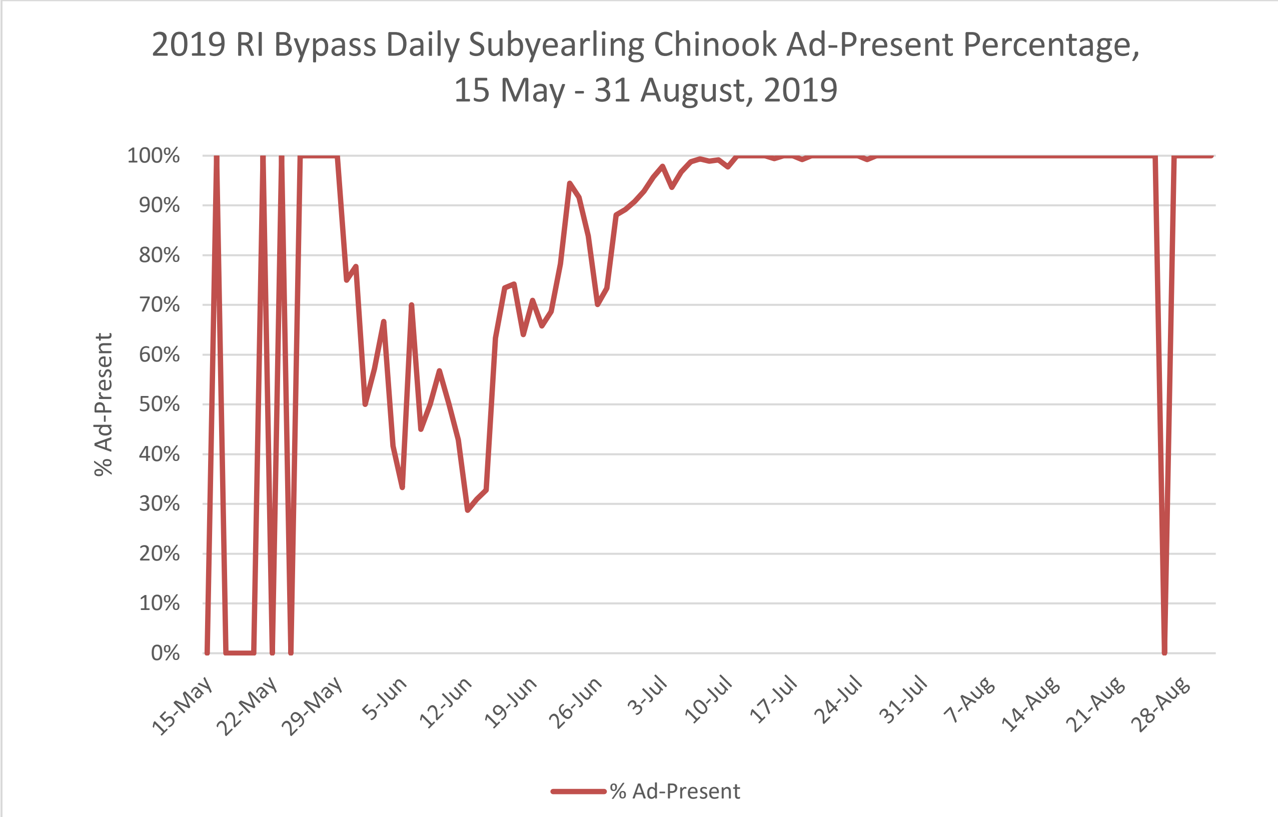
Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	17 April, 0001 hours
Spill stop date:	1 June, 2400 hours (immediate increase to 20% summer spill)
Percent of run with spill:	Yearling Chinook – 99.7%; steelhead – 99.9%; sockeye – 98.5% (spring and summer fish spill combined)
Cumulative index count:	18,855 yearling Chinook; 9,881 steelhead; 7,416 sockeye (as of 31 August)
Spring spill percentage:	11.67% (10.03% fish spill, plus 1.64% forced spill)
Avg river flow at RI:	128,137 cfs (17 April – 1 June)
Avg spill flow at RI:	14,948 cfs (17 April – 1 June)
Total spill days:	46



Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	2 June, 0001 hours
Spill stop date:	19 August, 2400 hours
95% Est. passage date:	3 August
Percent of run with spill:	98.5% on 19 August (estimated as of 31 August)
Cumulative index count:	11,876 subyearling Chinook (as of 31 August)
Summer spill percentage**:**	20.13% (19.90% fish spill, plus 0.23% forced spill)
Avg river flow at RI:	101,744 cfs (2 June - 19 August)
Avg spill flow at RI:	20,482 cfs (2 June - 19 August)
Total spill days:	79




2019 RI Bypass Daily Subyearling Chinook Ad-Present Percentage,
15 May - 31 August, 2019
% Ad-Present
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15-May
22-May
29-May
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
% Ad-Present

Juvenile Index Counts 2009-2019 from the Rocky Reach Juvenile Fish Bypass Sampling Facility and Rock Island Bypass Trap Smolt Monitoring Program (SMP) 1 April – 31 August (Tables 1 and 2).

Table 1. Rocky Reach Juvenile Bypass index sample counts, 2009-2019

Species	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018	2019
Sockeye	40,758	724,394	67,879	384,224	199,497	553,645	53,575	1,374,418	**60,432**	**597,162**	**34,212**
Steelhead	6,309	4,931	5,683	4,902	2,528	5,270	4,157	1,478	**2,928**	**1,458**	**3,769**
Yearling Chinook	18,946	33,840	24,400	95,207	29,018	15,871	32,220	41,676	**37,302**	**23,274**	**15,610**
Subyearling Chinook	11,944	59,751	17,246	5,774	22,073	22,327	37,104	8,905	**27,404**	**9,122**	**33,299**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2009-2019

Species	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018	2019
Sockeye	4,926	37,404	18,697	46,788	25,111	38,596	4,128	56,638	**11,117**	**76,245**	**7,416**
Steelhead	17,636	17,194	28,408	16,957	15,099	28,299	12,549	17,663	**32,135**	**24,731**	**9,881**
Yearling Chinook	9,225	11,802	26,407	25,759	28,324	26,429	16,762	44,784	**50,604**	**49,702**	**18,855**
Subyearling Chinook	8,189	23,205	27,397	27,298	17,170	34,527	15,349	13,270	**63,579**	**27,540**	**11,876**

***** In 2014, as directed by the HCP, Chelan PUD conducted bypass operations outside of the normal operating period of 1 April to 31 August to assess achievement of bypass operations for 95% of the subyearling Chinook outmigration. The Rocky Reach juvenile fish bypass operated from 1 April through 15 September, and the Rock Island bypass facility at powerhouse 2 operated from 1 April through 15 September.

Appendix B
Habitat Conservation Plan Hatchery Committees 2019 Meeting Minutes and Conference Call Minutes

FINAL

23 S. Wenatchee Avenue, Suite 220
Wenatchee, Washington 98801
509.888.2070

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: February 22, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the January 16, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCP) Hatchery Committees (HC) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held on Wednesday, January 16, 2019, from 9:00 a.m. to 1:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will attempt to provide coho salmon broodstock collection protocols to Mike Tonseth by early February for inclusion in the draft 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will research past co-mingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery or other locations (Item I-A). *(Note: this item is ongoing.)*
- Larissa Rohrbach will obtain approval or abstention from NMFS to approve the December 2018 meeting minutes (Item I-A). *(Note: NMFS did not respond to a request for a vote within 5 business days and therefore abstained. Brett Farman [NMFS] approved via email on February 13, 2019)*

- Larissa Rohrbach will schedule a tentative conference call on March 11, 2019, at 2:30 pm for the HCP-HC and PRCC HSC to discuss the draft 2019 Broodstock Collection Protocols (Item I-A). *(Note: Rohrbach sent a calendar placeholder via email on January 28, 2019)*
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation Plan for PUD Hatchery Programs (update to the 2017 Plan)* based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item II-A)
- Mike Tonseth will share draft 2019 Broodstock Collection Protocols with the HCP-HC and PRCC HSC by February 11 (Item II-B).
- Greg Mackey will confirm with Betsy Bamberger (Douglas PUD) whether Douglas PUD will use the Washington Animal Disease Diagnostic Laboratory (WADDL) for in-season bacterial kidney disease (BKD) testing during 2019 broodstock collection and confirm that WADDL methods will provide ELISA optical density test results (Item II-B).
- Kirk Truscott will discuss with Colville Confederated Tribe (CCT) biologists whether elemental signature analysis in fish scales, fin rays, or otoliths could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item II-B).
- Mike Tonseth will ask Andrew Murdoch for interim pre-spawn mortality data for spring Chinook salmon to incorporate into the 2019 Broodstock Collection Protocols (Item II-B).
- Larissa Rohrbach will add the size of upper Columbia River conservation programs as a periodic agenda item (Item II-C). *(Note: this item is ongoing)*
- Mike Tonseth will ask Andrew Murdoch to provide to the PUDs a list of passive integrated transponder (PIT)-tag arrays that will be shut down if not funded, the cost to operate and maintain these arrays, and the cost of PIT tagging steelhead at the Priest Rapids Dam Off-Ladder Adult Fish Trap (OLAFT; Item II-D)
- Larissa Rohrbach will draft email distribution lists merging HCP-HC and PRCC HSC recipients for review and approval by the HCP-HC and PRCC HSC and the HCP Coordinating Committees (Item II-E). (*Note these documents were emailed by Rohrbach to the HCP-HC and PRCC HSC on February 7, 2019)*
- Larissa Rohrbach and Tracy Hillman will revise and distribute meeting protocols for the HCP-HC and PRCC HSC for review and approval (Item II-E). (*Note these documents were emailed by Rohrbach to the HCP-HC and PRCC HSC on February 7, 2019)*
- Tracy Hillman will send the Statement of Agreement (SOA) regarding conflicts of interest to Larissa Rohrbach for inclusion of language in the meeting protocols (Item II-E). *(Note: The most recent Conflict of Interest Policy, dated January 26, 2013, was emailed by Hillman to Rohrbach on January 17, 2019)*

Wells Hatchery Committee

- Greg Mackey will provide a revised version of Douglas PUD's draft 2019 Monitoring and Evaluation (M&E) Implementation Plan for HCP-HC approval by email (Item III-A).

Decision Summary

- The HCP-HC and PRCC HSC agreed to add analysis of linkage disequilibrium to the Hatchery M&E Plan (update to the 2017 Plan). Chelan PUD, Douglas PUD, Grant PUD, U.S. Fish and Wildlife Service (USFWS), WDFW, CCT, and the Yakama Nation (YN) approved during the meeting on January 16, 2019, and NMFS abstained (Item II-A). *(Note: Brett Farman [NMFS] approved via email on February 13, 2019)*.

Agreements

- The HCP-HC and PRCC HSC agreed to the following items regarding joint meetings:
  - Combine meeting attendance into one forum
  - Issue one meeting agenda (including estimated duration for discussion items) and one set of meeting minutes
  - Develop similar protocols for documentation and distribution of materials in emails, pending agreement to final distribution lists
  - Develop joint meeting protocols
- Chelan PUD, Douglas PUD, Grant PUD, USFWS, WDFW, CCT, and YN approved during the meeting on January 16, 2019, and NMFS abstained (Item II-E). *(Note: Brett Farman [NMFS] approved via email on February 13, 2019)*

Review Items

- Larissa Rohrbach sent an email to the Rocky Reach and Rock Island HCs on January 21, 2019, notifying them that the 2019 Wells HCP Action Plan is available for a 30-day review with edits due to Tom Kahler by February 21, 2019.

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the December 19, 2018 Meeting Minutes (Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and explained the purpose for changes in the structure of today's agenda. Hillman noted that this will be the first meeting in which the HCP-HCs and PRCC HSC will meet with a single chair/facilitator on the same day. To meet the needs of the newly-formed meeting structure, changes have been made to the format of the agenda including subsections that reflect grouping of agenda items by the names of the committees (i.e., Wells, Rocky Reach, Rock Island, or PRCC HSC) and addressing action items within each subsection of the agenda. These changes will allow different parties to join or leave portions of the meeting that are relevant to their agreements.

Hillman asked for any additions or changes to the agenda. Additions were requested as follows:

- Hillman struck the NMFS consultation update due to lack of NMFS representation at the meeting.
- Sarah Montgomery moved the "Streamlining HCP-HCs and PRCC HSC meetings" discussion from the PRCC HSC section of the agenda to the Joint HCP-HCs/PRCC HSC section of the agenda.
- Catherine Willard added an item to the Rocky Reach and Rock Island HCs regarding an update on Tumwater Dam fishway repairs.

Larissa Rohrbach said there were only editorial or clarifying revisions to the December 19, 2018 meeting minutes and no substantive revisions requiring review by the HCP-HCs and PRCC HSC representatives. Representatives for Douglas PUD, Chelan PUD, Grant PUD, YN, and USFWS approved the December minutes. Representatives from WDFW and CCT abstained. Representatives from NMFS were not present due to the partial federal government shutdown, causing Hillman to delay final approval of the minutes for an additional 5 business days at which time NMFS may respond with their approval via email, or a lack of response will be noted as abstention from voting. If no response is obtained by January 24, 2019, Larissa Rohrbach said she will notify the NMFS representatives via email that the December minutes are approved. Brett Farman (NMFS) approved via email on February 13, 2019.

Action items from the HCP-HC meeting on December 19, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on December 19, 2018)*:

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*

  Hillman provided an update on the status of this action item by describing the multiple paired before-after, control-impact (MPBACI) modeling tool, which demonstrates population-level responses to spring Chinook salmon supplementation in paired treatment and control streams. Hillman said the model was built using data from the Coordinated Assessments Data Exchange[1] and other sources from the YN and Nez Perce tribes. He said he is still compiling data and revising the model.

  Hillman showed MPBACI models in his draft spreadsheet "Spring Chinook Stock/Recruit Data for Treatment and Reference Areas," and shared the following:

  - Calculation of before-after, control-impact (BACI) contrasts, which show the magnitude of supplementation effects
  - Graphical analysis of BACI data
  - Preliminary results from different statistical tests including analysis of covariance (ANCOVA), randomization tests, Monte Carlo simulations, simple T-tests using difference scores, and complex, mixed-model analyses of variance (ANOVA) using raw data. The latter includes fixed and random factors with nested and fully crossed factors.
  - A variance table showing the sources of variation that are analyzed using the mixed-model ANOVA model.
  - The advantages of using complex mixed models over simpler models. Hillman developed the complex models in SYSTAT.

  Hillman said he sent the mixed model to Dr. Barb Downes (University of Melbourne) for peer review, and she gave it a positive review. To check the model, Hillman said he ran it using data from both Drs. Downes and Carl Schwarz (Simon Fraser University, retired) and found the model performed correctly.

  Hillman will use this information to update the M&E Plan (update to the 2017 Plan). Greg Mackey asked what the difference is between this method and the previous approach. Hillman said this approach includes comparing a supplemented population with all control

[1] Further information about the Coordinated Assessments Data Exchange can be found at: https://www.streamnet.org/coordinated-assessments-des.

populations using one analysis. Previous plans used separate analyses for each paired treatment and control population. Hillman said he is still troubleshooting the equation for estimating the BACI contrast. In preliminary tests using data in Schwarz, (2015)[2] the equation does not always give the same answer provided by Schwarz. Hillman said when he is finished testing the models, he will make changes in the M&E Plan and pass the document to the HCP-HC and PRCC HSC for review.

- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey reminded the group that the purpose of this task is to determine whether to include jacks in broodstock, and if so, what is the appropriate number or percentage. He said on the pragmatic side in a small program, if the program is short on wild brood, it may be better to use a wild jack versus an older hatchery-origin male. He proposed avoiding a blanket prohibition against using jacks in broodstock collection protocols. Mike Tonseth agreed, considering managers would want to know parental origin of a jack to avoid using progeny of naturally spawning hatchery fish. Mackey agreed but noted that managers would also not want to exclude genetic variability associated with jacks. Keely Murdoch said previous analyses of spring Chinook salmon in the Wenatchee Basin as part of the reproductive success study show a stronger association with females than males. She said for this reason, incorporating age-3 males in the broodstock may not be a major issue. Mackey noted the question is whether early maturation is heritable and whether programs would increase early-maturing males in the hatchery population by including jacks in broodstock, and how that would vary in different years based on frequency-dependent spawning rates. Tonseth said there is a bigger size disparity between jacks and older males in spring Chinook salmon than summer Chinook salmon and suggested that broodstock chosen by size inevitably includes some jacks and excludes some older fish. He suggested that managers review data from previous years to find out if this has happened. Todd Pearsons said there may be some adjustments to the protocols this year to achieve numbers needed due to predicted low abundance. Tonseth confirmed the need to include some age-3 fish due to low projected escapement for 2019. Mackey noted this item is still ongoing and will not be resolved for the 2019 Broodstock Collection Protocols.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*

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[2] Schwarz, C.J. 2015. Analysis of BACI experiments. Chapter 12 in course notes for beginning and intermediate statistics. Available at: http://www.stat.sfu.ca/~cschwarz/CourseNotes.

Tracy Hillman suggested that Murdoch provide coho salmon broodstock collection protocols to Mike Tonseth earlier than late February to allow for draft broodstock collection protocols to be distributed 10 days before the February meeting, in line with the SOA specific to PUD programs. Murdoch said this is very early for developing their typical YN coho salmon protocol because coho salmon spawn so late in the year. Murdoch will attempt to provide the protocols in January.

- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting pre-spawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A).*
  Tonseth said additional analysis is needed and the timeline for providing modeling results will be extended because some federal staff involved in the modeling are furloughed due to the partial federal government shutdown.
- *Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item I-A).*
  Murdoch provided the 2018 Sliding Scale and Safety Net Update spreadsheet to the HCP-HC via email on January 3, 2019. Murdoch said this action item is complete. This item will be discussed in today's meeting (Item II-B.6).
- *Keely Murdoch will research past co-mingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery or other locations (Item I-A). (Note: this item is ongoing.)*
  Murdoch said this action item is ongoing.
- *Keely Murdoch will provide information about the passive integrated transponder (PIT)-tagging strategy for the coho salmon that will be acclimated at Twisp Pond (Item I-A).*
  Murdoch provided this update via email to the HCP-HC on January 3, 2019. Murdoch said this action item is complete.
- *Sarah Montgomery will obtain approval for the October and November 2018 meeting minutes from NMFS (Item I-A).*
  Montgomery said final versions of the meeting minutes were distributed on December 20, 2018, and this action item is complete.
- *Hatchery Committees representatives will review recommendations provided by the geneticist panel and send any additional questions to Tracy Hillman by January 7, 2019 (Item II-A).*
  Hillman said he received no feedback. All HCP-HC and PRCC HSC representatives agreed that information provided was sufficient. Hillman said he will follow up with geneticists to finalize the feedback. This item will be discussed in today's meeting (Item II-A).
- *Sarah Montgomery and Tracy Hillman will compile potential March 2019 conference call dates and send a poll to the Hatchery Committees representatives (Item IV-A).*

Montgomery sent the poll following the meeting on December 19, 2018, requesting feedback by January 4, 2019. Montgomery asked the representatives which date is best for an optional conference call to discuss broodstock collection protocols. She said the goal is to resolve changes to the protocols prior to the March 20, 2019 meeting. All representatives agreed to set a placeholder for a conference call on Monday, March 11, 2019, at 2:30 pm. Larissa Rohrbach said she will send a meeting invitation.

II. Joint HCP-HCs and PRCC HSC

A. Genetic Monitoring (Tracy Hillman)

Tracy Hillman reminded the committees that they received recommendations from the geneticist panel on December 10, 2018, in a document titled, *Response to questions posed by the HCP Hatchery Committee regarding the PUD M&E Plan*. Hillman said this item was available for review and discussion in December and no major issues were identified. Further, he received no requests from the HCP-HC or PRCC HSC representatives asking for additional information from the geneticists. Mike Tonseth suggested including this background information in the M&E Plan for PUD Hatchery Programs (update to the 2017 Plan). He said the responses from geneticists confirmed the committees are correct in their assumptions about monitoring. Hillman suggested also appending the document from the geneticists to the M&E Plan.

Todd Pearsons said there was one question about whether linkage disequilibrium was calculated for both hatchery and natural fish and asked if this has been resolved since the last conference call with geneticists. Greg Mackey confirmed the work has been done and included in the previous genetic reports. Pearsons said one reason feedback is needed now was to make sure genetic analysis was included in the M&E Plan to allow the PUDs to initiate contracting for genetics analysis and reporting.

Hillman asked the HCP-HC and PRCC HSC whether to include analysis for linkage disequilibrium (item No. 1 in the response from geneticists) in the current M&E Plan, which would allow the PUDs to contract for the work accordingly. Representatives present from the Wells, Rocky Reach, and Rock Island HCP HCs and PRCC HSC (Douglas PUD, Chelan PUD, Grant PUD, USFWS, YN, WDFW, and CCT) approved adding linkage disequilibrium analysis to the M&E Plan. A NMFS representative was not present (and unable to respond to a delayed vote for longer than 5 business days); therefore, NMFS abstained from voting. (Note: Brett Farman (NMFS) approved via email on February 13, 2019.)

Catherine Willard volunteered to update the M&E Plan by the March meeting.

B. Broodstock Collection Protocols Review (Todd Pearsons)

Mike Tonseth stated the level of likely adult management needed this year will likely be minimal due to low predicted returns for spring and fall Chinook salmon. He predicts meeting broodstock targets will be difficult. Todd Pearsons asked whether the HCP-HC and PRCC HSC can move forward with reviewing the broodstock collection protocols without run projections, because they have been a cause of delay in previous years. Tonseth answered that WFDW is on time for drafting the 2019 Broodstock Collection Protocols with run projections. Because early forecasts were showing such low numbers, WDFW is prioritizing incorporating realistic numbers into the protocols before releasing them for review. Tonseth said he will share the draft 2019 Broodstock Collection Protocols before February 10, 2019.

Pearsons said there is a need to resolve the discussion around the use of jacks in the broodstock. He said the existing protocols are very prescriptive. He asked if the protocols can be revised so they are more like guidelines rather than prescriptions—define the ideal but provide ways to deviate and find alternative choices. Tonseth said he has revised the draft for some programs to have less prescriptive protocols and allow for defaulting to backup options if in-season run forecasting changes.

Tracy Hillman reviewed issues that were raised during discussions of the 2018 Broodstock Collection Protocols (summarized in the document, *Emerging Discussions from draft 2018 Broodstock Collection Protocols*) to determine which ones are still outstanding.

1. Yakama Nation Summer Chinook Egg Requests at Wells Hatchery

This item was discussed throughout 2018 and is no longer outstanding.

2. Use of Age-3 Males in Broodstock

Greg Mackey is continuing to work on this item as discussed during review of the action items.

3. Bacterial Kidney Disease Risk Assessment

Hillman said this outstanding issue is whether WADDL's testing and reporting methods for BKD risk assessment are consistent with PUD program management, monitoring and reporting requirements. Tonseth said WDFW performed enzyme-linked immunosorbent assay (ELISA) testing in 2018 because WADDL's laboratory was not set up to complete the testing. Mackey said Betsy Bamberger coordinated with WADDL regarding how to report ELISA results in a way that managers are able to use the results to make decisions consistent with the past (i.e., using optical density [OD] values), but WADDL was reticent to produce an OD number that does not meet certified laboratory standards. Tonseth said from a resource management perspective this is still useful. Mackey said WADDL's approach is that if a fish has both a positive ELISA and quantitative polymerase chain reaction (qPCR) result, it is confirmed positive for BKD; however, the fish may be subclinical for pathology. Tonseth noted that a 2006 SOA specifies that OD values will be used to determine BKD risk assessment—this SOA would need to be updated. Tonseth said broodstock collection protocols are developed based on OD values for when to cull and when not to cull, so to be consistent with 2019 protocols, WADDL would need to provide a methodology that is relatable to the OD methodology.

Kirk Truscott asked whether a broodstock overage is always collected to allow for culling. Tonseth said yes, and if programs use WADDL for BKD risk assessment, there needs to be a method that allows managers to cull within the overage collected.

Mackey noted the WADDL approach is a more rigorous test and is less prone to false positives.

Mackey said he will work with Bamberger to compare the different testing and reporting methods between WDFW laboratories and WADDL and determine a management approach comparable to past years.

Hillman said this is a topic for future HCP-HC and PRCC-HSC meetings. Secondarily, the committees will need to determine whether a new SOA is needed with a new protocol for BKD culling.

4. *Differentiating Natural-Origin Okanogan River Spring Chinook Salmon During Methow Fish Hatchery Broodstock Collection at Wells Dam*

Hillman said this outstanding issue is how to identify Okanogan River natural-origin spring Chinook salmon from other natural-origin stocks during broodstock collection at Wells Dam for the Methow Fish Hatchery. This item is not relevant in 2019 but will be in the near future. Truscott and Tonseth determined the first 4-year-old returning fish from the Okanogan program will need to be differentiated at Wells Dam beginning in 2021.

Representatives present discussed possible methods for differentiating the stocks. Tom Kahler asked whether elemental scale analysis is a possible method. Truscott answered that it is possible to observe a signature from tributaries in different basins. The difficulty would be catching, holding, and analyzing fish in time. Pearsons said this was done with fish collected at Tumwater and results were mixed. Laser ablation was done on scales, fins, and otoliths. Life-history variation made it difficult as fish moved around between waters. Tonseth asked whether there is a way to set up methods in 2020 to analyze 3-year-old returners. Mackey suggested collecting yearling juveniles in September to test the methods. Truscott said that would likely not work because managers would need to collect scales from wild yearling smolts known to originate from the Okanogan. However, he said it may be worthwhile to collect scales in the future from PIT-tagging efforts and snorkel surveys. Tonseth agreed that it may be worthwhile to start analysis now to determine a baseline, but he does not know of an easy way to differentiate adults. Hillman said elemental signature analyses work but are costly. Truscott agreed and volunteered to discuss internally the feasibility of using elemental signature analysis for differentiating adults.

5. *Priest Rapids Hatchery Fall Chinook Salmon Integration – How to Achieve It Without Fish from Alternative Collection Sites/Methodology*

Hillman said this issue is about whether fall Chinook salmon adults collected at various collection sites can be integrated into the broodstock.

Tonseth said hook and line provided many more natural-origin fish than sampling at the OLAFT in 2018. Pearsons said the time between when the fishery was closed and when hook-and-line collection started created a situation where fish were readily caught this year and survived transport well. Tonseth said based on the current run forecast, this could be repeated in 2019. Pearsons said staff working on fish transportation were overwhelmed on the first day and methods for handling will be improved in the future. Tonseth said it may be good practice to allow 1 week between fishery closure and broodstock collection. Pearsons agreed but said collecting too late begins to overlap with fish spawning, which is not desirable for broodstock collection.

6. *Conservation Program Size*

Hillman said this topic is about adjusting conservation program sizes for upper Columbia spring Chinook salmon to make sure programs are set at biologically defensible levels.

Hillman asked whether the draft 2019 Broodstock Collection Protocols will include any adjustments to sizes of conservation programs. Tonseth said the discussion hasn't been had with the Yakama Nation yet given interim timing on analyses using previous methods and updating those data. There are new data to incorporate. Tonseth said he would also like to see life-cycle modeling results. If there is a size adjustment in the 2019 protocols, it will be an interim proposal based on the original methodology. He said it may not make a difference this year as they will be limited to one third of the run for broodstock collection and will likely need to use safety-net fish for the Chiwawa program. Pearsons asked for clarification. Keely Murdoch said that the end goal is to determine how many natural-origin fish will be used for broodstock. Technically the conservation program would be the same size but would be backfilled by safety-net fish, as needed. The safety-net program would increase if the conservation program decreases. If there are not enough natural origin fish to meet the requisite component, then the shortfall will be backfilled by hatchery progeny. Tonseth said if they were to collect the target number of natural-origin fish for the Nason program in 2019, that may require collecting the entire run and the program would be in the negative for natural-origin fish returning back to Nason Creek. He said we need to avoid "mining" the Chiwawa program to meet these needs. Pearsons asked, for instance, if the run projection is 75, the program would take one third (25 fish) and back-fill with safety-net fish? Tonseth answered yes. Pearsons said we may not need to know conservation program adjusted numbers for 2019—but it seems to take a long time to get updated program size so we should continue to work on it regularly (based on life-cycle modeling and pre-spawn mortality).

Pearsons asked whether the spawner-recruitment curves and assumptions could be updated in the meantime with more recent information. Hillman answered the analyses will be updated for the 10-Year Program Review report. Pearsons suggested that escapement calculations could be based on adult-to-juvenile escapement, because it seems like the adult-to-juvenile data are cleaner, with stronger correlations (r value). Hillman said this was true for some tributaries (such as the Chiwawa River), but not for others (such as the White River and Nason Creek).

Tonseth said these analyses will make no difference for how fish are allocated in 2019 due to low projected numbers but agrees these are important for future years and proposed updating targets and collection curves with interim values while data are being finalized. Murdoch said updating pre-spawn mortality data is the highest priority, specifically, including details on sex-specific and hatchery versus wild variation in pre-spawn mortality. She said WDFW is working on pre-spawn mortality data and suggested that they could provide a pre-spawn mortality average for updating the calculations in the meantime while data are being finalized. Tonseth said Tumwater Dam is the location at which those fish can be managed, so having accurate estimates of pre-spawn mortality upstream from Tumwater Dam is important to management. Kahler said he believes migration through Tumwater Canyon is an energetic challenge and pre-spawn mortality would largely manifest itself upstream from the dam. Tonseth said there is a significant difference in pre-spawn mortality between natural-origin and hatchery-origin fish that could be due to differences in fat reserves. Murdoch said this could also be related to where different fish hold and the habitat quality in those holding areas; some holding areas are energetically expensive, such as in the lower Chiwawa River.

Murdoch shared the spreadsheet, "2018 Sliding Scale and Safety Net Update with composite analysis and current sliding scale," which Sarah Montgomery distributed to the committees on January 3, 2019 (Attachment B). She said the spreadsheet included updated escapement numbers, updated smolt-to-adult return rates, and updated broodstock needs. Pearsons asked what other items should be updated, even if data are provisional. Tonseth answered that spawner escapement (for the future years) should be updated. Murdoch said the analysis is mainly missing updates to escapement goals, pre-spawn mortality, and needs an updated adult-to-adult spawner-recruitment goal. A new curve could be used for the next spawner escapement estimate. Hillman said he will be updating spawner-recruitment curves for the 10-Year Program Review report. Tonseth said he will ask Andrew Murdoch whether interim information can be used to update curves now, with footnotes indicating the curves are provisional and to be updated as pre-spawn mortality data are updated.

Pearsons asked what the next program is for evaluating changes to program size. Tonseth and Murdoch said the Wenatchee program should be analyzed and updated as much as possible before the Methow program, which does not yet have a management plan or technical document dictating the size of conservation programs in the basin. Tonseth said this has long been a recognized need for the Methow program and asked whether there is a need for a full-blown management plan as in the Wenatchee or something smaller. Pearsons asked if a rough schedule could be developed for including updated conservation size numbers for the Methow program in the 2020 broodstock collection protocols with the main motivation to avoid using more natural-origin fish than necessary. Tonseth said there is no previous analysis in the Methow to fall back on, so this will be a substantial amount of work, but can certainly be a goal for the committees. Kahler said that Douglas had analyzed this during the consultation for the Methow spring Chinook programs and had data and analysis to provide in the interim.

A discussion was had about adding a safety-net program to the Methow Hatchery programs. Murdoch asked whether a new population proportionate natural influence (PNI) model is needed for the Methow basin. Tonseth said there is no need for an additional safety-net program in the PNI model. Tonseth and Matt Cooper said the approach is to treat the Methow basin as an aggregate.

Pearsons said he is interested in completing these analyses and updates so it can be incorporated into the 2020 broodstock collection protocols knowing not all analyses or discussions will be done. Tonseth agreed but said it may not be reasonable due to uncertainties about feasibility. Pearsons asked to add the topic of evaluating conservation program sizes to the meeting agenda every few months to continue progress. Larissa Rohrbach said she will maintain this topic as a periodic agenda item.

Hillman said WDFW previously discussed streamlining the broodstock protocols and asked Tonseth how this effort is going. Tonseth said the protocols are shorter than previous years and he continues to find areas to streamline.

C. Re-Evaluating Conservation Program Size

See above discussion, Item II.B.6.

D. Brood Year 2020 Steelhead Sampling at the Off-Ladder Adult Fish Trap

Mike Tonseth informed the committees that WDFW PIT-tagging efforts at the Priest Rapids Dam OLAFT will switch from steelhead to spring Chinook salmon. This work is funded by the Bonneville Power Administration (BPA), and WDFW is proposing to use those funds to develop spring Chinook salmon mark-recapture escapement models. Thus, the PUDs may need to take over some portion or all of steelhead sampling at the OLAFT (in 2019) and/or funding future PIT-tag arrays operation and maintenance (O&M) that will lose funding from BPA. He said key questions to support a PIT-tag-based escapement model for steelhead have been answered and WDFW plans to redirect funds to the study of spring Chinook salmon. WDFW cannot use BPA funds to fund both steelhead and spring Chinook salmon investigations. He said WDFW needs to know whether there will be a PUD funding back-fill for PIT-tag-based steelhead work by early March. If there is no plan to fund steelhead sampling at the OLAFT, PIT-tag arrays currently funded by BPA for steelhead will be turned off for steelhead returns and switched on again for spring Chinook salmon returns. This affects the 2020 brood because sampling for brood at the OLAFT occurs in 2019. He said sites may be switched off in July 2019.

Tom Kahler asked for clarity on discretionary funding and the impetus for moving investigations to spring Chinook salmon rather than continuing work with steelhead. Kahler asked what the program will get from switching to spring Chinook salmon. Tonseth answered that this would allow for estimating spawning and pre-spawn mortality with a PIT-tag-based model rather than relying on spawner surveys. Keely Murdoch said there is a knowledge gap between spring Chinook salmon returning and spawning. In the Wenatchee Basin, data collected at Tumwater Dam and the reproductive success study provide some information, but there is a data gap for the rest of the upper Columbia Basin. Kahler said some of that information is available from sampling at Wells Dam. Tonseth said sampling at the OLAFT addresses the entire evolutionary significant unit, whereas sampling at Tumwater or Wells dams addresses local populations. Specifically, information is lacking on pre-spawn mortality in the Entiat River and lower Wenatchee River to estimate mainstem Columbia impacts to tributary populations. Kahler said it seems preliminary to use a PIT-tag-based model for spring Chinook salmon until results are finalized for steelhead.

Catherine Willard asked if WDFW is seeking PUD funding for the 2019 steelhead PIT-tagging at the OLAFT if the PUDs choose to use PIT-tag-based escapement calculations. Tonseth said he is making the PUDs aware that WDFW's plan is to move the funding to spring Chinook salmon because WDFW has determined their work on steelhead is complete. The redd-count-based model and PIT-tag-based model are currently available. He said the intent of this discussion to inform the HCP-HC and PRCC-HSC that PIT-tag-based escapement estimates for steelhead may not be available for 2020 without funding from the PUDs. The PUDs could fund PIT-tagging at the OLAFT or array O&M; although, the cost of array O&M is less predictable.

Kirk Truscott asked whether the lack of funding will affect PIT-tag arrays in the Okanogan and how eliminating arrays would affect spawner escapement estimates. Tonseth said certain arrays would stay on; the lowest mainstem arrays would stay functional for adult management and most others would be turned off. Truscott said most in the Okanogan would remain functional as they are funded by other entities, but there is a concern that money spent maintaining arrays in the Okanogan may not be well-spent if arrays in the Methow are being turned off and spawning escapement cannot be estimated because the PIT-tag-based model relies on escapement data from other tributaries. Tonseth said this should not be a concern because the lowest array will still be operating.

Todd Pearsons asked whether the BPA funding is Accord funding that goes to the State. Tonseth answered this is BPA Accord money that goes to WDFW to fund BPA's mitigation obligations; the State has some flexibility on where to use the funding. Willard asked if BPA needs to approve the switch of funding from sampling steelhead to Chinook. Tonseth stated WDFW informs BPA how the funding is being used. Tracy Hillman provided some history on how monitoring activities were identified for BPA funding. He said several years ago the region identified steelhead escapements as a data gap. It appears the data gap has been addressed with the development of the mark-recapture model and WDFW is now proposing to use BPA funding to address other data gaps. Hillman said it is up to the HCP-HC and PRCC HSC to determine if they will use the model, which requires PIT tagging and PIT-array maintenance, or use a different approach to estimate steelhead escapement. He said for spring Chinook salmon, carcass surveys will still be needed even if an escapement model is developed. The distribution of natural-origin and hatchery-origin fish is not well addressed with mark-recapture models.

Greg Mackey said the factors in this decision for Douglas PUD are sampling fish at Wells Dam versus OLAFT. The program could stop stock assessment at Wells Dam and could cut back collection in the fall at Wells Dam, but Douglas PUD needs to know how many arrays need O&M and how many are critical for decision making. Programs need to do a cost-benefit analysis to determine the most effective choice. Mackey asked whether other entities like the USFWS would contribute if they are producing steelhead, or are all entities producing spring Chinook salmon going to participate. It would be difficult to support PIT-tagging or array O&M if only one PUD supports it. Kahler said there is added scrutiny because PUDs are not allowed to fund activities without remuneration. Tonseth said it may make sense for the PUDs to fund arrays that are required for meeting obligations rather than PIT-tagging.

Truscott asked whether WDFW would begin PIT-tagging spring Chinook salmon at the OLAFT in 2020 and whether a permit is needed. Tonseth said that technically, their permits already allow sampling at Priest Rapids Dam. Truscott said he recalled issues with fish movement at the OLAFT. Pearsons said spring Chinook were delayed due use of the OLAFT during the year of the Wanapum Dam fracture. Truscott agreed that presents one problem and asked whether another problem could be a funding shortfall for both tagging and array O&M—if there is no PIT-tagging, there would be no reason to maintain arrays. Tonseth confirmed WDFW will fund either PIT-tagging at OLAFT or PIT array O&M, but not both.

Willard requested that Andrew Murdoch provide the PUDs with a list of arrays at risk of being shut down, the cost of maintaining those arrays, and the cost of tagging at Priest Rapids Dam.

Kahler asked what protocol would be followed for sampling spring Chinook salmon at the OLAFT. Tonseth answered the work would be the same as for steelhead in terms of staff time and tagging approximately 15% of the run. Kahler asked whether there is a concern about exacerbating pre-spawn mortality due to handling. Kahler said that adding another handling event to spring Chinook salmon will contribute to pre-spawn mortality, but at an unknown rate. Tonseth agreed there will be some double handling of fish, for instance at Priest Rapids and Tumwater dams, but the total number of fish handled will be less. Kahler asked whether they will all be trapped. Tonseth answered no. At Tumwater Dam (and Wells Dam), trapping would only be for adult management and broodstock collection because sampling at Priest Rapids Dam will have already collected data on age, gender, and other metrics, so fewer fish would be handled at upstream sites. Kahler said that reasoning may not apply to Wells Dam, where many wild fish need to be handled. Tonseth said a sort-by-code system could be used at upstream sites to avoid excessive handling if fish are tagged and sampled at Priest Rapids Dam.

Kahler said history indicates that teaming with BPA leads to establishing programs that then require PUD funding in the future. Truscott said the other way to look at it is that BPA funds the development of models, which then can be used by the PUDs for monitoring. Kahler said this is true for steelhead, but he does not see the utility for spring Chinook salmon because of the need to continue spawning-ground surveys to obtain carcass data. Murdoch said perhaps the PIT-tag data will provide more information or maybe it will be determined that carcass surveys provide more useful data for spring Chinook salmon. Programs should consider the best data sources on a case-by-case basis. Pearsons said that the same market forces (power prices) that are currently influencing BPA decisions and the same market conditions can also affect the PUDs funding decisions.

E. Streamlining HCP-HCs and PRCC HSC Meetings

Tracy Hillman summarized that the goal of facilitating HCP-HC and PRCC HSC meetings is to increase efficiency, but there is also a need to maintain separation between the committees. The following materials or approaches could be merged:

- Agendas and Minutes: Hillman suggested developing one set that covers everything and is sent to all members of all committees. Materials would be distributed in emails (rather than having to search a SharePoint site). The Grant PUD SharePoint and Douglas PUD Extranet sites would be treated as repositories for materials, but all materials will go out over email.

- Distribution lists: Sarah Montgomery said the distribution lists need to be approved by the HCP Coordinating Committees for distributing Wells, Rocky Reach, and Rock Island HCP materials to non-committee members. Douglas PUD and Chelan PUD need to review their rules about distribution. Representatives present agreed that draft minutes and draft materials should only go to representatives and alternates due to confidentiality requirements. Anything final should go to the larger distribution groups. Larissa Rohrbach said she will develop proposed distribution lists and send them out to representatives and alternates for their review. Once the HCP-HC approve the lists, they will be provided to the HCP Coordinating Committees for approval.
- Protocols: Hillman noted his roles for the HCP-HC is Chairman and for the PRCC HSC is Facilitator, which entail different roles in decision-making processes between the HCP-HC and PRCC and HSC. Rohrbach will update protocols to reflect merging meeting forums and make any updates based on the realistic application of the protocols. Rohrbach will send updated protocols to representatives and alternates for approval. Hillman said the protocols need updated language on conflicts of interest and will send updated language to representatives and alternates for approval.
- Agenda order: Hillman asked whether the order that the committees present their items on the agenda should rotate or be fixed. All agree that Joint HCP-HC items should come first, then committees with shortest agenda items (i.e., those that can be addressed quickly) should go first following joint items. Todd Pearsons asked whether predicted times could be added to the agenda. Hillman said there has been pushback against this idea within the HCP-HC because they want to make sure agenda items are fully vetted without a time limit. Mike Tonseth said adding times lets invited speakers know when they should arrive or call into the meeting. Greg Mackey said time limits are good for items that may not be resolved in the current meeting. All agreed to include estimated times for each agenda item (representatives will include a time estimate when they propose an agenda item).
- Naming conventions: the committee name will be used to indicate discussion topics (i.e., Wells HC, Rocky Reach HC, Rock Island HC, and PRCC HSC) in both the agenda and meeting notes. In merged materials, the group will be named "HCP-HC and PRCC HSC" or shortened to "HC/HSC."

All HCP-HC and PRCC HSC representatives present (Chelan PUD, Douglas PUD, Grant PUD, USFWS, WDFW, YN, CCT) voted to approve merging attendance, meeting agendas, meeting minutes, documentation, and distribution of materials in emails for HCP-HC and PRCC HSC business. A NMFS representative was not present and unable to respond to a delayed vote for longer than 5 business days; therefore, NMFS abstained from voting. (Brett Farman [NMFS] approved via email on February 13, 2019).

III.Wells Hatchery Committee

A. Douglas PUD 2019 Implementation Plan (Greg Mackey)

Keely Murdoch said the status quo in the Douglas PUD 2019 M&E Implementation Plan may not work for steelhead if certain aspects of steelhead PIT tagging and data analyses are not funded by BPA. Therefore, she requested revisions to the plan allowing for flexibility for planning around this uncertainty, as representatives did for the Chelan PUD 2019 Implementation Plan. Greg Mackey said the proposed revisions seemed vague, so he has not decided whether to send that version to the HCP-HC for approval. Murdoch said she attempted to use the same language as was approved for the Rocky Reach and Rock Island Plan that draws attention to the potential changes in activities in 2019 to support broodstock selection. Mackey said if a version with this proposed revision is approved, he foresees a need for a one-page amendment in the future once it is clear what methods will be used to enumerate steelhead. Murdoch said as phrased this does not commit Douglas PUD to one course of action or another. Mackey said the edits to the Douglas PUD plan have not been discussed yet and that today's discussion on funding PIT-tagging activities and arrays created the need for further internal discussion before finalizing the 2019 M&E Implementation Plan language. Mackey said he will distribute a revised version of the plan to the committees for approval once Douglas PUD discusses this internally.

IV. Rocky Reach and Rock Island Hatchery Committees

A. 2019 Spring Chinook Salmon and Coho Salmon Final Acclimation at Chewuch Pond (Catherine Willard)

Catherine Willard provided an update and reminder that 2019 is the first year coho salmon and spring Chinook salmon will be co-acclimated together in the Chewuch Pond. She said 80,000 coho salmon will be co-mingled with spring Chinook salmon. Chelan PUD is operating the pond.

B. Tumwater Dam Fishway Maintenance Update (Catherine Willard)

Catherine Willard provided an update on fishway maintenance at Tumwater Dam involving reinforcing the walls around the fishway. She said completion of the project has been delayed and the project will not be completed until mid- to late-March. The fishway will remain open through that time. Trapping will still occur at night around construction activities. Mike Tonseth said WDFW will be doing minimal adult management at Tumwater Dam this year and may not need to trap fish.

V. PRCC HSC

A. Committee Updates and Meeting Summary Review (Todd Pearsons)

Todd Pearsons asked the PRCC HSC representatives whether it is still useful to have routine updates on the activities of other committees such as the Fall Chinook Work Group, PRCC, or U.S. v. Oregon. Pearsons recommended eliminating these routine updates due to lack of interest and time constraints, but if there are important issues from other committee meetings, these will be brought onto the agenda. All representatives present agreed.

Pearsons said the November conference call meeting summary is going to be approved via email votes provided to Andy Chinn (Ross Strategic). Pearsons requests that all members make their votes before the end of January so Ross Strategic can finalize the last meeting summary of 2018.

VI. Administration

A. Next Meetings

Hillman asked the HCP-HC and PRCC HSC whether they want to schedule an additional conference call in March to potentially discuss broodstock collection protocols. All agreed. Sarah Montgomery noted the best date based on responses to the poll is March 11. All agreed to a potential conference call on March 11, 2019, at 2:30 p.m.

The next HCP-HC and PRCC HSC meetings are on February 20, 2019 (Grant PUD), potential conference call on March 11, 2019, and March 20, 2019 (Grant PUD).

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	2018 Sliding Scale and Safety Net Update with composite analysis and current sliding scale

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*	Colville Confederated Tribes
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Matt Cooper*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Ryan Fortier°	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Pat Wyena°	Wanapum Tribe

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

Summary

1. Sliding Scale

a. Suggest initially implementing sliding scale A (or similar). Sliding Scale A is based upon the range in NOR runs sizes observed between 1999 and 2008. PNI of 0.67 will likely be achieved in the near term. Sliding scales based on percentiles will need to be revisited and adjusted as increased NOR run sizes return. Suggest revisiting sliding scale on 5-year intervals.

b. Sliding Scale B is based on the range of run sizes that might be observed, limited by the escapement goal. If sliding scale B is used in the near term, PNI goals will likely not be met. However a sliding scale based upon the range of run sizes may be appropriate as we begin to see larger run sizes. Alternatively a sliding scale based upon the range of run sizes observed may need to be adjusted as run sizes increase.

2. Conservation / Safety Net program options

Options were run modeling results (PNI and escapement upstream of TWD) using varying conservation / Safety Net program sizes

1 **Conservation / Safety Net (100% and 0%)** resulted in large numbers of excess HOR to be surplused, severe restrictions on spawning escapement, and the lowest PNI of all options modeled.

2 **Conservation / Safety Net (67% and 33%)** resulted in a slightly higher total escapement upstream of TWD and slightly improved PNI, however escapement was still largely restricted below goals and large surpluses of hatchery origin fish still occur on a regular basis

3 **Conservation/ Safety Net (50% and 50%; For the Chiwawa Program this would be a 150K conservation program)** resulted in a higher total escapement, meeting escapement goals in 6 of 10 years, and PNI goals are met. Excess HOR are reduced. However in lowest return years HORs from the conservation program may be insufficient to meet escapement goals associated with the PNI and broodstock goals.

4 **Conservation / Safety Net (33% and 67%)** resulted in the highest total escapement with the least amount of excess HORs, however given the small size of the conservation program, HOR fish may not be available in low to moderately low years to meet the escapement goals associated with the sliding scale of PNI. So this option may not actually result in higher escapements.

A. Based on Percentiles or NOR returns from 1999-2008

	NOR Run Size					
Percentile	**Chiwawa**	**Nason Creek**	**White**	**Wenatchee River**	**PNI**	**Nason/Chiwawa Comp**
<75th	>372	>350	>87	>910	>.8	>774
50% - 75%	278-372	259-349	68-86	631-909	≥ 0.67	517-773
25% - 50%	208-277	176-258	41-67	525-630	≥ 0.50	372-516
10%-25%	176-208	80-175	20-40	400-524	≥ 0.40	280-371
<10th	<175	<80	<20	<400	Any PNI	<280

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal **(Conservation Programs Only - Safety Net Excluded)**	74			
Nason Creek Escapement Goal	542			
NOR Target Extraction Rate	33%			
Conservation Program Size		**125,000**	**56%**	
Safety Net Program Size		**98,670**	**0%**	
		223,670		

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**608**	0.004864	**581**	0.00465
Minimum HOR runs size:	**384**	0.003076	**45**	0.00036
Maximum HOR run size:	**792**	0.006334	**1953**	0.01562
	10 year	**All**		
Mean HO R Needed	**429**	**376**		
Minimum HOR Needed	**139**	**116**		
Maximum HOR Needed	**557**	**594**		
Mean / Total Escapement	**503**	5033	**469**	**8744**
Mean/ Total Recruits	**366**	3795	**365.51**	**6945**
Mean PNI*	**0.44**		**0.46**	

***PNI Calcuated for the whole basin may be higher**

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed	Total Esc'nt	pHOS	PNI Target	PNI	Est. No. Adult NOR Recruits	2.96E-01 / 2.00E-03
1999	22	0.333	7	67	0.10	15	527	594	542	0.97	Any	0.09	393	
2000	223	0.333	74	0	0.99	149	393	466	542	0.72	0.50	0.58	393	
2001	294	0.333	74	0	1.00	220	220	294	440	0.50	0.67	0.67	375	
2002	347	0.333	74	0	1.00	273	257	257	530	0.48	0.67	0.67	391	
2003	193	0.333	64	10	0.86	129	413	423	542	0.76	0.50	0.53	393	
2004	297	0.333	74	0	1.00	223	222	222	445	0.50	0.67	0.67	376	
2005	83	0.333	28	46	0.37	55	70	116	125	0.56	0.40	0.40	229	
2006	118	0.333	39	35	0.53	79	341	376	420	0.81	0.40	0.40	370	
2007	82	0.333	27	47	0.37	55	70	117	125	0.56	0.40	0.40	229	
2008	139	0.333	46	28	0.63	93	449	477	542	0.83	0.40	0.43	393	
2009	164	0.333	55	19	0.74	109	433	452	542	0.80	0.40	0.48	393	
2010	59	0.333	20	54	0.27	39	503	557	542	0.93	Any	0.22	393	
2011	252	0.333	74	0	1.00	178	364	364	542	0.67	0.50	0.60	393	
2012	222	0.333	74	0	1.00	148	394	394	542	0.73	0.50	0.58	393	
2013	72	0.333	24	50	0.32	48	494	544	542	0.91	Any	0.26	393	
2014	199	0.333	66	8	0.90	133	409	417	542	0.76	0.50	0.54	393	
2015	145	0.333	48	26	0.65	97	445	471	542	0.82	0.40	0.44	393	
2016	143	0.333	48	26	0.64	95	447	473	542	0.82	0.40	0.44	393	
2017	90	0.333	30	44	0.41	60	95	139	155	0.61	0.40	0.40	256	
Mean	**165**		**50**	**23**	**0.69**	**116**	**347**	**376**	**469**	**0.72**		**0.46**	**365.51**	Average All (1999 Included)
10-Year Mean	**149**		**48**	**26**	**0.65**	**100**	**403**	**429**	**503**	**0.79**		**0.44**	**366**	Average Last 10 years

Summary of Option 1: This option has the potential to produces the lowest PNI, lowest Escapement, and lowest total Recruits. Hatchery returns are in excess of what is needed in all years.

Reduced Conservation Program and increased Safety-Net

Brood Goal	59		
Nason Creek Escapement Goal	542		
Target Extraction Rate	33%		
Conservation Program Size		**100,000**	**45%**
Safety Net Program Size		**123,670**	**55%**
		223,670	

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**486**	0.004864	**465**	0.00465
Minimum HOR runs size:	**308**	0.003076	**36**	0.00036
Maximum HOR run size:	**633**	0.006334	**1562**	0.01562
	10 year	**All**		
Mean HO R Needed	**422**	**380**		
Minimum HOR Needed	**209**	**166**		
Maximum HOR Needed	**542**	**579**		
Mean / Total Escapement	**512**	5118	**487**	**9118**
Mean/ Total Recruits	**375**	3849	**375.17**	**7128**
Mean PNI*	**0.48**		**0.49**	

***PNI Calcuated for the whole basin may be higher**

						Theoretical		Total						**2.96E-01**
Year	**Estimated Nason NOR Run Size at TWD**	**Target Extraction Rate**	**NOB**	**HOB**	**pNOB**	**NOS**	**HOS**		**Total Esc'nt**	**pHOS**	PNI Target	**PNI**	Est. No. Adult NOR Recruits	**2.00E-03**
1999	22	0.333	7	52	0.12	15	527	579	542	0.97	Any	0.11	393	
2000	223	0.333	59	0	1.00	164	378	437	542	0.70	0.50	0.59	393	
2001	294	0.333	59	0	1.00	235	225	284	460	0.49	0.67	0.67	379	
2002	347	0.333	59	0	1.00	288	254	254	542	0.47	0.67	0.68	393	
2003	193	0.333	59	0	1.00	134	408	408	542	0.75	0.50	0.57	393	
2004	297	0.333	59	0	1.00	238	222	222	460	0.48	0.67	0.67	379	
2005	83	0.333	28	31	0.47	55	135	166	190	0.71	0.40	0.40	281	
2006	118	0.333	39	20	0.67	79	463	483	542	0.85	0.40	0.44	393	
2007	82	0.333	27	32	0.46	55	125	157	180	0.70	0.40	0.40	275	
2008	139	0.333	46	13	0.78	93	449	462	542	0.83	0.40	0.49	393	
2009	164	0.333	55	4	0.93	109	433	437	542	0.80	0.40	0.54	393	
2010	59	0.333	20	39	0.33	39	503	542	542	0.93	Any	0.26	393	
2011	252	0.333	59	0	1.00	193	349	349	542	0.64	0.50	0.61	393	
2012	222	0.333	59	0	1.00	163	379	379	542	0.70	0.50	0.59	393	
2013	72	0.333	24	35	0.41	48	494	529	542	0.91	Any	0.31	393	
2014	199	0.333	59	0	1.00	140	402	402	542	0.74	0.50	0.57	393	
2015	145	0.333	48	11	0.82	97	445	456	542	0.82	0.40	0.50	393	
2016	143	0.333	48	11	0.81	95	447	458	542	0.82	0.40	0.49	393	
2017	90	0.333	30	29	0.51	60	180	209	240	0.75	0.40	0.40	310	
Mean	**165**		**44**	**15**	**0.77**	**121**	**359**	**380**	**487**	**0.73**		**0.49**	**375.17**	Average All (1999 Included)
10-Year Mean	**149**		**45**	**14**	**0.76**	**104**	**408**	**422**	**512**	**0.79**		**0.48**	**375**	Average Last 10 years

Summar 2: Increased PNI, Increased escapement, Increased recruitment. In below average years will need to use safety net fish in broodstock and/or spawning grounds (may not be a bad thing).

Reduced Conservation Program and increased Safety-Net

Brood Goal	50		
Nason Creek Escapement Goal	542		
Target Extraction Rate	33%		
Conservation Program Size		85,000	38%
Safety Net Program Size		138,670	0%
		223,670	

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**413**	0.004864	**395**	0.00465
Minimum HOR runs size:	**261**	0.003076	**31**	0.00036
Maximum HOR run size:	**538**	0.006334	**1328**	0.01562

	10 year	**All**		
Mean HO R Needed	**444**	**426**		
Minimum HOR Needed	**502**	**509**		
Maximum HOR Needed	**533**	**570**		
Mean / Total Escapement	**542**	5420	**535**	**10179**
Mean/ Total Recruits	**393**	3933	**392.19**	**7452**
Mean PNI*	**0.50**		**0.52**	

***PNI Calcuated for the whole basin may be higher**

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed From Conservation Program	Total Esc'nt	pHOS	PNI Target	PNI	Est. No. Adult NOR Recruits	2.96E-01 2.00E-03
1999	22	0.333	7	43	0.15	15	527	570	542	0.97	Any	0.13	393	
2000	223	0.333	50	0	1.00	173	369	419	542	0.68	0.50	0.59	393	
2001	294	0.333	50	0	1.00	244	241	291	485	0.50	0.67	0.67	384	
2002	347	0.333	50	0	1.00	297	245	245	542	0.45	0.67	0.69	393	
2003	193	0.333	50	0	1.00	143	399	399	542	0.74	0.50	0.58	393	
2004	297	0.333	50	0	1.00	247	233	233	480	0.49	0.67	0.67	383	
2005	83	0.333	50	0	1.00	33	509	509	542	0.94	0.40	0.52	393	
2006	118	0.333	50	0	1.00	68	474	474	542	0.87	0.40	0.53	393	
2007	82	0.333	50	0	1.00	32	510	510	542	0.94	0.40	0.52	393	
2008	139	0.333	46	4	0.93	93	449	453	542	0.83	0.40	0.53	393	
2009	164	0.333	50	0	1.00	114	428	428	542	0.79	0.40	0.56	393	
2010	59	0.333	20	30	0.39	39	503	533	542	0.93	Any	0.30	393	
2011	252	0.333	50	0	1.00	202	340	340	542	0.63	0.50	0.61	393	
2012	222	0.333	50	0	1.00	172	370	370	542	0.68	0.50	0.59	393	
2013	72	0.333	24	26	0.48	48	494	520	542	0.91	Any	0.34	393	
2014	199	0.333	50	0	1.00	149	393	393	542	0.73	0.50	0.58	393	
2015	145	0.333	48	2	0.97	97	445	447	542	0.82	0.40	0.54	393	
2016	143	0.333	48	2	0.95	95	447	449	542	0.82	0.40	0.54	393	
2017	90	0.333	30	20	0.60	60	482	502	542	0.89	0.40	0.40	393	
Mean	**165**		**43**	**5**	**0.92**	**122**	**405**	**426**	**535**	**0.75**		**0.52**	**392.19**	Average All (1999 Included)
10-Year Mean	**149**		**42**	**8**	**0.83**	**107**	**435**	**444**	**542**	**0.80**		**0.50**	**393**	Average Last 10 years

Option 3. Mean run size for the conservation program is less than the mean number of HORs needed for broodstock and spawning grounds.
Would need to use safety-net fish in most years. Not recommened.

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal (Conservation Programs Only - Safety Net Excluded)	150 (76 Chiwawa, 74 Nason)		
Nason/Chiwawa Escapement Goal	1129		
NOR Target Extraction Rate	33%		
Combined Conservation Program Size (125K Nason, 144K Chiv		**269,000**	**73%**
Nason Safety Net Program Size		**98,670**	**27%**
		367,670	

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**1308**	0.004864	**1251**	0.00465
Minimum HOR runs size:	**827**	0.003076	**97**	0.00036
Maximum HOR run size:	**1704**	0.006334	**4202**	0.01562
	10 year	**All**		
Mean HO R Needed	**613**	**702**		
Minimum HOR Needed	**397**	**397**		
Maximum HOR Needed	**997**	**1169**		
Mean / Total Escapement	**1036**	10363	**1074**	**19907**
Mean/ Total Recruits	**1258**	12536	**1260.93**	**23958**
Mean PNI*	**0.63**		**0.58**	

***PNI Calcuated for the whole basin may be higher**

Year	Estimated NOR Run Size at TWD - whole basin	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	3.45E-01 4.61E-04
1999	110	0.333	37	113	0.24	73	1056	1169	1129	0.94	Any	0.21	1305	
2000	486	0.333	150	0	1.00	336	793	943	1129	0.70	0.50	0.59	1305	
2001	791	0.333	150	0	1.00	641	209	359	850	0.25	0.80	0.80	1154	
2002	628	0.333	150	0	1.00	478	472	472	950	0.50	0.67	0.67	1214	
2003	398	0.333	133	17	0.88	265	864	881	1129	0.76	0.50	0.54	1305	
2004	870	0.333	150	0	1.00	720	250	250	970	0.26	0.80	0.80	1225	
2005	222	0.333	74	76	0.49	148	981	1057	1129	0.87	Any	0.36	1305	
2006	234	0.333	78	72	0.52	156	973	1045	1129	0.86	Any	0.38	1305	
2007	239	0.333	80	70	0.53	159	970	1040	1129	0.86	Any	0.38	1305	
2008	335	0.333	112	38	0.74	223	906	944	1129	0.80	0.40	0.48	1305	
2009	469	0.333	150	0	1.00	319	810	810	1129	0.72	0.50	0.58	1305	
2010	476	0.333	150	0	1.00	326	803	803	1129	0.71	0.50	0.58	1305	
2011	1047	0.333	150	0	1.00	897	232	232	1129	0.21	0.80	0.83	1305	
2012	797	0.333	150	0	1.00	647	213	213	860	0.25	0.80	0.80	1160	
2013	486	0.333	150	0	1.00	336	793	793	1129	0.70	0.50	0.59	1305	
2014	744	0.333	150	0	1.00	594	535	535	1129	0.47	0.67	0.68	1305	
2015	549	0.333	150	0	1.00	399	401	401	800	0.50	0.67	0.67	1121	
2016	553	0.333	150	0	1.00	403	397	397	800	0.50	0.67	0.67	1121	
2017	282	0.333	94	56	0.63	188	941	997	1129	0.83	0.40	0.43	1305	
Mean	**511**		**127**	**39**	**0.76**	**385**	**679**	**702**	**1074**	**0.62**		**0.58**	**1260.93**	Average All (1999 Included)
10-Year Mean	**574**		**141**	**9**	**0.94**	**433**	**603**	**613**	**1036**	**0.57**		**0.63**	**1258**	Average Last 10 years

Summary of Option 1: This option has the potential to produces the lowest PNI, lowest Escapement, and lowest total Recruits. Hatchery returns are in excess of what is needed in all years.

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal	135 (76 Chiwawa, 59 Nason)		
Nason Creek Escapement Goal	1129		
NOR Target Extraction Rate	33%		
Combined Conservation Program Size (100K Nason, 144K Chiwawa)		**244,000**	**66%**
Nason Safety Net Program Size		**123,670**	**34%**
		367,670	

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**1187**	0.004864	**1135**	0.00465
Minimum HOR runs size:	**750**	0.003076	**88**	0.00036
Maximum HOR run size:	**1545**	0.006334	**3811**	0.01562
	10 year	**All**		
Mean HO R Needed	**603**	**691**		
Minimum HOR Needed	**258**	**1042**		
Maximum HOR Needed	**982**	**1154**		
Mean / Total Escapement	**1042**	10418	**1077**	**20007**
Mean/ Total Recruits	**1262**	12572	**1264.21**	**24020**
Mean PNI*	**0.64**		**0.59**	

Year	Estimated NOR Run Size at TWD - whole basin	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed From	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	3.45E-01 4.61E-04
1999	110	0.333	37	98	0.27	73	1056	1154	1129	0.94	Any	0.22	1305	
2000	486	0.333	135	0	1.00	351	778	913	1129	0.69	0.50	0.59	1305	
2001	791	0.333	135	0	1.00	656	214	349	870	0.25	0.80	0.80	1166	
2002	628	0.333	135	0	1.00	493	482	482	975	0.49	0.67	0.67	1228	
2003	398	0.333	133	2	0.98	265	864	866	1129	0.76	0.50	0.56	1305	
2004	870	0.333	135	0	1.00	735	235	235	970	0.24	0.80	0.80	1225	
2005	222	0.333	74	61	0.55	148	981	1042	1129	0.87	Any	0.39	1305	
2006	234	0.333	78	57	0.58	156	973	1030	1129	0.86	Any	0.40	1305	
2007	239	0.333	80	55	0.59	159	970	1025	1129	0.86	Any	0.41	1305	
2008	335	0.333	112	23	0.83	223	906	929	1129	0.80	0.40	0.51	1305	
2009	469	0.333	135	0	1.00	334	795	795	1129	0.70	0.50	0.59	1305	
2010	476	0.333	135	0	1.00	341	788	788	1129	0.70	0.50	0.59	1305	
2011	1047	0.333	135	0	1.00	912	217	217	1129	0.19	0.80	0.84	1305	
2012	797	0.333	135	0	1.00	662	213	213	875	0.24	0.80	0.80	1169	
2013	486	0.333	135	0	1.00	351	778	778	1129	0.69	0.50	0.59	1305	
2014	744	0.333	135	0	1.00	609	520	520	1129	0.46	0.67	0.68	1305	
2015	549	0.333	135	0	1.00	414	386	386	800	0.48	0.67	0.67	1121	
2016	553	0.333	135	0	1.00	418	422	422	840	0.50	0.67	0.67	1147	
2017	282	0.333	94	41	0.70	188	941	982	1129	0.83	0.40	0.45	1305	
Mean	**511**		**117**	**30**	**0.80**	**394**	**673**	**691**	**1077**	**0.61**		**0.59**	**1264.21**	Average All (1999 Included)
10-Year Mean	**574**		**129**	**6**	**0.95**	**445**	**597**	**603**	**1042**	**0.56**		**0.64**	**1262**	Average Last 10 years

Summary of 2: increased PNI, increased escapment, increased recruitment

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal	126 (76 Chiwawa, 50 Nason)		
Nason Creek Escapement Goal	1129		
NOR Target Extraction Rate	33%		
Combined Conservation Program Size (85K Nason, 144K Chiwawa)		**229,000**	**62%**
Nason Safety Net Program Size		**138,670**	**38%**
		367,670	

Conservation Program:	SAR (BY2002-2011)		SAR (89-11)	
Mean HOR run size:	**1114**	0.004864	**1065**	0.00465
Minimum HOR runs size:	**704**	0.003076	**82**	0.00036
Maximum HOR run size:	**1450**	0.006334	**3577**	0.01562
	10 year	**All**		
Mean HO R Needed	**602**	**687**		
Minimum HOR Needed	**413**	**1033**		
Maximum HOR Needed	**973**	**1145**		
Mean / Total Escapement	**1049**	10493	**1082**	**20132**
Mean/ Total Recruits	**1266**	12620	**1268.23**	**24096**
Mean PNI*	**0.64**		**0.60**	

***PNI Calcuated for the whole basin may be higher**

Year	Estimated NOR Run Size at TWD - whole basin	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed From Conservation Program	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	3.45E-01 4.61E-04
1999	110	0.333	37	89	0.29	73	1056	1145	1129	0.94	Any	0.24	1305	
2000	486	0.333	126	0	1.00	360	769	895	1129	0.68	0.50	0.59	1305	
2001	791	0.333	126	0	1.00	665	225	351	890	0.25	0.80	0.80	1179	
2002	628	0.333	126	0	1.00	502	473	473	975	0.49	0.67	0.67	1228	
2003	398	0.333	126	0	1.00	272	857	857	1129	0.76	0.50	0.57	1305	
2004	870	0.333	126	0	1.00	744	256	256	1000	0.26	0.80	0.80	1241	
2005	222	0.333	74	52	0.59	148	981	1033	1129	0.87	Any	0.40	1305	
2006	234	0.333	78	48	0.62	156	973	1021	1129	0.86	Any	0.42	1305	
2007	239	0.333	80	46	0.63	159	970	1016	1129	0.86	Any	0.42	1305	
2008	335	0.333	112	14	0.89	223	906	920	1129	0.80	0.40	0.52	1305	
2009	469	0.333	126	0	1.00	343	786	786	1129	0.70	0.50	0.59	1305	
2010	476	0.333	126	0	1.00	350	779	779	1129	0.69	0.50	0.59	1305	
2011	1047	0.333	126	0	1.00	921	208	208	1129	0.18	0.80	0.84	1305	
2012	797	0.333	126	0	1.00	671	229	229	900	0.25	0.80	0.80	1185	
2013	486	0.333	126	0	1.00	360	769	769	1129	0.68	0.50	0.59	1305	
2014	744	0.333	126	0	1.00	618	511	511	1129	0.45	0.67	0.69	1305	
2015	549	0.333	126	0	1.00	423	427	427	850	0.50	0.67	0.67	1154	
2016	553	0.333	126	0	1.00	427	413	413	840	0.49	0.67	0.67	1147	
2017	282	0.333	94	32	0.75	188	941	973	1129	0.83	0.40	0.47	1305	
Mean	**511**		**111**	**25**	**0.82**	**400**	**672**	**687**	**1082**	**0.61**		**0.60**	**1268.23**	Average All (1999 Included)
10-Year Mean	**574**		**121**	**5**	**0.96**	**452**	**597**	**602**	**1049**	**0.56**		**0.64**	**1266**	Average Last 10 years

Chiwawa Data

	Brood year	Number of tagged smolts released	Estimated adult captures	SAR	
	1989	42,707	188	0.0044	
	1990	52,798	19	0.00036	
	1991	61,088	36	0.00059	
	1992	82,976	31	0.00037	
	1993	221,316	284	0.00128	
	1994	27,135	21	0.00077	
	1996	12,767	67	0.00525	
	1997	259,585	2,549	0.00982	
	1998	71,571	1,118	0.01562	
	2000	46,726	365	0.00781	
	2001	374,129	1,824	0.00488	
10	2002	145,074	674	0.00465	
9	2003	216,702	763	0.003520964	
8	2004	491,987	2975	0.006046908	
7	2005	489,664	1506	0.003075578	
6	2006	548,777	2604	0.004745097	
5	2007	292,682	1301	0.004445097	
4	2008	609,286	3859	0.006333643	
3	2009	433,608	1560	0.00359772	
2	2010	342,778	2104	0.006138084	
1	2011	278,801	1697	0.006086779	
	Average	***116,489***	***598***	***0.004751899***	Mean All Years
				0.00036	Min All Years
				0.01562	Max All Years
				0.004864	Mean (BY02-11)
				0.0030756	Min (BY 02-11)
				0.0063336	Max (BY02-11)

Nason Data

Data NOT YET AVAILBLE - STILL USE CHIWAWA FOR MODELING

Brood year	Number of tagged smolts released	Estimated adult captures	SAR	
Average	***116,489***	***598***	***#DIV/0!***	Mean All Years
			0	Min All Years
			0	Max All Years
			#DIV/0!	Mean (BY02-11)
			0	Min (BY 02-11)
			0	Max (BY02-11)

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: March 28, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the February 20, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCP) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, February 20, 2019, from 9:00 a.m. to 3:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook at the Methow Hatchery; Item I-A). *(Note: Larissa Rohrbach distributed an email from Mackey including a paper and presentation by Hankin et al.[1,2] to the HCP-HCs and PRCC HSC representatives on February 22, 2019. This item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HCs meeting (Item I-A). *(Note: this item is ongoing)*.
- Catherine Willard will update the genetics section of the Monitoring and Evaluation Plan for PUD Hatchery Programs (Update to the 2017 Plan) based on the genetics panel

[1] Hankin, D. G., J. Fitzgibbons, and Y. Chen, 2009. "Unnatural Random Mating Policies Select for Younger Age at Maturity in Hatchery Chinook Salmon (*Oncorhynchus Tshawytscha*) Populations." *Canadian Journal of Fisheries and Aquatic Sciences* 66(9):1505-1521.
[2] Hankin, D. G., J. Fitzgibbons, and Y. Chen, 2011. *Unnatural Random Mating Selects for Younger Age at Maturity in Hatchery Chinook Salmon Stocks*. Oral presentation.

recommendations and will append the recommendations from the panel to the plan (Item I-A). *(Note: this item is ongoing.)*

- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*
- Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A). *(Note: this item is ongoing.)*
- The following updates will be made to the draft 2019 Broodstock Collection Protocols pertaining to Joint HCP-HCs and PRCC HSC items (Item II-A):
  - Mike Tonseth will add Appendix C to the draft 2019 Broodstock Collection Protocols describing return-year adult management plans.
  - Greg Mackey will revise Douglas PUD's broodstock collection protocol for Methow coho salmon captured at Wells Dam.
  - Kirk Truscott will comment in the draft broodstock collection protocol regarding the number of steelhead collected in the fall that have intact adipose fins and no coded wire tag (CWT).
  - Keely Murdoch will provide the number of summer Chinook salmon eggs required from Wells Hatchery for the Yakima Basin program.
  - Tonseth will revise language about the allocation and marking of spring Chinook salmon in the Nason Creek conservation and safety-net programs.
  - Tonseth will distribute a revised version of the Broodstock Collection Protocols by March 6, 2019, to be discussed on the March 11, 2019 conference call.

  (Note: Rohrbach distributed an email from Tonseth including revised draft 2019 Broodstock Collection Protocols to the HCP-HC and PRCC HSC on March 8, 2019).
- Mike Tonseth will distribute the costs of tagging steelhead at the Priest Rapids Dam Off-Ladder Adult Fish Trap (OLAFT) and the upper Columbia River passive integrated transponder (PIT)-array operation and maintenance (O&M) budgets to the PUDs and inform the Chair when this has been distributed (Item III-A). (*Note: Tonseth emailed Tracy Hillman on February 25, 2019, to inform him that this item is complete.*)
- Mike Tonseth will invite Andrew Murdoch to the next HCP-HCs and PRCC HSC meetings on March 20, 2019, to answer questions about PIT-tagging spring Chinook salmon at the OLAFT (Item III-A). *(Note: Tonseth emailed Tracy Hillman on February 25, 2019, to inform him that Murdoch will attend the March 20, 2019 meeting. This item is complete.)*
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating the proportionate natural influence (PNI) for the Nason spring Chinook and Chiwawa spring Chinook programs (Item II-A).

- Brett Farman will inform the HCP-HCs of the publication date for public review of the Methow River Steelhead Environmental Assessment (EA) (Item II-C).
- Brett Farman will inform the HCP-HCs of the publication date for public review of the Section 10 permit for the unlisted Chinook salmon bundle (Item II-C). *(Note: Farman emailed Larissa Rohrbach on March 6, 2019 to inform the Committees that the UCR unlisted Chinook NEPA and HGMP bundle will be published within the week.)*

Wells HCP Hatchery Committee

- Greg Mackey will provide a revised version of Douglas PUD's draft 2019 Monitoring and Evaluation (M&E) Implementation Plan for HCP-HCs approval by email (Item III-A).

PRCC Hatchery Subcommittee

- The following updates will be made to the draft 2019 Broodstock Collection Protocols pertaining to PRCC HSC items (Item V-B):
  - Mike Tonseth will revise the Broodstock Collection Protocols for the natural-origin (NOR) Methow (Carlton) summer Chinook salmon program to identify a seasonal target number of adult fish to be collected rather than weekly collection goals due to low numbers expected in 2019.
  - Tonseth will review the assumptions and target number of proposed NOR Methow (Carlton) summer Chinook salmon to determine if this number could be increased similar to 2018 targets.
  - Todd Pearsons will organize a conference call with Tonseth and Paul Hoffarth (WDFW) to develop a plan to determine the number of fall Chinook salmon broodstock to be collected during the 2019 Angler Broodstock Collection (ABC) fishery and the OLAFT.

  (Note: Rohrbach distributed an email from Tonseth including revised draft 2019 Broodstock Collection Protocols to the HCP-HC and PRCC HSC on March 8, 2019).

Decision Summary

- There were no decisions approved during today's meeting.

Agreements

- There were no agreements discussed during today's meeting.

Review Items

- Larissa Rohrbach sent an email to the Rocky Reach and Rock Island HCs on February 11, 2019, notifying them that the 2019 Rock Island and Rocky Reach HCP Action Plan is available for a 30-day review with edits due to Catherine Willard by March 13, 2019 (Item IV-A).
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on February 12, 2019, notifying them that the draft 2019 Broodstock Collection Protocols are available for review with comments and edits due to Mike Tonseth by March 1, 2019 (Item II-A and V-B).
- Larissa Rohrbach sent an email to the PRCC HSC on February 21, 2019, notifying them that the draft Priest Rapids Hatchery M&E Implementation Plan is available for 30-day review with comments and edits due to Todd Pearsons by March 25, 2019 (Item V-C).
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on February 7, 2019, notifying them that the updated meeting protocols, distribution lists, and draft Conflict of Interest Statement of Agreement (SOA) are available for review with comments and edits due to Rohrbach by March 15, 2019 (Item II-B).

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and approve the January 16, 2019 Meeting Minutes (Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the agenda. Three items were added to the agenda:

- Greg Mackey added an announcement of a job opening at Wells Hatchery to the Wells HC agenda items
- Catherine Willard added an update on the Tumwater fishway to the Rocky Reach and Rock Island HC agenda items
- Todd Pearsons added the 2019 Draft Priest Rapids Hatchery M&E Implementation Plan to the PRCC HSC agenda items

The HCP-HCs and PRCC HSC representatives approved the revised agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised draft January 16, 2019 meeting minutes. Larissa Rohrbach said there are some outstanding comments and revisions, which the representatives reviewed and addressed. The HCP-HCs and PRCC HSC representatives approved the draft January 16, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on January 16, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on January 16, 2018)*:

Joint HCP-HCs and PRCC HSC topics

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's* Review of Spring Chinook Salmon in the Upper Columbia River *under HCP-HCs' purview (Item I-A).* Hillman said this item is ongoing. Hillman said he has the statistical tools for analyzing total spawners in a BACI analysis, and is now developing the tool for analyzing productivity by return year. Next, he plans to figure out when the before and after treatment time periods should be: that is, when hatchery fish would first start to affect the productivity of natural-origin fish.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing. Mackey said he identified a paper by Hankin et al. for distribution about modeling age structure of a hatchery population. Hankin et al. found that a simple protocol of structuring broodstock management to mate females with larger males can shift the population to an older age structure and prevent the shift to a younger age structure. A 2x2 factorial approach is used now in the Methow spring Chinook salmon program. In addition, due to genotyping all potential brood for stock identification, the capacity exists to identify full-sibs and half-sibs to avoid those crosses. Todd Pearsons said this approach was used in the White River. Catherine Willard said this approach was used for Snake River Sockeye at Redfish Lake, Idaho. Bill Gale asked if there is a minimum number needed for this approach to work. Tom Kahler agreed this was an important question and noted the Methow program is small. Gale said this may not be possible for conservation programs that are small.
- *Keely Murdoch will attempt to provide coho salmon broodstock collection protocols to Mike Tonseth by early February for inclusion in the draft 2019 Broodstock Collection Protocols (Item I-A).*
  Murdoch said this item is complete. Murdoch said the protocol is ready and will be distributed following the meeting.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HCs meeting (Item I-A).*

Tonseth said this item is ongoing.

- *Keely Murdoch will research past co-mingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery or other locations (Item I-A).*
  Murdoch said this item is complete. Murdoch identified years in which co-mingling occurred. She said that the ratio centered around 50% (49-53%) coho salmon over those years at the Spring Creek acclimation site but that at the Twisp acclimation site it would be mostly coho salmon. Greg Mackey said the ratio would be approximately one-third Chinook salmon and two-thirds coho salmon.
- *Larissa Rohrbach will obtain approval or abstention from NMFS to approve the December 2018 meeting minutes (Item I-A).*
  Rohrbach said this item is complete. NMFS did not respond to a request for a vote within 5 business days and therefore abstained. Brett Farman [NMFS] approved via email on February 13, 2019.
- *Larissa Rohrbach will schedule a tentative conference call on March 11, 2019, at 2:30 pm for the HCP-HCs and PRCC HSC to discuss the draft 2019 Broodstock Collection Protocols (Item I-A).*
  Rohrbach said this item is complete. Rohrbach sent a calendar placeholder via email on January 28, 2019.
- *Catherine Willard will update the genetics section of the* Monitoring and Evaluation Plan for PUD Hatchery Programs (2017 Update) *based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item II-A).*
  Willard said this item is ongoing.
- *Mike Tonseth will share draft 2019 Broodstock Collection Protocols with the HCP-HCs and PRCC HSC by February 11 (Item II-B).*
  Rohrbach said this item is complete. Larissa Rohrbach distributed the 2019 Broodstock Collection Protocols in an email on February 12, 2019.
- *Greg Mackey will confirm with Betsy Bamberger (Douglas PUD) whether Douglas PUD will use the Washington Animal Disease Diagnostic Laboratory (WADDL) for in-season bacterial kidney disease (BKD) testing during 2019 broodstock collection and confirm that WADDL methods will provide ELISA [enzyme-linked immunosorbent assay] optical density test results (Item II-B).*
  Greg Mackey said this item is ongoing. Greg Mackey said Douglas PUD still plans to use WADDL, but it is unclear at this time if WADDL plans to report optical density (OD) values. If Douglas PUD cannot get the ODs through WADDL, they will contract with the State of Washington. Mike Tonseth asked if there is similarity in how the ODs are interpreted by both laboratories to determine if culling is needed in-season. Mackey said Bamberger is in the process of determining this. This topic will be added to an upcoming meeting agenda with Bamberger.

- *Kirk Truscott will discuss with Colville Confederated Tribe (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item II-B).*
  Truscott said this item is ongoing. The major unknown is whether those elemental signatures would still be present in adults 4 to 5 years out. The technique works for juvenile identification; it is unknown if the signature is maintained in adult fish. Truscott said that at this time, collections at Wells Dam cannot distinguish the stocks of natural origin fish. He said that CCT doesn't want Okanogan River fish to be incidentally collected for Methow brood. Tom Kahler clarified that not all fish are encountered at Wells Dam because there are two ladders and trapping may not be in operation every day at both ladders.
- *Mike Tonseth will ask Andrew Murdoch for interim pre-spawn mortality data for spring Chinook salmon to incorporate into the 2019 Broodstock Collection Protocols (Item II-B).*
  Tonseth said this item is complete. Tonseth has asked for an update from Murdoch. Tonseth said that some values are available for gross management decisions, but that data are not refined for use in the analysis for recalculating the size of the Wenatchee spring Chinook conservation programs.
- *Larissa Rohrbach will add the size of upper Columbia River conservation programs as a periodic agenda item (Item II-C).*
  Rohrbach said this item is ongoing.
- *Mike Tonseth will ask Andrew Murdoch to provide to the PUDs a list of passive integrated transponder (PIT)-tag arrays that will be shut down if not funded, the cost to operate and maintain these arrays, and the cost of PIT tagging steelhead at the Priest Rapids Dam Off-Ladder Adult Fish Trap (OLAFT; Item II-D).*
  Tonseth said this item is ongoing. Tonseth said he will send this information to the PUDs within 4 to 5 days following the meeting and will inform the HCs when it has been distributed.
- *Larissa Rohrbach will draft email distribution lists merging HCP-HCs and PRCC HSC recipients for review and approval by the HCP-HCs and PRCC HSC and the HCP Coordinating Committees (Item II-E).*
  Rohrbach said this item is complete. This item will be discussed in today's meeting. (Note: documents were emailed by Rohrbach to the HCP-HCs and PRCC HSC on February 7, 2019.)
- *Larissa Rohrbach and Tracy Hillman will revise and distribute meeting protocols for the HCP-HCs and PRCC HSC for review and approval (Item II-E).*
  Rohrbach said this item is complete. This item will be discussed in today's meeting. (Note: documents were emailed by Rohrbach to the HCP-HCs and PRCC HSC on February 7, 2019.)
- *Tracy Hillman will send the Statement of Agreement (SOA) regarding conflicts of interest to Larissa Rohrbach for inclusion of language in the meeting protocols (Item II-E).*

Rohrbach said this item is complete. This item will be discussed in today's meeting. Hillman said a question was raised about whether there is still a need for a Conflict of Interest SOA. Bill Gale said there should be some written agreement for people in the future to reference but does not have to be a formal SOA. Hillman agreed that it could be a simple paragraph within the meeting protocols. (Note: The most recent Conflict of Interest Policy, dated January 26, 2013, was emailed by Hillman to Rohrbach on January 17, 2019.)

Wells Hatchery Committee

- *Greg Mackey will provide a revised version of Douglas PUD's draft 2019 Monitoring and Evaluation (M&E) Implementation Plan for HCP-HCs approval by email (Item III-A).*
  Mackey said this item is ongoing. This item will be discussed in today's meeting.

II. Joint HCP-HCs and PRCC HSC

A. Broodstock Collection Protocols Review (Mike Tonseth)

Mike Tonseth asked that written comments on the Draft 2019 Broodstock Collection Protocols be returned to him by Friday, March 1, 2019, to flag outstanding issues and return a second draft to HCP-HCs and PRCC HSC representatives a few days ahead of the March 11, 2019 special conference call. Bill Gale asked when U.S. Fish and Wildlife Service (USFWS) Ecological Services will be asked to review protocols relative to the Bull Trout Biological Opinions or Bull Trout permit constraints. Gale said review by Sierra Franks at USFWS Ecological Services is needed because approval by the HCs assumes there is Endangered Species Act coverage for impacts of the broodstock collection activities on listed species. Tonseth said ideally USFWS Ecological Services would comment on the plan now.

Tonseth said major changes to the Broodstock Collection Protocols include the following:

- Much of the technical content has been moved to appendices.
  Notables that were bulleted in the front of the document that have been carried over from year to year have been eliminated. Those that are important for this year have been maintained.

Tonseth further explained several bulleted notables. Tracy Hillman recorded edits to the bulleted notables during the meeting for Tonseth to carry through in revisions to the rest of the document.

Elimination of a Fall Collection Component for the Methow Safety-Net and Okanogan Steelhead Programs

Tonseth proposed to eliminate fall steelhead collection (adult hatchery steelhead collection for the Methow Safety-Net and Okanogan programs at Wells Dam and hatchery). Tonseth said there has always been a surplus of fish for the Methow Safety-Net and Okanogan programs. He said there are opportunities to use traps at Wells Hatchery in the spring to collect more spawners instead of fall collection. It has become laborious to deal with overages every year – requiring Wells hatchery to rear fish that turn out to be surplus to program needs and for WDFW to identify bodies of water for fish to be transferred to and coordinating fish transfers, and Wells Hatchery and WDFW staff must then stock out the surplus fish. Kirk Truscott said another problem is that spawners collected in the fall do spawn earlier so they are unable to mate with fish collected in spring. Truscott will review this with his staff to confirm, but preliminarily agrees he would accept ending collection in the fall. He said even during the poorest years, at least 58 fish (the target number) can be collected in the Wells volunteer channel in the spring. Tonseth said they will still read CWTs to identify return origin so that those identified as Okanogan can still be allocated to that program.

Expansion of Spring Chinook Salmon Collection at Wells East and West Ladder Traps

Tonseth said this is actually continuation of an ongoing broodstock collection strategy.

Appendix Review

Tonseth said ideally the appendices can be rolled over year-to-year. Tonseth asked representatives to review the following appendices:

- Appendix I – Summarizes all juvenile rearing and release plans. Tonseth said that if a program is not identified, the plans are status quo. Tonseth asked that representatives ensure all plans are up to date.
- Appendix J – Summarizes summer and spring Chinook salmon disease management at Eastbank Hatchery. Tonseth said there are minor language changes. He said fish are being inoculated with Draxin. He said inoculation by Oxytet will be used on an as needed basis for *Columnaris* only.
- Appendix K – Summarizes Yakama Nation (YN) coho salmon protocols provided by Keely Murdoch. Tom Kahler noticed there is no Douglas PUD plan for coho salmon collection though it is a component of the program. Greg Mackey will provide revisions in written comments on the Broodstock Collection Protocols.
- Appendix G – Summarizes the management plan for managing surplus juvenile spring Chinook salmon and summer steelhead. Tonseth asked the representatives to ensure that past discussions have been accurately captured for managing overages. Tonseth said these plans were in last year's Broodstock Collection Protocols in the body of the document. He said there were revisions to language for this year.
- Appendix H – Summarizes continued inclusion of a plan in place for the 2018 Methow conservation steelhead brood. Tonseth said that last year some parts of the plan were not

followed. He said the existing plan was carried forward with the note that the plan will be followed this year. He said the plan was contingent on NOR collection by hook-and-line in the Methow basin and that last year an overage was collected by hook-and-line. He said this may be more challenging this year due to low numbers of returning adults. Tonseth asked when the collection would start. Matt Cooper and Mackey said it would have started already if the river temperatures were warmer, and that it will start as soon as the weather changes and the river is thawed.

Chelan Falls Broodstock Collection at Wells Dam Volunteer Trap

Tonseth said there were changes to broodstock collection for the Chelan Falls summer Chinook salmon program. Tonseth asked Catherine Willard to clarify the changes.

Willard said that for three years, Chelan PUD piloted broodstock collection at the Chelan River Canal Trap. She said in the first year all 100 fish were collected; however, second- and third-year collections were interrupted by other activities (gravel augmentation, outage). This year, a new Washington Administrative Code changed safety precautions making the Chelan River Trap infeasible to operate without major, expensive modifications.

Willard said Chelan PUD will prioritize collection at the Wells Dam Volunteer Trap while concurrently piloting a temporary weir located in the Chelan River Habitat Channel and collection by beach seine in the Chelan Falls spawning channel. Tonseth said there will need to be coordination with brood collection at Wells Hatchery program to ensure collection at the volunteer trap for the Chelan Falls program occurs within the same trapping period as brood for the Wells summer Chinook programs. Truscott said they haven’t determined details on the timing of weir installation and beach seining activities. Tonseth said any broodstock collected should be retained, but those collected later in the season are less likely to be used due to higher disease potential (BKD, *Columnaris*) and lower egg quality.

Gale said he is concerned about entering into a long-term agreement that Wells Dam is always going to provide the backstop for Chelan Falls. Willard and Tonseth agreed the long-term commitment is to collect broodstock for the Chelan Falls program in the Chelan River. Truscott said it’s unlikely that collection at Chief Joseph Hatchery would be done to back-fill summer Chinook salmon programs. He said by design there are few fish collected there in order to support tribal harvest programs and it is unlikely that CCT would support collection. Tonseth said he will revise the protocol to state that the HCs will discuss alternative options if collection in the Chelan River falls short of target numbers.

Collection of Surplus Broodstock

Gale said that the USFWS Regional Office is formulating a more defined policy for how USFWS handles requests for surplus fish. He said it will require a formal request to the regional administration, rather than simply being handled by local USFWS staff, and this may make the disposition of surplus fish more complicated.

Tonseth said that in the past, protocols were written to ensure broodstock were collected throughout the return run. This year, returns will be so low all fish should be collected early in the run regardless of weekly targets to ensure meeting broodstock goals, instead of trying to distribute collections throughout the run and perhaps not collection enough fish. Tonseth recommended taking early advantage of the collection days and sites available, noting it is not something normally advocated by the HC, but may be a prudent action. This has not been written into the 2019 protocols yet. Tonseth requested that representatives discuss adding this to this year's protocols. Todd Pearsons asked which programs may be affected by low numbers. Tonseth said the spring and summer Chinook salmon programs will have low numbers. Truscott said they had to incorporate hatchery-origin fish at Chief Joseph Hatchery last year as well. Tonseth said he will review last year's data to determine whether all trapping opportunities and locations were well utilized.

Tonseth said in the Wenatchee River, depending on early summer flows and the low expected summer run forecast, the Dryden Traps may not be very efficient. He said there may be a need to collect summer Chinook salmon at Tumwater and Dryden dams simultaneously in 2019 rather than rely on weekly collection quotas or only going to Tumwater Dam once a deficit in brood numbers occurs at Dryden. Truscott asked whether NOR fish arriving at Dryden early in the season would be returned to the river. Tonseth said no, typically collection is frontloaded, but in years of low returns there is a deficit at Dryden and numbers are made up at Tumwater later. Pearsons asked if they are only proposing to retain NOR fish for broodstock (pNOB). Tonseth said yes, the program would just deviate from use of a weekly collection quota and would retain any NO adult summer Chinook as it is encountered at either Dryden or Tumwater Dams. He does not expect that for this brood year, not collecting broodstock throughout the return will cause long-term harm to the population.

Collection of Chinook Salmon to Support Chief Joseph Hatchery

Tonseth said that the Chief Joseph Hatchery may collect summer Chinook brood at Wells Dam if needed. Pearsons asked if this has ever been done. Tonseth answered that this has never been done before, but this year it could, if adult returns to Chief Joseph Hatchery fall short of broodstock targets.

Tonseth said adipose-clipped only (no CWT) spring Chinook encountered at Methow Hatchery or WNFH could be transferred to the Chief Joseph Hatchery CCT segregated program. Gale asked whether the assumption that it is a Chief Joseph Hatchery fish is correct or if it could be a wire-shed from an Endangered Species Act-listed program—how would you know? Gale said he is unsure if it is permitted to make that transfer of a 'wire-shed' fish to Chief Joseph Hatchery (CCT segregated program, which is a program for harvest). Gale said it would be rare but if it is a realistic occurrence, USFWS and CCT are at risk of moving fish that are not permitted for use in the Chief Joseph Hatchery segregated program. Tonseth asked Truscott to review this bullet to determine if this language should be kept and if it would be permitted to cross ESA-listed fish with a Chief Joseph Hatchery CCT segregated program fish.

Collection of Summer Chinook Salmon at Wells Hatchery for the Yakama Nation Yakima River Program

Tonseth asked Keely Murdoch and Truscott to review the collection of summer Chinook salmon from the Wells Hatchery Volunteer Channel to support the YN's Yakima River summer Chinook salmon program. Draft protocols identify up to 350,000 eggs could be transferred assuming 300,000 juveniles would be released. Brood may not be collected for that program due to differing positions between the CCT and the YN. Tonseth would like to know whether the YN will collect those fish so that, in the event that they will not be collected, they can be allocated elsewhere (e.g., for food). Truscott agreed it is difficult to justify moving fish from Wells to the Yakima program.

Murdoch suggested establishing the following priorities in the Broodstock Collection Protocols for allocation of broodstock collected at Wells Dam: 1) Wells Hatchery program; 2) other upper Columbia River programs; 3) the Yakima program. Gale asked whether these transfers are always occurring as eggs. Murdoch said yes, transfers are made as green eggs (gametes). Gale said USFWS is getting requests for fish from many sources and appreciates the effort to prioritize. Kahler agreed this allows for coordinating collection at the Wells volunteer ladder where holding surplus fish is undesirable. Gale asked what the YN summer Chinook salmon program size is. Murdoch said 250,000 eggs could be requested from sites where available, and the Hatchery and Genetic Management Plan (HGMP) says up to 400,000 eggs could be collected.

Murdoch said that Melinda Goudy (YN) provided a presentation and answered questions about developing a local broodstock but explained there wasn't a good opportunity to collect in the Yakima River. She said Goudy took the questions from this committee and had a meeting with staff in the Yakima Basin who decided to start releasing smolts at Prosser Dam to have a collection point for returning adults to develop a local broodstock. Murdoch said additional eggs were requested last year to meet this need. She said that now there is a release site (Prosser) specifically to support local broodstock development, this is similar to the way the coho reintroduction project has approached local broodstock development in the Wenatchee Basin, with releases from Leavenworth NFH.

Gale requested some certainty around the number of eggs that could be requested by the program this year. Murdoch stated the goal of 300,000 juveniles may have changed since last fall to include a release group for Prosser. Gale noted there were enough adults last year at Entiat to support the Yakima program but with the contingency that early returning fish will be prioritized for consumption, late returning fish seem to meet the Yakima needs just fine. Murdoch read an email from Goudy stating that the original release goal of summer Chinook salmon in the Yakima Basin was 500,000 and is still the goal. Goudy said that initial years focused on 250,000 with an emphasis on jump-starting collection at Prosser Dam. Murdoch said the release at acclimation sites is still part of the plan. Murdoch said to differentiate summer and fall Chinook salmon collected at Prosser Dam, 100% of the summer Chinook salmon will be tagged with CWTs, and 100% of fall Chinook salmon will be adipose-fin-clipped. Murdoch will confirm with YN staff the total number requested. Gale asked that the Broodstock Collection Protocols state the specific number requested from each hatchery or define priorities for review by the USFWS Regional Office.

Operating Tumwater Trap to Facilitate Lamprey Passage

Tonseth asked that representatives review to ensure protocols are acceptable to the HCs.

Appendix B – Marking Rates

Tonseth asked that representatives review to ensure protocols are acceptable to the HCs.

Appendix C – Return Year Adult Management Plans

Tonseth said he will distribute Appendix C in the coming days.

Appendix A – Biological Assumptions

Tonseth said a second table was added that responds to feedback on the number of adults and egg targets. This will help determine if there may be an overage or underage for a program. Table 2 may need revision based on discussion of the spring Chinook salmon broodstock collection plan. Tonseth noted these targets are program-specific. Gale asked whether Tonseth has all information needed from USFWS. Tonseth answered the necessary information is typically in Appendix B and some information for steelhead programs upstream from Wells Dam is integrated in the steelhead plan.

Allocation of Smolts in the Nason Creek Conservation Program and Safety-Net Program

Tonseth presented an interim reduction of Nason Creek spring Chinook salmon conservation program (wild parents) size to 100,000 juveniles and increase in safety-net program (hatchery parents) size to 123,670 (see page 19, Table 10 of draft Broodstock Collection Protocol).

Tonseth said 490 wild spring Chinook salmon returns and 2,966 hatchery returns are expected upstream from Tumwater (Table 9). Matt Cooper asked whether that estimate seems high for hatchery returns. Gale said expecting approximately 3,500 fish to return from a 450,000 smolt release would be a smolt-to-adult return ratio that seems high. Tonseth agreed and said WDFW's model tends to over-predict hatchery returns but has generally been accurate for wild returns. Tonseth said he may use a correction factor to adjust these numbers based on last year's results.

Pearsons asked whether the PUDs are using too many NOR fish to maintain their programs and if there are truly that many hatchery returns, won't there still be some hatchery fish removed at Tumwater? Tonseth reminded the HCs that when using the sliding scale system, the target PNI shifts. Cooper asked whether the NO run size can be tracked in season. Tonseth said NORs cannot be tracked very well in season because only approximately 25 to 30 NO PIT tags may return, mostly from the Chiwawa and only a couple from Nason, which is a low number for expanding to total return in season.

Tonseth said the bigger issue in need of discussion is reducing the size of the Nason conservation program of 125,000 fish to 100,000 in light of low expected NO returns in 2019.[3] Murdoch said that YN did not agree to reducing the conservation program size based on broodstock origin. When insufficient NOR returns are available, hatchery origin fish are intended to be used in the conservation program. The number of wild fish extracted for broodstock would not change over what is proposed in the protocols, rather, hatchery fish should be used to back-fill the conservation program (and would be adipose fin-present). Tonseth said offspring of hatchery parents could be allocated to the safety-net program and would be marked as safety-net program fish are. Tonseth said this would not be a proposal to change US v Oregon but would provide a notice to change marking within HCP and settlement agreement programs. Gale said this may affect the federal programs. Truscott said Nason Creek conservation program juveniles are currently adipose-fin-present and tagged in the body with CWTs, but they could be tagged with wire differently.

Truscott said the discussion is about how to mark 25,000 juvenile fish that have hatchery-origin adults but will be marked as a conservation program fish; how important is it to manage a small number of adults (250 adults) resulting from this group? Truscott asked how important it is to prioritize wild x wild progeny over hatchery x hatchery progeny on spawning grounds? Murdoch answered there is no rule in the Nason conservation program to prioritize wild x wild progeny on the spawning ground but that it's going to be increasingly important to manage safety-net fish (hatchery x hatchery progeny) on the spawning grounds. Tonseth agreed but said in years of high abundance a lot of hatchery x hatchery progeny would have to be removed to prioritize wild x wild progeny on

[3] Reduction of the conservation program would not change the overall production obligation for Nason Creek.

the spawning grounds. Murdoch suggests deferring to the management plan that states that conservation program fish would be adipose-fin-present, conservation fish would be recycled back into the program, and if there are not enough conservation fish, safety-net fish would be used but all would be marked adipose-fin-present if they are a conservation program fish. The intent is to avoid the previous management approach of a floating program size based on return size. Pearsons asked for clarification—are we talking about flexing the size of the conservation and safety-net programs? Murdoch answered no, we are not talking about flexing the programs annually, but if we are talking about reducing the conservation program size, more approval will be needed at higher levels of management. Tonseth said he doesn't think the conservation program size will change much this year. Murdoch noted there could be a limited number of natural-origin adults (58), and the remainder of the broodstock to meet the conservation program would be backfilled with adult returns from the conservation program. Murdoch and Gale noted one of the management strategies of the programs is to backfill the program with hatchery fish so as not to reduce the program size.

Hillman said he thought the spreadsheet model, which was partially updated and distributed by Murdoch in January, would be used to determine the number of fish allocated to the conservation and safety-net programs. However, the model still needs addition information and results from the model have not yet been approved by the committees. Thus, Hillman asked if it is premature to identify changes to the number of fish in the conservation and safety-net programs. Tonseth agreed this represents an interim reduction in conservation program number. Tonseth requested time to rerun the escapement estimates and revisit the management plans to ensure they are in agreement on number of fish per program and marking of those fish, and then revise the language in the protocol so it isn't framed as a reduction in size of the conservation program.

Pearsons asked why there would be resistance to moving all conservation NOR fish into the broodstock collection and back-filling from the safety-net program. Murdoch said there is a history of limiting conservation program size due to limited number of NOR fish for the broodstock. She said a review of the program was done in the past to make clear that all fish used for the conservation program should be adipose-fin-present. She said that now we are meeting production goals but potentially altering the marking of program fish. Pearsons said there is no disagreement that the aggregate program size should be met but potentially a disagreement about marking.

Gale said changes to program size should be something that should be discussed separately, and potentially a separate SOA. Gale said changes in production and marking targets for each component of the aggregate program should be decided outside the broodstock collection protocols and then will need to be discussed in the US v Oregon arena before implementation. Pearsons thought this committee should be able to make decisions and inform US v Oregon and that US v Oregon should not influence decision making for this group. Gale partially agreed, but decisions that deviate from US v Oregon agreements need to be memorialized somewhere other than within broodstock collection protocols.

Truscott said he would be concerned about reducing the size of the conservation program (fish that are afforded the most protection) because of low return predictions. Other tagging options could be explored that allow for adult management at Tumwater Dam and protection from harvest.

Willard said if hatchery x hatchery fish are adipose-fin-present, how does that affect PNI? Murdoch said they are still marked with CWTs. Thus, they will be identified as hatchery fish when they are collected for broodstock prior to using the multi-population PNI model. Tonseth said the multi-population PNI model is not a requirement in the Wenatchee permit, as it is in the Methow Basin.

Brett Farman said NMFS now has models that do compensate for differing program types (i.e., safety-net and conservation programs to adjust PNI). Farman will work with Charlene Hurst and Tonseth to explore different inputs in the models. Farman said changes to program allocation would require approval by the HCs.

Hillman summarized that there are two issues to research and discuss further: 1) is there a need to change allocations for conservation and safety-net programs (this should be decided outside the broodstock collection protocols); and 2) how fish within each program (conservation and safety-net) are to be marked.

B. Streamlining

Tracy Hillman asked representatives to provide comments on meeting coordination documents to himself and Larissa Rohrbach over email. Final versions of the distribution lists and meeting protocols will be brought to the HCP-Coordinating Committee and the Priest Rapids Coordinating Committee.

C. NMFS Consultation Update

Brett Farman said the Methow Steelhead permit has been drafted and is in review. He said once the EA is completed, the EA and both Wells and WNFH HGMPs will go out for comment. Tom Kahler asked when the EA will be published. Farman said the Methow Steelhead EA is in line behind some other projects with no expected publication date. He said the comment period will be 30 days. Bill Gale asked why the WNFH Steelhead HGMP is going out for public comment; he thought it had already gone out for public comment. Farman confirmed that typically HGMPs go out at the same time as EAs for public comment. He said the Winthrop Steelhead HGMP does need to go out for public comment as part of the EA but noted they typically receive no comments on the HGMPs.

Farman said Emi Kondo (NMFS) asked about the status of the Wenatchee summer Chinook HGMP submission for the unlisted Chinook salmon bundle. Deanne Pavlik-Kunkel (Grant PUD) answered that the cover letter is waiting to be signed and once it is signed it will be sent to NMFS. Farman said the unlisted Chinook salmon bundle EA is ready for publication and will be posted once the HGMP is received. He said the EA may not be published immediately due to a backlog from the January 2019 furlough. Todd Pearsons asked about the review and timing of the draft unlisted Chinook salmon bundle permit. Farman confirmed that the unlisted Chinook salmon permits are out for review by general council. Once revised per the internal review, they will be made available for public comment.

Farman said Charlene Hurst asked whether bull trout information is being collected. Catherine Willard said yes. Chelan PUD talked to Karl Halupka (USFWS) prior to his retirement and stated that this information will be included in annual reports. Halupka indicated he was comfortable changing the due date for bull trout reporting from September to correspond to the PUD's annual reporting timeline. Gale confirmed that those annual reports will be sent to USFWS Ecological Services. Gale asked if bull trout reporting is being tracked in the Methow because it has not been a requirement but should be accounted for somehow. Kahler answered that Andrew Gingrich (Douglas PUD) has reported on bull trout take (e.g. due to trapping) in an annual report that goes to Steve Lewis (USFWS) for the Bull Trout Management Plan. Gale asked whether angling encounters were coordinated with USFWS to avoid double counting. Tonseth confirmed there will be an appendix in the annual PUD report documenting bull trout encounters.

III. Wells Hatchery Committee

A. Wells Monitoring and Evaluation Implementation Plan

Greg Mackey explained that Douglas PUD has not accepted the most recent revisions to the Wells M&E Implementation Plan made by Keely Murdoch because of uncertainty around the methods to be used for estimating brood year 2020 steelhead escapement (first discussed in the January 16, 2019 HCP-HCs and PRCC HSC meeting). Tracy Hillman suggested making the language added by Murdoch more specific. Kahler proposed first receiving information on the issues creating uncertainty (costs of PIT-tagging at the OLAFT and operating and maintaining PIT arrays that may not be covered by WDFW). Then, Douglas PUD would consider this internally before revising the language in the Wells M&E Implementation Plan. It would then go to the Wells HC for a final vote.

Mike Tonseth asked about the HCP-HCs protocol for voting on decision items. Tom Kahler said the Chair can grant each party one 5-day extension to the typical review period prior to voting on a decision item. If the voting party does not vote within the 5-day extension period, the committee assumes the silent party abstains from voting. In this case, the revised version of the Wells M&E Implementation Plan has not yet been reissued as a decision item. Kirk Truscott noted that had a different methodology of estimating steelhead spawner abundance without use of PIT tags been proposed in any of the draft M&E Implementation Plans, CCT may not have approved them. Bill Gale asked if a change to these methods would bring all the M&E Implementation Plans up for a re-vote and all representatives confirmed that it would. (Chelan PUD's 2019 M&E Plan was modified and approved in the meeting on August 15, 2018.)

Mackey said Douglas PUD has not been using the WDFW steelhead escapement model based on tagging at the OLAFT. Rather, they PIT tag steelhead at Wells Dam and recapture (detect PIT tags) at arrays within the Methow River basin. Hillman asked whether results from the two different models have been compared. Mackey said no, because the WDFW model is not readily available and has only been shown to the committees in a presentation from Andrew Murdoch. Mackey said having the WDFW model published would allow Douglas PUD to evaluate whether the WDFW model could be used for the Methow River and, if so, rescope their M&E Implementation Plan. Tonseth will ask Andrew Murdoch to share WDFW's internal comparison between model outputs.

Truscott said PIT tagging steelhead at the OLAFT is key to accurate spawner escapement estimates in the Okanogan River. Truscott said that if PIT tagging at the OLAFT is not funded by WDFW, CCT would preferentially support funding the PIT tagging at the OLAFT versus funding certain arrays.

Gale asked whether the O&M and replacement costs for arrays is being divided between steelhead and spring Chinook salmon. Tonseth said operation for tracking spring Chinook salmon would be three months whereas arrays must be operational nearly year-round to track steelhead and therefore would be more costly.

Kahler asked what were the Bonneville Power Administration's (BPA's) goals for installation of the PIT arrays originally? Kahler asked if there is a need for an Independent Scientific Review Panel review of WDFW's proposal (to shift from PIT tagging steelhead to spring Chinook salmon). What is BPA's opinion on how these arrays are managed? Do they consider these arrays valuable for steelhead and spring Chinook salmon? Tonseth answered that WDFW has latitude to apply the funding to its objectives and may have already moved toward modifying the scope of the use of the BPA funding from supporting steelhead PIT tagging at OLAFT or PIT array O&M to working on the spring Chinook salmon escapement model.

Hillman reminded the HCs representatives of an outstanding action item for WDFW, which is to provide the PUDs with the cost of PIT tagging at the OLAFT, cost of array O&M, and providing a list of arrays at risk of being turned off. Todd Pearsons asked for clarification on what "turning off" arrays means? Pearsons asked what the cost would be of allowing automated arrays to continue to run. Tonseth answered that "turning off" an array means that no future data management would be provided and no O&M would be provided for those that are not automated (e.g., those running on generators).

Kahler noted that there is no certainty that BPA will agree with WDFW's proposed switch to modeling spring Chinook salmon. Kahler asked what the rationale is for PIT tagging spring Chinook salmon. What is achieved by creating a spring Chinook salmon spawner escapement model that differs from existing methods (e.g., spawning ground surveys and carcass surveys)? Tonseth said a PIT-tag-based model will improve accuracy of the escapement estimates. Willard noted that spring Chinook escapement estimates above Tumwater are already corrected to improve accuracy. Keely Murdoch said a PIT-tag-based model gives run escapement for each of the tributaries allowing for better estimates of pre-spawn mortality (not spawning escapement). Kahler said all spring Chinook salmon are still handled at Tumwater and Wells dams; adding another handling point at Priest Rapids could significantly contribute to pre-spawn mortality.

The PUDs and USFWS have remaining questions about the utility of shifting effort from steelhead to spring Chinook salmon. Tonseth will invite Andrew Murdoch to the next meeting to answer questions about the goals of switching from PIT tagging steelhead to spring Chinook salmon at the OLAFT.

B. Wells HCP Action Plan (Tom Kahler)

Tom Kahler presented the Draft 2019 Wells HCP Action Plan to the Wells HC (Attachment B) and noted additions compared to previous years. Kahler said he will reissue an updated version following the meeting and Wells HC members will respond with feedback to Mackey by February 21, 2019.

C. Job Opening (Greg Mackey)

Greg Mackey said that Douglas PUD has an open position at the Wells Hatchery for a Hatchery Specialist and asked HCP-HCs and PRCC HSC representatives to let potential candidates know. He said the job listing is posted on the Douglas PUD website and applicants can be referred to him. Kirk Truscott asked about the level of expertise. Mackey said this is a high-level technician position that reports directly to Pat Phillips (Douglas PUD). Mackey said the job is open until enough qualified applications have been collected and the position is filled.

IV. RR and RI HCs

A. Action Plan (Catherine Willard)

Catherine Willard presented the Draft 2019 Chelan PUD Action Plan (Attachment C) and noted the additions compared to previous years and identified the timing of events. Rocky Reach and Rock Island HCs representatives have 30 days to review the plan. Representatives will send comments to Willard by March 13, 2019.

B. Tumwater Dam Fishway Update

Catherine Willard said the concrete core samples showed that erosion is not as bad as previously thought at the Tumwater Dam Fishway and no repair work is necessary at this time. Mike Tonseth asked when the ladder would be re-watered. Willard said that it was not de-watered.

V. PRCC HSC

A. Approve the January 16, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the draft January 16, 2019 meeting minutes as revised.

HCP-HCs and PRCC HSC members agreed that in most meetings, all the minutes (HCP-HCs and PRCC HSC) can be revised and approved at the same time. Pearsons noted for the record it needs to be clear when representatives are approving PRCC HSC minutes at the beginning of meetings.

B. Broodstock Collection Protocols for PRCC HSC Programs

Mike Tonseth explained several bulleted notables in the draft broodstock collection protocol pertaining to the PRCC HSC programs.

Carlton Summer Chinook Salmon

Tonseth said given the low expected natural-origin summer Chinook return, the Methow summer Chinook salmon program (Carlton Summer Chinook salmon; Grant PUD program may have difficulty in meeting the 2019 collection target under past trapping protocols where a weekly collection quota was used. NOR brood and protocols could be revised to take advantage of fish in hand during collection at Wells Hatchery if supported by the HSC. He said the target would be a seasonal goal rather than weekly collection goals.

Todd Pearsons said there may be a revision needed to target a higher number for the Carlton summer Chinook salmon program, with target numbers that are more similar to last year. Todd Pearsons said that Eric Lauver (Grant PUD) said they have not met targets for several years. Tonseth said there was a higher number of Chinook salmon collected in 2018 based on dramatically lower than expected fecundities in the 2017 brood. Based on production assumptions, the number recommended should be sufficient for 2019. Pearsons said the program is flush this year because they took 68 (136 total) instead of 61 adults per gender in 2017 but that there was under-collection in previous years. Tonseth said that based on the eyed egg count the program is bumping up against the 110% production limit and he does not want to increase the number collected to avoid producing a surplus. Tonseth said he will review the assumptions and numbers to determine if the target number could increase. Pearsons said if it fits the program assumptions, he supports changing the targets to the number collected last year.

Fall Chinook Trapping at the OLAFT

Tonseth said WDFW has proposed to eliminate trapping fall Chinook salmon at the OLAFT and increase effort from hook-and-line collection (Angler Broodstock Collection or ABC effort) in this years broodstock collection protocols. This year fall Chinook salmon returns to the lower Columbia are predicted to be some of the lowest on record. WDFW has opted not to advocate for collection of fall Chinook salmon at the OLAFT to reduce impact to NOR spawning aggregates upstream from Priest Rapids. Pearsons noted that predicted runs back to the Hanford Reach are not anywhere near the historical lows and that predictions indicate that escapement targets will be met. Tonseth said for aggregates above the Hanford Reach we know very little about the predicted run size. Pearsons said the proposed elimination of OLAFT collections was a surprise because Grant PUD relies on handling at the OLAFT for collection for PNI. This is a substantial change to the program that is being introduced in the broodstock collection protocols without discussion in the HSC. Broodstock collection protocols should reflect changes that have been discussed previously and should not be a surprise to the programs. Tonseth said fall Chinook salmon forecasts were not available until January. Pearsons said there is a tradeoff between passing fall Chinook salmon past the OLAFT versus meeting the PNI targets at Priest Rapids hatchery program and the Hanford Reach. Pearsons said there is an expectation that we will meet our brood targets but may not meet PNI targets. He said the PNI target may not be met for the Hanford Reach without the use of the OLAFT in large part because of the low pNOB in the U.S. Army Corps of Engineers' program. The pNOB of the PRH program boosts the PNI for the Hanford Reach substantially.

Matt Cooper asked whether the ABC effort could be as successful as it was last year. Pearsons said if the fishery is as successful as last year, collection at the OLAFT is probably not needed. Pearsons said Paul Hoffarth (WDFW) suggests the collection rate in the ABC fishery may not be as successful and Grant PUD should assume approximately 500 fish could be collected. Pearsons said Hoffarth is not comfortable closing the harvest fishery early, which is what allowed for large numbers for broodstock collection last year. Tonseth said WDFW needs to protect spawning aggregates moving upstream by minimizing collection at downstream points such as the OLAFT. Kirk Truscott agrees that protecting some of the upstream spawning aggregates would be even more important with climate change. Pearsons said the tradeoff is allowing fall Chinook salmon to pass Priest Rapids versus collection at the OLAFT. Pearsons noted that last year was even more of a concern because the predicted run size was smaller than this year and yet full escapement was met. Tonseth said fish probably should not have been collected at the OLAFT last year either. Truscott suggests Tonseth go back to WDFW to attempt to enhance collection in the ABC fishery.

Bill Gale said collecting sufficient NOR brood (in the fishery or the OLAFT) is one piece of PNI management but the other piece is management of the proportion of hatchery origin spawners (pHOS) on the spawning ground. How does this affect our ability to manage fish on the spawning ground? Pearsons said that pHOS has been very good (~10%). Pearsons said last year the volunteer trap was run as long as was able because the trap wasn't becoming filled. He added the U.S. Army Corps of Engineers has also been keeping the trap open to bring fish into Ringold. Tonseth said Ringold made improvements to their trap that will enhance their ability to bring adults into the trap. Pearsons said Ringold typically doesn't get a lot of NORs. Pearsons said he is not opposed to collection by ABC if Paul Hoffarth is comfortable with it. He said there will be additional transfer boats and trucks allocated this year to improve collection and transfer, and there will be a high cap on participants (100 boats).

Pearsons said he will organize a conference call with himself, Tonseth, and Hoffarth to develop a plan to present to the PRCC HSC. Pearsons asked if the plan is to maintain collection at the OLAFT, will Truscott approve knowing CCTs aversion to trapping at the OLAFT. Truscott said the later arriving fish may be the most important to the Okanogan. Truscott said he will have a hard time buying into the status quo (1,000 fish at OLAFT) but that it would be more acceptable to collect half as many at the OLAFT (500 fish). Keely Murdoch said she wants to make sure that enough broodstock can be collected and will be interested to know how the conversations develop. She said there is no preference for whether the fish come from ABC or the OLAFT. Pearsons said the broodstock needs can be met by using the hatchery channel. Tonseth said the concern is not meeting production goals but pNOB [PNI goal] for the Hanford Reach. Tonseth said that low pHOS helps the PNI. Pearsons said there were many fish collected last year in the ABC allowing spawning combinations of 1:1, 1:2, and 1:4.

C. Priest Rapids Monitoring and Evaluation Implementation Plan

Todd Pearsons will distribute the draft 2019 Priest Rapids M&E Implementation plan to the PRCC HSC this week or next week for a 30-day review. He said highlights and changes to the plan will be shown as using track changes. He said the following changes will be made:

- An ABC task will be moved from M&E to O&M
- Removal of a completed task related to CWTs and carcass bias. This task will be summarized in the comprehensive report and annual updates have been included in the M&E annual reports

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are on February 20, 2019 (Grant PUD), a conference call on March 11, 2019, and March 20, 2019 (Grant PUD).

The HCP-HCs and PRCC HSC will hold the special conference call on March 11, 2019, to discuss revisions to the first draft of the 2019 Broodstock Collection Protocols. Mike Tonseth will receive comments on the first draft by March 1, 2019, then will send around a revised draft with redlines shown in track changes and a clean copy by March 6, 2019. Tonseth requested that representatives make revisions to the clean copy. The goal will be for the HCP-HCs and PRCC HSC to approve the 2019 Broodstock Collection Protocols in the March 20, 2019 meeting.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Final 2019 Douglas PUD Wells HC Action Plan
Attachment C	2019 Chelan PUD RI/RR HCs Action Plan

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Todd Pearsons‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Matt Cooper*‡	U.S. Fish and Wildlife Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Pat Wyena°	Wanapum Tribe
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

FINAL 2019 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. **Juvenile Fish Bypass**
   a. Gas Abatement Plan (GAP) and Bypass Operating Plan (BOP) to CC...... 18 January 2019
   b. CC comments on GAP/BOP to DCPUD .... 12 February 2019
   c. CC approval of GAP/BOP .... 21 February 2019
   d. Submit final GAP/BOP to FERC for approval .... 28 February 2019
   e. 2019 Bypass operations at Wells .... 9 April 2019 – 19 August 2019

2. **Annual Monitoring of Juvenile Migration Run Timing**
   a. 2019 draft passage-dates analysis and post-season bypass report to CC.........October 2019
   b. CC approval of 2019 final report ....November 2019

3. **Fishway Outage Schedule for Fishway Inspection, Maintenance, and Fishway Projects**
   a. West Fishway.. 12 February 2019 – 28 February 2019
   b. East Fishway .... 7 January – 5 February 2019
   c. Adult Fishway Trap Coordination Meeting .... April 2019

4. **Multi-Year Sub-yearling Chinook Life-history Study**
   a. Draft juvenile life-history report to CC .... April 2019
   b. Final juvenile life-history report ....July 2019

5. **Review and Approval of 2019 Hatchery Broodstock Collection Protocol**
   a. Draft protocol to CC for review.. 16 February 2019
   b. CC approval of draft protocol .... 27 March 2019
   c. Deadline for submission of protocol to NMFS... 13 April 2019

6. **Pikeminnow Control Program**
   a. Draft 2018 pikeminnow report to HCP CC .... April 2019
   b. Final 2018 pikeminnow report.. June 2019
   c. 2019 Pikeminnow removal – Wells Project................................ March – November 2019

7. **Avian Protection Plan**
   a. Bird Hazing..April – August 2019

8. **2020 Survival Verification Study**
   a. CC approval of Study Plan .... January 2019
   b. Obtain contract for implementation .... Fall 2019
   c. Obtain/set up equipment and infrastructure for implementation ...... Fall 2019-Spring 2020
   d. Tag study fish...November 2019

9. HCP Annual Report

a. Draft 2018 annual report to DCPUD for review.. 9 January 2019
b. Draft 2018 annual report to CC for 30-day review.................................... 6 February 2019
c. CC comments on draft 2018 report due to Anchor QEA............................... 6 March 2019
d. Final 2018 annual report to DCPUD .... 21 March 2019
e. Final 2018 annual report due to FERC .... 30 March 2019

WELLS HCP HATCHERY COMMITTEE

1. Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan
- a. Ongoing implementation ....January – December 2019
- b. Draft annual report for 2018 to Douglas PUD ....July 2019
- c. Draft annual report to Hatchery Committee (HC) .... September 2019
- d. Final annual report to HC ....November 2019
- e. Draft 2020 implementation plan to HC ....July 2019
- f. HC approval of final 2020 implementation plan ....October 2019

2. Assessment of Precocial Maturation or Residualism
- a. Methow Hatchery spring Chinook lethal sampling .... March 2019
- b. Wells steelhead visual assessment .... April 2019

3. Twisp Population Study
- a. Implementation (to be determined)...September – October 2019
- b. 2014, 2015, 2016, 2017, 2018 Reports .... June 2019

4. 2019 Broodstock Collection Protocol
- a. Draft to HC for review .... 9 February 2019
- b. HC approval of draft protocols .... 21 March 2019
- c. CC approval of Wells Dam trapping operations................................ 27 March 2019
- d. Deadline for submission to NMFS .... 13 April 2019

5. Annual Implementation – Okanagan Sockeye Fish/Water Management Tools
- a. Water Year 2017-2019...October 2018 – September 2019
- b. Incubation Protection and Emergency Monitoring.............................January – April 2019
- c. Redd Scour Prevention Activities .... April-May 2019
- d. Optimization of Limnetic Rearing Environment .... July-September 2019
- e. Sockeye Spawning Protection Levels .... October-November 2019
- f. Kokanee Elevation and Protection Levels .... October-November 2019
- g. Water Budget (Snowtel, River and Lake Gage, Withdrawals)... January – December 2019

6. Methow Steelhead Relative Reproductive Success Study
- a. Implementation ....March 2010 – December 2021
- b. Annual report on genetic analysis... September/October 2019
- c. Biological data in Annual M&E Report (above) .... September 2019
- d. Final report.. 2021/2022

7. Hatchery Genetic Management Plans
- a. Receive new Wells steelhead hatchery permit................................*to be determined, 2019*
- b. Receive new Wells summer Chinook hatchery permit....................*to be determined, 2019*

8. Chief Joseph Hatchery Production
- a. Fund hatchery production (spring/summer Chinook)..2019
- b. Fund monitoring and evaluation 2019

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars ($284,793.79 in 2019 dollars) .... 11 January 2019

2. **Annual Report - Plan Species Account Status**
   a. Submittal of 2018 account-status report to Tributary Committee (TC): ...... 3 January 2019
   b. Integration into 2018 HCP Annual Report: .... January 2019

3. **General Salmon Habitat Program**
   a. Project review and funding .... January-December 2019

4. **Small Project Program**
   a. Project review and funding Decision .... January-December 2019

2019 Rocky Reach and Rock Island
HCP Action Plan

COORDINATING COMMITTEE	Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
Deliver 2018 RR Bypass Evaluation Report				D				F																												
Deliver 2019 RR Bypass Operations Plan				D					F																											
Deliver 2018 RI Bypass Evaluation Report				D					F																											
Deliver 2019 RI Bypass Operations Plan				D				F																												
Update HCP CC on RR Unit Repairs																																				
Update HCP CC on RI PH1 B1-B4 Unit Repairs																																				
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring										S																										C
Deliver 2019 RR/RI Spill Plan							D			F																										
Deliver 2019 RR/RI Spill Report																										D			F							
RR 9% Summer Spill																S							C													
RI 10% Spring Spill											S												C													
RI 20% Summer Spill																S							C													
RR Juvenile Fish Bypass Operations										S														C												
RI Juvenile Bypass Trap Operations										S														C												
2018 HCP Annual Report							D			F																										

HATCHERY COMMITTEE	Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
2018 Hatchery M & E Report																	D								F											
2020 Hatchery M & E Implementation Plan																						D						F								
Broodstock Collection Protocols	S										C																									
Dryden Water Quality Monitoring (Year 8)								S																			C									
Chelan Falls Broodstock Collection-Pilot Seining and Temporary Weir																				S							C									
Chelan Hatchery Rehabilitation Engineering Feasibility	D																																			
Chiwawa Weir Maintenance Engineering Permitting	D																																			
Eastbank Well Generator Installation									C																											
Pilot Outplant adult MetComp spr Chinook to Chewuch																							S				C									
Steelhead Residualism Plan - *Permit No. 18583*	D																																			
Implement Year 2 of 3 of the Steelhead Release Plan to inform the Steelhead Residualism Plan					S													C																		
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							
Receive Unlisted Permit (Wenatchee and Chelan Falls summer Chinook)	D																								C											

TRIBUTARY COMMITTEE	Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
RR and RI Plan Species Account Annual Deposit			C																																	
General Salmon Fund Approval	→ Ongoing																																			
General Salmon Fund Implementation	→ Ongoing																																			
Small Project Review and Approval	→ Ongoing																																			
Small Project Implementation	→ Ongoing																																			

D = Draft Document
F = Final Document

S = Start Project
C = Complete Project

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: April 18, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the March 11, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Conference Call

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCP) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) conference call was held on Monday, March 11, 2019, from 2:30 p.m. to 4:15 p.m. Attendees are listed in Attachment A to these meeting minutes.

Conference Call Action Items

Joint HCP-HCs and PRCC HSC

- Greg Mackey will forward Douglas PUD's suggested revisions describing broodstock and egg obtainment for the Douglas PUD Coho program (refers to Appendix K of the Protocols) to Keely Murdoch, Bill Gale and Matt Cooper for their review before inclusion in the Broodstock Protocols.
- Mike Tonseth will add language to the Protocols that allows flexibility in the future to select for older males using alternative, non-random mating strategies.
- Mackey will summarize numbers for Committee discussion and make edits to Protocols on the likelihood that all summer steelhead broodstock could be collected at the Wells Volunteer Trap in the spring to eliminate fall-collection for the MSN and Columbia Safety-Net (CSN) programs.
- Tonseth will redistribute the Methow Basin spring Chinook translocation plan for review and discussion in the March 20, 2019 meeting. Tonseth will ask Michael Humling (USFWS) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to WNFH.
- Catherine Willard will send the Relative Reproductive Success (RRS) study extension memorandum to Rohrbach with the translocation plan for distribution *(Rohrbach distributed an email from Willard and the attached RRS study extension and translocation plan to the HCP-HC and PRCC HSC following the March 11, 2019 conference call).*

- Tonseth will confirm with Andrew Murdoch (WDFW) that DNA sampling of the 2018 to 2023 returns is still consistent with the original RRS extension agreement and provide an updated extension.
- Tonseth will send the Methow Basin Steelhead Conservation program broodstock collection protocols by angling to Humling and Snow for review.
- Bill Gale and Cindy Raekes (USFWS) will send suggested edits to Mike Tonseth regarding the Chiwawa Weir operations protocols to optimize operation and protect bull trout per the BiOps.
- Willard will email notes that summarize 2018 Chiwawa Weir operations. *(Willard notified Rohrbach that she emailed details on 2018 Chiwawa Weir operations to USFWS and WDFW on March 11, 2019)*.
- Tonseth will convene a Joint Fisheries Parties meeting to discuss marking to identify hatchery x hatchery returns from fish used to backfill the Nason and Chiwawa Conservation Program.
- Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding Broodstock Collection Protocol topics for presentation in HCP-HC and PRCC HSC meetings throughout the year.

Hillman and Rohrbach will help the HCP-HCs and PRCC HSC identify co-authors and opportunities to make revisions to the Protocols in advance of 2020 deadlines Decision Summary

- There were no decisions approved during today's conference call.

Agreements

- There were no agreements discussed during today's conference call.

Review Items

- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC including the revised draft 2019 Broodstock Collection Protocols on March 8, 2019. Mike Tonseth requested that final comments on the clean copy of the revised protocols be submitted to him by March 15, 2019.

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda (Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and said the purpose of today's call is to review the revised draft 2019 Upper Columbia River Broodstock Collection Protocols (Protocols).

Hillman asked if there were any questions regarding the approach to reviewing the Protocols. Todd Pearsons said that most of the questions or concerns raised by the PRCC HSC had been resolved in the most recent edits. Hillman said that all parties except NMFS and U.S. Fish and Wildlife Service (USFWS) have submitted comments. Bill Gale said USFWS had similar comments to those already submitted by the other parties and will add some in today's meeting as needed.

II. Joint HCP-HCs and PRCC HSC

A. Broodstock Collection Protocols Review (Mike Tonseth)

Mike Tonseth said that after presenting the first draft of the Protocols, there were two major outstanding issues to resolve: 1) trapping at the Priest Rapids Dam Off-Ladder Adult Fish Trap (the OLAFT); and 2) Wenatchee spring Chinook salmon broodstock collection. Tonseth said both have been resolved in the revised draft Protocols.

Tonseth reviewed the following outstanding issues, which were flagged for discussion and resolution. Tonseth said additional comments or edits from other parties could be addressed after discussing those he had flagged.

Appendix K: Mid-Columbia Coho Salmon, page 3

Tonseth said there is uncertainty about whether the Douglas PUD coho salmon program would receive green eggs [or eyed eggs] from coho salmon broodstock collection facilities. The comment from Greg Mackey reads,

> DPUD [Douglas PUD] would prefer to receive green eggs for our Coho program spawned at WNFH. The 2018 brood was too advanced because they were brought to Wells as eyed eggs. We need to chill the eggs to hold them back to rear the Coho at Wells – or they will get really big. Need to note this in the Appendix K when it arrives.

Tonseth said he will rely on Mackey and Keely Murdoch to decide how best to revise the coho salmon protocol. Murdoch said Douglas PUD had sent a paragraph of suggested language immediately prior to this conference call and that she will need to discuss with others not on this call to resolve the uncertainty. Murdoch said her concerns with the proposed language are the specific naming of Winthrop National Fish Hatchery (WNFH) and that it commits the YN to the use of green eggs. Murdoch said she would rather insert language allowing flexibility to use eyed eggs or green eggs. Murdoch said there is a need to discuss the choices with WNFH and YN staff to resolve the language. Mackey said it's an issue of incubation timing. Tonseth said the parties have an opportunity to submit final edits to the Protocols by end of day (EOD) on March 15, 2019.

Bill Gale said if suggested changes need to involve USFWS staff to please keep himself and Matt Cooper informed as well. Mackey said he will forward the suggested language to Gale and Cooper.

Use of Age-3 Spring Chinook Salmon Males (Jacks) into Methow River Basin Broodstock, pages 5 and 6

Tonseth said the issue of including age-3 males (jacks) in broodstock remains unresolved. Tonseth said that Mackey is not greatly supportive of using age-3 males in broodstock, but alternatively has suggested designing better (non-random) mating strategies (to select for older males) such as those proposed in Hankin et al. (2009, 2011). Tonseth said the question for the HCs is whether to carry on with the status quo this year or take on a different strategy this year. Mackey said he initially brought up the idea of using NOR age-3 males on a limited basis in place of hatchery-origin (HOR) males if age 4+ NOR males are in limited supply. Mackey said it would be wise to pursue a mating protocol that more integrates aspects of population management. Tonseth said a protocol using genetic data and age data for each fish could produce a more robust mating matrix to avoid familial crosses. Tonseth said this approach could be done with the Nason conservation program because all fish would be handled at Tumwater Dam. It could also be used for the Twisp/Methow conservation program. Tonseth asked whether representatives still want to consider this new approach in 2019. Todd Pearsons said consideration of a new approach to the mating matrices is worth discussion, but time constraints prevent making a decision this year. Pearsons suggested adding some language that allows flexibility to consider alternative strategies in the future.

Pearsons said this is one example of rushing the discussion of large topics so close to the Protocol deadline such that the representatives feel constrained about making decisions. Pearsons said he would prefer to design a process that starts these discussions earlier in the year so large changes can be made prior to drafting Protocols. Tracy Hillman said that Tonseth identified this topic last March/April (2018) and that researching the use of age-3 fish in the broodstock has been an action item for some time. Pearsons clarified that the new part being proposed is the mating matrix to avoid familial crosses, not the use of age-3 fish in the broodstock. Hillman said that he and Larissa Rohrbach will keep this and other outstanding issues on the HCP-HCs and PRCC HSC agendas throughout the year to encourage earlier discussion.

Fall Collection of Summer Steelhead Broodstock, pages 8 and 9

Tonseth said the first draft of the Protocols described eliminating the fall collection of back-up steelhead broodstock for the Methow Safety-Net (MSN) and Okanogan programs. This alternative is to backfill the MSN with 160,000 juveniles from a spring-collected component. Mackey said they could move forward with the protocol as written.

Mackey said he could summarize numbers for Committee discussion to estimate the likelihood that all broodstock could be collected at the Wells Volunteer Trap in the spring to eliminate fall-collection for the MSN and Columbia Safety-Net (CSN) programs. Tonseth said he is not opposed to moving the CSN collection to spring as well as the MSN collection. Mackey said that for the CSN program, fall collection is ok, but the spawning season is long, over 10 to 12 weeks with many egg-takes, so it is easier to take all brood in the spring to coordinate spawning. Tonseth suggested adding placeholder language to the Protocols explaining that an update can be made once average numbers of fall and spring brood are reviewed and this topic can be revisited. Tonseth said for this year, there are likely to be sufficient numbers for spring collection; however, it is unknown if there will be a sufficient number of females. Mackey said he will work with Tonseth to incorporate edits to the Protocols as soon as possible.

Trapping and Utilization of Spring Chinook Salmon in the Methow Basin, pages 7, 8, and 35

Tonseth said the Methow spring Chinook salmon forecast indicates that there will not be sufficient numbers to meet a release target of 400,000 for the safety-net program at WNFH. Tonseth suggested using any Methow Hatchery returns (HOR) for translocation out to the spawning grounds. Tonseth said this will require a plan for collection of the adults and locations for translocation. Tonseth said otherwise WNFH returns (surplus to the Methow Hatchery program) would be used for broodstock to meet the 400,000-smolt production target for WNFH program and the Chief Joseph Hatchery (CJH) 10j program. Tonseth said there will probably not be a need for adult management at the Methow Hatchery trap unless the run size exceeds forecast. Gale asked if this proposed use is for Methow Hatchery HOR fish returning to Methow Hatchery. Tonseth said yes, and Methow Hatchery returns to WNFH. Gale said USFWS has PNI targets to meet for the Methow Spring Chinook Salmon Hatchery Program Biological Opinion (BiOp) and must ensure they do not violate the BiOp by shunting all fish for translocation. Gale said that PNI targets may not be relevant with such low numbers this year. Tonseth said PNI targets are provided in Table 6, page 37, and are based on estimated WNFH, Twisp, and Methow/Chewuch returns. Tonseth said even though no adult management occurs other than removal of age-3 males, PNI would still be above 0.67. Tonseth said if all surplus fish are translocated (56 WNFH fish), PNI would drop to 0.67 but given the size of the return, the PNI could go as low as 0.5 and still meet the conditions of the permit. Gale asked if these

PNI calculations were made with the 3-population model. Tonseth said this was calculated using the more rudimentary method, but it doesn't vary much from the 3-population model.

Gale asked if there are planned translocation areas and logistics. Tonseth said there is a translocation plan that was developed by the Hatchery Committees about 3 years ago that identified locations, but there haven't been enough adults to carry through with it yet. He said this year the low numbers almost necessitate carrying out the translocation plan to maintain some minimum level of spawner abundance in the natural environment. Tonseth said he will redistribute the translocation plan this week and it can be discussed in the HCP-HC meeting next week (March 20, 2019). Gale asked, out of the 329 expected HOR spawning escapement, how many would you transport? Tonseth said up to a total of 163 spawners would be transported (excluding the 56 surplus HOR fish from WNFH) and the proportion of hatchery-origin spawners (pHOS) would range from 23% to 29%. Tonseth said if the run-size is more robust than predicted, a management decision could be made to rapidly change the approach. Peter Graf asked what the total number proposed for translocation is and where they would be collected. Tonseth said there would be 163 HOR spawners for translocation and he could ask Humling and Snow to estimate the number of Methow returns that are likely to return to WNFH. Gale said this number also depends on how the Methow trap is operated; the proposal would be to run the Methow trap to remove WNFH fish, instead of shutting down the ladder early so that WNFH fish are passed. Tonseth agreed that this proposal depends upon running the Methow trap late in the season so spawners can be collected and moved to desirable locations rather than leaving them in the creek. Gale said USFWS is likely supportive but has concerns about sending all HOR fish that arrive at WNFH away to translocation sites. Gale will review the details of the plan and discuss it with Humling before making a decision.

Appendix C: Wenatchee Spring Chinook Salmon Adult Management, page 32-33, Table 2

Tonseth said that for the Wenatchee Basin, he does not anticipate the need for any adult management (other than removal of age-3 males). Tonseth said the run forecast is low enough that fish not needed for broodstock can be allowed to escape. Pearsons said that after removing jacks the sex ratio looks low for males and asked whether it is a good idea to remove all the jacks. Tonseth said during handling at Tumwater Dam, the sex ratio has been reduced to 75% males and assuming males can spawn with more than one female, this ratio is adequate without allowing jacks. Tonseth said trapping doesn't occur at all hours of the day at Tumwater Dam, so some jacks will likely pass when the trap is not in operation. Pearsons asked if the sex ratio could be higher toward males than reflected in Table 2? Tonseth said yes, noting it is difficult to predict the number of jacks. Pearsons said this could be an effective population size issue. Tonseth said the Committees could look at the recent 5-year summary to estimate number of age-3 males that have made it past Tumwater.

Pearsons said it is desirable to get closer to a 1-to-1 ratio. Tonseth said he would not recommend allowing all males upstream, especially if there is a high jack number.

Peter Graf asked if handling of adult spring Chinook for adult management and the Relative Reproductive Success (RRS) study occurs simultaneously at Tumwater Dam. Tonseth answered, yes. Catherine Willard asked if handling adult spring Chinook for the RRS study at Tumwater would continue past 2018. Willard said that in 2014, the HCs had approved an extension of the RRS study and asked if there is an update. Tonseth said the extension was for the 2018 brood, so there is a need to track the cohort through 2023. Willard said meeting notes indicate that no passive integrated transponder (PIT)-tagging of adults would be done from 2018 to 2023. Tonseth agreed, no PIT-tagging would be done, but DNA sampling would be necessary in 2019 to 2023 to sample the 'grandchildren' (F2 generation) of the initial 2013/2014 cohort. Tonseth said the 2018 brood will be the last group DNA-sampled as juveniles and as returning adults. Tonseth said he will confirm with Andrew Murdoch that DNA sampling of the 2018 to 2023 returns is still consistent with the original agreement that was recorded in notes or in an SOA. Willard suggested updating the January 2014 memorandum on the extension of the RRS study to clarify. Willard will send the RRS study extension memorandum to Rohrbach with the translocation plan for distribution.

Twisp River Steelhead Conservation Program, page 10

Tonseth said that in Appendix H (the draft preferred alternative approach for the Methow Basin Steelhead Conservation plan), Mackey suggested committing to a 5- to 10-year plan and, if necessary, to identify what modifications are needed. Mackey said that Douglas PUD has collected broodstock with USFWS by angling in the river and at the Twisp Weir, then brood go to WNFH, where they are spawned, and eggs are dispersed into the S1 program at Wells and S2 program at Winthrop. Mackey said capturing brood by angling was a stop-gap measure to address the Raiman-Laikre issue that was raised 2 years ago, but there was a question from the YN about whether it will continue to be successful to collect broodstock by hook-and-line for the preferred alternative. Mackey said last spring was the first spring when the preferred approach was implemented; it was successful even in a low return year and produced a surplus of eggs. Mackey said that hook-and-line collection could be similarly successful this year. Murdoch said YN was skeptical whether all broodstock could be collected via hook-and-line and said it will be important to keep the effort up and reevaluate the approach if it's not working. Cooper confirmed it has been easy to find volunteers. Cooper said they are close to meeting their brood component this year. Cooper said it has helped that there hasn't been a fishery, so fish are naïve and easily captured this year despite the cold water. Gale said the challenge to this approach would be if there is a large enough run that a fishery is allowed and broodstock collection should be carried out with hook-and-line; this could be a case for allowing a fall fishery only. Tonseth added, or a fishery only after brood have been collected. Tonseth proposed moving the preferred alternative approach forward instead of maintaining it as a draft in the Protocols but adding a sunset date for re-evaluation. Gale suggested sending the Protocols to Humling and Snow for review, then making a final decision in the March 20 HCP-HC meeting.

Tonseth asked the representatives for any additional comments or questions. Gale said he had three topics to discuss further, as follows:

Use of Chief Joseph Hatchery Segregated Fish Collected in the Methow Basin

Gale said he is uncomfortable using CJH fish collected in the Methow Basin for the backup program at CJH, because it would be using identified stray fish as brood in the CJH. Gale suggested deletion of the bulleted statement at the top of page 3, adding that the action would not provide many fish for the CJH program anyway. Tonseth said this was an addition by Kirk Truscott and that Truscott did revise it to use the word “may.” Tonseth said a decision on retaining or deleting this action would be made in the next HCP-HC meeting on March 20, 2019, with Truscott in attendance.

Collection of Summer Chinook Salmon at Wells Dam for the Yakima River Program

Gale noted that the collection of summer Chinook salmon at Wells Dam seems to have been struck completely by Truscott. Gale said this makes collection at Entiat Hatchery the default, which has not been discussed. Gale said the use of surplus fish at Wells Dam should be maintained as a possibility and should be discussed with Truscott in attendance. Murdoch said Truscott would not be able to approve a protocol that reserves surplus fish from Wells Dam for the YN from the outset but noted that perhaps surplus fish could be acquired as eggs. Murdoch has informed YN staff that these conversations are ongoing. Tonseth said the YN is on the surplus fish distribution list for receiving surplus eggs, but typically decline. Truscott is suggesting that YN not decline this surplus in the future. Gale asked for the parties to keep him informed so the Entiat Hatchery is not the primary source for the YN program, which would impact USFWS’s ability to use surplus fish at Entiat Hatchery for other reasons.

Chiwawa Weir Operations

Gale said Cindy Raekes and Sierra Franks (USFWS) reviewed protocols for broodstock collection at the Chiwawa Weir and may suggest some edits. Raekes said USFWS has concerns about the cumulative trapping day limit. Raekes suggested holding to the 15-day trap limit and then adjusting to continue trapping later in the season, if needed. Raekes said some spawning data are also lacking for determining the 5-year estimated mean number of adult bull trout in the Chiwawa Basin. Raekes said all the other content in the Protocols seems consistent with the BiOp for the Wenatchee River

Spring Chinook Salmon, Summer Chinook Salmon, and Steelhead Hatchery Programs (November 2017).

Tonseth said the concern is the lack of NOR returning this year. Tonseth said bull trout are so much more abundant than spring Chinook salmon in years like this that the 15-day trapping limit is a handicap to broodstock collection. Tonseth said the Protocols list the same number of days allocated as last year (20 days) but the program still did not meet the NOR target.

Gale said USFWS is suggesting starting with 15 days of trapping, then evaluating whether more days should be added. Gale said that last year the additional days didn't help to collect additional NOR spring Chinook salmon. Tonseth said the Protocol lacks flexibility and does not want to be constrained to using the additional trapping days at the end of the season. Tonseth said that if they had allocated those additional 5 days at a different time, the flexibility could have allowed them to be used at the beginning or middle of the run. Willard noted the weir did not begin operation until later in the season due to high flows. Gale said spring Chinook salmon were missed at the beginning of the season not because days were being held in reserve but because of high flow conditions. Tonseth said he wants to avoid a situation that limits trapping days and then requires two to three weeks to resolve in season so that resolution occurs too late in the season. Gale and Raekes said they will suggest edits that would be amenable to both WDFW and USFWS and in line with the bull trout BiOp. Willard said she will look through notes and emails to confirm what happened last year.

In-Season Brood Number Adjustments

Mackey said that for programs using hatchery fish (safety-net and harvest programs, in particular), it would be helpful for all to agree to a range in the target numbers rather than a single target number.

Mackey said a range would provide some bounds for program managers to make decisions in-season and make adjustments if the fish look beat-up, smaller, or younger than expected so that fecundity and/or survival would be low. Mackey said he has a model for estimating confidence intervals to arrive at a range of target numbers instead of point estimates. Tonseth agrees to have this discussion but that to change the past practices it should be presented to the HCP-HCs and PRCC HSC as a proposal. Tonseth said there will be variability in how much latitude could be provided, especially for listed populations. Mackey agreed that listed stocks might be tightly regulated to a specific number; however, the safety-net and harvest programs often have surplus fish anyway, and this would allow some flexibility on using them for brood so as to provide a greater likelihood of meeting program targets. Tonseth said there is currently some latitude built-in to the Protocols; currently there is no latitude for changes in uses due to pre-spawn mortality related to culturing issues. Tonseth said he would not want to see any flexibility used as a crutch for bad culturing practices. Tonseth said this would need to be tailored to a program by program approach.

Mackey said he will reserve the issue of establishing ranges for broodstock collection targets for future discussions.

Update on Nason Conservation Program Size Discussions

Pearsons asked whether a decision was made about the sizing of the Nason program. Tonseth agreed in a discussion with Murdoch that it was premature to propose a reduction in the program at this time and that the parties may have different interpretations of the direction of the program at this time. Tonseth said that all information needs to be made available from the previous analysis for original sizing of the program, as well as updates to the life cycle model for updating the program size, and updated run size information. Tonseth notes that there is more work to do before the Joint Fisheries Parties (JFP) can move forward with a formal proposal to reduce the conservation programs.

Pearsons asked if there will be a combination of NOR and HOR fish in the Nason Conservation Program broodstock this year and if they will all be marked as conservation program fish. Tonseth said, yes. He said in discussions with Murdoch it was decided that tracking wild x wild fish for brood or escapement to the spawning ground will always be the priority. Tonseth said there is a footnote in Appendix B about the JFP discussing a secondary mark for identifying hatchery x hatchery fish to be used for adult removal, passage, or inclusion into hatchery programs. Murdoch said YN does not think a supplemental mark is necessary, but if it's important to other parties, she is willing to discuss it in the JFP. Tonseth said if there is no secondary mark, the program would lose ability to prioritize crosses when fish return. Willard asked if a decision will be made before marking this year? Tonseth said this decision may not be made prior to marking the Chiwawa fish but could be made for the brood to be marked one year from now. Willard said she will need some direction because there will be ~70% HOR fish for the brood year 2018 conservation program. Tonseth said the default mark will be a snout coded wire tag and no adipose clip.

Brett Farman said he has not had time to update his analysis of PNI using the 3-population model (to determine the influence of hatchery x hatchery spawners). Murdoch said as permits are written, it doesn't make a difference who the parents were, but it would be nice to know for the implementation of the program. Tonseth said the biggest impact to PNI when these fish return are how many we allow on the spawning grounds, which depends on the number of NOR fish. Lower NOR results in higher pHOS and higher PNI. Tonseth said the permit condition is to calculate PNI on a rolling 5-year average such that 1 or 2 bad years could be counterbalanced by good years. Tonseth will convene a JFP meeting soon to discuss this topic.

Broodstock Collection Protocols Document Production

Hillman asked why the Protocols are authored by WDFW and not by the permit holders. Tonseth said WDFW is co-permittee and there was a clause that WDFW would develop them. Murdoch said this came from the history of WDFW operating all of the hatchery programs. Pearsons said some of their (Grant PUD) permits say the permit holders should develop the annual spawning protocols. Willard said permit holders would be WDFW and the PUDs. Tonseth said that in a way, all parties do write the Protocols together during the editorial process. Tonseth said there are a number of elements that are becoming streamlined, such as materials in the appendices, allowing them to be made available earlier. Tonseth said Pearsons' comment on timelines for developing the Protocols should be addressed in the Committees and potentially lead to revising the SOA on Protocol development timelines. Tonseth said the parties would have to develop a list of which elements could be developed earlier versus later in the year.

Deanne Pavlik-Kunkel said this process feels a bit broken; there did not seem to be enough time to discuss major proposed changes to programs for the Protocols. Pavlik-Kunkel said Grant PUD's position is that there should be modifications to this process. Hillman suggested drafting parts of the Protocols in November or December of the previous year and perhaps sharing the drafting responsibility with the PUDs. Hillman said he and Rohrbach can help identify some of the big changes that require discussion prior to first draft of Protocol development and identify sections that can be worked on by others in the Committees to share the workload. Pearsons agreed that the reasonable starting point would be modifying that SOA. Pearsons said Tonseth has done everything consistent with the SOA; perhaps the Committees just need to back up the due dates. Tonseth agreed that modifying the SOA is a good place to start because the SOA is already on the books; however, it may not be an SOA for the HSC. Tonseth agreed to identifying certain pieces that can be worked on earlier.

III.PRCC HSC

A. Broodstock Collection Protocols for PRCC HSC Programs

Discussion topics pertaining to the PRCC HSC were addressed in the Joint HCP-HCs and PRCC HSC section of the agenda.

IV. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings will be held on March 20, 2019 (Grant PUD), April 17, 2019 (Grant PUD), and May 15, 2019 (Grant PUD).

Tonseth requests that comments on the revised draft 2019 Protocols be submitted to him by EOD Friday, March 3, 2019, so he can distribute a final draft back out to the representatives by EOD Monday March 6, 2019 (depending on scope of the comments).

The HCP-HCs and PRCC HSC will approve the 2019 Broodstock Collection Protocols during the March 20, 2019 meeting.

V. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
Larissa Rohrbach°	Anchor QEA, LLC
Tracy Hillman°	BioAnalysts, Inc.
Catherine Willard*°	Chelan PUD
Greg Mackey*°	Douglas PUD
Todd Pearsons‡°	Grant PUD
Peter Graf‡°	Grant PUD
Deanne Pavlik-Kunkel°	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Matt Cooper*‡°	U.S. Fish and Wildlife Service
Bill Gale*‡°	U.S. Fish and Wildlife Service
Cindy Raekes°	U.S. Fish and Wildlife Service
Mike Tonseth*‡°	Washington Department of Fish and Wildlife
Keely Murdoch*‡°	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: April 18, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the March 20, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCP) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, March 20, 2019, from 9:00 a.m. to 3:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Fish Hatchery (FH) (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing)*
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan)* based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow FH programs (Item I-A). *(Note: this item is ongoing.)*

- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating the proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs. *(Note: this item is ongoing.)*
- Brett Farman will inform the HCP-HCs of the publication date for public review of the Methow River Steelhead Environmental Assessment (Item II-F). *(Note: this item is ongoing.)*
- Brett Farman will inform the HCP-HCs on the publication date for public review of the Section 10 permits for the unlisted Chinook salmon bundle (Item II-F). *(Note: Larissa Rohrbach distributed an email from Farman and draft permits for the Section 10 programs to the HCP-HCs and PRCC HSC on March 28, 2019. This item is complete.)*
- Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Winthrop National Fish Hatchery (WNFH) to inform a translocation discussion during the April 17, 2019 HCP-HCs meeting. (Item I-A) *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the *2017 Out-planting Surplus Methow Composite Spring Chinook Salmon Adults* memorandum for review and discussion during the April 17, 2019 HCP-HCs meeting. (Item II-A)
- Mike Tonseth will confirm with Andrew Murdoch that Wenatchee Spring Chinook DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success (RSS) Study extension agreement and provide an update to that extension. (Item I-A) *(Note: this item is ongoing.)*
- Mike Tonseth will convene a Joint Fisheries Parties meeting to discuss marking to identify hatchery x hatchery returns from fish used to backfill the Nason and Chiwawa conservation programs. (Item I-A) *(Note: this item is ongoing.)*
- Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman and Larissa Rohrbach will maintain the following list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Protocols). (Item I-A) *(Note: this item is ongoing.)*
  - Use of age-3 males in broodstock
  - Use of alternative, non-random mating strategies
  - Establishing ranges around broodstock collection targets
  - Source for Chiwawa spring Chinook salmon broodstock
- Tracy Hillman and Larissa Rohrbach will help the HCP-HCs and PRCC HSC identify co-authors and opportunities to make revisions to the Protocols in advance of 2020 deadlines (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will send suggested language on broodstock protocols for the Douglas PUD coho salmon program to Keely Murdoch and Cory Kamphaus (Yakama Nation [YN]) for

approval and to Mike Tonseth for inclusion into the 2019 Protocols by end of day March 20, 2019 (Item II-A). *(Note: language was incorporated into the 2019 Protocols that were distributed by Larissa Rohrbach on March 21, 2019.)*

- Mike Tonseth will email a final draft of the 2019 Protocols to Larissa Rohrbach for distribution to the HCP-HCs and PRCC HSC by end of day March 21, 2019 (Item II-A) *(Note: the 2019 Protocols were distributed by Rohrbach via email on March 21, 2019.)*
- HCP-HCs and PRCC HSC representatives or alternates will vote by email whether to approve the 2019 Protocols by end of day March 22, 2019 (Item II-A). *(Note: the 2019 Protocols were approved by the Wells, Rock Island, and Rocky Reach HCs and the PRCC HSC Parties by email on March 22, 2019.)*

Wells HCP Hatchery Committee

- Greg Mackey will provide a revised version of Douglas PUD's draft 2019 M&E Implementation Plan for HCP-HC approval by email (Item I-A). (*Note: This item is ongoing*)

RI and RR HCP Hatchery Committee

- Mike Tonseth will email the Hatchery and Genetic Management Plans (HGMPs), biological opinions (BiOps), and permits that give direction on marking spring Chinook salmon in the Chiwawa and Nason conservation and safety-net programs to Larissa Rohrbach for distribution to the HCP-HCs and PRCC HSC and filing on the Extranet site (Item IV-A). (*Note: Relevant documents were distributed and filed by Rohrbach on March 21, 2019*).
- Mike Tonseth will confirm the timeline for tagging juvenile Chiwawa spring Chinook salmon in 2019 (Item IV-A).
- Brett Farman will ask Amilee Wilson and Craig Busack (National Marine Fisheries Service [NMFS]) to clarify the intent of the direction provided in NMFS BiOps for marking Chiwawa and Nason conservation program juvenile spring Chinook salmon (Item IV-A)

PRCC Hatchery Subcommittee

- Tracy Hillman will ask the PRCC to provide specific instructions in writing regarding what they want the PRCC HSC to do with the White River spring Chinook salmon hatchery memorandum (Item V-C). *(Note: Hillman sent an email to the PRCC Chair regarding this topic.)*
- PRCC HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item V-C).

Decision Summary

- The Wells, Rocky Reach, and Rock Island HCP-HCs and PRCC HSC approved the 2019 Broodstock Collection Protocols as follows: WDFW approved via email on March 21, 2019, and Chelan PUD, Douglas PUD, Grant PUD, YN, CCT, USFWS, and NMFS approved via email on March 22, 2019. (Note: the Wells HCP-CC also approved the 2019 Protocols on March 26, 2019, and the final version was distributed to the committees on March 28, 2019.)

Agreements

- There were no agreements discussed during today's meeting.

Review Items

- Larissa Rohrbach sent an email to the PRCC HSC on February 21, 2019, notifying them that the draft Priest Rapids Hatchery M&E Implementation Plan is available for 30-day review with comments and edits due to Todd Pearsons by March 25, 2019 (Item V-A).
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on February 7, 2019, notifying them that the updated meeting protocols, distribution lists, and draft Conflict of Interest Statement of Agreement (SOA) are available for review (Item II-B).
- Larissa Rohrbach sent emails to the HCP-HCs and PRCC HSC on March 28, 2019, notifying them that the draft NMFS Section 10 Permits for the Takes of Endangered and Threatened Species are available for review with comments due to Emi Kondo (NMFS) by April 15, 2019.

Finalized Documents

- Larissa Rohrbach distributed the final 2019 Wells HCP Action Plan, approved by the Wells HCP-Coordinating Committee, to the HCP-HCs on March 22, 2019.
- Larissa Rohrbach distributed the final 2019 Protocols, approved by the HCP-HCs, to the Wells Coordinating Committee Chair and copied the PRCC facilitator, on March 22, 2019, for approval by the Wells HCP-CC (Item II-A).
- Larissa Rohrbach distributed the final Wells HCP Annual Report, approved by the Wells HCP-Coordinating Committee, to the HCP-HCs on March 28, 2019.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and approve the February 20, 2019 Meeting Minutes (Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the agenda. Catherine Willard added the topic "Marking brood year 2018 Chiwawa spring Chinook salmon" to the Rock Island Hatchery Committee section of the agenda. The HCP-HCs and PRCC HSC representatives approved the revised agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised draft February 20, 2019 meeting minutes. Larissa Rohrbach said there were some revisions that the representatives then reviewed. The HCP-HCs and PRCC HSC representatives approved the draft February 20, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on February 20, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on February 20, 2019 and March 11, 2019)*:

Joint HCP-HCs and PRCC HSC Topics

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's* Review of Spring Chinook Salmon in the Upper Columbia River *under HCP-HCs' purview (Item I-A).* Hillman said this item is ongoing. He said protocols will be updated as tools are developed for the 10-year comprehensive reports.
- *Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery; Item I-A).* Mackey said this item is ongoing.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HCs meeting (Item I-A).*
  Tonseth said this item is ongoing, pending acquisition of additional information to inform the model.
- *Catherine Willard will update the genetics section of the* Monitoring and Evaluation Plan for PUD Hatchery Programs (2017 Update) *based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A).*
  Willard said this item is ongoing.
- *Greg Mackey will confirm with Betsy Bamberger (Douglas PUD) whether Douglas PUD will use the Washington Animal Disease Diagnostic Laboratory (WADDL) for in-season bacterial kidney*

disease (BKD) testing during 2019 broodstock collection and confirm that WADDL methods will provide ELISA [enzyme-linked immunosorbent assay] optical density test results (Item I-A).
Bamberger said this item will be discussed in today's meeting.

- *Kirk Truscott will discuss with Colville Confederated Tribe (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).*
  Truscott said this item is ongoing.
- *Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A).*
  Rohrbach said this item is ongoing.
- *Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating the proportionate natural influence (PNI) for the Nason spring Chinook and Chiwawa spring Chinook programs (Item II-A).*
  Farman said this item is ongoing.
- *Brett Farman will inform the HCP-HCs of the publication date for public review of the Methow River Steelhead Environmental Assessment (EA) (Item II-F).*
  Farman said this item is ongoing and it was further discussed in section II-F.
- *Brett Farman will inform the HCP-HCs of the publication date for public review of the Section 10 permit for the unlisted Chinook salmon bundle (Item II-F). (Note: Farman emailed Larissa Rohrbach on March 6, 2019 to inform the Committees that the UCR unlisted Chinook NEPA and HGMP bundle will be published within the week.)*
  Farman said this item is ongoing and it was further discussed in section II-F.

Joint HCP-HCs and PRCC HSC Topics for Finalizing the 2019 Upper Columbia River Broodstock Collection Protocols

- *Greg Mackey will forward Douglas PUD's suggested revisions describing broodstock and egg obtainment for the Douglas PUD Coho program (refers to Appendix K of the Protocols) to Keely Murdoch, Bill Gale and Matt Cooper for their review before inclusion in the Broodstock Protocols.*
- *(Item II-A).*
  Mackey said this item is complete.
- *Mike Tonseth will add language to the Protocols that allows flexibility in the future to select for older males using alternative, non-random mating strategies (Item II-A).*
  Tonseth said language has been added allowing flexibility for inclusion of age-3 males. Mackey said proposals to change mating strategies should be discussed in future meetings with more thoughtful research, but timing was not adequate for the 2019 Protocols.

- *Mackey will summarize numbers for Committee discussion and make edits to Protocols on the likelihood that all summer steelhead broodstock could be collected at the Wells Volunteer Trap in the spring to eliminate fall-collection for the MSN and Columbia Safety-Net (CSN) programs (Item II-A).*

  Mackey said he will discuss this item during today's meeting.
- *Tonseth will redistribute the Methow Basin spring Chinook translocation plan for review and discussion in the March 20, 2019 meeting. Tonseth will ask Michael Humling (USFWS) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to WNFH (Item II-A).*

  Tonseth said this item is ongoing (with Humling and Snow).
- *Catherine Willard will send the Relative Reproductive Success (RRS) study extension memorandum to Rohrbach with the translocation plan for distribution (Item II-A) (Note: Rohrbach distributed an email from Willard and the attached RRS study extension and translocation plan to the HCP-HC and PRCC HSC following the March 11, 2019 conference call).*

  Willard said this item is complete.
- *Tonseth will confirm with Andrew Murdoch (WDFW) that DNA sampling of the 2018 to 2023 returns is still consistent with the original RRS extension agreement and provide an updated extension (Item II-A).*

  Tonseth said this item is ongoing.
- *Tonseth will send the Methow Basin Steelhead Conservation program preferred draft alternative for collecting broodstock by angling to Humling and Snow for review (Item II-A).*

  Tonseth said this item is complete.
- *Bill Gale and Cindy Raekes (USFWS) will send suggested edits to Mike Tonseth regarding the Chiwawa Weir operations protocols to optimize operation and protect bull trout per the BiOps (Item II-A).*

  Gale said this item is complete.
- *Willard will email notes that summarize 2018 Chiwawa Weir operations (Item II-A). (Willard notified Rohrbach that she emailed details on 2018 Chiwawa Weir operations to USFWS and WDFW on March 11, 2019).*

  Willard said this item is complete
- *Tonseth will convene a Joint Fisheries Parties meeting to discuss marking to identify hatchery x hatchery returns from fish used to backfill the Nason and Chiwawa Conservation Program (Item II-A).*

  Tonseth said this item is ongoing.
- *Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding Broodstock Collection Protocol topics for presentation in HCP-HC and PRCC HSC meetings throughout the year (Item II-A).*

Hillman said this item is ongoing

- *Hillman and Rohrbach will support the HCP-HC and PRCC HSC to identify sections of the Protocols that can be authored earlier in the drafting process by various HCP-HC and PRCC HSC members in future years (Item II-A).*
  Hillman said this item is ongoing; potential approaches to be determined with HCP-HCs and PRCC HSC members' help.

Wells Hatchery Committee

- *Greg Mackey will provide a revised version of Douglas PUD's draft 2019 Monitoring and Evaluation (M&E) Implementation Plan for HCP-HCs approval by email (Item I-A).*
  Mackey said this item is ongoing.

II. Joint HCP-HCs and PRCC HSC

A. Approve Broodstock Collection Protocols for HCP-HC Programs – DECISION ITEM

Mike Tonseth said there is an additional version of the Protocols that reflects edits provided by USFWS late on March 19, 2019. Tracy Hillman projected the most recent version during the meeting for review.

Tonseth said the following three topics lack resolution in the Protocols:

1. Elimination of back-up steelhead collection in the fall at the Wells Volunteer Channel
2. Chiwawa Weir spring Chinook salmon trapping plan that minimizes impacts to bull trout in compliance with USFWS permits
3. Translocation of surplus adult Methow spring Chinook salmon

Backup Steelhead Collection in the Fall at the Wells Volunteer Channel

Tonseth said the HCP-HCs representatives agreed to the proposed elimination of all back-up collection of Methow and Okanagan steelhead broodstock in the fall.

However, Tonseth said there was not resolution on whether to continue to collect fall backup broodstock for the Columbia Safety Net steelhead program from the Wells Volunteer Channel. Tonseth said the concern, particularly this year when the run is low, is there may not be enough females collected in spring when the majority of fish moving through the rivers are more likely to be males.

Greg Mackey provided a summary of the number of fish in the CSN program. Mackey said the CSN releases 160,000 smolts directly into the Columbia River. He said adult return counts are only available for very recent years because the program is relatively new in its current form and fish have not been surplused from the Wells FH Volunteer Channel until recent years. Mackey said that in

2017, there were 224 and in 2018 there were 242 adult steelhead returns to the Wells FH Volunteer Channel. Mackey did not know the sex ratios. Mackey said these represent swim-ins in approximately March, but more could be collected with increased effort. Mackey said for the CSN, 86 steelhead would be needed, so there are plenty of spring returns to cover the CSN.

Mackey said that between captures by angling (USFWS) and captures at WNFH that could be used for the CSN (or MSN) program, there are currently 44 fish (21 males and 18 females). Mackey estimated that today potentially a couple hundred fish would be cleared out of the Wells Volunteer Channel, enough to cover the approximately 40 remaining needed for the CSN. Bill Gale said WNFH just started trapping in the weir and volunteer channel last week and may capture fish from other programs. If there is a surplus (in excess of needs for WNFH brood and the Methow Safety-Net program), those fish could be used for the CSN. Mackey asked if there are other intended uses for surplus fish at WNFH. Gale said that in the past there were other uses (e.g., spawning trials) but this year there are none. Gale asked if CSN spawning happens at Wells Hatchery. Mackey said yes. Gale said one difficulty of putting WNFH fish into the CSN program would be the transfer to Wells because spawning is happening now at WNFH. Kirk Truscott said if the Protocols are edited, he would want to make sure Methow program targets are met before allocating surplus fish from Methow FH to the CSN. Truscott also requested that if the Committee agrees to no back-up collections in the fall, that the volunteer ladder collection to back-fill shortfalls in the Okanogan Program will be prioritized above the CSN program. Tonseth said it may be a good test to operate the (Wells) Volunteer Trap this spring as if doing adult management to see how many adults there are and what the sex composition is to anticipate what to expect for the 2020 brood.

Mackey said a good estimate of the total run is possible as adults come up the Columbia River in the fall. It could be assumed that only spring collection would be done unless the run forecast looks bad, then additional fish could be captured in September or October.

Tonseth said a concern is the 2019 return is predicted to be low for 1-salt steelhead to be used for the 2020 brood. Truscott said this could result in a skewed sex ratio toward females.

Mackey said maintaining fish health while holding fall-collected fish on well-water for extended periods of time is also a challenge.

Mackey said, for program flexibility, an in-season decision could be brought to the HCs based on run size; if the run is low, fish could be collected in the fall. Mackey said this could be a formal decision or a notice to the HCs. Gale said USFWS would like this to be a formal decision by the HCs rather than a notice. Gale asked if the in-season decision would only pertain to using surplus brood for the CSN. Mackey answered yes.

Hillman asked if the edits to the Protocols are adequate. Mackey said the protocol was edited to move entirely to spring collection of steelhead broodstock. Tonseth said if all are comfortable with this change, he will accept those edits. Truscott said CCT gives provisional approval based on adequate numbers to meet Methow program targets. Tonseth will revise the Protocols to reflect the suspension of fall collection of steelhead brood for the CSN with flexibility for the HCs to make an in-season decisions if the fall run-size looks low.

Chiwawa Weir Operation

Tonseth said USFWS provided language that dictates the parties (i.e., WDFW and Chelan PUD) that would give notice to the USFWS if there is a need to change the number of days of Chiwawa Weir operation causing a change in the numbers of bull trout encountered. Gale said this would require informing USFWS Ecological Services. Cindy Raekes (USFWS) has approved this language. Truscott asked whether 20 days of trapping at the Chiwawa Weir has already been authorized. Gale and Tonseth answered yes. Gale said the allowance is to encounter less than 10% of the estimated bull trout spawning population. Last year this allowed for a limit of 93 encounters at the weir. Gale said the intention of the language in the Protocols is for USFWS Ecological Services to review the Protocols each year.

Tonseth said due to low expected run size, any natural-origin spring Chinook salmon encountered during the Chiwawa Weir collection days will be retained.

Out-Planting Methow Spring Chinook (Appendix C)

Gale said he provided comments on the Protocols regarding how Methow FH natural-origin spring Chinook salmon are retained for Methow FH broodstock. Gale reminded the Committees members that translocation of all Methow FH returns not needed for broodstock to natural spawning areas was proposed by WDFW. Gale said that: 1) USFWS thinks active trapping at Methow FH should be done to prevent hatchery fish from spawning at the hatchery outfalls; and 2) USFWS is concerned about out-year effects on PNI of using only WNFH fish for brood. Gale said that according to the 3-population PNI prediction, it will be harder to meet the PNI goal of 0.67. Gale said USFWS suggests an approach of prioritizing females for out-planting and using males for WNFH brood. This approach keeps PNI at 0.5, minimizes hatchery by hatchery spawning in the wild, and promotes female-driven hatchery by wild spawning in the wild. Gale said the intent would be to use the translocation plan that was developed 2 years ago as a starting point (2017; distributed by Larissa Rohrbach on March 11, 2019).

Tonseth said there are three proposals to consider:

1. The original proposal to allocate all Methow FH returns (to Methow FH and WNFH) in excess of needs for WNFH for translocation
2. Maintain males for use at WNFH for broodstock
3. Allocate all Methow FH adults that return to Methow FH for translocation, and allocate all females that return to WNFH for translocation

Tonseth said the proposals would require operation of traps at Methow FH and WNFH for the full season to collect brood and collect Methow FH fish to translocate them to desirable sites (instead of spawning at the hatchery). Any translocation would depend upon return rates. Gale said a certain percentage of returning adults will bypass trapping even if traps are run; estimating this escapement would be a useful detail. Mackey asked whether in the original translocation plan there was a cap on the number to be translocated. Gale said yes, a cap of 200 hatchery-origin spring Chinook salmon adults was proposed; with a sex ratio that was skewed toward females (F:M of 1.0:0.2). Tonseth said based on the current run prediction, he has concerns there will be few males and translocation of too many females would bias interpretation of the success of the program if those females cannot find mates in the wild. Truscott said the Protocols should be clear that translocation is an issue that depends upon adequate returns. Truscott said allocating fish for translocation could cause a trickledown effect resulting in a lack of sufficient Methow FH returns for broodstock to support the Winthrop NFH stepping-stone production, requiring Winthrop returns to be used to satisfy Winthrop production and potentially jeopardizing Okanogan 10j broodstock collection that utilize Winthrop returning adults.

Tonseth said the Protocols will state that the 2017 translocation plan will be revisited and recommendations will be made for the 2019 activities.

Douglas PUD Program Comments and Revisions

Mackey said he revised a paragraph to be inserted into the YN coho salmon program appendix reflecting that Douglas PUD has a coho salmon program with broodstock collected within the YN program. The language also describes the activities based on discussions with Keely Murdoch and Cory Kamphaus. Mackey will send language to Tonseth and Keely Murdoch for her approval and inclusion into the Protocols by the end of today.

Mackey said Douglas PUD hatchery staff desire higher brood numbers than described in the Wells summer Chinook salmon yearling and subyearling broodstock collection plans. Mackey said Douglas PUD will not hold up approval of the Protocols but changes for these programs could be made between now and July 1. Tonseth said if it makes sense to change the plan, it is supported by WDFW.

Tonseth will send final revised Protocols to the HCP-HC and PRCC HSC representatives by late Thursday for email vote on Friday so the Protocols can be presented to the Wells HCP Coordinating Committee next week. Rohrbach will email final Protocols to the Wells HCP Coordinating Committee Chair (John Ferguson) and support (Kristi Geris) by the end of the day Friday.

B. Streamlining

Tracy Hillman said this topic will be addressed in a future meeting.

C. Spring Chinook Salmon Carcass Recovery Bias

Andrew Murdoch said there are two papers that describe approaches to estimating spawning escapement using carcass recovery methodologies (distributed to the Committees by Larissa Rohrbach on March 19, 2019[1,2]). Andrew Murdoch said the model is being refined to be submitted for publication this fall.

Andrew Murdoch said Mike Hughes (WDFW) will give a presentation, then Andrew Murdoch will provide an overview of carcass recovery methodologies that can be used. He will describe three variations for spring Chinook salmon and three for steelhead at a high level of detail.

Hughes gave a presentation entitled “Spring Chinook Carcass Recovery Bias in the Upper Wenatchee Basin.” This is preliminary work developed by Hughes and Kevin See (Biomark). The key messages from the presentation are noted here.

- Slide 2: There are biases in carcass recovery on the spawning grounds resulting in biased spawning population estimates.
- Slide 3: Study objectives are to develop a model that predicts spring Chinook salmon carcass recovery rates in the upper Wenatchee Basin and corrects for biases. Results were shown for 2011 and 2013.
- Slide 4: Methods. 100% of fish were marked at Tumwater Dam. Tagging was done in June and July and carcasses were recovered in September. Pre-spawn mortalities and fallbacks presented problems. To address these problems, only detections of live passive integrated transponder (PIT)-tag fish on spawning grounds were used as recovery data.
- Slides 5 to 8: Recovery rates are highly variable between years. Other factors affecting recovery include river discharge (high water years vs low water years) and stream type (glacial-fed streams having lower recovery due to turbidity than non-glacial streams).

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[1] Murdoch, A.R., C.H. Frady, M.S. Hughes, and K. See, 2018. Estimating Population Sampling Error for Spring Chinook Salmon Based on Redd Surveys. Draft manuscript.

[2] Murdoch, A.R., C.J. Herring, C.H. Frady, K. See, and C.E. Jordan, 2018. Estimating observer error and steelhead redd abundance using a modified Gaussian area-under-the-curve framework. Can. J. Fish. Aquat. Sci. 75: 2149–2158 (2018) dx.doi.org/10.1139/cjfas-2017-0335

- Slide 9: Recovery rates also vary by channel type (pool-riffle vs plane-bed) with less complex channel types (plane-bed channels) showing a trend toward lower recovery rates.
- Slides 10 and 11: Across all 10 years of data, median recovery rate by sex shows recovery of females is greater than males. This reflects post-spawning behavior of females as they guard redds and die near the redd. In contrast, males are not faithful to specific spawning locations and can be found in the thalweg or pools. There is also a trend toward recovery of larger fish of both sexes.
- Slide 12: Recovery variability was examined using the following variables in the model: river discharge, stream type, channel type, sex, and fish size. Fish origin was not added into the model because no differences were observed between natural-origin and hatchery-origin fish. Differences in size and behavior are captured in the other variables.
- Slides 13 to 16: Relative importance of variables were shown graphically. The following conclusions were made:
  - Lower recovery was experienced with higher discharge, glacial streams, and plane-bed channel types for both males and females.
  - Size (post-orbital to hypural length [POH]) has almost no influence on recovery of female carcasses. They observed interactions between stream type and discharge. Freshet information was not included in the model for females.
  - Size and freshets affect recovery of male carcasses.
- Slides 17 and 18: At this time, they have examined corrected versus non-corrected data for only 2011 and 2013. Survey programs are underestimating the number of younger males.
  - Todd Pearsons asked why 2011 and 2013 were chosen for analysis. Hughes said 2011 was a high jack and high discharge year, while 2013 was a more average water year and typical Tumwater return (jack return). Andrew Murdoch said all years will be analyzed; these are preliminary results and they are unsure how representative these years are.
- Slide 19: Fish per redd and spawning abundance. Comparison shown between estimates for observations at Tumwater Dam, observed carcasses, and corrected by channel type. They also showed differences in spawning distribution between natural-origin and hatchery-origin fish.
  - Peter Graf asked what the difference is between plane bed use in 2011 and 2013? Hughes said there were many differences between years including flows and a large jack return in 2011. Andrew Murdoch said in 2013, ratios between plane-bed and pool-riffle use tended to be more similar. Hatchery-origin fish tend to use plane-bed channels because this is the channel type in the Chiwawa River near the acclimation site.
- Slides 20 to 26: Corrected sex ratios are really driven by the fish-per-redd calculation. Modeled results show that surveys would underestimate younger age-class fish and overestimate older age-class fish. Underestimation of younger fish, which tend to be HORs, causes underestimation of HORs on the spawning grounds.

Andrew Murdoch said this model shows the "spawner to carcass" phase rather than the "pre-spawn to carcass" phase, which was published in 2010 and was affected by pre-spawn mortality.

Kirk Truscott said he thought surveys were more likely to overestimate females. Hughes said the data shown are proportions, so the correction is not to add more females. Hughes said the model results are driven by the fish-per-redd ratio. By applying different fish-per-redd ratios corrected by channel type, the ratio of M:F changes. In the plane-bed reaches, the overall carcass recovery is low, compounded by more hatchery fish in plane-bed reaches.

Greg Mackey asked if it is possible the model would provide an estimate that is actually less than the actual number of carcasses observed? Hughes said no, proportions are corrected by adjusting probabilities of recovery and applying new recovery probabilities to ratios of males to female.

Andrew Murdoch said the model presented allows for the use of carcass sampling to generate fish-per-redd calculations for each channel type and each stream for more accurate estimates of spawner distribution between HORs and natural-origin returns (NOR). Andrew Murdoch said it also allows for understanding differences in space upstream from Tumwater. Mike Tonseth asked whether estimates still depend upon having robust carcass data. Hughes and Andrew Murdoch said yes, a total lack of collection of a given fish type gives outlier-adjusted results. Andrew Murdoch said rolling the data up to the evolutionarily significant unit level somewhat mitigates the influence of outliers.

Estimating Pre-Spawn Survival

Andrew Murdoch presented slide 27 on pre-spawn survival in the Chiwawa River. Andrew Murdoch said the survival estimates start with detections at the in-basin array. He said in a previous exercise, they saw HORs always had lower pre-spawn survival, but data were not corrected for carcass-recovery bias. He said corrected data show that there is a carcass bias for females driven by a lack of pool-riffle reaches in the Chiwawa River where males would be found. He said a different picture emerges when data are corrected for carcass-recovery bias. Corrected data show similar HOR and NOR pre-spawn survival rates. Andrew Murdoch said survival of males is lower for HOR fish. Results were unexpectedly different from previous analysis.

Tracy Hillman asked whether estimates in the Chiwawa River were driven primarily by most hatchery-origin fish using plane-bed reaches and the fact that hatchery-origin fish are smaller and younger? Andrew Murdoch said yes, the strongest factor is channel type and a weaker effect was fish size. He said in the past, pre-spawn survival estimates were not possible for males.

Hillman highlighted the important point that pre-spawn loss is about 40% to 70%. Andrew Murdoch said yes, the same results were observed in 2010. Andrew Murdoch said the power of the model is the number of detections observed on redds (3,500). He said they designed the model to be transferrable as long as there is information on redds and channel type.

Truscott asked whether this represents the maximum pre-spawn survival? Andrew Murdoch said yes, because measuring started near the mouth of the Chiwawa River. Thus, it does not include losses in the Wenatchee River. Mackey asked if the conclusions depend on redd counts, could one underestimate redds and underestimate survival. Andrew Murdoch said Area Under the Curve (AUC) was used to estimate spring Chinook salmon escapement and assumed one redd per female and that males spawn with one female. He said they know from the RRS study that this may not be the case. He said it is difficult to tease apart fish that returned from those that actually spawned. He said estimates of males could be high because we know males spawn with more than one female (more than one redd).

Hillman said it is surprising that survival did not change more with flows. Andrew Murdoch said yes, there is a bigger problem than anticipated to determine the factors that affect survival; this at least provides more accurate survival numbers.

Graf asked how will results be affected for 2014 and later when adult management was implemented (all jacks removed)? Andrew Murdoch said this will recast all the escapement predictions.

Keely Murdoch asked, given what you know about different habitat uses between HOR and NOR, how does this change interpretation of pre-spawn survival trends? Andrew Murdoch said the different pre-spawn survival previously observed between HOR and NOR was an effect of bias. Now the focus should be on identifying factors for pre-spawn mortality and keeping adults alive that have returned.

Graf asked whether the carcasses observed were spawned out. Tonseth said yes. Graf asked whether evidence has been found of fish that have died before spawning? Andrew Murdoch said yes, we do see them, but that finding carcasses that are not spawned out is fairly rare. He further indicated they are only looking during the spawning season and pre-spawn mortality is probably occurring throughout the season (prior to spawning). He said the females observed are those that have been guarding redds. He added there is still uncertainty about how behavior affects observation of pre-spawn mortalities.

Comparison of Methods for Estimating Spawning Escapement

Andrew Murdoch compared three methods for estimating spawning escapement for spring Chinook salmon (slides 29 and 30) and steelhead (slides 31 through 33)

The spring Chinook salmon 3.0 method is the least biased method so far; it incorporates the bias correction model, which corrects for observer bias, carcass location, and sex ratios.

The steelhead 3.0 method uses AUC but is a PIT-tag detection and redd count hybrid. This method relies on PIT tagging at Priest Rapids Dam (the off-ladder adult fish trap [OLAFT]). Andrew Murdoch said fish are not assigned to a tributary during tagging; adjustment for pre-spawn mortality is based on radio telemetry results to generate HOR/NOR and sex ratios for the mainstem. The data can be used to roll up to a population level estimate. Andrew Murdoch compared methods for different tributaries.

Entiat steelhead that survive to the mouth of the river tend to survive to spawn. In the Methow and Wenatchee basins, version 2.0 or 3.0 can be used. The Okanogan River is a very different system than where the Gaussian AUC model was developed. Truscott said there are different water conditions with high turbidity in the Okanogan and surveys are affected by stream flows, which can delay surveys for several days or weeks. Andrew Murdoch said there are models to correct for that, but it helps to capture the peak of spawning. Hillman said he thinks there is a lot of overlap between summer Chinook salmon and steelhead spawning habitat use because of a lack of suitable spawning gravels in the Okanogan River.

Pearsons said the Committees are currently in the process of analyzing data for the comprehensive report to compare supplemented (treatment) areas to references areas. He said they are lacking comparable information (unbiased data) from reference areas and asked whether they could (erroneously) be making corrections to treatment data and not reference area data, or the "after" period and not the "before" period? He said they could be making assumptions based on incorrect comparisons.

Andrew Murdoch said older data (before data) are wild fish and therefore are less biased. Programs would need to identify the bias associated with hatchery fish in the after period. He said in some cases it may be easier to adjust for observer bias with GPS data during the "after" period. Pearsons said productivity depends on both NOR and HOR data. Andrew Murdoch said if a bias is specifically associated with the treatment (e.g., supplementation with hatchery fish), that bias could be adjusted to achieve a better estimate for the treatment. He said the entire time series for the Wenatchee could be compared to other areas with less complete datasets as analysis progresses (e.g., little Wenatchee, White River).

Betsy Bamberger asked whether the old and new models could be run simultaneously? Andrew Murdoch said they will be running the old method and new method for comparison. Hillman said assuming all data are collected the same way, you can make the comparisons because the bias is likely the same for both treatment and reference areas. If you adjust one group for bias and not the other, comparisons would be confounded. Hillman said surveys in the upper Columbia River are more robust than in other regions. He said there is so much variation in the data, treatment effects are difficult to identify, and analyses lack suitable power even if there is a long time series of data.

Hillman thanked the presenters and concluded the discussion on carcass recovery bias and estimating escapement.

D. Steelhead PIT-Tagging at the Off-Ladder Adult Fish Trap and Array Operations and Maintenance

Andrew Murdoch said WDFW is still planning to move forward on PIT-tagging spring Chinook salmon at the OLAFT. Andrew Murdoch said WDFW is reducing their scope for antenna operations and maintenance but adamant about using every array necessary. They will eliminate upper Entiat Basin former Integrated Status and Effectiveness Monitoring Program (ISEMP) arrays. Andrew Murdoch said it is the goal of the Bonneville Power Administration to move operations and maintenance for all arrays (remnants of ISEMP arrays and WDFW-operated arrays) into a single project for efficiency of operations. This month PTAGIS will create an instream PIT-tag array subcommittee, which will ensure instream arrays are functioning and performing similar to mainstem arrays.

Andrew Murdoch said that use of paired antenna rows overestimates detection probability and underestimates escapement because detections by each antenna are not independent.
Andrew Murdoch said that they are advocating for detections at two sites farther apart to lower the detection bias at the lower detection point. He said they wish to demonstrate that loss of a detection point could lead to underestimation of escapement. Catherine Willard asked how far apart arrays need to be. Andrew Murdoch said arrays used are at least 10 miles apart. He said it helps for viable salmonid population metrics to have arrays at the downstream end and one in tributaries upstream. He said array placement is consistent for much of the upper Columbia River. Andrew Murdoch said the proposal is to model steelhead escapement in all of Eastern Washington (Okanogan, Wenatchee, and Methow); life history is very different between these tributaries, between spring spawners and holdovers. He said the tributaries to the Snake have a different model due to differences in life history.

Andrew Murdoch said the original motivation was to use the investment in PIT arrays for more than just steelhead. He said the steelhead viable salmonid population project is really a data gaps project—the first six data gaps have been addressed, some still exist, and some are emerging and WDFW wants to maintain flexibility to address those data gaps. The motivation to switch to tagging spring Chinook salmon would be to understand what's going on across the spring Chinook salmon evolutionarily significant unit and to develop a model to observe salmon recovery trends. He said the motivation is to leverage the fish data in the Wenatchee Basin to influence project prioritization.

Greg Mackey asked of the arrays that are critical for the OLAFT PIT-tag model, are any contracted through Biomark? Andrew Murdoch said no, none in the Methow. Mike Tonseth said WDFW is a subcontractor to Biomark for only the arrays originally funded by ISEMP; others are WDFW-funded arrays. Andrew Murdoch said there are no former ISEMP arrays in the Methow. He said there are arrays WDFW inherited from the Bureau of Reclamation (Pat Connolly's group) that required rebuilding. Andrew Murdoch said the Entiat and Wenatchee array operations will be funded but not for array maintenance. Tonseth said Okanogan arrays are a combination of WDFW and former-ISEMP arrays. ISEMP has ended, and funding sources are still unresolved.

Willard asked if PIT-tag arrays used for steelhead mark-recapture modeling will not be turned off assuming PIT tagging steelhead at OLAFT is continued? Willard said if a switch to PIT tagging spring Chinook salmon occurs, steelhead tagging would start July 1 and Chelan PUD uses the mark-recapture based estimates for tributary steelhead escapement estimates in the Wenatchee sub-basin. Willard said, assuming BPA approves WDFW using funds that are currently used for PIT tagging steelhead at OLAFT to PIT tagging Chinook at OLAFT, the funding need for PIT tagging steelhead at OLAFT would be for this year, Douglas PUD is already funding WDFW to estimate escapement into the Methow tributaries by PIT-tagging steelhead at Wells. Andrew Murdoch said stock assessment for all upper Columbia River steelhead could occur at OLAFT. He said Douglas PUD could amend contracts to allocate WDFW staff and resources differently in the Methow. Todd Pearsons said there would be a number of decisions to be made because Grant PUD shares run composition modeling at Wells with CCT. Pearsons said Grant PUD would need to think about, for example, switching to PIT tags from spawner surveys in the Okanogan River. Andrew Murdoch said this was the purpose of comparing different survey and modeling methods in the earlier presentation. Willard said Chelan PUD is committed to using the "3.0" version of the model for Wenatchee steelhead because Chelan PUD has been using this model for the past five years.

Andrew Murdoch said that when Upper Columbia wild spring Chinook salmon run size starts dropping, there are Adaptive Management Implementation Plan triggers within the Federal Columbia River Power System BiOp that requires agencies to "help out." Andrew Murdoch said tagging at OLAFT can support this and can also support adult management.

Kirk Truscott said he has 2 questions:

1. Will steelhead be PIT tagged at the OLAFT in 2019? Willard said Chelan PUD will be PIT tagging at the OLAFT in 2019.
2. Will PIT tagging at the OLAFT provide sufficient data for steelhead stock assessment for stocks upstream from Wells Dam? Andrew Murdoch said yes, there is so much overshoot at Wells that the stock assessment for Methow and Okanogan at Wells is currently inaccurate. Andrew Murdoch said PIT tagging at the OLAFT will benefit all programs upstream from Priest Rapids

Dam. He said the accuracy of using PIT-tag detections for small tributary spawning streams isn't as good but can be more accurate when data are rolled up to the distinct population segment level. Andrew Murdoch said the hope is that new high density polyethylene (HDPE) arrays are much more durable than the old polyvinyl chloride (PVC) arrays. He said he is still working with PTAGIS to reduce data management costs.

Tracy Hillman thanked Mike Hughes and Andrew Murdoch for their presentations.

E. Comprehensive Report Update

Todd Pearsons said the PUDs have been moving ahead with the 10-year analyses. The rough schedule outlined in the SOA is to provide the draft comprehensive report to the HC and HSC in 2020. Keely Murdoch asked how this is different from the 5-year analytical report. Pearsons said this is a 10-year manuscript-style report broken down into chapters developed by different authors. Keely Murdoch asked who writes the report and will there be an opportunity to comment on the report. Pearsons said the PUDs are writing the report, BioAnalysts is doing much of the statistical analysis, and that it will be provided to the Committees for review and approval. Pearsons said the comprehensive report is designed to be an integration of results and comparison to literature and other programs around the upper Columbia River.

F. NMFS Consultation Update

Brett Farman said the summer/fall Chinook Salmon bundle Environmental Assessment may be heading to NMFS headquarters today for review.

Farman said the Section 10 permits (for takes of threatened and endangered species) are being reviewed by counsel this week or next. Farman said those permits will then go out for review by the programs at the same time as they go out for public comment.

Farman said he is still waiting for an update on the steelhead program permits.

Larissa Rohrbach asked the HCP-HC and PRCC HSC Representatives what their feedback for Emi Kondo is on the dissemination of HGMP publication announcements. Truscott said Representatives and Alternatives (HCP-HC; or HSC primary list) should be notified and it is up to NMFS to disseminate announcements more broadly. Bill Gale said the distribution list should be similar to when HGMPs were sent out several years ago. Farman said NMFS is making more effort to notify interested parties than in the past. Gale asked if announcements would be posted to the Federal Register and NMFS' public website. Farman said yes.

III.Wells Hatchery Committee

A. Washington Animal Disease Diagnostic Lab Bacterial Kidney Disease Testing Update (Tentative)

Betsy Bamberger said the WADDL is able to report raw optical density (OD) values resulting from BKD assays. WADDL has revised protocols in use by federal hatcheries. Bamberger said Douglas PUD still needs to consider differences in cost between using WADDL and WDFW laboratories for BKD testing. Mike Tonseth asked whether WADDL is still working on a go-between between their method and the state's OD threshold method? Bamberger said no, there are many differences between methods and they would already use their in-house methods. Bamberger said if a change in methods were requested from WADDL, the programs would have to be very specific about what they want WADDL to do. Tonseth said the Methow BiOp requires use of the OD values for culling decisions that are based on fixed thresholds. Bill Gale said USFWS has negotiated with WADDL to provide the raw data, but for the federal hatchery programs, the decision thresholds are not fixed, data are binned, and thresholds determined after the fact. Gale said their approach is more conservative than using a fixed threshold for culling. Bamberger said because there are no clear relationships between OD limits and clinical disease, it is more of a risk-management tool. Bamberger said the program can ask WADDL for raw data. Tracy Hillman said the state's existing thresholds are very similar to what WADDL uses for the federal programs. Bamberger said there is laboratory-to-laboratory variability. Tonseth said the BiOp for the Section 10 permit dictates the thresholds. The HC would need to recommend a deviation from the current approach.

IV. RI HC

A. Marking the Chiwawa 2018 Brood

Catherine Willard said that the brood year 2018, Chiwawa spring Chinook salmon program is supposed to be 100% wild by wild crosses for a conservation program; however, wild by wild fish currently make up only about 30% of the conservation program and the remaining 70% consists of hatchery by hatchery crosses due to not collecting enough natural-origin brood. There are currently 50,000 wild by wild-origin progeny and 125,000 hatchery by hatchery-origin progeny. Under the proposed action analyzed within the BiOp, any shortfall in Nason and Chiwawa fish to meet the safety-net program would result in use of hatchery-origin fish. The program would apply an adipose fin clip to Nason and Chiwawa safety-net fish.

Keely Murdoch said that sounds different than what was in the Spring Chinook Salmon Management Plan and the HGMP. Willard said the permits do not specifically mention marking. Willard said the bottom line should be the terms and conditions agreed to in the permits and what was analyzed in the BiOps. Mike Tonseth said this does create a problem if the management plan was the material considered when issuing the BiOp, but the BiOp seems contradictory to the management plan. Tracy Hillman asked which document are we supposed to follow if there is conflicting information among documents. Willard said she is interested in knowing what NMFS' opinion is on this issue. Tonseth said the BiOp was written to consider direct and indirect take (such as from harvest on marked fish).

Bill Gale said the first thing is to review the HGMP. The proposed action reviewed by the BiOp is supposed to summarize the HGMPs. Willard said that Craig Busack may be the best person to answer our questions because he was one of the authors of the BiOp.

Hillman asked if we need NMFS to interpret the documents and provide guidance on what should be done. Gale said yes, but if there is conflicting guidance. The HCs needs to come to consensus on what to do. Brett Farman said his inclination is to mark fish based on origin of the brood, but the Committees should review the documents to understand if that was implied and expressed. Farman said he will discuss the issue with Amilee Wilson and Craig Busack to understand the original intent of the marking direction in the BiOps.

Tonseth said a follow-up discussion needs to be had after: 1) all are able to review the BiOps, HGMPs, and Management Plan; and 2) Tonseth gets information from Chuck Aldrich (WDFW) on timing of tagging to set up the timeline for a follow-up discussion on marking. Tonseth said this decision will affect the 2018 brood and the 2019 NOR shortfall. Tonseth said the timeline is to tag in summer 2019, but the outreach has started in order to reserve the tagging trailer.

Tonseth said he will collect all documents being discussed (Spring Chinook Salmon Management Plan, HGMPs, Permits, and BiOps) and send them to Larissa Rohrbach for distribution. Hillman said there should be a location on the Extranet where all these documents should be filed. Rohrbach said she would determine the appropriate place for these resources on the Extranet.

Keely Murdoch stated that after recalculation of the Chiwawa program, which resulted in a smaller production number, she thought the number of required natural-origin brood needed for the program would be met, but it has not been met. Willard stated that the committee should consider if it makes sense to collect spring Chinook at Tumwater Dam that are very likely genetically Chiwawa fish (Willard stated the genetic assignments from 2018 which included 38 out of 60 samples typing back to the Chiwawa at 90% or greater) and put them back in the river and hope that they are trapped at the Chiwawa weir. The natural-origin brood target has only been met in one out of five years of collecting Chiwawa brood at the Chiwawa weir due to meeting the bull trout encounter rate and low natural-origin spring Chinook returns. Willard said the Committees need to continue the conversation on where the broodstock for Chiwawa will come from.

Gale said there is a philosophical question at hand about whether hatchery-origin fish used to back-fill the conservation quotient are in fact "safety-net" fish (and therefore tagged by ad-clipping) or should all conservation fish be ad-present regardless of origin. Gale said the original intent of the programs was to ensure a set quotient of fish would escape harvest (by not ad-clipping them).

Tonseth said it is important to understand which fish would be moved up-river for spawning. Tonseth said if the program is producing fewer conservation fish, in subsequent years there could be an effect on PNI. Keely Murdoch said the original intent was to ensure that it would be a rare occurrence to move hatchery fish into the conservation program. The assumption was that the NOR run would increase over time; the current limitation on NORs was not forecasted. Willard said there are natural-origin fish that are passed over Tumwater that could be retained for conservation programs. Willard said there are genetic implications of using the F2 generation from safety-net fish in the conservation program

Tonseth said WDFW does not have an issue with moving more hatchery fish into the conservation program. He said the 3-population model should be used to determine how PNI will be affected if you allow more safety-net fish on the spawning grounds. Gale said if you use the Methow as an example, WNFH partial percentage of hatchery origin broodstock is no more than 50% and the 3-population PNI allowed them to conclude that they should strive to have less than 5% safety-net fish on the spawning ground to maintain percentage of hatchery origin broodstock targets. Tonseth said the Chiwawa hatchery program is 100,000 fish, which is much smaller than the Methow program. Gale said the decision depends on the proportion of safety-net fish on the spawning grounds, not the absolute numbers. Gale said the low percentage of natural origin broodstock composition of the safety-net fish will have a higher effect on PNI than the high percentage of natural origin broodstock of the conservation program. Pearsons said if you have empirical information about relative reproductive success it may not be necessary to use PNI, which is a theoretical number.

V. PRCC HSC

A. Approve the February 20, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the draft February 20, 2019 meeting minutes as revised.

Larissa Rohrbach reminded PRCC HSC members to return comments on the Priest Rapids Hatchery M&E Implementation Plan to Todd Pearsons by March 25, 2019.

B. Approve Broodstock Collection Protocols for PRCC Programs – DECISION ITEM

Tracy Hillman said the PRCC program Protocols will be approved over email following distribution of a final revised version as will be done by the HCP-HCs.

Todd Pearsons said the outcome of a discussion by the Joint Fisheries Parties about marking Nason conservation program fish should later be brought back to the HSC. Mike Tonseth said there will be overlap with the Chiwawa marking discussion so the topic should be revisited by the HSC and HCP-HCs.

C. Review and Re-Scope the White River Memorandum

Tracy Hillman received a memorandum from Elizabeth McManus (Ross Strategic) regarding the history of PRCC HSC involvement on the topic of re-initiating a White River spring Chinook salmon hatchery program. Hillman said he talked to Craig Busack, who committed to spending time this summer to address this topic with the PRCC HSC.

As a bit of background, Keely Murdoch said in the process of considering the Lake Wenatchee proposal (on which the PRCC ultimately voted not to proceed), the PRCC identified data needs with the intent to issue a Request for Proposals (RFP) to address those data needs. Keely Murdoch said it was her understanding that Curt Dodson (Grant PUD) tasked the PRCC HSC to develop an RFP based on those data needs. Bill Gale and Peter Graf said their interpretation of the PRCC's guidance was to determine if an RFP was needed. Gale said there was no written guidance from the PRCC, so it is unclear what they want.

Keely Murdoch suggested using the word "re-scope" if the goal is a consensus memorandum from the HSC. She said it is difficult to come to consensus on what type of data she will need to make the decision and to secure the support of her upper management. Keely Murdoch said that if that recommendation is not to start a hatchery program, there needs to be some good reasons why and good alternatives. For the YN, getting to recovery is the ultimate goal and the National Oceanic and Atmospheric Administration (NOAA) has signaled to the YN the importance of the White River. Ultimately, we may need to provide other recommendations that could be used as an alternative to achieve recovery of the White River aggregate to show why the recommendation not to restart the hatchery program makes sense. Keely Murdoch said there is difficulty coming to consensus because the data needed to inform one representative's particular program is not the same as for another. Graf said the solution may be a memorandum that is not a consensus memorandum. Graf said this does not have to be the last say. At any time, the HSC can add to this memorandum and revisit it. Gale said the current version of the memorandum highlights the areas of non-consensus.
Keely Murdoch said the memorandum currently does not inform why there is non-consensus.

Todd Pearsons suggested appending information that is not evident in the memorandum that communicates each party's interests and needs for a decision to be made in the future. Hillman said each entity could identify the minimum data or information that is needed to make a decision. Hillman said the memorandum already provides a lot of this information in tables. Gale said he does not like the idea of each agency providing their data needs. Gale asked why the HSC representatives wouldn't just communicate the needs back up through each PRCC representative for consideration by the PRCC.

Pearsons said there are topics where consensus would never be achieved because there are probably true differences in opinion among the entities. Graf said those differences are fundamental to the scope of starting a new hatchery program and include each agency's philosophical approach to mitigation. Keely Murdoch said there may be other ways to increase the productivity of the White River spawning aggregate. She said there is agreement that the White River aggregate is still an important piece of recovery of the species. Mike Tonseth said this principle is in the Recovery Plan, which was adopted by NMFS.

Tonseth asked what the intention is of the 2013 SOA. Did it include identifying data gaps or providing alternatives to a hatchery program? He added, there is a need to ask the PRCC for clarity. Pearsons said he did not read text about providing alternatives to restarting the White River hatchery program in the SOA and GPUD folks that negotiated the SOA said that alternative mitigation was not part of the agreement. Keely Murdoch said there is not a difference of interpretation of the SOA on whether or not to restart a White River program.

Keely Murdoch said there are two topics that would prevent a decision to restart a White River hatchery: 1) shorelines permitting with Chelan County due to challenges complying with the Washington State Shoreline Management Act; and 2) broodstock source. She read the revised Shorelines Management Plan in the meeting that now has new language that is less restrictive for aquaculture for the purposes of recovery. Gale said previously Chelan County was responding to public perception of aquaculture and its constituents. Tonseth said that is a political aspect and not a technical aspect. The HSC was tasked with considering the technical aspect.

Pearsons asked preliminarily if any Party is going to promote the idea of a White River spring Chinook salmon hatchery program? Keely Murdoch said she doesn't know. Pearsons said there will be several large datasets arising from M&E work that will inform this decision. Keely Murdoch agreed but said data are lacking for understanding juvenile Chinook salmon survivability through Lake Wenatchee and what the ecological mechanisms are that are limiting White River Chinook salmon. Hillman asked whether any decision triggers have been drafted ("if this, then that" type of language). For example, if you find high predation rates in the lake on White River Chinook salmon by bull trout, would that mean no hatchery program should be pursued? Hillman asked whether the HSC could make the decision. Keely Murdoch said the HSC will make the decision informed by recommendations from an expert panel.

Pearsons said a lot was invested in PRCC HSC discussions on the White River program in the past without much tangible benefit. Hillman said an alternative approach that is not necessarily HSC consensus is to provide lists of minimum data needs from each Party. The minimum list would be much more stripped down from the existing list. Hillman suggested that if the minimum was identified, the Parties might find more consensus.

Gale asked if there is a timeline for this? Keely Murdoch said the decision needs to be made by 2026; the timeline for achieving consensus and involving an expert panel by 2026 may start now if 3 to 4 years of data collection is needed prior to 3 years of committee and expert consideration. Tonseth said the current permits expire in 2026 and no current permit would cover the 2026 brood. A new permit and consultation would be needed. Pearsons said two things could happen: 1) the HSC could decide they don't want to restart a hatchery program, which could restart a discussion on alternatives; or 2) the decision does not need to be made until 2026 when the expert panel is convened. Grant PUD would not be supportive of investing in facility work planning before a decision about restarting a program and that won't be made until 2026.

Hillman said Craig Busack indicated that NOAA needs to provide an opinion on the status of the White River spring Chinook salmon aggregate. Graf said because there is no timeline on this memorandum, he suggested we wait until Busack re-engages with HSC. Keely Murdoch suggested asking the PRCC for additional guidance before Busack re-engages.

Hillman will ask Denny Rohr (PRCC Facilitator) to provide written instructions from the PRCC on what exactly the PRCC wants the HSC to do. HSC Representatives will assemble their list of minimum data or information needs to make a decision on the White River program.

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are on April 17, 2019, at Grant PUD; May 15, 2019, at Grant PUD; and June 19, 2019, at Grant PUD.

VII. List of Attachments

Attachment A List of Attendees

Attachment B Final 2019 Broodstock Collection Protocols

Attachment C Presentation: Spring Chinook Carcass Recovery Bias in the Upper Wenatchee Basin

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Todd Pearsons‡	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Michael Humling	U.S. Fish and Wildlife Service
Alf Haukenes	Washington Department of Fish and Wildlife
Chad Jackson*‡	Washington Department of Fish and Wildlife
Mclain Johnson	Washington Department of Fish and Wildlife
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Research Office
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March 22, 2019

To: NMFS, HCP HC's, and PRCC HSC

From: Mike Tonseth, WDFW

Subject: **FINAL HCP HC and PRCC HSC APPROVED UPPER COLUMBIA RIVER 2019 BY SALMON AND 2020 BY STEELHEAD HATCHERY PROGRAM MANAGEMENT PLAN AND ASSOCIATED PROTOCOLS FOR BROODSTOCK COLLECTION, REARING/RELEASE, AND MANAGEMENT OF ADULT RETURNS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, summer Chinook salmon, Coho salmon, and summer steelhead associated with the mid-Columbia HCPs; spring Chinook salmon, summer Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project and Salmon and Steelhead Settlement Agreement (FERC No. 2114); and fall Chinook salmon consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams (ACOE funded), respectively. These programs are funded by Chelan, Douglas, and Grant County Public Utility Districts (PUDs), and ACOE, and are predominately operated by the Washington Department of Fish and Wildlife (WDFW) with the exceptions of: 1) the Omak Creek/Okanogan Basin steelhead broodstock collection, and acclimation/release of Omak Creek steelhead, which is implemented by the Confederated Tribes of the Colville Reservation (CTCR), and 2) The Wells and Methow fish hatcheries operated by Douglas PUD.

This protocol is intended to be a guide for 2019 collection of salmon (19BY) and steelhead (20BY) broodstocks in the Methow, Okanogan, Wenatchee, and Columbia River basins. It is consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation), mitigation production levels (e.g., HCPs and Priest Rapids Salmon and Steelhead Settlement Agreement/2008 BiOp), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, USFWS consultation requirements.

Notable in this year's protocols are:

- Continuing for 2019, no age-2 or 3 males will be incorporated into spring or summer/fall Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only) and to minimize the necessity of using hatchery origin males in lieu of.

- Elimination of fall adult hatchery steelhead collections for the Methow Safety Net (MSN), Columbia Safety Net (CSN), and Okanogan programs. In-season run escapement forecasting will be used to determine if some level of fall broodstock collection will be needed for the CSN program to ensure the production obligation can be met. Otherwise the default brood collection period will be spring 2020.

- Continuation of spring Chinook trapping efforts at the Wells Dam East and West ladder traps consistent with 2018 operations.

- Inclusion of Appendix I, which summarizes program specific rearing/release plans (if available) outside the body of the protocols.

- Inclusion of Appendix J, which summarizes 2019BY spring and summer Chinook disease management plans.

- Inclusion of Appendix K: BY19 YN UCR coho broodstock plans.

- Expansion of Appendix G to include species/program specific management plans for managing surplus juvenile spring Chinook and summer steelhead.

- Continued inclusion of Appendix H, which describes a draft preferred approach to integration of the Methow conservation steelhead programs as well as minimize the potential for or increase the risk of a Ryman-Laikre effect in the Twisp River watershed.

- Chelan Falls broodstock collection will be prioritized at Wells Dam volunteer trap (WDVT), sufficient to meet the entire Chelan Falls yearling program of 576K while concurrently piloting alternate broodstocking methodologies. Adults collected via a temporary weir within the Chelan River Habitat Channel and beach seining in the Chelan Tailrace fail may be used to offset the number of brood needed at Wells FH if timing and fish condition are supportive of retaining them. In the event Wells FH and the two proposed pilot efforts cannot secure the appropriate number of summer Chinook broodstock for the Chelan Falls program, other locations (as determined by the Hatchery Committees) may be used. .

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net smolts (up to 17 adults). The remainder of the broodstock (51) will be WNFH returns collected at WNFH (or by angling/trapping for WNFH program) and/or Methow Hatchery and surplus to the WNFH program needs. Collection of Wells stock may be used if WNFH and Twisp returns are insufficient. The collection of adults will occur in spring of 2020.

- Summer Chinook collections at Wells Dam ladder traps to support the CJH integrated program (adipose present non-wired adults) and Well Dam ladder traps and the Wells Hatchery volunteer trap to support the CJH segregated program (adipose clipped adults) may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Spring Chinook eggs identified through CWTs from ad-clipped + CWT CJH segregated returns that occur during spawning at Methow FH or WNFH may be transferred to the CJH Program for inclusion in the CJH spring Chinook segregated program.

- Reduction of NO fall Chinook broodstock from the OLAFT from 1,000 to 650.

- Targeted collection of about 600 adipose present, non-coded wire tagged fall Chinook using hook-and-line efforts in the Hanford Reach.

- Continuation of Tumwater trap operations to facilitate lamprey passage. Using Rocky Reach and Rock Island lamprey passage data as a surrogate, it is proposed to open the Tumwater Dam fishway to passage between 10PM and 6AM daily from September 1 to mid-December. This should allow open passage for at least 60%-70% of the lamprey while still accommodating coho and steelhead broodstocking and steelhead adult management. Because this is the second year to operate under this schedule, some in-season adjustments may need to be made based on lamprey observations (during trapping periods) and the magnitude of steelhead adult management required.

- Addition of the 2019 YN UCR coho broodstock collection plans (includes the DPUD Coho program brood).

These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and/or other sampling locations. Additional adaptive management actions as they relate to broodstock objectives may be implemented as determined by the HCP-HC or PRCC-HSC and within the boundaries of applicable permits.

Also included in the 2019 Broodstock Collection Protocols are:

Appendix A: 2019 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2020 BY Summer Steelhead Hatchery Programs
Appendix B: Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations
Appendix C: Return Year Adult Management Plans
Appendix D: Site Specific Trapping Operation Plans
Appendix E: Columbia River TAC Forecast
Appendix F: Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans
Appendix G: DRAFT Hatchery Production Management Plan
Appendix H: DRAFT Preferred Alternative for 2020 BY and beyond, Methow Sub-basin Conservation Steelhead Programs
Appendix I: Program Specific Rearing and Release Descriptions
Appendix J: 2019 BY spring and Summer Chinook Disease Management Plans
Appendix K: 2019 YN Coho Broodstock Collection Plans

Methow River Basin

Coho - Douglas PUD Program- Methow Basin – Twisp River

The Douglas PUD (DPUD) coho program began with brood year 2018. The target release is 37,000 yearling coho. Broodstock are collected for the Yakama Nation (YN) and the DPUD program collectively by the YN at Wells Dam and Hatchery, Winthrop National Fish Hatchery (WNFH), and Methow Hatchery. The broodstock are transported to, held, and spawned at WNFH. The DPUD program obtains eggs to rear at Wells Hatchery from WNFH. See Appendix K for a complete description of the YN coho program and broodstock collection.

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be prioritized for the aggregate conservation program in the Methow Basin. Collections of natural-origin fish will not exceed 33% of the Methow Composite (i.e., non-Twisp) and Twisp natural-origin run escapement consistent with take provisions in Section 10 (a)(1)(A) Permits 18925 and 20533.

Hatchery-origin spring Chinook, if needed, will be collected in numbers excess to program production requirements to facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production shortfalls. Based on historical Methow FH spring Chinook ELISA levels above 0.12, any hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 20% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch/Twisp programs). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permits 18925 and 20533, culling will include the destruction of eggs from hatchery-origin females with ELISA levels greater than 0.12 and/or that number of hatchery-origin eggs required to maintain an aggregate production of 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by DPUD Fish Health and the Wells, Rocky Reach, and Rock Island HCP's- and the Priest Rapids CC - HSC to be a substantial risk to the program. Progeny of natural-origin females with ELISA levels greater than 0.12 may be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

WDFW genetic assessment of natural-origin Methow spring Chinook (Small et al. 2007) indicated that Twisp natural-origin spring Chinook can be distinguished, via genetic analysis, from non-Twisp spring Chinook with a high degree of certainty. The Wells HCP Hatchery Committee accepted that Twisp-origin fish could be genetically assigned with sufficient confidence and that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic/stock analysis will be obtained from adipose-present, non-CWT, non-ventral-clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam, and origins assigned based on genetic analysis. Natural-origin fish retained for broodstock will be PIT tagged (pelvic girdle) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to the WDFW genetics lab in Olympia Washington for genetic/stock analysis. Spring Chinook collected from Wells will be held until genetic analysis results are received then transferred to and retained at Methow Hatchery and spawned for each program depending on results of DNA analysis. Brood collection of NORs at Wells will be based upon assignment of Twisp NORs to the Twisp program and non-Twisp NORs being used to support Methow and Chewuch River releases. Spring Chinook collected at Methow Hatchery will be held at MFH until genetic analysis results are received and then handled accordingly.

The number of natural-origin Twisp and Methow Composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural-origin adults returning and the collection objective limiting extraction to no greater than 33% of the natural-origin spring Chinook return to the Methow Basin. Natural origin fish not assigning to the Twisp or Methow Composite will be released back into the Columbia River.

Weekly estimates of the passage of Wells Dam by natural-origin spring Chinook will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%. Hatchery origin adults trapped at the Winthrop NFH may be included, if needed, in the event of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2019 is estimated at 1,803 spring Chinook, including 1,018 hatchery and 785 natural origin spring Chinook (Table 1 and Table 2). In-season estimates of natural-origin spring Chinook will be adjusted proportional to the estimated returns to Wells Dam at weekly intervals and may result in adjustments to the broodstock collection targets presented in this document. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2019 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and biological assumptions listed in Appendix A.

The 2019 aggregate Methow spring Chinook broodstock collection will target up to 128 adult spring Chinook (18 Twisp, 110 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 7.9% of the CWT tagged hatchery adults and 22% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin spawning escapement to the Twisp, the 2018 Twisp origin broodstock collection will total 18 wild fish, representing 100% of the broodstock necessary to meet Twisp program production of 30,000 smolts. Methow Composite fish are expected to represent about 34% of the CWT tagged hatchery adults and 78% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin recruits, the 2019 aggregate Methow/Chewuch broodstock collection will total 110 natural-origin spring Chinook. Broodstock collected for the aggregate Methow conservation programs represents 100% of the broodstock necessary to meet the Methow programs production of 223,765 smolts. The Twisp River releases will be limited to releasing progeny of broodstock identified as wild Twisp and or known Twisp hatchery-origin fish, per ESA Permit 18925. The MetComp releases will include progeny of broodstock identified as wild non-Twisp origin (or known Methow Composite hatchery origin if needed to meet shortfalls in the production goal) fish. Age-3 males ("jacks") will not be collected for broodstock unless needed to meet effective population goals and minimize contribution of hatchery fish within the conservation program.

Table 1. Brood year 2014-2015 age class-at-return projection for wild spring Chinook above Wells Dam, 2019.

Brood Year	Smolt Estimate		Age-at-return							
			Twisp sub-basin				Methow sub-basin			
	Twisp[1]	Methow Basin[2]	Age-4	Age-5	Total	SAR[3]	Age-4	Age-5	Total	SAR[4]
2014	28,380	41,353	164	**25**	210	0.0074	707	**145**	906	0.0219
2015	22,738	26,491	**131**	20	168	0.0074	**453**	92	580	0.0219
Estimated 2019 Return			**131**	**25**	**156**		**453**	**145**	**598**	

[1] *Smolt estimate is based on sub-yearling and yearling emigration (Charlie Snow, personal communication).*
[2] *Estimated Methow Basin smolt emigration based on Twisp Basin smolt emigration, proportional redd deposition in the Twisp River and Twisp Basin smolt production estimate.*
[3] *Geometric mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*
[4] *Geometric mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*

Table 2. Brood year 2014-2016 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2019.

Stock	Projected Escapement											
	Origin								Total			
	Hatchery				Wild				Methow Basin			
	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total
MetComp	48	292	10	**350**	17	453	145	**615**	65	745	155	**965**
%Total				34.4%				78.3%				53.5%
Twisp	16	54	11	**81**	14	131	25	**170**	30	185	36	**251**
%Total				7.9%				21.7%				13.9%
Winthrop (MetComp)	71	503	13	**587**					71	503	13	**587**
%Total				57.7%								32.6%
Total	135	849	34	**1,018**	31	584	170	**785**	166	1,433	204	**1,803**

Table 3. Number of broodstock needed for the combined Methow spring Chinook conservation program production obligation of 223,765 smolts, collection location, and mating strategy.

By obligation	Production target	Number of Adults		**Total**		
		Hatchery	Wild			
Chelan PUD	60,516		17F/17M	**34**		
Douglas PUD	29,123		9F/9M	**18**		
Grant PUD	134,126		38F/38M	**76**		
Total	**223,765**		**64F/64/M**	**128**		
By program		Number of Adults			Collection location	Mating protocol
		Hatchery	Wild	**Total**		
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**55F/55M**	**110**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**64F/64M**	**128**		

Trapping at Wells Dam will occur at the East and West ladder traps beginning on May 1, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through June 30, 2019 (collection quotas will be prioritized for the May 1-June 22 time frame). Spring Chinook broodstock collection and stock assessment sampling activities authorized through the 2019 Douglas PUD Hatchery M&E Implementation Plan will utilize a combination of trapping on the East and West ladders as per the detailed descriptions of the modified trapping operations for spring Chinook collection in Appendix D. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota). Collection goals will be developed by Wells M&E and DPUD staff to identify the most appropriate spatial and temporal approach to achieving the overall brood target. All natural origin spring Chinook collected at Wells Dam for broodstock will initially be held at Wells FH pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or be transferred to WNFH.

Collection of ad-clipped +CWT spring Chinook adults may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH 10j program
Trapping at the Twisp Weir for spring Chinook may begin May 1 or at such time as spring Chinook are observed passing Wells Dam and may continue through August 23. The trap may be operated up to seven days per week/16 hours per day (provided it is manned during active trapping).

However, trapping at the Methow Hatchery Outfall trap may continue beyond the Twisp Weir operations as needed to meet basin wide PNI/pHOS objectives. Hatchery-origin adults captured at the Methow Hatchery Outfall (surplus to the Methow Hatchery program) will be: 1) used for adult out-planting to increase natural production and secondarily, 2) transferred to the WNFH for incorporation into WNFH brood, or 3) removed as surplus as to meet ESA permit requirements of both facilities.

Steelhead

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations (Table 5). Broodstock for the conservation programs (USFWS and DPUD) is achieved via angling in the Methow Basin and trapping at the Twisp Weir (as needed), respectively. Broodstock for the Methow safety net program is achieved primarily through returns to WNFH (including hook and line-caught HOR steelhead) and surplus fish removed at Methow Hatchery and the Twisp Weir. Broodstock for the Columbia safety net is achieved primarily through adult returns to the Wells volunteer trap or secondarily through surplus adults collected at MFH and WNFH. Broodstock for the Okanogan conservation program (GPUD) is achieved via Omak weir, dip-netting and or box traps in tributaries to the Okanogan River and hook-and-line in the mainstem Okanogan and tributaries. Broodstock collected for the Okanogan safety net program (GPUD) is primarily collected from Omak Creek but also in the Okanogan River and tributaries to the Okanogan River via box traps, traditional dip-net methods and hook-and-line angling, and at Wells FH via the volunteer trap. Generally incubation/rearing occur for the DPUD conservation program, Methow safety net, Okanogan, and Columbia River releases at Wells Fish Hatchery (FH). Methow Hatchery may be used to temporarily hold broodstock that are ultimately transferred to Wells Hatchery or WNFH. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin summer steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Presently the HCP HC and Joint Fisheries Parties are continuing to work to develop, approve, and implement an alternative to past programmatic approaches to more fully coordinate the collective Methow sub-basin steelhead conservation programs as well as address concerns over potential Ryman-Laikre (RL) effects in the Twisp River watershed. Some elements of a preferred alternative (see Appendix H), are still being piloted for the 2020 brood. The HC parties have not approved a long-term plan for the Twisp program pending results of the 2018 and 2019 pilot years brood collection efforts. The broodstock collection protocols for the 2020 brood will remain the same as those described in the 2018 Broodstock Collection Protocols. If the alternative in Appendix H or other alternative is approved prior to implementation of the 2020 BY conservation programs, the 2019 Broodstock Collection Protocols will be updated to reflect the new direction.

Specific program brood sources are structured as follows:

Broodstock collection for the DPUD and GPUD summer steelhead programs is designed to meet program production goals while minimizing the probability of producing overages. The following broodstock collection logic provides a step-by-step process whereby DPUD, GPUD, and WNFH summer steelhead broodstock will be collected.

1. February 2020-April 2020: Hook-and Line collections in the Methow mainstem: target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release; 13 broodstock collected downstream of Twisp) and the WNFH (up to 200,000 release; up to110 broodstock collected throughout Methow mainstem). These natural origin fish are to be transported to WNFH, spawned collectively, and a portion of the progeny sufficient to meet the 24,000 release target will be transferred to Wells Hatchery as eyed eggs. By-catch of hatchery origin fish will be retained as broodstock for the WNFH program (Ad+CWT), the Methow Safety-Net (CWT only, Ad+CWT), and the Columbia Safety-Net (Ad only, Ad_CWT), as needed. Adults in excess of broodstock needs will be managed as surplus. Go to #2.

2. March-May 2020: Twisp Weir collection. Target sufficient natural origin summer steelhead for the Twisp Conservation component (13 adults; 24,000 release). Hatchery-origin fish to be removed at a rate to meet pHOS management target. CWT-only fish to be used as broodstock for the Methow Safety-Net up to 25% (approximately 14 broodstock). Additional CWT-only broodstock may be used in the Columbia Safety-Net. CWT+Ad may be used in the Columbia Safety-Net. Go to # 3.

3. March-May 2020: WNFH Volunteer Channel and Methow Hatchery Volunteer channel. Natural origin fish may be collected if present and included in the WNFH and Methow River collected component of the Twisp Conservation Program. Hatchery origin fish will be collected and used as broodstock in the WNFH program (Ad+CWT), Methow Safety-Net program (Ad+CWT), and the Columbia Safety-Net program (Ad+CWT, Ad only). Such fish may be used to augment the fish previously collected described in #s 1 and 2, above. Adults in excess of broodstock and escapement needs will be managed as surplus. Go to #4.

4. March-May 2020: Okanogan River Basin collections to target, up to 58 adult steelhead, consistent with provisions included in the CTCR Tribal Resource Management Plan (TRMP) BiOP. Go to #5.

5. March-May 2020: The Wells Volunteer Channel will be used to collect AD+CWT, Ad only, and CWT only hatchery origin adult summer steelhead to be used as backfill for Methow Safety-Net, Columbia Safety-Net, Okanogan Program, and WNFH program (if desired by USFWS) should any of these program lack sufficient broodstock for the collections described above. Adult hatchery origin steelhead in excess of broodstock needs will be surplused.

Twisp River – Conservation Releases

Due to the recent increased concern for inbreeding depression risk (Ryman-Laikre) for the Twisp program as a result of low N_e and other confounding issues, the design of the Twisp program is currently under review.

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan can be implemented.

The current plan (BY 2020) collects approximately 13 natural origin fish as broodstock from the Methow Mainstem (hook and line) and approximately 13 natural origin fish as broodstock from the Twisp River (weir).

Wells Hatchery – Methow River Release

The Wells Hatchery Methow River release (Methow safety net program) uses locally collected hatchery origin broodstock representative of the Twisp and WNFH conservation programs and as needed, the Methow safety-net program. Adults are collected in concert with adult management and broodstock collection (including hook-and-line) activities at the Twisp Weir, Methow Hatchery, and WNFH. As a backup strategy, hatchery origin broodstock may be collected from Wells Hatchery Volunteer Channel in spring 2020 if other broodstock collection measures fall short. Beginning with the 2018 release, fish will be truck planted at Effy Bridge (RKM 13) in the lower Methow.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use progeny returns from the Methow Safety-Net broodstock (described above). The remaining production for the Columbia Safety-Net may include hatchery origin broodstock collected via hook-and-line in the Methow River, Twisp Weir, adult returns to the Methow Hatchery and Winthrop NFH, and may be augmented with fish collected in spring 2020 from the Wells Volunteer channel if needed to fulfill the program. Surplus eggs and/or fry from the Columbia and Okanogan broodstock may be utilized for other programs in the upper Columbia. Fish are released to the Columbia River, immediately downstream of Wells Dam.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural-origin (NO) fish collected through hook-and-line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, WNFH hatchery-origin returns will be prioritized, followed by Methow safety-net hatchery returns. Transfer of adult and/or gametes/eggs between program will be carefully choreographed to ensure fish are being utilized in the most efficient and effective manner. Fish may be released throughout the Methow basin.

Okanogan River and Tributary Releases

The Okanogan River conservation program uses a combination of natural- and hatchery-origin adults collected in Omak Creek and elsewhere in the Okanogan Basin through CCT collection efforts. Surplus eggs and/or fry from the Okanogan River program broodstock may possibly be utilized for other programs in the upper Columbia or otherwise surplussed at the earliest time when overages are apparent.

Should the Okanogan Basin spring period collection fail to achieve sufficient broodstock to meet programmed production, steelhead will be collected from the Wells Hatchery volunteer ladder in the spring of 2020, sufficient to meet broodstock needs. Fish with positive CWT or PIT tag for Okanogan origin will be the priority to fill the shortfall in broodstock, followed by unknown hatchery origin fish.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2020 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
DPUD Conservation[2]	WNFH – 2S; Wells Hatchery 1S	Douglas PUD	Twisp River @ Buttermilk Bridge, Methow basin @ WNFH or other location as determined by the HCP-HC	48,000 (S_1)	Twisp Weir and Methow basin (angling)
Methow Safety-Net	Wells Hatchery	Douglas PUD	Effy Bridge – Lower Methow River	100,000	HxH: Twisp Weir (up to 25%) + WNFH Hatchery (75%) or WNFH 1st, MFH 2nd to make up balance
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Columbia River @ Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	Methow basin @ WNFH or other locations as determined by the JFP	Up to 200,000 (S_2)	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River and Spring Creek Weir.
Okanogan[1]	Wells Hatchery/ St. Mary's Pond	Grant PUD/CCT	Okanogan tributaries	100,000[1]	Okanogan Basin, Wells FH/Wells FH/Dam

[1] CCT received approval for the Okanogan steelhead HGMP as part of their Tribal Resource Management Plan in February, 2017. Omak Creek and Wells Fish Hatchery are no longer separate hatchery programs. Up to 58 broodstock (NOB or HOB) may be collected from throughout the Okanogan basin (or Wells Dam if necessary) to meet the 100k program.
[2] The DPUD Twisp conservation program is currently under re-development after detection of inbreeding depression risk. The HC and JFP have committed to developing an approved plan in sufficient time for implementation.

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 6), biological assumptions (Appendix A), and the probability that sufficient adult steelhead will return in 2019/2020 to meet production objectives absent a reliable preseason forecast at the present time.

For the 2020 brood steelhead programs operating above Wells Dam, a total of 334 adults (194 natural origin and up to 140 hatchery origin adults) are estimated to be needed to fulfill the respective mitigation obligations (Table 6). To support these obligations and to ensure sufficient backup adults are available in the event spring tributary based collection efforts fall short of targets, spring 2020 trapping at Wells Dam and/or Wells FH may be implemented to selectively retain sufficient adults to backfill shortfalls in spring collections (west [and east, as necessary] ladder and volunteer trap collection; Table 5). As a note, all potential broodstock will be scanned for PIT tags at collection and PIT tagged fish will be returned to the river to meet their monitoring objective. Any adult determined to have been part of the Yakama Nation's kelt reconditioning program will be released in the vicinity it was collected.

Twisp Conservation Program (DPUD)

The HC and JFP are working to redefine the scope and nature of the 2020 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan (the current draft plan be reviewed in Appendix H) can be implemented.

Methow Safety Net Program

Up to 14 surplus hatchery-origin Twisp-stock steelhead (to meet up to 25% of the 100K Methow Safety-Net release) will be targeted at collection locations including the Twisp Weir and moved as live adults to Wells Hatchery for spawning. No less than 40 hatchery adults will be targeted at WNFH and through angling efforts, and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). If collection via hook-and-line, at the Twisp Weir, and WNFH and MH traps/collection efforts are unsuccessful (Table 5) then broodstock will be trapped in the Wells Volunteer channel in spring 2020. Coordination between USFWS, DPUD, and WDFW staff will occur during the season to determine prioritization.

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will be targeted for retention through hook–and-line collection efforts in the Methow River (Table 6). In the event of a shortage, excess hatchery steelhead from the Twisp Weir and volunteer returns to the WNFH (including angle-caught fish) will be utilized as needed to augment WNFH broodstock. Should there be inadequate surplus steelhead from these sources, excess hatchery steelhead (presumed Methow Safety-Net origin) captured at the Methow Hatchery volunteer trap will be used to fulfill the program. Natural-Origin females will be live-spawned and reconditioned by YN.

Okanogan Conservation Program (GPUD/CCT)

Up to 58 adult steelhead will be targeted in the Okanogan Basin, including up to 100% natural-origin adults (dependent on run size and within the 33% natural origin extraction rate) (Table 5). Broodstock collected at Wells FH that are subsequently identified as Okanogan-origin will be transferred to the Okanogan program (as needed to meet program obligations). Due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5) further broodstock shortfalls for the Okanogan may be supplemented with broodstock collected in the spring of

2020 at the Wells Fish Hatchery Volunteer Ladder and/or Wells Dam east/west ladder traps to meet the production obligation.

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild			Hatchery	Wild
DPUD Columbia R. SN	86		Wells FH/Dam, Methow River, WNFH, Methow Hatchery, Twisp Weir	Wells Hatchery	86	
DPUD Methow R. SN	54		Twisp weir (14), Methow River, WNFH[3] (46)	Wells Hatchery/Dam	54	
DPUD Met. Conservation		26	Twisp Weir; Methow basin	NA		26
GPUD Okanogan R.	0-58[6]	0-58[7]	Omak Cr., Okanogan R. and tributaries,	Wells Hatchery/Dam[5]	0-58	(1st priority) 0-58
USFWS Methow R.		110	Methow R. WNFH[4]	Methow Hatchery	Up to 54[8]	110[8]
Total (PUD programs)	**140-198**	**26-84**			**140**	**26-84**
Total (All programs)	**140-198**	**136-194**			**140-252**	**136-194**

[1] Assumes a 1:1 sex ratio (see Table 6). Natural origin females will be live spawned and reconditioned.
[2] Primarily uses hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH. May include Methow safety net adults collected via angling, or adult returns to WNFH and Methow FH.
[3] May also include excess hatchery origin adults collected via angling and at Methow FH and the Twisp Weir.
[4] Spring collection of hatchery origin steelhead as needed to meet program for the Okanogan Program. Shortfall, if encountered, to be met with Wells Hatchery Volunteer Channel collection in spring.
[5] Dependent upon number of NOR broodstock collected in the Okanogan Basin, age structure and fecundity to achieve sufficient brood for a100k smolt program for the Okanogan.
[6] Depending upon NOR abundance and trapping efficiency.
[7] Broodstock composition for the WNFH conservation program is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2020 brood summer steelhead programs. Includes primary collection location(s) and mating strategy. *Broodstock totals do not include additional fish that may be collected at other locations as a backup for shortfalls from primary collection sources*.

Program	Production target/request	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
DPUD[1] Columbia R.	160,000	43F/43M		**86**	Wells FH/ Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	27F/27M		**54**[4]	Twisp Weir, MFH, WNFH, Wells FH/Dam	1:1
DPUD Methow Conservation	48,000		13F/13M	**26**	Twisp Weir/Methow River	2x2 Factorial
GPUD Okanogan R.[3]	100,000		29F/29M	**58**[5]	Okanogan R./Omak Creek	1:1/2x2[7]
USFWS Conservation[8]	200,000[8]		55F/55M	**110**	Methow River[6]	2X2 Factorial
Total[4]	**608,000**	**70F/70M**	**97F/97M**	**334**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow River release of HxH fish produced from either adults returning from the Winthrop conservation program, adults trapped at MFH, and/or surplus hatchery adults from the Twisp weir, or Wells FH/Dam.
[3]CCT intends to achieve greater than 0.5 pNOB, but the actual number will be dependent upon run size and trap efficiency, per the HGMP. Numbers of hatchery and wild males and females in this table should not be taken as the goal or limit for any collection effort, as it could be up to 100% pNOB or pHOB.
[4] Additional hatchery adults may be collected at Wells FH to augment shortfalls in collections for the Methow safety net.
[5] Additional hatchery origin adults may be collected during the spring of 2020 at Wells Dam/Wells FH to augment shortfalls in Okanogan Basin collection efforts.
[6] Collection priority: 1) hook and line, 2) adult returns to WNFH, 3) excess adult returns to Methow Hatchery.
[7] A 1:1 mating protocol will be used for all HxH/HxW crosses within the Okanogan. The Okanogan locally-adapted natural stock (WxW) will utilize a minimum 2x2 factorial mating to minimize potential negative effects associated with a small effective population size.
[8] Production is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Overall collection for the PUD programs will be 224 fish (Table 6) and limited to no more than 33% of the entire run and/or 33% of the natural origin return. Hatchery and natural origin collections will be consistent with the respective run-timing of hatchery and natural origin steelhead at Wells Dam, Omak Weir and the Twisp Weir. Trapping at the Wells Dam ladders may occur between 01 August, 2019 and 30 April, 2020, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. (Appendix D). The Twisp Weir operates from early March (dependent on river conditions) through the end of the steelhead spawning run (spring Chinook trapping takes over by June 1). Trapping occurs daily for broodstock collection and gene flow management.

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments may be made based on in-season monitoring and evaluation. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

Summer/fall Chinook

The summer/fall Chinook mitigation program in the Methow River utilizes adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 200,000 summer/fall Chinook smolts for acclimation and release from the Carlton Acclimation Facility.

The TAC 2019 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2014, 2015, and 2016 spawn escapement to tributaries above Wells Dam indicate sufficient summer Chinook will return past Wells Dam to achieve full broodstock collection for supplementation programs above Wells Dam. The following broodstock collection protocol for the Methow summer Chinook program was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives, and program assumptions (Appendix A).

For 2019, up to 124 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 62 females for the Methow summer Chinook program (Table 7). Collection will be proportional to return timing between 01 July and 15 September. Summer Chinook stock assessment will run concurrent with summer Chinook broodstock collection at the west ladder trap. Trapping may occur up to 3-days/week, 16 hours/day (48 cumulative hours per week). Age-3 males ("jacks") will not be collected for broodstock unless needed to pair with females.

Should use of Wells Dam be needed to meet any shortfalls in Chief Joseph Hatchery broodstock for summer/fall Chinook programs, the CCT will notify the HCP-HC and Wells HCP Coordinating Committee/PRCC-HSC and coordinate with Douglas PUD, Grant PUD, and WDFW to facilitate additional broodstock collection effort. Summer Chinook broodstock collection efforts at Wells Dam, should they be required to meet CJH program objectives, will be conducted concurrent with broodstock collection efforts for the Methow summer Chinook program and or steelhead collection efforts for steelhead programs above Wells Dam.

If the probability of achieving the broodstock goal is reduced based on passage at the west ladder or actual natural-origin escapement levels, broodstock collections may be expanded to the east ladder trap and/or origin composition will be adjusted to meet the broodstock collection objective. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 7. Number of broodstock needed for Grant PUDs Methow summer Chinook production obligation of 200,000 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
Methow	200,000		62F/62M	**124**	Wells Dam	1:1
Total	**200,000**		**124**	**124**		

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Collection at the Wells FH volunteer channel will be used to collect the broodstock necessary for the Wells FH yearling (320,000) and sub-yearling (484,000) programs.

Because of CCT concerns about sufficient natural-origin fish reaching spawning grounds and to ensure sufficient NOR's being available to meet the CCT summer Chinook program, incorporation of natural-origin fish for the Wells program or programs with broodstock originating from the Wells volunteer channel, will be limited to fish collected in the Wells volunteer channel. The program includes up to 10% natural origin broodstock. The following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

DPUD will target 532 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs (Table 8). Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin July 1 and terminate by August 31. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not exceeding 10% representation of natural origin fish in the summer Chinook broodstock collection. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

For 2019, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Wells Fish Hatchery volunteer trap. The Chelan Falls Canal Trap (CFCT) was piloted from 2016 to 2018 to collect adult Chinook broodstock, but for various reasons the trapping season was truncated and the CFCT was unsuccessful, in meeting the broodstock requirements for the Chelan Falls program. Chelan PUDs assessment of the financial investment necessary to make the CFCT viable has determined it to be unfeasible at the present time.

While broodstocking efforts in 2019 will be prioritized at the Wells volunteer trap, Chelan PUD will evaluate the installation and operation of a temporary picket weir in the Chelan River habitat channel and utilizing the CCT to evaluate the feasibility of beach seining for adult Chinook in the Chelan tail race area. Specific details of these two efforts have yet to be finalized. However, if implemented and successful, adults collected will be incorporated into the Chelan Falls program and adult brood numbers from the Wells volunteer trap will be appropriately reduced.

If shortfalls in adult needs are expected and the number of females needed to meet program has not been reached by August 15th, the HCP HC will discuss whether broodstock collection may default to surplus summer Chinook collected from other HCP approved locations to make up the difference. The 2019 broodstock target for the Chelan Falls program is 390 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 8. Number of broodstock needed for the combined Chelan and Douglas PUD Columbia River below Wells summer Chinook production obligations of 1,380,000 smolts, collection location, and mating strategy. Also includes broodstock necessary for outside programs that rely on adult collection at Well Hatchery in 2019.

Program	Production target	Number of Adults[1]		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	96F/96M		**192**	Wells VC[2]	1:1
Wells 0+	484,000	170F/170M		**340**	Wells VC[2]	1:1
Chelan Falls 1+	576,000	195F/195M		**390**	Wells VC[2]	1:1
Total	**1,380,000**	**461F/461M**		**922**		

[1] The number of adults collected for these programs may indirectly incorporate natural origin fish; however, because they are volunteers, the number is likely to be less than 10% of the total.
[2] Wells Hatchery volunteer channel trap.

Wenatchee River Basin

In 2019 the Eastbank Fish Hatchery (FH) is expecting to early rear spring Chinook salmon for the Chiwawa River and Nason Creek acclimation facilities located on the Chiwawa River and Nason Creek. The program production level target for the Chiwawa program (Chelan PUD obligation) in 2019 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 72 natural origin spring Chinook (Table 10). The spring Chinook production obligation as currently described in the BiOp and Section 10 permit for Grant PUD in the Wenatchee Basin is 223,670 smolts (125,000 conservation and 98,670 safety net) and based upon the biological assumptions (Appendix A) will require a total broodstock collection of 136 adults (66 natural origin and 60 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2019 is estimated at 1,599 spring Chinook, including 1,209 hatchery and 390 natural origin spring

Chinook (does not include age-3 males; Table 9). In-season estimates of natural-origin spring Chinook to Tumwater Dam will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2019.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	238	27	**265**	70	8	**78**	350	40	**390**
Estimated hatchery return	905	30	**935**	265	9	**274**	1,170	39	**1,209**
Total	1,143	57	**1,200**	335	17	**352**	**1,520**	**79**	**1,599**

Table 10. Number of broodstock *needed* for the combined Wenatchee spring Chinook production obligation of 367,969 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Chiwawa Conservation[4]	144,026	7/7M	31F/31M	**76**	Chiwawa Weir and Tumwater Dam[3]	2x2 factorial
Nason Conservation	125,000	8F/8M	26F/26M	**75[1]**	Tumwater Dam[3]	2x2 factorial
Nason Safety net	98,670	30F/30M[2]	0	**60**	Tumwater Dam	1:1
Total	**367,969**	**90**	**114**	**211[4]**		

[1] Includes ~10% additional NO fish for the Nason program to account for fish that may assign back to the White River spawning aggregate. No more than 52 NO fish will be retained for spawning.
[2] Chiwawa hatchery fish will only be collected to satisfy the Nason Cr. safety net program if in-season estimates of returning Nason conservation fish fall short of expectations.
[3] Collection of NO fish at Tumwater for the Chiwawa program will include previously PIT tagged adults (NO juveniles PIT tagged at the Chiwawa smolt trap) and/or excess NO adults/eggs/progeny originating from females with assignments >95% to the Chiwawa from the Nason conservation program.
[4] Total includes the 10% over-collection as part of the genetic assignment variance for the Nason conservation program.

Chiwawa River Conservation Program Broodstocking:

The 2019 pre-season forecast for NO adults back to the Chiwawa is well below the 2018 forecast (527 and 265 for 2018 and 2019 forecasts, respectively). It is under these circumstances that WDFW is proposing to maintain the number of bull trout encounters (and subsequent number of trappings days) to facilitate meeting the Chiwawa spring Chinook broodstock collection target as agreed to by the HCP HC. Consistent with the realized shortfall in NO broodstock in 2018, the 2019 operations plan seeks to maintain the number of bull trout encounters to about 93 (this theoretically increases the number of trapping days available from 15 to about 20). However, to minimize impacts to bull trout, operations will initially target the lower 15 day and 71 bull trout encounter levels. If additional NO brood collection is required operations may be extended to the 20 day and 93 bull trout encounter level. Should the higher level of trapping activity be required the USFWS will be notified in writing. Any further in-season modification of this plan would require concurrence on the part of the HC and the USFWS prior to implementation.

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 27 previously PIT-tagged NO spring Chinook from the Chiwawa River could be collected at TWD between June 1 and July 15, concurrent with Nason Creek brood stocking, adult management, RM&E, and the RRS Study.
- The balance adults needed to meet the Chiwawa Conservation program (up to ~76 total or ~38 females) would be collected at the Chiwawa Weir (HO adults will be collected at Tumwater Dam during the Nason broodstocking).

    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 15 cumulative trapping days and/or 71 bull trout encounters or after notifying the USFWS, 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.
    - Using the most recent 3-year redd count data (2014-2017; 2016 and 2018 survey data was not collected due to widlfires), the 10% threshold is 148 bull trout as determined by an average number of redds in the Chiwawa sub-basin of 739 (expands to 1,147 adults at a 1:1 sex ratio).
    - No more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using up to a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS.
    - To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program (either through trap inefficiency or to not exceed 33% NO extraction), HO adults (presently estimated at 19% [N=14] of the total broodstock requirement, however may be

adjusted up or down depending on the run) would be collected at TWD to make up the shortfall (see Table 10) between June 1 and July 15.

- For additional assurance and to help reduce effort at the Chiwawa Weir, during broodstock collection for the Nason conservation program, any excess adults not genotyping to the White River will be retained for the Nason program and an equivalent number of adults that have assignment probabilities >95% for Chiwawa, will be transferred to the Chiwawa program.
- Historic and in-season data for NO spring Chinook timing to the lower Chiwawa array from TWD will be used to determine optimal dates for collection.
- Any bull trout that are caught at the Chiwawa trap will be immediately removed and released at a site ~10KM upstream of the weir to prevent fallback/impingement and to mitigate for potential delay. Handling and transport will be conducted by WDFW hatchery staff.
- If a bull trout is killed during trapping, despite implementing conservation measures, trapping activities will cease and not continue until additional measures to minimize risks to bull trout can be discussed with the USFWS.

Table 11. PIT tagged natural origin adults to Tumwater Dam for the most recent 5-years (2014-2018) with conversion rates from Bonneville Dam.

	Detections at Bonneville Dam		Detections at Tumwater Dam			
Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
2016	8	34	8	1.000	24	0.706
2017	5	31	3	0.600	31	1.000
2018	1	27	1	1.000	26	0.963
Mean	5.8	40.0	3.8	0.687	27.6	0.755
Geomean	4.6	38.0	2.7	0.582	27.5	0.724

Nason Creek Conservation Program Broodstocking:

- Up to ~58 NO spring Chinook (to allow for up to 10 percent of White River NO fish estimated to be encountered at Tumwater Dam MSA; Table 10) would be collected at TWD between June 1 and July 15.
    - Only 52 NO adults (26 females) and 16 HO adults (8 females) will be retained to produce the 125K Nason Conservation program.
    - Collection of additional HO fish may occur in the event NO collection/retention falls short of expectation or would exceed 33% extraction.
    - Brood stock collection would run concurrent with adult management, RM&E, and the Spring Chinook Relative Reproductive Success Study. The GAPS microsatellite panel and existing GAPS plus WDFW spring Chinook Wenatchee

baseline will be used for genotyping and GSI analyses similar to methods used beginning in 2013.

- Decision Rules:
  - Any fish that assigns to the White River with greater than 90% surety will be released in the White River.
  - Unassigned fish (individuals that can't be assigned to the Wenatchee Population or Leavenworth NFH), will be released upstream of Tumwater Dam at the Alps or Swift Water rest stop.
  - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the highest assignment probabilities (>95%) to the Chiwawa will be incorporated into the Chiwawa conservation program if needed or otherwise returned to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- At the current run forecast, up to ~60 HO spring Chinook adults (from conservation program [1st priority] – identified by snout wire + body wire) would be targeted at TWD (Table 10) between June 1 and July 15, concurrent with NO brood stock collection, adult management, RM&E, and the Spring Chinook Relative Reproductive Success (RRS) Study to meet a 98,670 smolt release.

<u>Steelhead</u>

The steelhead mitigation program in the Wenatchee Basin uses broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 18583 provisions, broodstock collection will target adults necessary to meet a natural origin – conservation (WxW) oriented program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin and a hatchery origin (HxH) – safety net program. The conservation and safety net programs each make up approximately half of the 247,300 production obligation. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain a total of 136 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 70 hatchery origin adults will be targeted at Dryden Dam and if necessary Tumwater dam. The 66 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 14 November. Collection may also occur between 15 November and 5 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Only adipose present coded wire tagged hatchery fish (or previously PIT tagged WxW hatchery progeny) will be retained for the safety net program unless low returns require use of safety net adults (adipose clipped) to meet the production obligation. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and at Dryden Dam. In-season broodstock collection adjustments may be made based on this monitoring and evaluation.

To better ensure achieving the appropriate female equivalents for program production, the collection will include the use of ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinate adult steelhead collection in the mainstem Wenatchee River by hook and line. In addition to trapping and hook and line collection efforts, Tumwater and Dryden dams may be operated between February and early April the subsequent spring to supplement broodstock numbers if the fall trapping effort provides fewer than the required number of adults.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 12. Number of broodstock needed for the combined 2020 BY Wenatchee summer steelhead production obligation of 247,300 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wenatchee Conservation[1]	123,650	0	33F/33M	**66**	TWD[3]/Dryden LBT-RBT[4]	2x2 factorial
Wenatchee Safety net[2]	123,650	35F/35M	0	**70**	Dryden LBT-RBT[4] /TWD[4]	1:1
Total	**247,300**	**70**	**70**	**136**		

[1] Broodstock collection for the conservation program will occur primarily at Tumwater Dam and will only fall back to Dryden Dam trapping facilities if a shortfall is expected.
[2] Broodstock collection for the safety net program will occur primarily at the Dryden Dam trapping facilities to minimize activities at TWD that could increase unintended delays on non-target fish. Collection at Tumwater Dam will only occur if shortfalls in broodstock are expected at Dryden Dam.
[3] TWD=Tumwater Dam.
[4] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.

Summer/fall Chinook

Summer/fall Chinook mitigation programs in the Wenatchee River Basin utilize adult broodstock collections at Dryden and Tumwater dams, incubation/rearing at Eastbank Fish Hatchery (FH) and acclimation/release from the Dryden Acclimation Pond. The total production level target for BY 2019 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2019 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2014, 2015 and 2016 spawner escapement to the Wenatchee River indicate sufficient summer Chinook will likely return to the Wenatchee River to achieve full broodstock collection for the Wenatchee River summer Chinook supplementation program. Review of recent summer/fall Chinook run-timing past Dryden and Tumwater dams indicates that previous broodstock collection activities have omitted the early returning summer/fall Chinook, primarily due to limitations imposed by ESA Section 10 Permit 1347 to minimize impacts to listed spring Chinook. In an effort to incorporate broodstock that better represent the summer/fall Chinook run timing in the Wenatchee Basin, the broodstock collection will front-load the collection to account for the disproportionate collection timing. Approximately 43% of the summer/fall Chinook destined for the upper Basin (above Tumwater Dam) occurs prior to the end of the first week of July; therefore, the collection will provide 43% of the objective by the end of the first week of July. Weekly collection after the first week of July will be consistent with run timing of summer/fall Chinook during the remainder of the trapping period. With concurrence from NMFS, summer Chinook collections at Dryden Dam may begin up to one week earlier. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain up to 274 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 137 females (Table 13). To better ensure achieving the appropriate females for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock. Trapping at Dryden Dam may begin 24 June and terminate no later than 15 September and operate up to 7-days/week, 24-hours/day. Trapping at Tumwater Dam if needed may begin 15 July and terminate no later than 15 September and operate up to 48 hours per week for broodstock related activities.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 13. Number of broodstock needed for the combined 2019 BY Chelan and Grant PUD Wenatchee summer Chinook production obligations of 500,001 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Chelan PUD	318,185		87F/87M	**174**		
Grant PUD	181,816		50F/50M	**100**		
Total	**500,001**		**137F/137M**	**274**	Dryden LBT-RBT[1] /TWD[2]	1:1

[1] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.
[2] TWD=Tumwater Dam.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery (PRH) will generally begin in early September and continue through about mid-November. Juvenile release objectives specific to Grant PUD (5,599,504 sub-yearlings), and Federal (1,700,000 sub-yearlings at PRH + 3,500,000 smolts at Ringold Springs Hatchery – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE), mitigation commitments. Biological assumptions are detailed in Appendix A. For the Ringold Springs production, adult collection, holding, spawning and incubation occurs at PRH until the eyed-egg stage. Eyed eggs are transferred to Bonneville Hatchery until they are transferred for spring acclimation and release at Ringold Springs.

For 2019 NO adults will be targeted through hook-and-line angling efforts in the Hanford Reach and the OLAFT to increase the proportion of natural origin adults in the broodstock to meet integration of the hatchery program will also be incorporated into the program. It is estimated that approximately 600 adults may be collected through the hook-and-line efforts and 650 adults will be targeted from the OLAFT. Close coordination between broodstock collections at the volunteer channel, the OLAFT and through hook-and-line efforts in the Hanford Reach will need to occur so over collection is minimized. Fish surplus to production needs will be culled at the earliest possible life-stage (e.g, prior to ponding, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from hook-and-line caught broodstock will be prioritized for PRH programs (i.e. Hanford Reach angler caught fish will be, held in a separate pond from volunteer collected fish, spawned first each week, and to the extent possible segregated and reserved for the GPUD program).

Grant PUD staff will work closely with WDFW hatchery and M&E staff to maintain separation of gametes/progeny of angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,651 females will need to be collected to meet the 10,799,054 smolts required to meet the current three up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap, the OLAFT, and hook-and-line efforts on the Hanford Reach (Table 14).

To increase the probability of incorporating a higher percentage of NOR's from the volunteer channel, adipose present, non-CWT males and females will be prioritized for retention and males older than 3 will be prioritized. In addition, preliminary information suggests that the pNORs is higher in the later part of the trapping period than the earlier period. As data become available, the PRCC-HSC may choose, in-season, to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of broodstock necessary to backfill shortfalls.

<u>Implementation Assumptions</u>

1) Broodstock may be collected at any or all of the following locations/means: hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), the Priest Rapids Hatchery volunteer channel trap, and the OLAFT.

2) Assumptions used to determine egg/adult needs is based upon current program performance metrics.

3) Broodstock retained from the volunteer channel will exclude to the degree possible, age-2 and 3 males (using length at age; i.e. retain males ≥ 75 cm) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and also decrease the probability of using hatchery origin fish in the broodstock that are skewed towards earlier ages at maturity. Age-3 fish may be retained for broodstock if in-season run estimates suggest a shortage may occur.

4) Adipose present, non-CWT males and females will be prioritized for broodstock from the volunteer channel collected broodstock unless a shortage is expected.

5) Broodstock collected by hook-and-line will exclude age-2 to minimize genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and to ensure the highest proportion of NOR's in the collection.

6) All gametes of fish spawned from hook-and-line broodstocking efforts will be incorporated into the PRH based programs.

7) All juveniles released from PRH will, at a minimum, have a unique otolith mark so that returning adults can be identified.

8) Natural origin broodstock collection at the volunteer trap will be prioritized for the GPUD program by collecting fish when the probability of encountering natural origin fish is highest and balancing run-time representation.

Table 14. Number of broodstock needed for the combined Grant PUD and ACOE fall Chinook production obligations of 10,799,504 sub-yearling smolts at Priest Rapids and Ringold Springs hatcheries, collection location, and mating strategy in 2019.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,427F/1,498M	**3,925**		
ACOE-PRH	1,700,000	737F/454M	**1,191**		
ACOE – Ringold[1]	3,500,000	1,534F/947M	**2,481**		
Total	**10,799,504**	**4,698F/2,899M**	**7,597**		

Collection location	Estimated number of adults		Total		
	Hatchery	Wild			
Priest Rapids Hatchery	**3,838F/2,155**	**222F/132M**	**6,347**	PRH volunteer trap	1:2
OLAFT	**103F/51M**	**331F/165M**	**650**		1:2, 1:4
ABC[2,3]	**19F/36M**	**185F/360M**	**600**	Hanford Reach	1:2, 1:4

Total	**3,960F/2,242M** (6,202; 90.4%)	**738F/657M** (729; 9.6%)	**7,597**

[1] As of brood year 2009, Priest Rapids Hatchery is taking sufficient eggs to meet the 3,500,000 sub-yearling smolt release at Ringold-Meseberg Hatchery funded by the ACOE – late incubation of this program occurs at Bonneville.
[2] Estimated number of fall Chinook females and males to be acquired from the OLAFT in 2019. F/M ratios were derived through run at large data. Estimates of H/W were derived through otolith results.
[3] ABC fish are adults collected from hook and line collection efforts on the Hanford Reach. Estimates of F/M were derived through 2012-2014 spawn numbers. Estimates of H/W were derived through otolith results from 2013 -2017.

Appendix A

2019 Biological Assumptions and estimated adult, green egg, and eyed egg targets for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Table 1. 2019 Biological assumptions for UCR spring, summer, and fall Chinook and summer steelhead.

Program	Mean Values for 2013-2017								Mean Values 2011-2015 Brood[1]
	ELISAs		Fecundity		Prespawn Survival				
	H	W			H		W		
	≥ 0.12	≥ 0.2	H	W	M	F	M	F	G-E-R Survival
Methow SPC	0.210	0.031	3,673	4,124	0.923	0.944	0.986	0.970	0.881
Chewuch SPC	0.210	0.031	3,673	4,124	0.923	0.944	0.986	0.970	0.881
Twisp SPC	0.300	0.027	3,781	3,914	1.000	1.000	1.000	1.000	0.910
Twisp SHD	[redacted]	[redacted]	[redacted]	5,006	[redacted]	[redacted]	1.000	1.000	0.751
Wells SHD	[redacted]	[redacted]	5,796	[redacted]	0.959	0.972	[redacted]	[redacted]	0.657
Okanogan Conservation	[redacted]	[redacted]	[redacted]	5,041	[redacted]	[redacted]	1.000	0.956	0.741
Okanogan Safety Net	[redacted]	[redacted]	5,203	[redacted]	0.959	0.972	[redacted]	[redacted]	0.657
Wells SUC 1+	0.023	0.000	3,948	4,613	0.976	0.984	[redacted]	[redacted]	0.882
Wells SUC 0+	0.023	0.000	3,948	4,613	0.979	0.984	[redacted]	[redacted]	0.753
Methow SUC	0.000	0.044	[redacted]	4,156	[redacted]	[redacted]	0.973	0.972	0.837
Chelan Falls 1+	0.027	[redacted]	3,827	[redacted]	0.963	0.947	[redacted]	[redacted]	0.837
Wenatchee SUC	0.000	0.010	[redacted]	4,484	[redacted]	[redacted]	0.963	0.959	0.856
Wenatchee SHD	[redacted]	[redacted]	5,378	5,708	0.996	0.946	0.954	0.939	0.708
Nason SPC	0.031	0.009	[redacted]	4,515	[redacted]	[redacted]	0.975	0.969	0.889
Chiwawa SPC	0.030	0.004	3,920	4,573	0.978	0.989	0.989	0.981	0.896
Priest Rapids FAC 0+	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.784
ACOE @PRH	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.784
ACOE @Ringold	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.775

[1] Green egg to release survival.

Table 2. Summary of UCR 2019BY Chinook and 2020BY steelhead, broodstock (H/W; M/F), green egg, eyed egg, and smolt release targets by program.

Program	Adults				Green egg target[1]	Eyed egg target[1]	Smolt release target
	Hatchery		Wild				
	Male	Female	Male	Female			
Spring Chinook							
Methow Spring Chinook			38	38	152,243	144,631	133,249
Chewuch Spring Chinook			17	17	68,690	65,256	60,516
Twisp Spring Chinook			9	9	33,882	31,442	30,000
Nason Spring Chinook (Conservation)	8	8	26	26	141,884	131,101	125,000
Nason Spring Chinook (Safety net)	30	30			114,423	105,727	98,670
Chiwawa Spring Chinook	7	7	31	31	161,389	153,158	144,026
Steelhead							
Twisp Steelhead			13	13	63,915	55,734	48,000
Wells Steelhead (MR release)	27	27			152,207	129,528	100,000
Wells Steelhead (CR release)	43	43			243,531	207,245	160,000
Okanogan Steelhead			29	29	134,953	117,679	100,000
Wenatchee Steelhead (Conservation)			33	33	174,647	131,160	123,650
Wenatchee Steelhead (Safety net)	35	35			175,949	132,138	123,650
Summer Chinook							
Wells Yearling Summer Chinook	96	96			371,853	346,195	320,000
Wells Sub-yearling Summer Chinook	169	169			657,894	624,341	484,000
Methow Summer Chinook			62	62	249,946	230,700	200,000
Chelan Falls Yearling Summer Chinook	195	195			707,268	640,078	576,000
Wenatchee Summer Chinook			137	137	590,013	543,992	500,001
Fall Chinook							
Priest Rapids Fall Chinook	1,083	2,113	415	314	7,142,807	6,399,955	5,599,504
ACOE @PRH Fall Chinook	455	737			2,168,367	1,942,857	1,700,000
ACOE @Ringold Fall Chinook	947	1,534			4,516,129	4,046,452	3,500,000

[1] Estimated value at time of inventory to meet 100% of the production obligation at release.

Appendix B

Projected Brood Year Juvenile Production Targets, Marking Methods, Release Locations, Release Size, Release Type

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2019	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2021	13-18	Forced
2019	Wells SUC 0+ (DPUD)	480,000	Ad + CWT	3K-5K PIT	Columbia R. at Wells Dam	2020	50	Forced
2019	Wells SUC 1+ (DPUD)	320,000	Ad + CWT	Up to 120,000 PIT	Columbia R. at Wells Dam	2021	10	Volitional
2019	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2021	13	Forced
2019	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	20,000 PIT	Wenatchee R. at DAF	2021	18	Volitional
2019	CJH SUS 1+	500,000	Ad + 100K CWT	5,000 PIT	CJH	2021	10	Volitional
2019	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2020	50	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2021	10	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT		Riverside Pond	2021	10	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2021	10	Volitional
2019	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2020	50	Forced
Spring Chinook								
2019	Methow SPC (PUD)	108,249	CWT only	5,000 PIT	Methow R. at MFH	2021	15	Volitional
2019	Methow SPC (PUD)	25,000	CWT only	7,000 PIT	Methow R. at GWP (YN)	2021	15	Volitional
2019	Methow SPC (PUD)	60,516	CWT only	5,000 PIT	Chewuch R. at CAF	2021	15	Volitional
2019	Twisp SPC (PUD)	30,000	CWT only	5,000 PIT	Twisp R. at TAF	2021	15	Volitional
2019	Methow SPC (USFWS)	400,000	Ad + CWT	20,000 PIT	Methow River at WNFH	2021	17	Forced (2-day)

2019	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond/Riverside	2021	15	Volitional
2019	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT	Columbia R. at CJH	2021	15	Forced
2019	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only/TBD[1]	10,000 PIT	Chiwawa River at CPD	2021	18	Short term volitional
2019	Nason Cr. SPC (GPUD) (conservation)	100,000	CWT body tag/TBD[1,13]	5,000 PIT	Nason Cr. at NAF	2021	18	Forced
2019	Nason Cr. SPC (GPUD) (safety net)	123,670	Ad + CWT	5,000 PIT	Nason Cr. at NAF	2021	18	Forced
Fall Chinook								
2019	Priest Rapids FAC 0+ (ACOE)	1.7M	Ad + Oto	Approximately 43,000 spread across the fish released from PRH	Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	600,000	Ad+CWT+ Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	600,000	CWT + Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	1M[2]	Ad + Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	3.4M	Oto only		Columbia River at PRH	2020	50	Forced
2019	Ringold Springs FAC 0+ (ACOE)	3.5M	Ad + 400K CWT		Columbia River at RSH	2020	50	Forced
Steelhead								
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	35,451	Ad + CWT (HxH) CWT only (WxW)		Nason Cr. direct release	2021	6	Direct Plant
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	70,582	Ad + CWT (HxH) CWT only (WxW)	33,000 PIT	Chiwawa R. direct release	2021	6	Direct Plant
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	104,021	Ad + CWT (HxH) CWT only (WxW)		Upper Wenatchee R. direct release	2021	6	Direct Plant

2020	Wenatchee HxH (CPUD)	37,246	Ad + CWT		Lower Wenatchee R. direct release	2021	6	Direct Plant
2020	Twisp Conservation (DPUD)[11]	48,000	CWT only	5,000[7]	Twisp River at Buttermilk Bridge/TBD	2021	6	Direct Plant
2020	Wells HxH (DPUD)	100,000	Ad only	5,000 PIT	Methow River at Effy Bridge	2021	6	Direct Plant
2020	Wells HxH (DPUD)	160,000	Ad only	5,000 PIT	Columbia R. at Wells Dam	2021	6	Volitional
2020	MetComp WxW (USFWS)	Up to 200,000	Ad + CWT	20,000 PIT	Methow R. at WNFH and other locations TBD	2022[12]	4-6	(WNFH) other locations TBD
2020	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K [6]	Ad /CWT snout	Up to 20,000 PIT [,9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2021	5-8	Volitional capture Wells; truck planted in Salmon Creek, Similkameen R., and possibly other tributaries, TBD by fall of 2020.
2020	Okanogan WxW (CCT/GPUD)	Up to 100K [6]	Body and snout CWT[8]	Up to 20,000 PIT [,9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2021	5-8	Volitional from St. Mary's pond. The numbers going to Omak Creek and other tributaries will be determined by fall of 2020.

[1] WDFW would like to have a JFP discussion on an alternate tag (internal) for progeny of hatchery adults incorporated into the conservation program such that progeny of the wild parents can be prioritized. As such the minimum mark is identified with a TBD on an additional alternate mark.
[2] Externally marking of this group is presently funded by WDFW. Marking of this 1M fish is contingent on *US v. Oregon* Policy Committee approval for 2019.
[3] Presently all CWT's are applied to the snout.
[4] The Okanogan SPC program derives its juveniles from a 200K transfer of Methow SPC from WNFH as part of a reintroduction effort. Fish are released into the Okanogan Basin.
[5] The Chief Joe Hatchery SPC program presently receives surplus adults from the Leavenworth NFH as needed. Juveniles are released on station from CJH.
[6] Total Okanogan release not to exceed 100K + 10%.
[7] DPUD will tag 2,500 of the Twisp Only S1's and 2,500 of the Methow S1's. USFWS will tag 2,500 of the Methow S2's for release into the Twisp and 2,500 of the Methow S2's, will accompany the DPUD Methow S1's for an off station release.
[8] The Okanogan steelhead HGMP and NOAA's BiOp for the TRMP state that WxW progeny will receive a unique internal tag (CWT or PIT) and/or receive an alternative fin clip. At this time, CCT does not intend to use an alternative fin clip until/unless a high proportion of the released fish have WxW parents and there is an acceptable survival risk/benefit of the alternative fin clip.
[9] Total PIT tag release in the Okanogan 20,000
[10] Beginning with the 2017 brood, adult returns from the Nason conservation program will be utilized to meet the Nason safety net program and will receive a supplemental body tag (blank wire in the dorsal sinus) in addition to the adipose clip.
[11] With the recent detection of potential inbreeding depression effects in the Twisp conservation program, parties are continuing to develop a long term plan for the program. Once developed and agreed to, this table will be updated to reflect any changes.
[12] Winthrop NFH steelhead program produces 2-year (S2) smolts.
[13] For the 2020 brood, CWT placement will shift from the base of adipose fin to the dorsal sinus to evaluate if the adipose tagging location is responsible for spinal deformities and elevated mortality.

Appendix C

Return Year Adult Management Plans

At a gross scale, adult management plans will include all actions that may be taken within the current run year to address surplus hatchery fish (if any). At the time of submission for this document, spring Chinook will probably be the only group where a reasonable pre-season forecast may be available to lay out what the expected surplus is, how many can be expected to be removed through each action, etc. Preseason forecasts for steelhead will be available in September.

Wenatchee Spring Chinook

Pre-season estimates for age-4 and age-5 adults project a total of 1,599 (390 natural origin [24.4%] and 1,209 hatchery origin [75.6%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 1,143 Chiwawa and 335 Nason spring Chinook are to reach Tumwater Dam in 2019, of which about 343 (22.1%) and 1,209 fish (77.9%) are expected to be natural and hatchery origin spring Chinook, respectively. The balance of about 47 natural origin spring Chinook expected back are destined to the remaining spawning aggregates (Table 1). In-season assessment of the magnitude and origin composition of the spring Chinook return above Tumwater Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18118 and 18121.

Table 1. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2019.

	Chiwawa Basin[1]			Nason Cr. Basin[1]			Wenatchee Basin to Tumwater Dam[2]		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	238	27	**265**	70	8	**78**	350	40	**390**
Estimated hatchery return	905	30	**935**	265	9	**274**	1,170	39	**1,209**
Total	1,143	57	**1,200**	335	17	**352**	**1,520**	**79**	**1,599**

[1] Reflects NOR estimates to Tumwater Dam and has not been adjusted for pre-spawn mortality.
[2] Wenatchee Basin to Tumwater Dam total includes NORs to the White, Little Wenatchee, and Chiwawa rivers and Nason Creek.

Absent broodstock, conservation fisheries, or adult removal at Tumwater Dam (TWD), the expected number of age-4 and age-5 Hatchery Origin Returns (HOR) for the upper Wenatchee River Basin as a whole is estimated to be approximately 3.1 times the expected number of Natural Origin Returns (HORs; 3.5 times the number of NOR's in the Chiwawa River and in Nason Creek). The combined HO and NO returns will represent about 1.3 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 2). The combined HO and NO returns will represent about 70.4% of the number of adults needed to meet the interim Nason run escapement to TWD of 500 fish indicating a disproportionate number of hatchery origin spring Chinook may be on the spawning grounds in the fall of 2018 (Table 3).

Additional Adult Management

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Wenatchee Spring Chinook BiOp (2013; 2105) and Permits #18118, #18129 and #18121. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

2019 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks), and unknown hatchery origin adults (ad-/cwt-) during broodstock collection, run composition assessment, and the RSS. No additional adult removal is expected according to current models, Table 2. The return will be managed for escapement only unless actuals return are higher than the current forecast. In addition, approximately 90 HO and 114 NO adults will be removed between TWD and the Chiwawa Weir and retained for broodstock to support meeting the combined Grant and Chelan PUD Wenatchee spring Chinook obligation.

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2019.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	146	636	87	331	0	**418**
Males[4]	119	299	64	145	0	**209**
Sub-total	265	935	151	476	0	**627**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.52**
Expected pHOS						**0.76**

[1] Wild broodstock of 62 wild NO fish (38 females/38 males) for the Chiwawa conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 14 fish (7 females/7 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 418 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Run escapement and spawning escapement of Nason Creek hatchery and natural origin fish to Tumwater Dam and Nason Creek in 2018.

	To Tumwater Dam		To Nason Creek		Adults surplused at TWD[3]	Total Nason spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	43	186	53	97	0	**150**
Males[4]	35	88	41	43	0	**84**
Sub-total	78	274	94	140	0	**234**
Pre-spawn survival[6]			0.80	0.55		
Expected PNI						**0.56**
Expected pHOS						**0.60**

[1] Wild broodstock of 52 wild NO fish (26 females/26 males) for the Nason conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 76 fish (38 females/38 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 150 redds in Nason Creek under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Methow Spring Chinook

Pre-season estimates project a total of 1,803 (785 natural origin [43.5%] and 1,018 hatchery origin [56.5%]) spring Chinook back to the Methow Basin. Of the 1,018 hatchery returns, about 431 are estimated to be from the conservation program with the balance of 587 from the WNFH safety net program (Table 5).

Table 5. Brood year 2014-2016 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2019.

	Projected Escapement											
	Origin								**Total**			
	Hatchery				**Wild**				**Methow Basin**			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	48	292	10	**350**	17	453	145	**615**	65	745	155	**965**
%Total				34.4%				78.3%				53.5%
Twisp	16	54	11	**81**	14	131	25	**170**	30	185	36	**251**
%Total				7.9%				21.7%				13.9%
Winthrop (MetComp)	71	503	13	**587**					71	503	13	**587**
%Total				57.7%								32.6%
Total	135	849	34	**1,018**	31	584	170	**785**	166	1,433	204	**1,803**

Based on the current forecast, adult management to control MFH escapement, beyond removal of age-3 hatchery males during the course of broodstock collection and M&E, will not likely be needed. Active trapping and operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH) will likely be needed to retain WNFH hatchery adults, and collect returning MFH adults for potential translocation into the spawning grounds.

Presently hatchery fish from MH are prioritized to: a) contribute to the supplementation of the natural populations (up to either the escapement objectives or PNI/pHOS goal), b) make up shortfalls in natural-origin brood for the MH conservation program, and c) to support the 400K safety-net program at WNFH. As such both hatcheries will operate volunteer hatchery ladders to support removal of excess safety-net and conservation fish (when needed). MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH and conservation needs) to WNFH to support the safety-net program, to support removal of excess safety-net and conservation fish, or retain adults to facilitate testing translocation of conservation fish to under-seeded spawning areas as approved by the HCP HC and PRCC HSC. The translocation of conservation program adults may be prioritized over their use as broodstock for the safety net program as long as both programs can meet full production and gene flow (pHOS/PNI) terms and conditions on the spawning grounds. The intention of adult translocation is to increase natural production which is the primary function of the Methow Hatchery. Any implementation of adult translocation as a strategy to increase the abundance of spawners in the natural environment will require the review and refinement (if necessary) of the approved 2017 Out-planting plan for implementation in 2019. Implementation of a Return Year 2019 Out-planting Plan should be supported by updated escapement estimates and outlines the targeted number, gender, out-planting location, and evaluation criteria. It is expected that the information provided in the 2019 BCP will serve as the starting point for development of the out-planting plan.

Specific actions are as follows:

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Methow Spring Chinook BiOp (2017) and Permits #18925, #18927 and #20533. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

Twisp River Spring Chinook: spring Chinook in the Twisp River will be managed separately from the rest of the basin.

a. Adipose-clipped fish encountered at the Twisp Weir will be removed (putative WNFH returns or strays from outside of the basin).
b. Age-3 hatchery males will be removed and euthanized or transported to WNFH for surplusing unless there is a broodstock shortage – in that case age-3 males may be used as brood on a very limited basis (up to 2 Age-3 fish may be used if necessary, but up to one is preferred, only of necessary).
c. Adult management will be performed to maintain pHOS ≤0.50. pNOB will be >0.50 and may be allowed to fluctuate between 0.50 and 1.0 in order to achieve a pHOS ≤0.50.

d. Wild fish will be collected as broodstock – up to ~18 individuals, but not to exceed 33% of the wild run. Hatchery fish may be collected as broodstock, dependent on collection success of wild fish and provided that Twisp-program pNOB may not be less than 0.50.
e. The Twisp Weir will be fished for the duration of the broodstock collection, only, in 2019. Adult management activities will be incidental to broodstock collection. Once broodstock collection is completed, the weir will be opened to fish passage to limit delay/trapping effects on bull trout. During broodstock collection, the weir will be fished from 6:00 AM to 9:00 PM on a daily basis. Deviation from this schedule may be implemented based on the run size and catch efficiency for broodstock.

Methow River (MFH and WNFH) and Chewuch River Spring Chinook (MetComp):

a. Stock assessment will be performed at Wells Dam during the spring Chinook broodstock collection. This information on stock, hatchery:wild, and male:female composition in conjunction with fish counts at Wells Dam will be used to adjust in-season adult management targets.
b. MetComp returns will be managed by removing volunteers at WNFH and Methow Hatchery using the outfall traps at these facilities.
    i. All hatchery-origin age-3 males will be removed
        1. Gender identified by ultrasound.
    ii. The Methow FH and Winthrop NFH volunteer traps will be fished continuously (24 h per day/7 d per week) throughout the run and fish removed at least once daily (depending on specific facility limitations), or as often as needed when fish are present. Adjustments to the operation of the trapping facilities will be made based upon capture/extraction rates as well as bull trout encounters and take limitations.
    iii. Trapping may cease at Methow Hatchery if:
        1. Removal of MFH and WNFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season, and/or through the development of an approved Out-planting plan), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    iv. Trapping may cease at Winthrop NFH if:
        1. Removal of WNFH and MFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season, and/or through the development of an approved Out-planting plan), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    v. All adipose clipped returns encountered at WNFH and MFH volunteer traps will be removed.

1. Returns to WNFH will be retained at WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.
2. Returns to MFH will be transferred to WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.

vi. Conservation program returns may also be transported to specific reaches of the Methow and/or Chewuch Rivers (or other locations as determined by the HC/HSC) to meet the minimum spawning escapement objective or to experimentally augment spawner distribution (such an action will require an approved study or implementation plan by the HCP HC and PRCC HSC, and be permissible under current ESA permits).

Based on the preseason forecast for wild and hatchery spring Chinook to the Methow Basin, once NO broodstock requirements are fulfilled and accounting for an estimated prespawn mortality for NO fish of 50% (42% for HO fish), there will be approximately 329 NO spawners. Based upon the sliding PNI scale for NO run sizes >300 fish, the initial goal for 2019 will be to manage for a minimum spawning escapement of 548 spawners; to achieve this, based on the current forecast, the collection and translocation of hatchery fish will likely be needed (Table 6). This will require an approved out-planting plan for 2019 (using the approved 2017 plan as a starting point) that balances the current and out-year effects to PNI with the need to supplement natural production. Further, the 400K WNFH (in addition to the 200K 10j program) safety net program would need to utilize WNFH returning adults for some or all of its broodstock. Up to 100 % of the MFH HO returns collected at the outfalls would be translocated to the spawning grounds, any MFH HO returns retained may be used for broodstock for the WNFH safety net program to meet PNI requirements. It is expected that in the course of developing an out-planting plan for 2019, the parties will utilize the information provided in Table 6 as well as develop modeling scenarios to anticipate how various out-planting and broodstock collection strategies may impact natural production and PNI (using the multi-pop PNI calculation) in the current and out years.

Table 6. Calculated targets and projected adult management expectations for Methow spring Chinook in 2019 based on current run forecast.

Wild Spawning Escapement[1]		pNOB[2]	pHOS	PNI [3]	Hatchery Spawners[1,4]	Hatchery surplus[4]	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawning escapement
Twisp	76	0.96	0.29	0.77	31	0 MH		0	107
Methow/Chewuch	253	0.89	0.34	0.72	132	56 WNFH[5]	472 (316 WH+156 WH)	0	441
Total	329	0.93	0.33	0.74	163	56	472 (316 WH+156 WH)	0	548

[1] Adjusted for prespawn mortality.
[2] pNOB of conservation program only averaged for BY14, 15, and 16. pNOB target for BY19 is 1.0 for both programs.
[3] Because of the uncertainty around run forecasts, PNI was provisionally estimated using the PNI=pNOB/(pNOB+pHOS) equation.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value already considers hatchery adults needed to meet WNFH and Okanogan 10(j) production components.
5 If the estimated 56 surplus WNFH are allowed (or assumed) to be on the spawning grounds, PNI would drop to 0.67.

In-season assessment of the abundance and origin composition of the spring Chinook return above Wells Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18925, 18927, and 20533.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may occur at the Twisp Weir to meet an overall pHOS = 0.25 with 0.20 allocated to the Twisp Conservation program returns (the exception to this would be if a higher pHOS is still needed to wrap up the remaining time series on the Relative Reproductive Success Study as approved),the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, during broodstock collection efforts (including angling), or in combination with a conservation fishery, consistent with ESA authorizations.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations, consistent with ESA authorizations.

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Wenatchee tributary weir operations, consistent with ESA authorizations.

Adult management plans, if needed, will be finalized then and appended to this document.

Priest Rapids Fall Chinook

The Joint Fisheries Parties have an elevated interest in ensuring any surplus adults back to Priest Rapids Hatchery are made available to back fill anticipated shortfalls in other Columbia River fall Chinook programs given the low 2019 return forecast. As no specific action plan has yet been discussed or developed by the parties, this space is reserved for those details to be inserted at a later date.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for Tumwater Dam is summarized in Table 1):

1) **Real-time monitoring and trap operations:** The PIT tag antennae arrays at the entrance (low and high water entrances; A4 and A5) and at weir 18 (A1) within the Tumwater Dam ladder will be monitored by WDFW and Chelan PUD throughout all trapping activities described in this plan. Detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at the ladder entrances and last detection weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish detected at the ladder entrance. If the median passage time is greater than 48 hours, trapping will cease and fish will be allowed to exit via the ladder (i.e., bypass the trap). If trapping has been stopped, PIT tag passage monitoring will continue and trapping will resume if and when the median passage time is less than 24 hours. In summary, real-time PIT tag monitoring will occur both when the trap is operational and when fish are bypassed. This will provide an opportunity to evaluate trapping effects versus baseline passage rates through the ladder for future operations.

2) **Enhanced effort for Tumwater trapping operations from June 1 and July 15**: The Tumwater trap will be operated in an active-manned trapping condition (the ladder bypass will not be used however, fish may still ascend the denil [steep pass] unimpeded). The trap will be checked a minimum of 1x per day. More frequent trap checks will be made as fish numbers increase. Between June 16 and July 15 the Tumwater trap will be actively manned 24 hours/day 7 days/week utilizing two- three person crews (two people will sample fish and the third will maintain operation of the steep pass so that it will not be closed to passage). This represents an additional person to keep the denil operating constantly. If during this period staff are not available (due to logistical, funding, or other issues) to keep the denil operating continuously, the trap will be opened to allow for nighttime passage (this is in addition to passage required under a detected delay event).

3) **Enhanced effort and limited Tumwater trapping operations from July 16 to August 31**: The trap will be operated 3 days/week for up to 16 hours/day (not to exceed 48 hours per week) to support broodstock collection activities for summer Chinook and sockeye run composition sampling (CRITFC) and sockeye spawner escapement PIT tagging. Video enumeration and full passage will occur when trapping is not occurring.

4) **Planned Tumwater trapping operations from September 1 until mid-December:** To facilitate lamprey passage and meet coho and steelhead broodstocking and steelhead adult management needs, the trap is being proposed to operate up to 16 hours per day from 6AM to 10PM 7days/week manned or unmanned active trapping. The trap will be open for lamprey passage between the hours of 10PM and 6AM. During this time period

bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will be implemented with video enumeration when opened.

5) **Operations at Tumwater from mid-December until about mid-February:** During this period the trapping facility is not operated due to having been winterized. Only video enumeration and full passage are available during this period.

6) **Planned Tumwater trapping operations from mid-February through May:** The trap may return to a 24 hours/7days/week manned or unmanned active trapping for adult steelhead management and/or broodstock collection as needed. Beginning on or about May 1, limited spring Chinook broodstocking, run comp sampling, etc. may also occur. For this trapping period, real-time monitoring will continue to be implemented.

7) **Limitation in staffing or other unforeseen problems:** If WDFW staff are not available to operate the trapping facility (according to this plan) for any reason, then full passage will be allowed (fish will be allowed to bypass the trap and exit the ladder directly), until staff are able to return.

8) **Unforeseen scenarios and in season observations**: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and Chelan PUD will alert the Hatchery Committee and work cooperatively with the Services to determine whether changes are needed to further minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the Services.

Table 1. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and reproductive success activities anticipated to be conducted at Tumwater Dam in 2019. Blue denotes steelhead, brown spring Chinook, orange sockeye, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD pHOS mgt[1]		15 Feb				15 June			1 Sep			15 Dec
Su. SHD BS collection[2]									1 Sep		15 Nov	
Su. SHD Spawner Esc. tagging[3]		15 Feb				15 June			1 Sep			15 Dec
Spring Chinook RSS[4]					1 May		15 Jul					
Sp Chinook run comp[5]					1 May		15 Jul					
Sp Chinook pHOS mgt[6]					1 May		15 Jul					
Sp Chin stray mgt[7]					1 May		15 Jul					
Sp Chin BS collection					1 May		15 Jul					
Sockeye run comp[8]							15 Jul	15 Aug				
Sockeye spawner esc tagging[9]							15 Jul	15 Aug				
Su. Chin BS collection[10]							1 Jul		15 Sep			
Coho BS collection[11]									1 Sep		30 Nov	

[1] Adult management of the 2019 brood will end in June 2019. However it is anticipated that adult management will occur for the 2020 brood (if needed) beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at Tumwater Dam for other species.

[2] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[3] SHD spawner composition tagging at Tumwater Dam will run concurrent with SHD adult management and other (broodstock) activities at Tumwater Dam.
[4] The spring Chinook RSS will run from 1 May through about 15 July or at such time or at such time the sockeye return develops at Tumwater Dam.
[5] Spring Chinook run composition sampling will run concurrent with the RSS.
[6] Spring Chinook pHOS management will end in July consistent with the arrival of the sockeye return and run concurrent with RSS activities.
[7] Removal of unknown hatchery origin spring Chinook strays at Tumwater Dam will run concurrent with the RSS.
[8] Sockeye run composition sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for run composition sampling will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[9] Sockeye spawner escapement sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for spawner escapement tagging will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[10] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Tumwater Dam for summer Chinook broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[11] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Tumwater Dam for Coho broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Dryden Dam

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the right and left bank Dryden Dam traps is summarized in Table 2):

The Dryden Dam left and right bank trapping facilities will operate up to 7 days per week, 24 hours per day beginning June 24 and continue until as late as November 15. Both traps, if operated, will do so on concurrent days and will be checked and cleared every 24 hours, or sooner if it appears that run contribution to the facilities exceeds reasonable limits for adult holding.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 2. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Dryden Dam trapping facilities in 2019. Blue denotes steelhead, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Left Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul				15 Nov	
Su. SHD spawner esc. Tagging[2]							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection									1 Sep		30 Nov	
Right Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul					
Su. SHD spawner esc. Tagging2							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[4]									1 Sep		30Nov	

[1] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities. In the event steelhead brood cannot be met by Nov 14 and the YN coho program does not need to operate the trap(s), steelhead brood collection may continue independently through Dec 5.
[2] SHD spawner composition tagging at Dryden Dam will run concurrent with other (broodstock or M&E) activities at Dryden Dam.
[3] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Dryden Dam for summer Chinook broodstock will follow an up to 7d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Dryden Dam for Coho broodstock will follow an up to 7d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 5 of each year but typically ceases by the end of November.

Chiwawa Weir

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the Chiwawa Weir is summarized in Table 3):

Weir operations will be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.

Table 3. Summary of broodstock collection activities anticipated to be conducted at the Chiwawa Weir in 2019. Brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sp Chin BS collection						1 June		15 Aug				

Wells Dam Ladder and Hatchery Volunteer Traps

For 2019, WDFW and Douglas PUD propose the following plan (activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps are summarized in Table 4):

1). **East Ladder Trap:**

The East ladder trap will only be operated as needed to meet broodstock collection objectives and other management activities if they cannot be adequately fulfilled through the West ladder and Wells FH volunteer trap operations or if the use of either the West ladder or volunteer traps is precluded for some reason.

If the East ladder trap is used, it may begin as early as May 1 and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week and will run concurrent with any trapping activities occurring at the West ladder trap. The first exception to the above is that for spring Chinook between May 1 and June 20, the trap may operate a maximum of 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the West ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the East ladder trap may be operated, concurrent with the West ladder trap, 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment. Their request for trapping in 2019 did not specify trapping details other than timing (late June through early August), but their preference in past years has been to use the East ladder.

If daily river temperatures meet or exceed 21º C (69.8º F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

2). **West Ladder Trap:**

The West ladder may begin as early as May 1 for spring Chinook broodstock collection and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week. The first exception to the above is that for spring Chinook between

May 1 and June 20, the trap may operate under a maximum 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the East ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the West ladder trap may be operated 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment and may use the west ladder; however, their preference in past years has been to use the East ladder. CRITFC has proposed trapping from late June through early August.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

3). **Wells FH Volunteer Trap:** The Wells FH volunteer trap may begin as early as July 1 for summer Chinook broodstock collection and operate through mid-June of the following year for steelhead broodstock collection and adult management if needed. The trap may operate up to seven days per week/24 hours per day to facilitate broodstock collection and adult management actions.

If water temperatures in the trapping facility meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Wells Dam in 2019. Blue = steelhead, brown = spring Chinook, pink = summer Chinook, orange = sockeye, and green = Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
East/West Ladders												
Su. SHD BS collection[1]									1 Sep		15 Nov	
Su. SHD run comp.									1 Sep		15 Nov	
Su. SHD Spawner Esc. Tagging[2]									1 Sep		15 Nov	
Sp Chinook BS collection					1 May	30 Jun						
Sp Chinook run comp					1 May		15 Jul					
Sockeye SA [4]tagging[4]						2525 June		1717 Aug				
Su. Chin BS [3]collection[3]							1 Jul		15 Sep			

Coho BS collection[5]	15 Sep	15 Nov
Wells Volunteer Trap		
Su. SHD BS collection[1]	1 Sep	15 Nov
SHDBS/pHOS mgt.[6]	15 Feb – 15 June	1 Sep – 15 Dec
Su. Chin BS collection[7]	1 Jul	15 Sep
Su. Chin Surplussing	1 Jul	30 Oct

[1] Summer steelhead broodstock collection will be prioritized at West ladder and volunteer traps. However if broodstock objectives cannot be met at either of those two locations then trapping may occur at the East ladder concurrent with other activities.
[2] SHD spawner composition tagging at Wells Dam will run concurrent with other (broodstock or M&E) activities at Wells Dam.
[3] Summer Chinook broodstock collection for the Methow (Carlton) program will be prioritized at the West ladder trap. However if broodstock objectives cannot be met at the West ladder then trapping may occur at the East ladder. Trapping at the west and/or East ladders for summer Chinook broodstock will follow an up to 3d/week 16hr/day (48 cumulative hours) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] CRITFC trapping of sockeye for stock assessment and tagging typically begins the last week of June and extends through the third week of August, following an up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW spring or summer Chinook and steelhead broodstock collection and stock assessment trapping, preferring to trap on the East ladder.
[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock prior to September 27, will follow up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW steelhead broodstock collection and stock assessment trapping; from September 27 through October 9, an up to 5d/week 9hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities, and 7 days per week/16 hours per day beginning October 10. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2019 brood will end in June 2019. However it is anticipated that adult management will occur for the 2020 brood beginning 1 September 2019 or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.
[7] Summer Chinook broodstock collection for the Wells Hatchery programs will be prioritized at the Wells Hatchery volunteer trap. Trapping at the volunteer channel may occur up to 7 days per week, 24 hours per day and may include broodstock collection and/or adult management.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2019, WDFW and Douglas PUD propose the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Methow Hatchery Volunteer Trap

The Methow Hatchery volunteer trap may be operated for spring Chinook as early as May 1 through August 31 for broodstock collection and gene flow management. The trap may be operated from approximately March 1 through June 1 for steelhead broodstock collection and gene flow management. In all cases, the trap may be operated 24 hours a day, seven days a week. The trap will be checked at least once every 24 hours, but will be checked two or more times a day when fish are abundant. Trap operations will be adjusted if bull trout captures approach ESA take limits. Trapping operations will be halted prior to exceeding ESA take levels for any ESA listed species.

If daily river temperatures meet or exceed 21º C (69.8º F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Twisp Weir

1) **General Weir Operating Parameters:**
    a. Weir fished from ice out in late February/early March through mid-August.
    b. Steelhead trapping occurs from late February/early March through June 1.
    c. Spring Chinook Trapping occurs from June 1 until broodstock and adult management targets are achieved (usually prior to mid-August).
    d. The height of the weir panels is hydraulically controlled and panels are set at the water surface level when the weir is fishing to allow downstream migrating steelhead, spring Chinook, and bull trout to safely and effectively pass the weir.
    e. Weir is tended by DPUD or WDFW personnel whenever the trap is operated. WDFW is contracted by Douglas PUD under the HCP Monitoring and Evaluation Plan to monitor the trap.
    f. Operation of the weir under the ESA is currently authorized by Section 10 Permits 18925 and 1395 (1395 permit extended by NMFS on September 20, 2013).
    g. Real-time monitoring and trap operations: Throughout all trapping activities described in this plan, PIT tag interrogation locations WEL and WEA (Wells Dam), WEH (Wells Hatchery), LMR (Lower Methow River) and TWR (Twisp River) will be monitored by WDFW and DCPUD staff for detections of previously PIT tagged steelhead, spring Chinook, and bull trout. Detections at Wells Dam are nearly 100% efficient. However, detections at LMR and TWR during the higher flows, particularly when spring Chinook and bull trout are migrating, may be less than 20% efficient (comparing fall downstream movements to upstream movements). Data will be examined on a yearly basis to determine if there are peak periods when bull trout are most likely to pass the weir.
    h. When the weir is not fishing, the weir panels will be lowered to the stream bottom, or the traps will be opened to passage, or both. If only the weir panels are lowered the entrances to the traps will be closed.
    i. Limitation in staffing or other unforeseen problems: If staff are not available to staff the trapping facility (according to this plan) for any reason, or the trap will not be checked within 24 hours, then full passage will be allowed by lowering the weir panels or opening the traps or both, dependent on flow conditions until staff are able to return.
    j. Unforeseen scenarios and in-season observations: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and the District will alert the National Marine Fisheries Service, HCP Hatchery Committee, and/or the USFWS, as appropriate, and work cooperatively with these parties to minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the USFWS.
    k. Trapping effort monitoring: Trapping effort in the form of daily trap operation time will be recorded by trap operators. Trapping effort will be used in subsequent years to refine this plan.

l. Nocturnal vs diurnal use: Species composition during trapping hours will be recorded to document times of day when various species are trapped.
m. Trapping will be suspended prior to exceeding the take limits specified by USFWS for bull trout and by NMFS for summer steelhead and spring Chinook.
n. Broodstock collection target numbers are established annually prior to trapping based on predicted age composition, fecundity, and survival of broodstock and rearing in-hatchery.
o. This Plan does not limit other ESA Permit (1395 and 18925, Wells Bull Trout Biological Opinion) conditions that also apply under this plan.

2) Late February/Early March through June 1 Operations:

a. Weir begins fishing in late February or early March as environmental conditions allow.
b. The weir will be fished constantly during this time to trap steelhead, as conditions allow. The weir will be tended by WDFW personnel at least once daily, but twice daily or more when fish are present. An attempt will be made to capture all adult steelhead during this time period:
    i. Steelhead are trapped during this period for Twisp River broodstock collection for the Douglas PUD Twisp Steelhead Conservation Program (N~12-26).
    ii. Steelhead are trapped for population census data collection and for a relative reproductive success study of hatchery and wild steelhead required of Douglas PUD under the Wells HCP.
    iii. Steelhead are trapped to control the relative abundance of hatchery and wild steelhead adults upstream of Twisp Weir. Steelhead removed via adult management may be used as broodstock for other Douglas PUD and WNFH programs.
c. Bull trout have not been observed or trapped at the Twisp Weir prior to June 5^{th}.
d. No more than 118 adult and 50 sub-adult bull trout (also includes 19 juveniles) handled in the entire trapping season. Trapping would be suspended with one lethal take of any size bull trout.
e. High flows that may occur during the steelhead trapping season can significantly limit the efficiency of the weir or prevent fishing the weir. In these cases, the weir panels are lowered or over-topped by the water and the traps are opened for passage. During such flow episodes that prevent trapping, the weir and trap boxes are fully passable to all species.

3) June 1 through August Operations:

a. The weir will be fished selectively during this time period to trap spring Chinook broodstock. Normally the weir will be fished daily from 6:00 AM until 9:00 PM, but overnight trapping may be used if greater trapping effort is needed to collect spring Chinook broodstock. When the weir is not fishing, the weir panels will be lowered and/or the traps will be opened to allow passage.
b. Trapping effort will be based on meeting the spring Chinook broodstock collection target for adult spring Chinook of natural origin. In-season information derived from sampling and counts at Wells Dam and PIT tag detections at in-river

arrays will inform trapping operations in order to target spring Chinook while reducing effort when spring Chinook are not likely to be available.

c. Trapping will not necessarily occur every day or for 24 consecutive hours per day, dependent on efficiency of trapping operation in obtaining broodstock. Fine-scale scheduling of trap operations will be determined on a day-to-day basis.
d. No more than 118 adult and 50 sub-adult bull trout (also includes 19 juveniles) handled in the entire trapping season. Trapping would be suspended with one lethal take of any size bull trout.
e. Trapping will be suspended when the broodstock target is met. When the weir is not fishing the traps will be opened to allow passage and the weir panels will be lowered. The traps will be removed from the river in mid- to late August.
f. High flows significantly limit the efficiency of the weir or prevent fishing the weir entirely. In these cases, the weir panels are lowered and the traps are opened for passage. During high flow episodes that prevent trapping the weir is fully passable to all species.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Methow Hatchery and the Twisp Weir in 2019. Blue denotes steelhead and brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Methow Hatchery[1]												
SHD pHOS mgt.			1 Mar			15 Jun			1 Sep		15 Nov	
Sp. Chinook BS collection					1 May			30 Aug				
Sp. Chinook pHOS mgt.[2]					1 May			30 Aug				
Twisp Weir[3]												
Steelhead RSS			1 Mar		30 May							
Su. SHD BS collection			1 Mar		30 May							
SHD pHOS mgt.			1 Mar		30 May							
Sp. Chinook BS collection						1 June		15 Aug				
Sp. Chinook pHOS mgt.						1 June		22 Aug				

[1] Specific details on how operation of the Methow Hatchery volunteer trap will work for SHD adult management are still being worked out at this time.
[2] Adult management for spring Chinook at the Methow Hatchery volunteer trap will run concurrent with broodstock collection.
[3] Specific details on how operation of the Twisp Weir will work for 2019 to include the steelhead RSS, broodstock collection, and adult management and spring Chinook broodstock collection and adult management is still being worked out at this time.

Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT)

Table 5. Summary of broodstock collection, VSP monitoring, and/or run composition sampling activities anticipated to be conducted at the Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT) in 2019. Blue denotes steelhead, purple fall Chinook, and orange sockeye. All users of the OLAFT must have a signed Facility Use Agreement with GPUD.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chinook Run Comp.[2]									1 Sep		15 Nov	
Sockeye BS Collection[3]						22 Jun	10 Jul					

[1] Steelhead VSP monitoring, if it occurs in 2019, will target up to 15% of the annual return over Priest Rapids Dam. Presently that requires operation of the OLAFT up to 3 days/ week, 8 hours per day. The trap is opened to passage each night.
[2] Fall Chinook run composition runs concurrent with SHD VSP monitoring.
[3] Sockeye broodstock collection to support YN reintroduction efforts in the Yakima is based upon abundance based sliding scale. Depending on the strength of the return and allowable allocation, the trap may be operated up to 5 days per week, 8 hours per day beginning about 22 June and running through about 10 July. The trap is opened to passage each night.

Appendix E

Columbia River TAC Forecast

Table 1. 2018 Columbia River at mouth salmon returns – actual and forecast.

		2018 Forecast	2018 Actual	2019 Forecast
Spring Chinook		**248,520**	**176,642**	**157,500**
Willamette River		53,820	37,441	40,200
Sandy River		5,400	4,733	5,500
Select Areas**		12,300	9,887	8,200
Cowlitz River		5,150	4,000†	1,300
Kalama River		1,450	2,300†	1,400
Lewis River		3,700	3,200†	1,600
Lower River Total		**81,820**	**61,561**	**58,200**
Wind River**		5,300	3,109	n/a
Drano Lake/Little White Salmon River**		10,200	7,352	n/a
Hood River**		2,500	2,026	2,300
*Hood River wild***		*120*	--	--
Klickitat River**		1,990	667	n/a
Yakima River**		7,000	3,155	3,000
Umatilla River**		6,300	3,257	n/a
***Mid-Columbia total** (by subtraction)*		***39,200***	***34,641***	***40,000***
Upper Columbia (total)		20,100	12,844	11,200
Upper Columbia wild		*3,400*	*1,977*	*2,100*
Snake River Spring/Summer (total)***		107,400	67,596	48,100
*Snake River wild****		*18,500*	*11,339*	*8,200*
Upriver Total		**166,700**	**115,081**	**99,300**
Summer Chinook	**Upper Columbia**	**67,300**	**42,120**	**35,900**
Sockeye	**Total Sockeye**	**99,000**	**210,915**	**94,400**
Wenatchee		25,700	--	18,300
Okanogan		72,600	--	74,500
Yakima		50	--	1,300
Deschutes		50	--	100
Snake River		600	297	200

*Components may not sum to totals shown since individual forecasts are not available for all upriver spring Chinook tributaries. Wild components are included in the stock total.
**Return to tributary mouth.
***2018 return is based on standard TAC run reconstruction methodology.
†2018 returns to the Cowlitz, Kalama, and Lewis rivers are to the tributary mouth and are not directly comparable to the forecasts. These values will be updated when estimates for return to the Columbia River mouth are available.

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The Final 2018 Chelan Hatchery Monitoring and Evaluation Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Douglas PUD
The Final 2018 DCPUD ME Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Grant PUD

2018 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin and Methow Summer Chinook Salmon
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/2016%20GPUD%20Hatchery%20ME%20Implementation%20Plan%20for%20the%20Wenatchee%20Basin_FINAL.pdf?Web=1

2018 Priest Rapids Hatchery Implementation Plan
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/PRH%20ME%202016-17%20Implementation%20plan%20final.pdf?Web=1

Appendix G

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Hatchery Production Management Plan

The following management plan is intended to provide life-stage-appropriate management options for Upper Columbia River (UCR) PUD salmon and steelhead mitigation programs. Consistent, significant over-production or under-production risks the PUD's not meeting the production objectives required by FERC and overages in excess of 110% of program release goals violates the terms and conditions set forth for the implementation of programs under ESA and poses potentially significant ecological risks to natural origin salmon communities.

Under RCW 77.95.210 (Appendix A) as established by House Bill 1286, the Washington Department of Fish and Wildlife has limited latitude in disposing of salmon and steelhead eggs/fry/fish. While this RCW speaks more specifically to the sale of fish and/or eggs, WDFW takes a broader application of this statute to include any surplus fish and/or eggs irrespective of being sold or transferred.

We propose implementing specific measures during the different life-history stages to both improve the accuracy of production levels and make adjustments if over-production occurs. These measures include (1) Improved Fecundity Estimates, (2) Adult Collection Adjustments, (3) Within-Hatchery Program Adjustments, and (4) Culling at the earliest life-stage.

<u>Improved Fecundity Estimates</u>

A) Develop broodstock collection protocols based upon the most recent 5-year mean in-hatchery performance values for female to spawn, fecundity, green egg to eye, and green egg to release.

B) Use portable ultrasound units to confirm gender of broodstock collected (broodstock collection protocols assume a 1:1 male-to-female ratio). Ultrasonography, when used by properly trained staff will ensure the 1:1 assumption is met (or that the female equivalents needed to meet production objective are collected). Spawning matrices can be developed such that if broodstock for any given program are male limited, sufficient gametes are available to spawn with the females.

<u>Adult Collection Adjustments</u>

C) Make in-season adjustments to adult collections based upon a fecundity-at-length regression model for each population/program and origin composition need (hatchery/wild). This method is intended to make in-season allowances for the age structure of the return (i.e. age-5 fish are larger and therefore more fecund than age-4 fish), but will also make allowances for age-4 fish that experienced more growth through better ocean conditions compared to an age-5 fish that reared in poorer ocean conditions.

<u>Within-Hatchery Program Adjustments</u>

D) At the eyed egg inventory (first trued inventory), after adjustments have been made for culling to meet BKD management objectives, the over production will be managed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon funding recovery board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Governmental hatcheries in Washington, Oregon, and Idaho; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

E) At tagging (second inventory correction) fish will be tagged up to 110% of production level at that life stage. If the balance of the population combined with the tagged population amounts to more than 110% of the total release number allowed by Section 10 permits then the excess will be distributed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon recovery funding board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Transfer to another resource manager program such as CCT, YN, or USFWS program;
- Governmental hatcheries in Washington, Oregon, and Idaho;
- Placement of fish into a resident fishery (lake) zone, provided disease risks are within acceptable guidelines; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

F) In the event that a production overage occurs after the above actions have been implemented or considered, and deemed non-viable for fish health reasons in accordance with agency aquaculture disease control regulations (i.e. either a pathogen is detected in a population that may pose jeopardy to the remaining population or other programs if retained or could introduce a pathogen to a watershed where it had not previously been detected) then culling of those fish may be considered.

All, provisions, distributions, or transfers shall be consistent with the department's egg transfer and aquaculture disease control regulations as now existing or hereafter amended. Prior to department determination that eggs of a salmon stock are surplus and available for sale, the department shall assess the productivity of each watershed that is suitable for receiving eggs.

Species/Program Specific Juvenile Surplussing Protocols:

Surplus UCR Juvenile Steelhead Management

Above Wells Programs:

In the event excess HxH juveniles are produced from over-collection efforts to support the Methow Safety-Net and /or Okanogan programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Progeny transferred to the Columbia Safety-Net program provided fish health and/or marking requirements for the program can be met.

2. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met and provided basin wide pHOS/PNI allow for a decrease in program pNOB.

3. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

4. Out-planted to landlocked lakes within Okanogan County and/or Colville Reservation provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

5. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from any of the conservation programs occurs, the priority will be to incorporate those progeny either into an available conservation program (if a shortfall exists) or into the closest safety net program (in this case it would be the Methow safety net [MSN]). Excess safety net fish from the MSN will then be managed in accordance with the guidelines above.

Wenatchee Summer Steelhead:

In the event excess HxH juveniles are produced resulting from higher than expected in-hatchery survival, fecundities, etc.), the parties agree that distribution of juveniles will follow the following priority matrix:

1. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

2. Out-planted to landlocked lakes within Chelan, Douglas, or Grant counties provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

3. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from the conservation program occurs, the priority will be to incorporate those progeny into the closest safety net program Excess safety net fish will then be managed in accordance with the guidelines above.

Surplus Upper Columbia Juvenile Spring Chinook Management

Methow Sub-basin

In the event excess juveniles are produced from Methow Sub-basin spring Chinook programs, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess WxW progeny from the Methow conservation program(s) may be used to support shortfalls in the WNFH safety net program provided fish health and/or marking requirements for the program can be met.

2. Excess progeny from HO broodstock which *may* be collected to support the aggregate DPUD/GPUD/CPUD production obligation may be used to support any potential shortfall in the WNFH safety net program provided fish health and/or marking requirements for the program can be met.

3. In the event no other option exists within the Methow Sub-basin, excess hatchery progeny originating from the aggregate PUD production obligation, may be used to support the CCT 10(j) spring Chinook program in the Okanogan Sub-basin provided fish health and/or marking requirements can be met.

4. In the event no other option exists for excess hatchery progeny within the Methow Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

5. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Wenatchee Sub-basin

In the event excess juveniles are produced from Wenatchee Sub-basin spring Chinook programs (excluding Leavenworth), the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess progeny from the Chiwawa conservation program may be used to support shortfalls in the Nason conservation program provided fish health and/or marking requirements for the program can be met.

2. Excess progeny from the Nason conservation program may be used to support the Chiwawa conservation program provided they are progeny from females with assignment probabilities >95%. Additionally, it will require that fish health and/or marking requirements for the program can be met.

3. In the event excess NO production from the Nason program is not needed to or cannot support the Chiwawa (for reasons of fish health, marking, or ability to identify assignment probability), they will be incorporated into the Nason safety net program and prioritized over HxH progeny.

4. Excess progeny from the HO contingency broodstock collected for the Chiwawa program may be used to support any potential shortfall in the Nason safety net program provided fish health and/or marking requirements for the program can be met.

5. In the event no other option exists for excess hatchery progeny within the Wenatchee Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

6. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Appendix H

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Alternative Plan for 2019 BY and beyond, for Methow Sub-basin Conservation Steelhead Programs

Introduction

The objective of this draft plan is to provide a thumbnail approach for mitigating genetic concerns specifically in the Twisp Conservation program, and describe our alternative for future implementation (2018 and beyond) for Methow Subbasin conservation steelhead programs (Twisp and Winthrop NFH). Direction herein is general with seasonal/run-specific technical details to be worked out annually between operators and formalized through broodstock collection protocols and steelhead-specific management plans. Our intent for this memo is to serve as a vehicle for the Hatchery Committee to approve this direction by vote. While this plan is being presented as a preferred course of action by the parties, approval (and further refinement of a long term plan) is contingent upon successful broodstock collection of the 2018 brood. No modifications to program size or release numbers are proposed – only modification of brood stocking methodology, rearing/release strategies and parentage.

Genetic analysis of returning adult steelhead at the Twisp River weir as part of the Relative Reproductive Success Study, indicated that relatedness among the returning hatchery origin adults was high (T. Seamons, WDFW Genetics Lab, pers. comm.). This is not surprising given the small program size (Table 1), and may result in a reduction in genetic diversity and N_e, consistent with effects described in Ryman and Laikre (1991), hereafter “Ryman-Laikre” or “RL” effects.

In response to concerns about minimizing the potential long term risks/effects associated with RL, the HCP-HC and co-managers are looking to adopt a strategy to address potential (or increased) RL effects in the Twisp population as well as having a more integrated approach to steelhead conservation programs in the Methow sub-basin. Mitigating actions were selected with goals to increase genetic diversity, reduce risk of inbreeding on the spawning grounds, and increase N_e. Actions includes release of age-2 (S2) WNFH conservation program juveniles into the Twisp River and compositing a portion of the Twisp and WNFH conservation program broodstock (while retaining a small Twisp WxW (S1) release. Specifically, returning spawners will originate from a greater number of less-related parents compared to the resulting return if these actions are not undertaken.

From the alternatives discussed by a small work group, a hybrid approach (hereafter referred to as alterative 3) between a couple alternatives was developed (and is preferred) that aims to retain Twisp genetics within the Twisp basin but includes incorporation of non-Twisp conservation program genetics.

Alternative 3 was developed based on the desire to protect any remaining or developing Twisp genetic stock structure while balancing and mitigating for genetic concerns by managing N_e and potential spawner relatedness concerns. The major point by which Alt. 3 differs from other alternatives discussed is that a small Twisp x Twisp broodstock would continue to be operated instead of full compositing. No overall changes to current production and release levels would occur. Approximately six Twisp x Twisp (NOR) crosses would produce approximately 24K smolts for release back to the Twisp River. Annual Twisp releases would also include a 24K co-release of S2 smolts from the WNFH conservation program, allowing for unrelated returning adults to provide an increased level of genetic diversity into the Twisp to combat low N_e and reduce risk of inbreeding. This strategy would also provide an evaluation opportunity where potential Twisp stock performance could be evaluated against WNFH conservation program smolts, providing management guidance for continued future direction.

Implementation details for Alternative 3 follow:

Broodstock Collection

- Combined broodstock collection (joint DPUD, WDFW, USFWS, and YN effort)
  - Collection occurs throughout the Methow River, including below-Twisp River angling, Twisp Weir, and WNFH/MFH hatchery infrastructure
  - Broodstock Targets
    - Approximately 6-8* pairs NORs collected at Twisp Weir (half of Twisp program)
    - Approximately 61-65* NOR pairs (WNFH program plus half of Twisp program) collected throughout the Methow River via angling
    - As a contingency for under-collection of broodstock sufficient to fulfil the two components of Twisp-release production, broodstock collection at Twisp Weir could be increased to the traditional collection target of 13 pairs, as needed.
    - *Flexibility required in targets for variation in escapement, fecundity, inclusion of hatchery-origin brood (as per BiOp), etc.
  - All broodstock transferred to WNFH for holding and spawning
    - DPUD may collect up to 37 pairs of conservation program returns (Ad+CWT and CWT-only) at Wells Dam and/or via angling consistent with conservation program efforts and direct-transfer to Wells Hatchery for use in safety-net program
  - Data management for broodstock collection and spawning at WNFH will be primary responsibility of USFWS MCFWCO (all data would be shared with WDFW and DPUD to allow completion of HCP-HC related reports):
    - All broodstock uniquely PIT-tagged upon capture/transfer for assignment on spawn days
    - PIT data tied to collection date/location, mark, DNA samples
    - USFWS will provide standardized effort collection information to all angling participants
  - Adult management will continue to be a large part of broodstock collection efforts
    - Guided by terms and conditions for minimum escapement, pNOB, and mitigation requirements in BiOp
    - Supported generally (i.e. without run-specific details) in annual broodstock collection protocols (e.g. Tonseth 2017)

- Supported specifically (i.e. includes run-specific details) by annual FMEP and targets/goals established by small Methow Steelhead Working Group

Spawning

- All conservation program spawning will occur at WNFH
  - Spawning will be 2x2 factorial crosses
  - Half of Twisp program will be Twisp weir collected NOR x Twisp weir collected NOR as feasible. Individuals PIT-tagged as juveniles in the Twisp will be treated the same.
  - WNFH program and remaining half of Twisp program will be Methow Subbasin NOR x NOR as feasible
  - All NOR females will be live-spawned & transferred to YN Kelt Program
  - USFWS MCFWCO will collect and provide all spawning biological and cross data to WDFW M&E staff.

Gamete Management & Smolt Release

- Maintain 48K total smolt release in Twisp River
  - 24K will be known-Twisp NOR x NOR spawned at WNFH but sent to Wells for S1 rearing
  - 24K will be representative cross-section of WNFH component, reared as S2 smolts at WNFH
  - All releases will be direct smolt plants at Buttermilk Bridge (RKm 21)
- Maintain 100K-200K total conservation program smolt release to Methow Sub-basin outside Twisp
  - 24K cross-section of WNFH population will be transferred to Wells Hatchery for S1 rearing for WNFH on-station or alternative release sites in Methow Subbasin.
  - 24K cross-section of WNFH population will be reared as S2 on-station as paired release for 24K S1 group (above) for potential alternative release strategies, as per above. Any alternative release strategies will guided by JFP and consider need for gradual implementation and patience in awaiting environmental response to management changes.
  - Remaining 52-152K of WNFH population will be reared as S2 smolts for on-station release.

Table 1. Methow Subbasin steelhead hatchery programs under Alternative 3.

<table>
<tr><th>Program</th><th>Rearing Hatchery</th><th>Funding entity</th><th>Release site</th><th>Release goal</th><th>Broodstock</th><th>Genetic crosses</th><th>Age at release</th></tr>
<tr><td rowspan="3">Methow Subbasin Conservation</td><td rowspan="2">WNFH</td><td rowspan="2">Reclamation</td><td>Methow R. @ WNFH</td><td>52-152K[1]</td><td rowspan="3">60-65</td><td rowspan="3">WxW</td><td>2</td></tr>
<tr><td rowspan="2">Methow Subbasin[2]</td><td>24,000</td><td>2</td></tr>
<tr><td>Wells</td><td>DPUD</td><td>24,000</td><td>1</td></tr>
<tr><td></td><td>Wells</td><td>DPUD</td><td></td><td>24,000</td><td>6-8</td><td>WxW</td><td>1</td></tr>
</table>

Twisp Conservation	WNFH	Reclamation	Twisp R. @ Buttermilk Br	24,000	6-8	WxW	2
Methow Safety-net	Wells	DPUD	Methow R.[3]	100,000	68[2]	HxH	1
Total				348,000			

[1]WNFH program subject to pNOB/production sliding scale in BiOp.
[2]Initially Methow R. at WNFH but may include alternative offsite release strategies subject to JFP and HCP- HC guidance and BiOp terms and conditions. Would be paired S1 and S2 release.
[3]Methow Safety-net program released in Methow River at Lower Burma Bridge.

Discussion

Alternative 3 was proposed by the working group as it appears to provide the best compromise while also including measures to address the Spatial Structure and Diversity VSPs, by attempting to maintain (or allow) development of local stock structure in the Twisp Watershed. In addition, Alternative 3 provides a higher probability of finding an effective conservation hatchery strategy for the Twisp River, and elsewhere in the Methow Subbasin because it uses three conservation hatchery strategies: 1) local WxW Twisp Program, 2) Methow Composite S1 program, and 3) Methow Composite S2 program.

Table 2. Illustration of out-year effects of 2017 actions and proposed Alternative 3 on Twisp River spawning ground age/program composition.

Spawn/ Escapement Yr.	Age/Program composition of spawners (HOR only) on spawning grounds - Twisp Watershed only		
	Status Quo - S1 smolt supplementation only (all fish are Twisp Program only)	Additional spawners resulting from 2017-only, single-year Alt. mgmt. (juvenile release & brood compositing)	Spawner composition resulting from 2017 actions plus implementation of Alt. 3
2014	BY'10 1.2, BY'11 1.1	N/A	N/A
2015	BY'11 1.2, BY'12 1.1	N/A	N/A
2016	BY'12 1.2, BY'13 1.1	N/A	N/A
2017	BY'13 1.2, BY'14 1.1	N/A	N/A
2018	BY'14 1.2, BY'15 1.1	N/A	N/A
2019	BY'15 1.2, BY'16 1.1	BY'15 2.1 (WNFH)	BY'15 2.1 (WNFH)
2020	BY'16 1.2	BY'15 2.2 (WNFH), BY'17 1.1 (Met[1])	BY'15 2.2 & BY'16 2.1 (WNFH), BY'17 1.1 (Met+Twisp[1])
2021	*BY'18 1.1*[2]	BY'17 1.2 (Met[1])	BY'16 2.2 (WNFH) BY'17 2.1, BY'18 1.1 (Met+Twisp[1])
2022	*BY'18 1.2, BY'19 1.1*[2]	N/A	BY'17 2.2, BY'18 1.2 & 2.1, BY'19 1.1 (Met+Twisp[1])
2023	*BY'19 1.2, BY'20 1.1*[2]	N/A	BY'18 2.2, BY'19 1.2 & 2.1, BY'20 1.1 (Met+Twisp[1])
2024	*BY'20 1.2, BY'21 1.1*[2]	N/A	BY'19 2.2, BY'20 1.2 & 2.1, BY'21 1.1 (Met+Twisp[1])

[1]Combined Methow Subbasin Conservation Programs (yearlings raised at Wells Hatchery, 2-year smolts raised at WNFH).
[2]No BY'17 Twisp Program was developed; brood were composited. This column displays return composition if status quo were to return in 2018.

Appendix I

2019 Brood Program Specific Rearing and Release Plans

Unless specifically detailed below, rearing and release protocols will follow the number, date, and location identified in Appendix B. In addition, all releases will prioritize nighttime or necessary, late afternoon release timing to reduce potential predation related impacts. Release timing will also take advantage of increasing flows and turbidity to further provide improved post release survival advantages.

Methow Summer Chinook (Carlton Acclimation Facility):

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - The summer Chinook salmon acclimated at the Carlton Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Methow River flows are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempt's will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in the Methow River are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Methow River flows are not satisfactory due to insufficient snow pack.

Nason Creek spring Chinook (Nason Acclimation Facility):

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - Spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Nason Creek flows/conditions are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in Nason Creek are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Nason Creek flows are not satisfactory due to insufficient snow pack.

Wenatchee Summer Steelhead

Final Memorandum

Date: March 12, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

<u>Background</u>

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

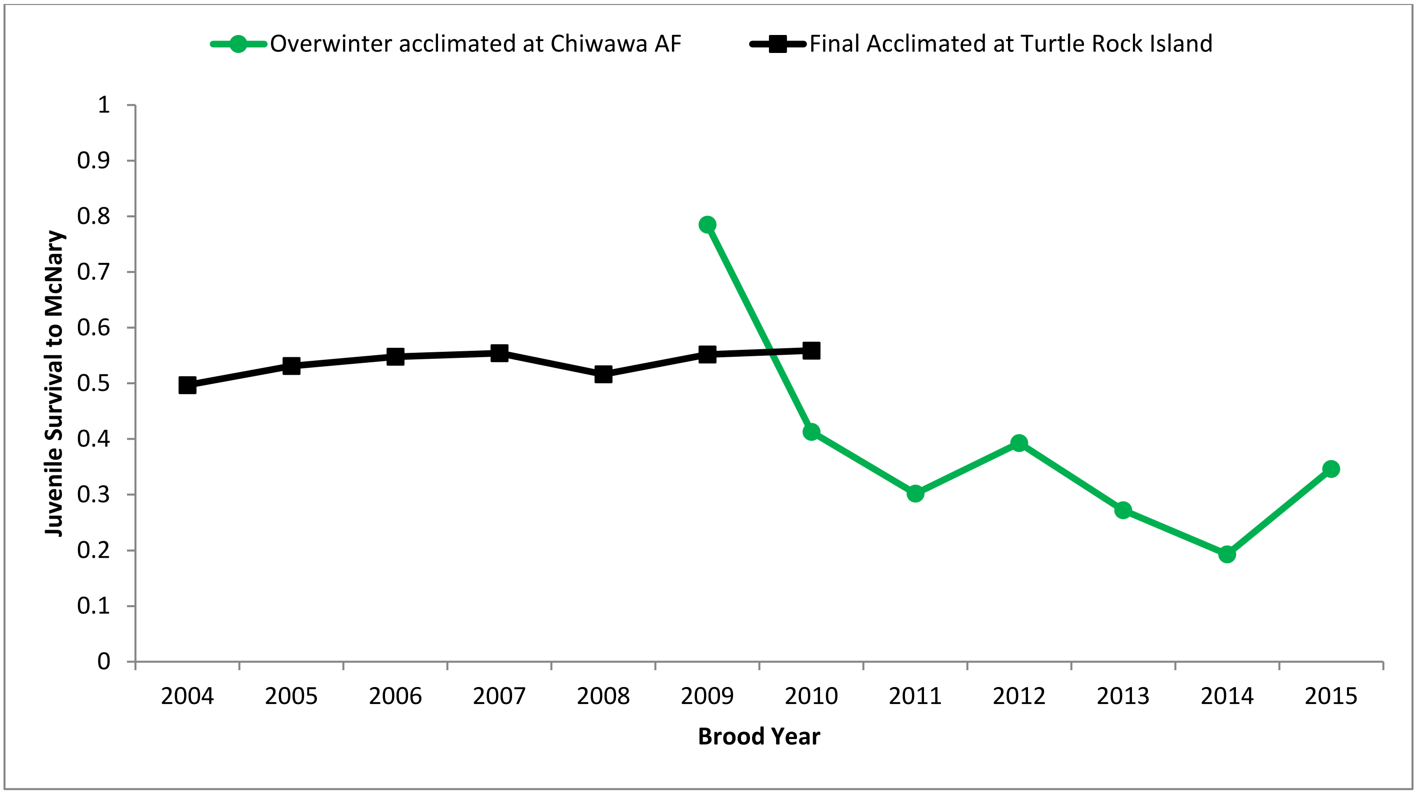

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

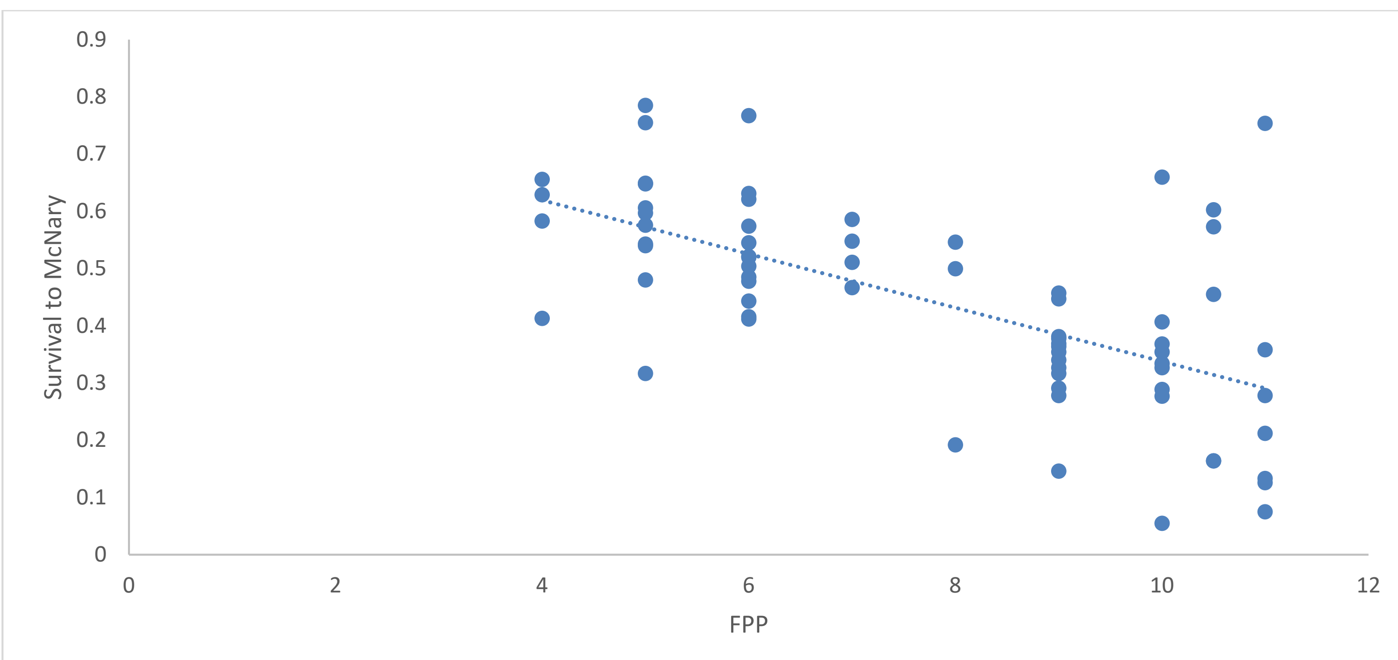

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

2018-2020 Release Strategy Objectives

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.
- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

Methods

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish ((statistical power $1-\beta$ = 0.80; α = 0.10, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	Brood Origin	Treatment	Estimated # PIT-tagged	Treatment PIT release size
RCY2	HxH	Size	5,500 small	11,000 Small Mixed
RCY2	WxW	Size	5,500 small	
RCY2	HxH	Size	5,500 medium	11,000 Medium Mixed
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8th. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location on the same day to the Chiwawa River (Table 2).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	Origin[1]	Estimated Number Released[2]	Estimated # PIT-tagged	Destination	rkm
RCY2	Mixed	58,067	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.
[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.
  Which release location should be utilized? All PIT-tags released in Chiwawa River well upstream from the detection array (RK 11.4).
- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
  - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

Input on post-release sampling to conduct GSI sampling and assessment of smolt index? See "Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program" March 12, 2018, Rock Island and Rocky Reach HCPs HCs notes.

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Appendix J

2018-2020 Brood year Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs.

Background: Hatchery broodstock disease profiles observed in some programs operating out of the Eastbank FH complex in 2017 (as well as other hatchery programs throughout the Columbia River Basin) resulted in higher than expected prespawn mortality and/or BKD ELISA results which required (under the terms and conditions of the Section 10 permits) culling eggs/fish at a higher rate than anticipated which put several programs considerably below the respective production targets. The inability to determine whether the deviation in performance in 2017 was the result of eliminating prophylactic antibiotic injection practices, as was historically conducted, or was related to environmental conditions (or a combination of both) has prompted WDFW to develop and implement a fish health treatment plan (adult broodstock only) beginning with the 2018 brood and running for at least three (3) consecutive brood years.

The overall goals are to primarily ensure integrated and/or recovery programs make the most efficient use of natural origin broodstock to avoid mining as well as maximize natural origin spawners while minimizing handling/unnecessary activities on broodstock. In addition where practical, we (WDFW) would like to see the use of antibiotics and other therapeutics reduced or eliminated over time. Having a controlled approach to evaluating the use of prophylactic treatments in these programs will allow the operators/managers to determine which programs may benefit from prophylactic treatments and which programs may be able to shift away from this practice, all of which is designed to reduce overall handling and associated effects as much as possible.

Methods: To minimize handling events, injections will be scheduled to occur either at collection or during sorting (such as during genetic sorting that occurs for the Nason spring Chinook program). Only females will be injected, in the intraperitoneal cavity (IP) with Draxin for BKD and if necessary, long acting Oxytetracycline for gram negative bacteria (i.e., *Columnaris*). Generally, injections will be prioritized for natural origin females as the control and hatchery origin females as the treatment for the spring Chinook programs. A slightly different approach will be used for each of the summer Chinook programs. All females receiving the injections will be considered the control given that this was the standard hatchery practice by which current disease result data sets and decisions are built on. All females will be PIT tagged at time of collection or injection to facilitate tracking of individual females (and possibly their progeny).

The results will be evaluated annually to determine if modifications to the current plan are necessary.

Program Specific Plans For 2019 Brood year:

Methow (Carlton/MEOK) Summer Chinook:

1) Collected at Wells Dam
2) 62 NO females are targeted for collection in 2019 with every other female will be injected at collection.
    a. Since the Twisp M&E staff are conducting run comp and broodstock collection activities at the Wells Dam East/West ladders, it makes sense for them to inject while the fish are sedated.

Chelan Falls Summer Chinook:

1) Collected at Well Hatchery Volunteer Trap
2) If injections cannot be accommodated at time of collection at Well Hatchery, adults collected over the course of a week will be placed at the head of the adult pond. At the end of the week, females will be PIT tagged and every other female will be injected then placed over the net and not handled again until spawning.
3) 195 HO females are targeted for collection and up to 97 will be injected.
4) Disease management may vary somewhat depending upon the determination of the pathogen in play (i.e., *Columnaris* may play a larger role than BKD which require different approaches).

Wenatchee Summer Chinook:

1) Collected at Dryden dams or Tumwater Dam.
2) No injections planned at this time. The Wenatchee summer Chinook program was the only EB program in 2017 which did not see a negative deviation in disease/prespawn mortality outcomes from the predicted so the 2019 plan is to stay consistent with the 2018 approach of no injections. If during the three year period, it appears the Wenatchee summer Chinook may benefit by evaluation of injection versus non-injection then we will make plans to accommodate that evaluation.
3) 137 NO females are targeted for collection and will not be injected.

Chiwawa Spring Chinook:

1) Collected at Tumwater Dam
    a. All previously PIT tagged Chiwawa NOR's collected will be combined with Nason Spring Chinook weekly collections at Eastbank.
    b. All Chiwawa NO females collected at Tumwater Dam will be injected during genetic sorting of the Nason Fish.
    c. HO females collected at Tumwater will not be injected.
2) Collected at Chiwawa Weir

   a. All female NO females collected at the weir will be injected at the time of collection.

3) 32 NO females are targeted for collection between the two locations and will be injected.
4) 4 HO females targeted for retention as part of the production shortfall backup, collected at Tumwater Dam will not be injected.

Nason Spring Chinook:

1) Collected at Tumwater Dam.
2) 26 NO females are targeted for retention and will be injected during genetic sorting.

37 HO females are targeted for retention. HO females will not be injected.

Appendix K

MID-COLUMBIA COHO BROODSTOCK

COLLECTION PROTOCOLS 2019

Yakama Nation

Fisheries Resource Management

Mid-Columbia Field Office

7051 Hwy. 97

Peshastin, Washington 98847

The Yakama Nation Fisheries Resource Management's (YN FRM) 2019 broodstock collection protocols for coho (*Oncorhynchus kisutch*) were developed to meet upper Columbia (Methow and Wenatchee basins) annual smolt release goals for 2021, as per the Mid-Columbia Coho Reintroduction Program's (MCCRP) Master Plan (YN 2017). Additionally, this document identifies the applicable operational planning to achieve adult collection goals and associated broodstock spawning conventions herein.

BROODSTOCK COLLECTION GOALS

Brood Year (BY) 2019 coho smolt production goals are 1,000,000 fish for release in the Wenatchee River basin and 1,000,000 fish for the Methow River basin.

Adult coho returning to the Wenatchee River basin will be collected at Tumwater Dam, Dryden Dam, Leavenworth National Fish Hatchery (LNFH), and/or Priest Rapids Dam (PRD); in order of collection priority. The program strives to achieve at least 50% of adult collections from Tumwater Dam with the remainder coming from Dryden Dam, LNFH and/or PRD. Coho collections from Tumwater Dam are important to encourage stock adaptation so that returning adults can reach key, upstream habitats within the upper basin. Based upon a phased approach, the Wenatchee program currently in Broodstock Development Phase II (BDPII; YN 2017). However, collecting sufficient female broodstock from Tumwater Dam has presented a challenge and identified the need for a contingency plan. The ratio of female to male coho navigating Tumwater Canyon to Tumwater Dam has been tilted heavily toward males. Due to this occurrence, the BDPII completion goal for the Wenatchee Basin has transitioned to collecting 50% of our female broodstock from Tumwater Dam for a three year period

In the Methow River basin, returning adults will be collected from Douglas County Public Utility District's (DCPUD) Wells Dam facilities (i.e., east and west ladders and Wells Fish Hatchery (FH) volitional channel), Winthrop National Fish Hatchery (Winthrop NFH), and Methow Fish Hatchery (Methow FH); in order of priority. Although project releases from Wells FH were concluded in 2013, some returning adults may be collected as volitional swim-ins to the facility's holding pond concurrent with summer Chinook and steelhead trapping efforts. The program will rely on Wells Dam facilities as primary collection locations to ensure a representative sample of returning adults from all in-basin release locations, as well as provide sufficient numbers of broodstock required for continued development of the Natural Production Implementation Phase (NPIP; YN, 2017) in 2021. In-basin collections will continue to include Winthrop NFH and Methow FH adult weir on a supplementary basis, as swim-ins to these facilities remain a key component in broodstock development. While coho have not been released from Methow FH, an adult weir will be used to collect returning adults since both hatcheries' surface water withdrawals come from a common, upstream diversion on the mainstem Methow River (Foghorn Irrigation Diversion). Broodstock collection goals for both Wenatchee and Methow programs are calculated from measured, mean survival rates that include pre-spawn adult mortality, average female fecundity, green egg survival, and hatch rates observed during past brood years.

In the Wenatchee River basin, collection of up to 1,264 adult coho will be necessary to release 1,000,000 smolts. **Table 1** illustrates the program's anticipated release, survival, and collection goals for brood year 2019**.** Throughout the program's history, adult coho sex ratios collected at Tumwater Dam have been tilted heavily towards males. If necessary, the likely disproportionate number of adult males may be reconciled by collecting additional adult females at alternative in-basin collection sites (i.e. - Dryden Dam or LNFH ladder).

Table 1. 2019 YN Wenatchee River Basin Program Release Target, Mean Survival, and Broodstock Collection Goal

Program target smolts released	Survival green egg to eyed [1]	Survival eyed egg to release[2]	Green eggs required	Average eggs per female[3]	Adult pre-spawn mortality[4]	Viable females required	Total female collection goal	Total adult collection goal [5]
1,000,000	87.4%	83.5%	1,370,258	2,778	6.5%	494	527	1,264

1. Due to unusual elevated mortality observed at the eyed egg stage in BY2014 & 2015, survival is based on an 9 yr. mean eyed egg rate for 2007- 2018 brood years, excluding 2014 & 2015.

2. Observed 7 yr. mean eyed to release survival rate includes 2008 to 2012 brood years, 2014 & 2015. 2013 was excluded as a large number of eggs were transferred to the Methow Basin. 2016 was excluded due to significant overwinter rearing predation at Leavenworth NFH. 2017 & 2018 percentages are yet to be determined.

3. Observed 12 yr. mean fecundity for 2007-2018 brood years.

4. Observed 12 yr. mean pre-spawn mortality observed in 2007-2018 adult brood years.

5. Based on observed, mean male-to-female ratio (57.3%M: 41.7%F) for 2008-2018 brood years.

In the Methow River basin, a maximum of 1,054 adult coho will be necessary to release 1,000,000 smolts. Anticipated release, survival, and collection goals for brood year 2019 are presented in **Table 2**. Throughout Broodstock Development Phase II (BDP II; YN 2017), Methow River basin collection goals were calculated as number of adult coho needed if broodstock were collected from Wells Dam and as swim-ins to Winthrop NFH and Methow FH to accomplish broodstock development goals as outlined in the Mid-Columbia Coho Master Plan (YN, 2017). After completion of BDP II in 2013, a programmatic transition was made to prioritize Wells Dam facilities to ensure collected adults were representative of all in-basin release locations. Since Wells Dam facilities will provide the primary brood source throughout the NPIP phases of the program, collection goals for 2019 are based on data collected at these facilities.

Table 2. 2019 YN Methow River Basin Program Release Target, Mean Survival, and Broodstock Collection Goal

Program target smolts released	Survival green egg to eyed [1]	Survival eyed egg to release[2]	Green eggs required	Average eggs per female [3]	Adult pre-spawn mortality[4]	Viable females required	Total female collection goal	Total adult collection goal [5]
1,000,000	84.6%	85.9%	1,376,057	2,728	4.4%	504	527	1,054

1. Observed 12 yr. mean eyed-egg rate for 2007- 2018 brood years.

2. Observed 10 yr. mean eyed to release survival rate for 2007-2016 brood years.

3. Observed 12 yr. mean fecundity for 2007-2018 brood years.

4. Observed 12 yr. mean pre-spawn mortality observed in BY 2007-2018 adults.

5. Observed 12 yr. mean male-to-female ratio for Wells Dam facilities (46.5%M: 53.5%F) for 2007-2018 broods. Total collection goal is based on a 1 M: 1 F ratio.

BROODSTOCK COLLECTION PROTOCOLS

Wenatchee River Basin

Past protocols focused on broodstock development in the sense of maximizing genetic diversity; attempting to collect a representative sample of returning adult coho from throughout the run. Based on information collected from 2000 to 2018, the first returning adult coho traditionally arrive at Dryden Dam during the second week of September. The run typically continues through the last week of November, with peak migration ordinarily occurring mid to late October. Migration timing over Tumwater Dam is characteristically one week later than observed at Dryden Dam. Beginning with brood year 2017, an effort to retain and distinctly floy tag first arriving fish at Dryden Dam has been instituted. Based on the strengthened ability of female coho to reach the Tumwater Dam in September versus October, a shift in prioritizing adults appearing early in the run has been set in place. Attaching the capture date specific tags allows a focus on mating as many early arriving pairs as possible at spawning. The long term result is anticipated to expand the annual number of adult coho arriving early in the run, thus increasing the number of adult female coho capable of ascending Tumwater Dam during optimal flow conditions.

Bi-weekly broodstock collection goals have been established for both Tumwater and Dryden dams and are illustrated in **Table 3.** Collection goals target a minimum of 50% of the broodstock from Tumwater Dam (YN 2017). Bi-weekly goals are intended to serve as a guide for collection from throughout the run but may be adjusted to ensure the newly implemented broodstock arrival time prioritization needs and adult accessibility are optimized. If during any week the broodstock collection goals are not met, the deficit will be carried over to the following week until the collection total is reconciled. Adults collected from PRD or LNFH will be assimilated into the combined weekly goal. A minimum of one male will be collected for each female to adhere to spawning protocols.

Table 3. 2019 Wenatchee River Basin Coho Broodstock Collection Goals

Calendar Week	9/1	9/8	9/15	9/22	9/29	10/6	10/13	10/20	10/27	11/3	11/10	11/17	TOTAL
Dryden Dam	1	5	14	47	52	90	131	124	107	39	18	4	632
Tumwater Dam	0	1	10	38	67	100	165	125	90	29	6	1	632
TOTALS	1	6	24	85	119	190	296	249	197	68	24	5	1,264

Between September 1 and November 2 of this year, broodstock collection at Dryden Dam will occur daily and in coordination with Washington Department of Fish and Wildlife's (WDFW) evaluation and monitoring staff and Eastbank Fish Hatchery (Eastbank FH) hatchery personnel, as it characteristically occurs concurrently with steelhead broodstock collection. YN will provide a minimum of two people each day to assist in operations and collection at Dryden Dam adult fish trapping facilities. Between November 3 and November 16, YN personnel ordinarily operate the trapping facility independently but will communicate with Eastbank FH, WDFW, and Chelan County Public Utility District (CCPUD) personnel regarding collections, trap maintenance, and operations. If YN staff foresees broodstock collection goals (through trapping efforts at Tumwater and Dryden dams) will not be met, adult coho may be collected at the LNFH adult ladder to prevent a deficit. Tumwater Dam operations will be coordinated with Eastbank FH personnel and/or WDFW evaluation crews and occur concurrently with WDFW steelhead brood collections.

Methow River Basin

Prior to 2005, coho broodstock collections for the Methow River program were solely conducted at Winthrop NFH; however, few coho completed this long migration and successful returnees were typically males. In 2005, the primary collection site shifted towards Wells Dam in an effort to intercept more returning Methow Basin coho and increase female collections in the process. Broodstock Development Phase I (BDP I) was initiated in 2006 and focused on eliminating the reliance on lower Columbia stocks and transitioning to a local broodstock. During BDP I, program adults began to demonstrate the ability to return in sufficient numbers to meet collection goals from both in-basin release locations (i.e., Winthrop NFH on-station raceways and back-channel pond) and Wells FH. By 2009, average contribution of swim-ins (Winthrop NFH and Methow FH combined) into the Methow broodstock had exceeded 50% (*avg.* = 52.7%) and were a predominant portion of the program. In 2010, the program transitioned to BDP II and swim-ins to these facilities were prioritized as the primary brood source, with collections at Wells Dam facilities providing supplementary adults. Broodstock Development Phase II was accomplished in 2013 for the Methow Program and a shift back to prioritizing collections at Wells Dam facilities was made in 2014. Collections in 2019 are intended to provide sufficient broodstock required for the continued development of NPIP in 2021, and will require incorporation of adults from all established, in-basin release locations. Since no in-basin collection locations currently exist (i.e., tributary collection weirs) that would provide for a representative sample of returning adults in-basin, Wells Dam facilities would provide those means. Adult collections will continue to occur at Winthrop NFH and Methow FH collection weir on an auxiliary basis, as swim-ins to these facilities will continue to be a key element to broodstock development.

At Wells Dam, proposed trapping operations would occur on the east and west ladders according to the following schedule (National Marine Fisheries Service (NMFS), 2017; Consultation Number WCR-2015-3778):

1) Sept 1- Sept 26: 3 days/week and 16 hrs/day
2) Sept 27-Oct 9: 5 days/week and 9 hrs/day
3) Oct 10- Dec 7: 7days/week and16 hrs/day

Trapping operations will be coordinated with WDFW and DCPUD and to maximize coinciding operations with WDFW evaluations and Wells FH summer steelhead and summer Chinook collections. If during this timeframe, WDFW/Wells FH is not operating one or both of the traps, YN personnel would assume full operations of both facilities and actively operate traps with all non-target fish being documented and passed upstream while minimizing handling. When operating the west ladder trap, coho salmon will be diverted directly from the ladder into the holding facility at Wells FH. Removal of coho from the temporary holding area, to include volitional swim-ins, will be coordinated with DCPUD/Wells FH personnel. YN staff will continue to transport collected adults at a minimum of three times per week with holding criteria to not exceed 150 coho at one time. During east ladder operations, trapped coho would be placed directly into a transport tank. All coho transported from Wells Dam facilities will have a unique mark to differentiate them at spawning from volunteer swim-ins at Winthrop NFH and Methow FH adult weir.

Supplemental collections at Winthrop NFH and Methow FH could, if required, occur up to seven days per week (24 hours/day) between September 1 and December 7 at both facilities (NMFS, 2017). Adults collected from Methow FH collection weir would be transported to Winthrop NFH for holding and spawning. All trapping operations at Methow FH will be coordinated with DCPUD.

Methow River basin weekly broodstock collection goals for 2019 are illustrated in **Table 4**. If during any week broodstock collection goals are not met, the deficit will carry over to subsequent weeks until collection totals are reconciled. Weekly trapping goals are intended to serve as a guide to ensure collection from throughout the run but may be adjusted mid-season to ensure that the total collection goal is met. Collection goals are expressed in numbers of adult coho needed if broodstock are solely collected from Wells Dam facilities. A minimum of one male will be collected for each female to adhere to spawning protocols.

Table 4. 2019 Methow River Basin Coho Collection Goals

Calendar Week	9/1	9/8	9/15	9/22	9/29	10/6	10/13	10/20	10/27	11/3	11/10	11/17	TOTAL
Wells Dam	3	21	81	181	237	209	179	98	36	8	1	0	1,054

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NMFS (National Marine Fisheries Service). 2017. Endangered Species Act (ESA) Section 7(a) (2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Mid-Columbia Coho Salmon Restoration Program: Operation and Construction. Consultation Number: WCR-2015-3778)

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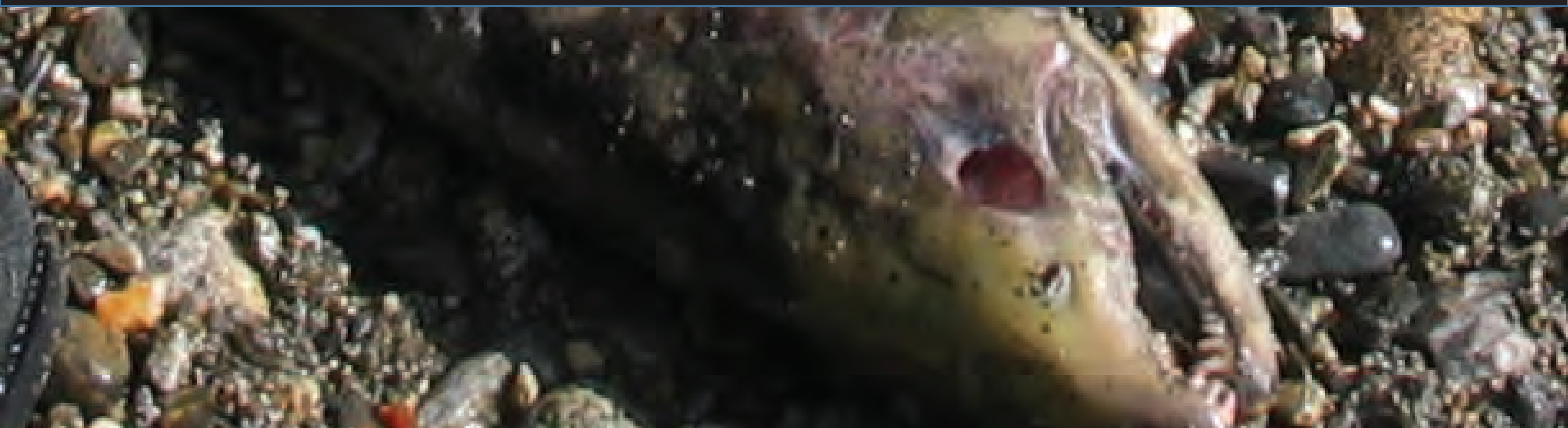
Attachment C

Spring Chinook Carcass Recovery Bias in the Upper Wenatchee Basin



Mike Hughes, Andrew Murdoch (WDFW)
Kevin See (Biomark)

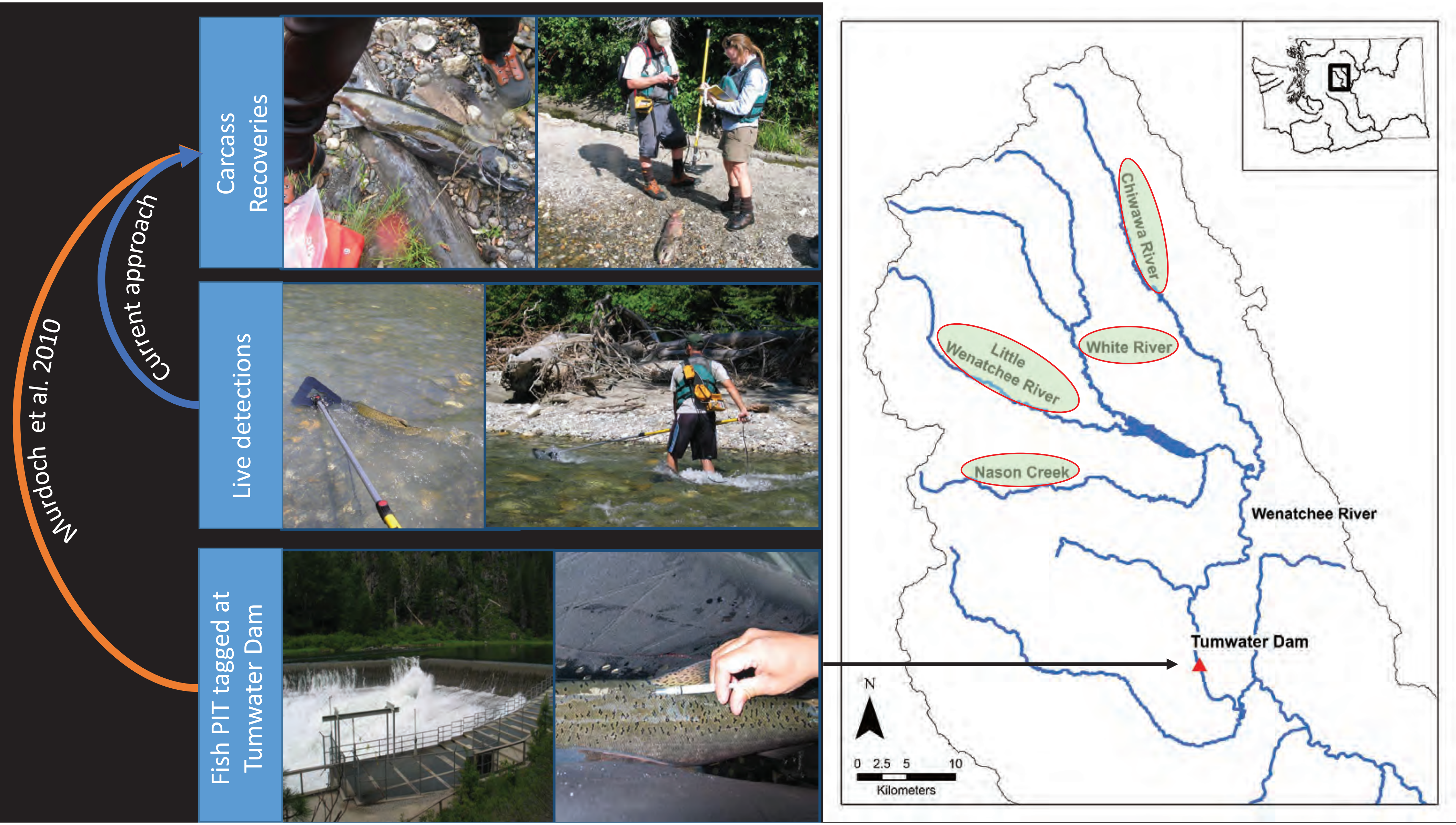
Utilization of Carcass Data

- Carcasses recovered on the spawning grounds are often used to reconstruct the demographics of a spawning population
- Assumes that these collections are truly a random sample of carcasses
- Carcass recovery probabilities have been shown to differ;
    - Sexes
    - Fish Size
- Resulting in a biased spawning population estimates

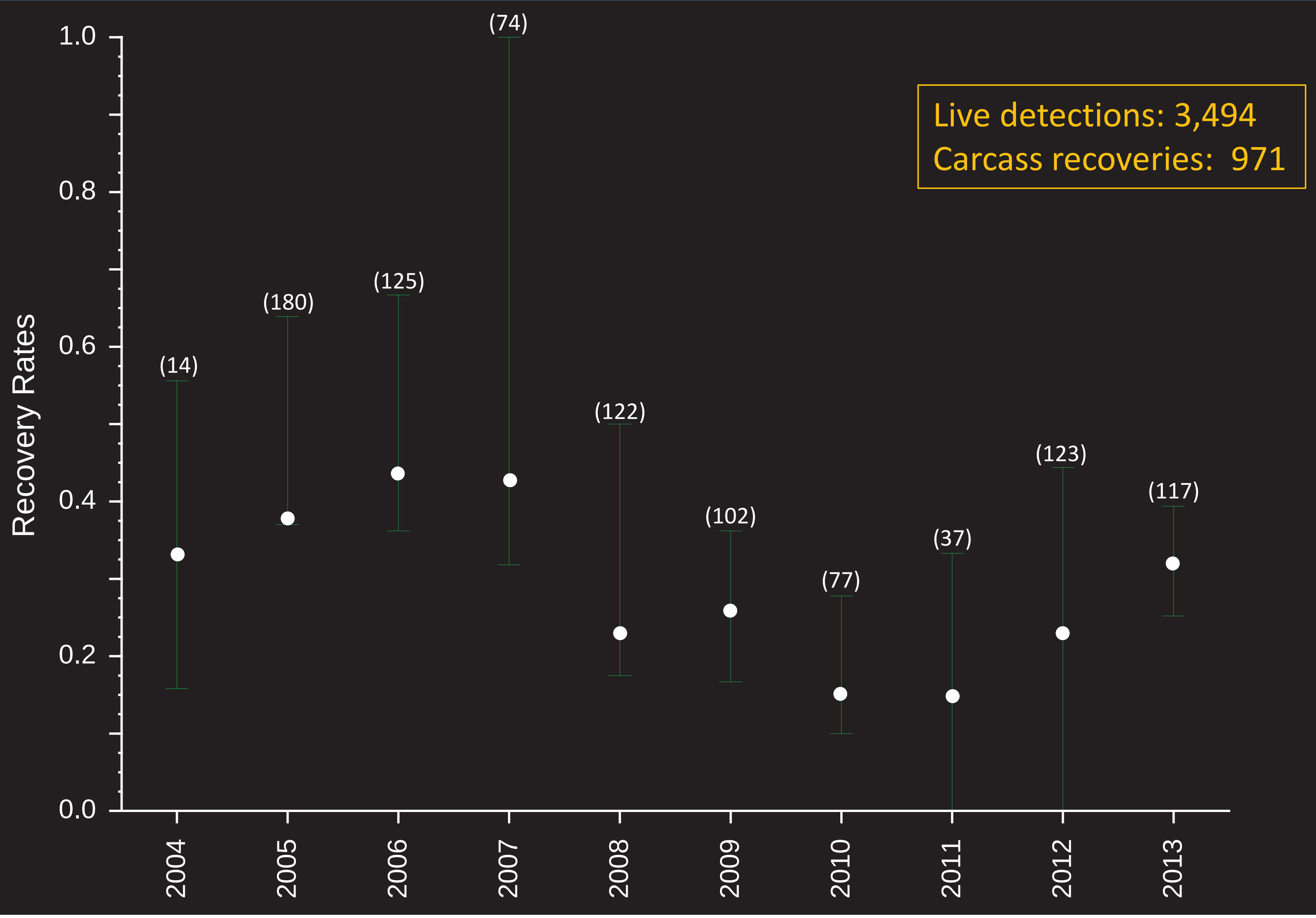
Study Objectives

- Evaluate carcass recovery rates and the factors that influence them
- Develop a model that predicts carcass recovery probabilities for spring Chinook Salmon in the upper Wenatchee Basin
- Recalculate the demographics of the spawning populations using corrected carcass recovery data
  - Preliminary results for Chiwawa River in 2011 and 2013

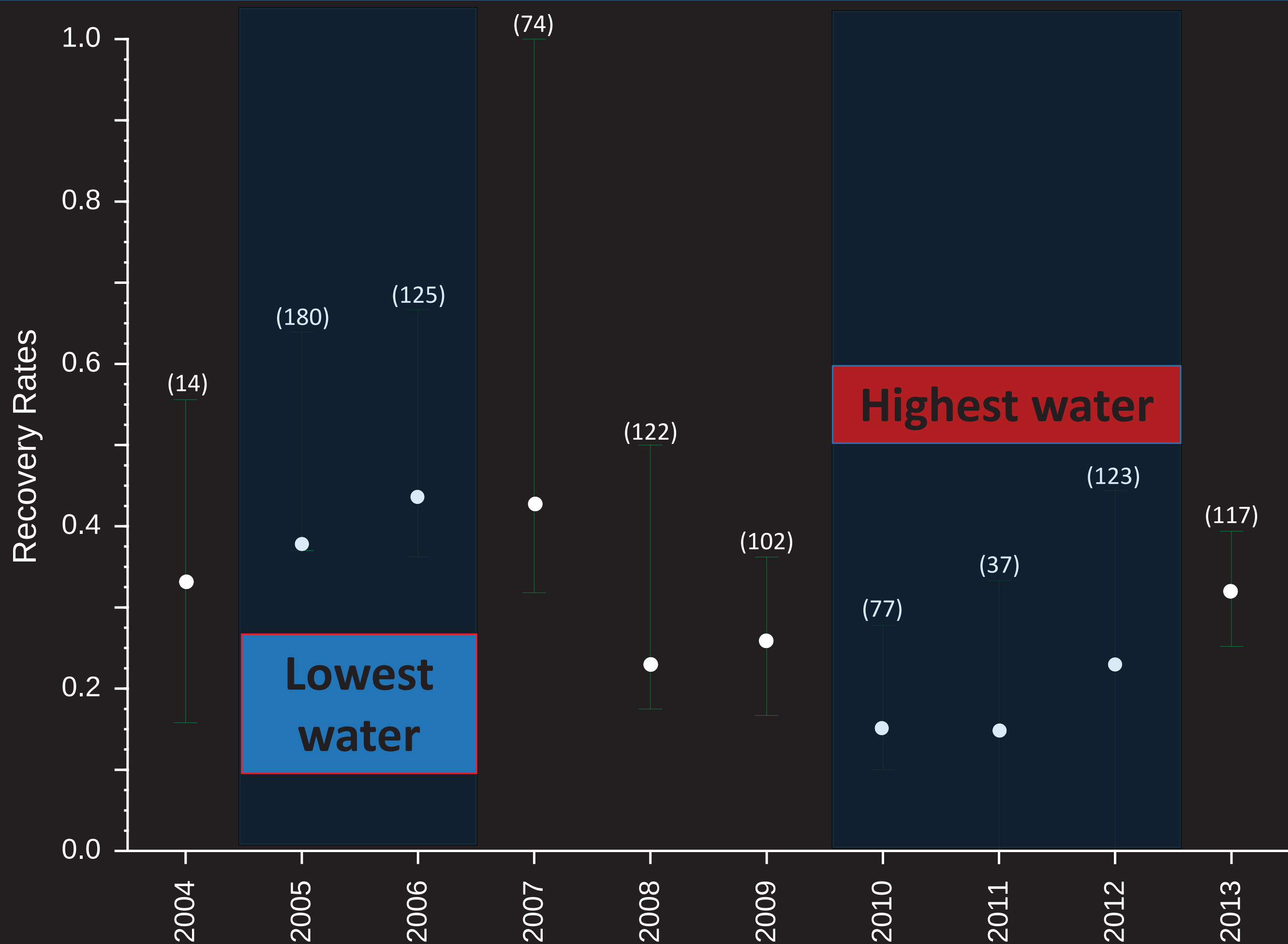
Attachment C



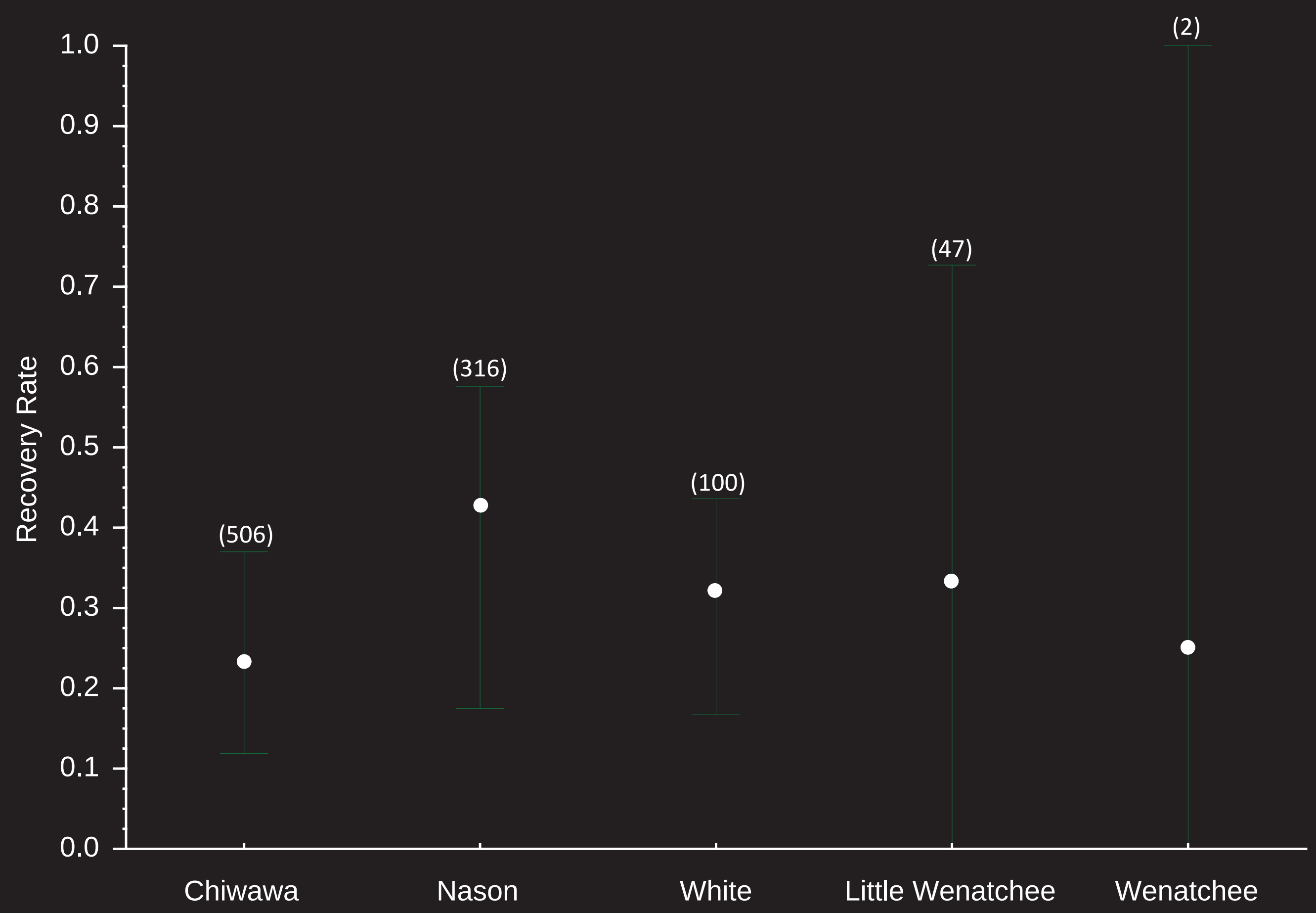
Recovery rates across all tributaries by year



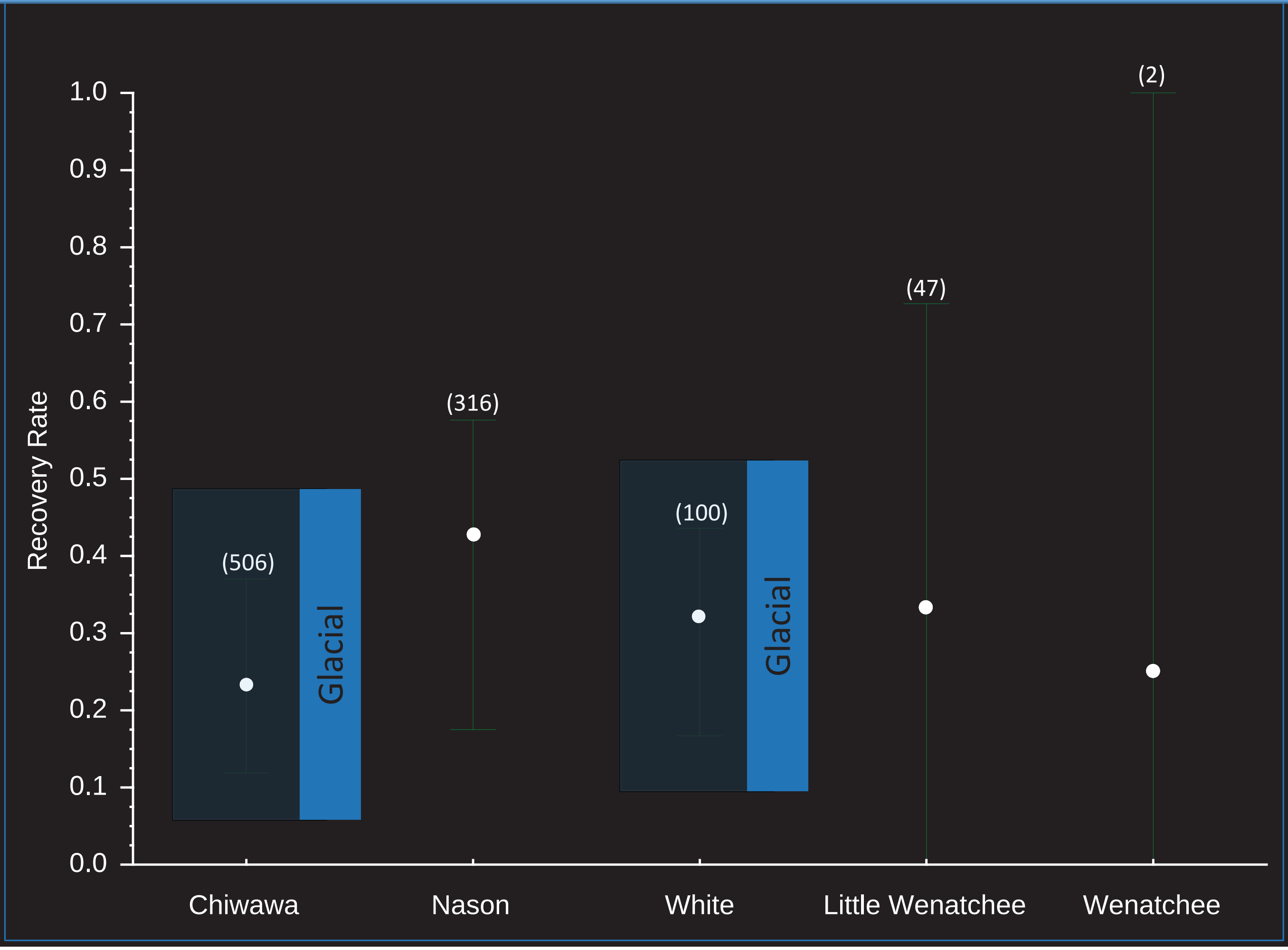
Recovery rates across all tributaries by year



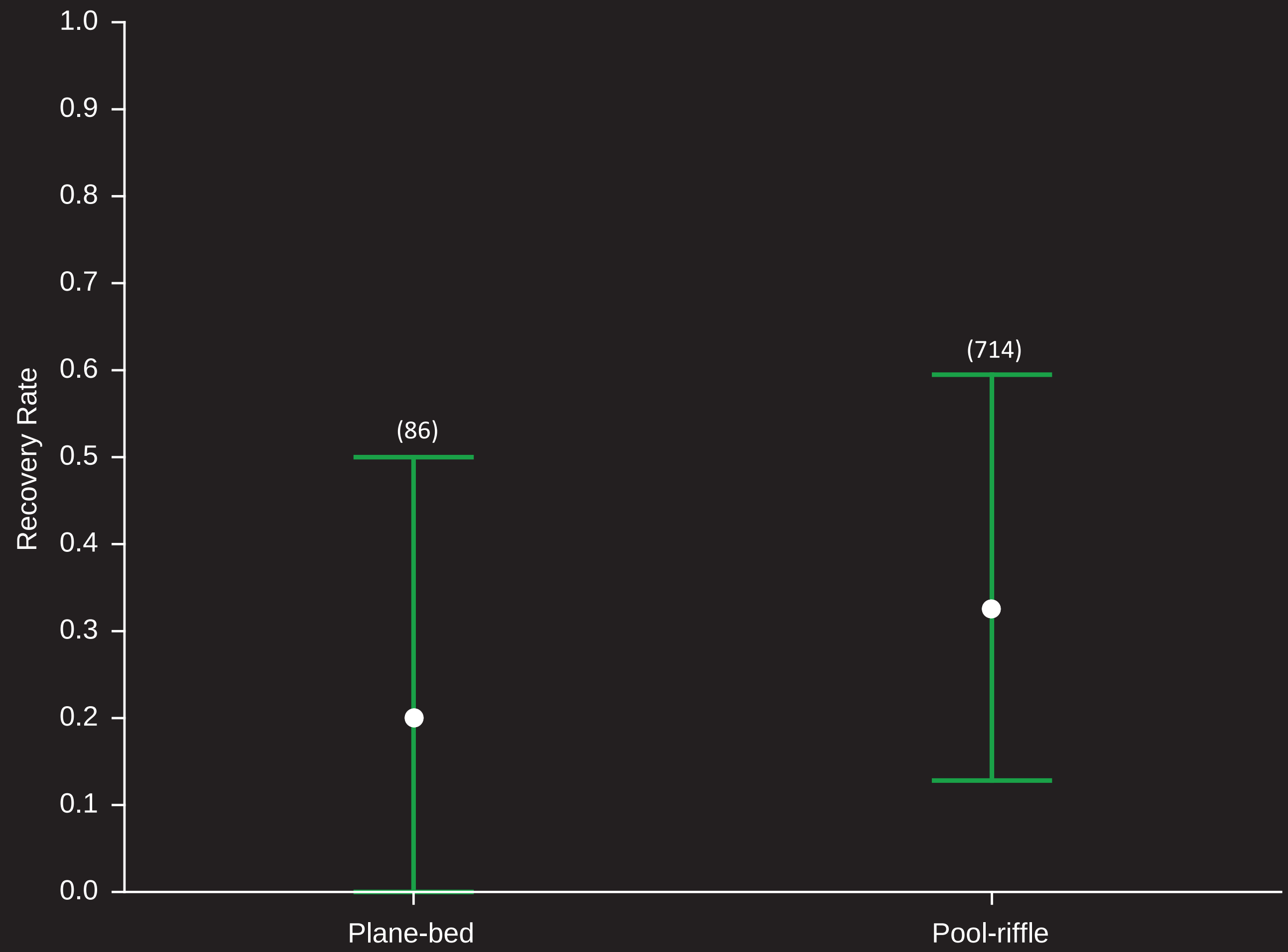
Median recovery rates by tributary



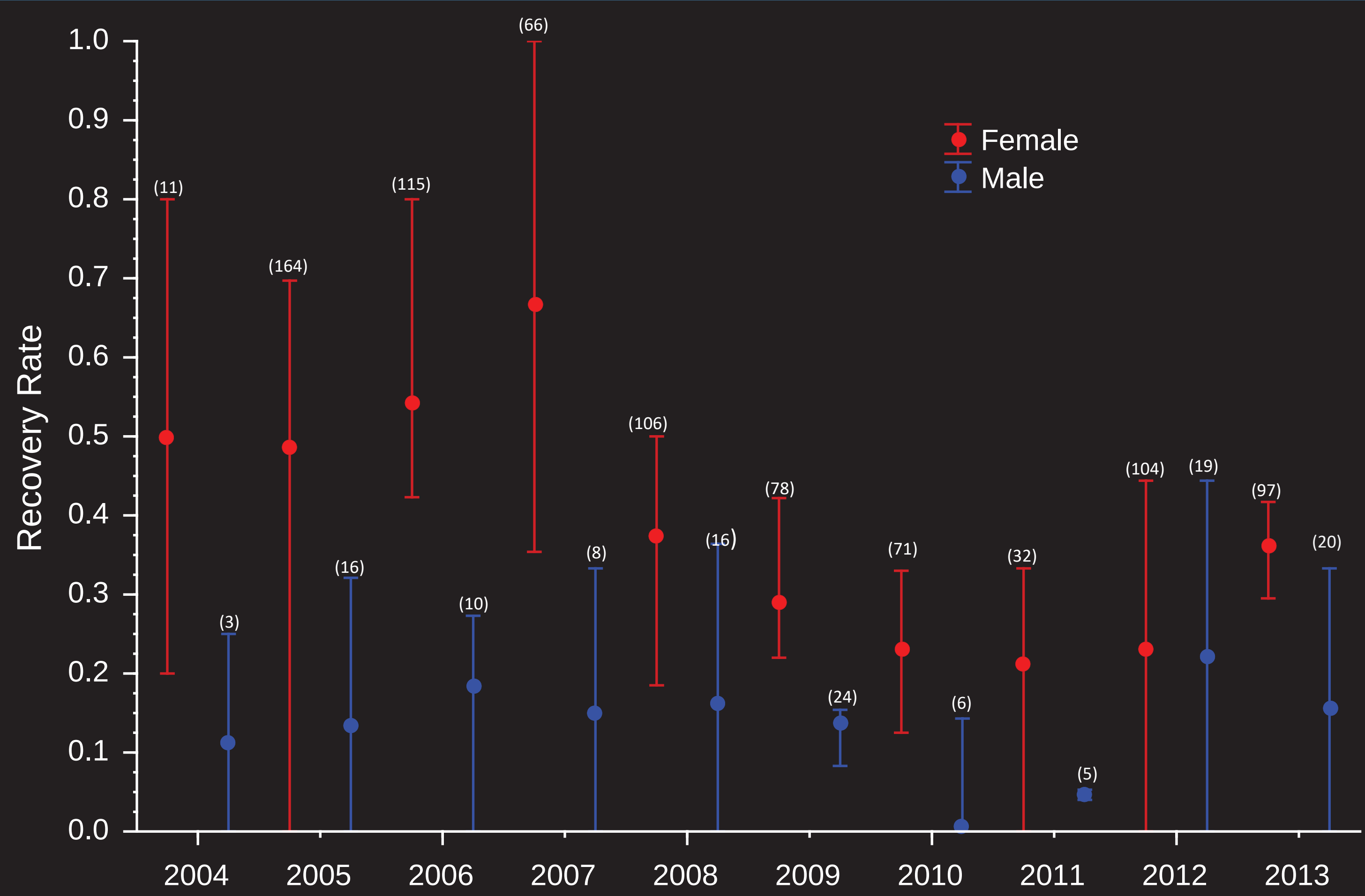
Median recovery rates by tributary



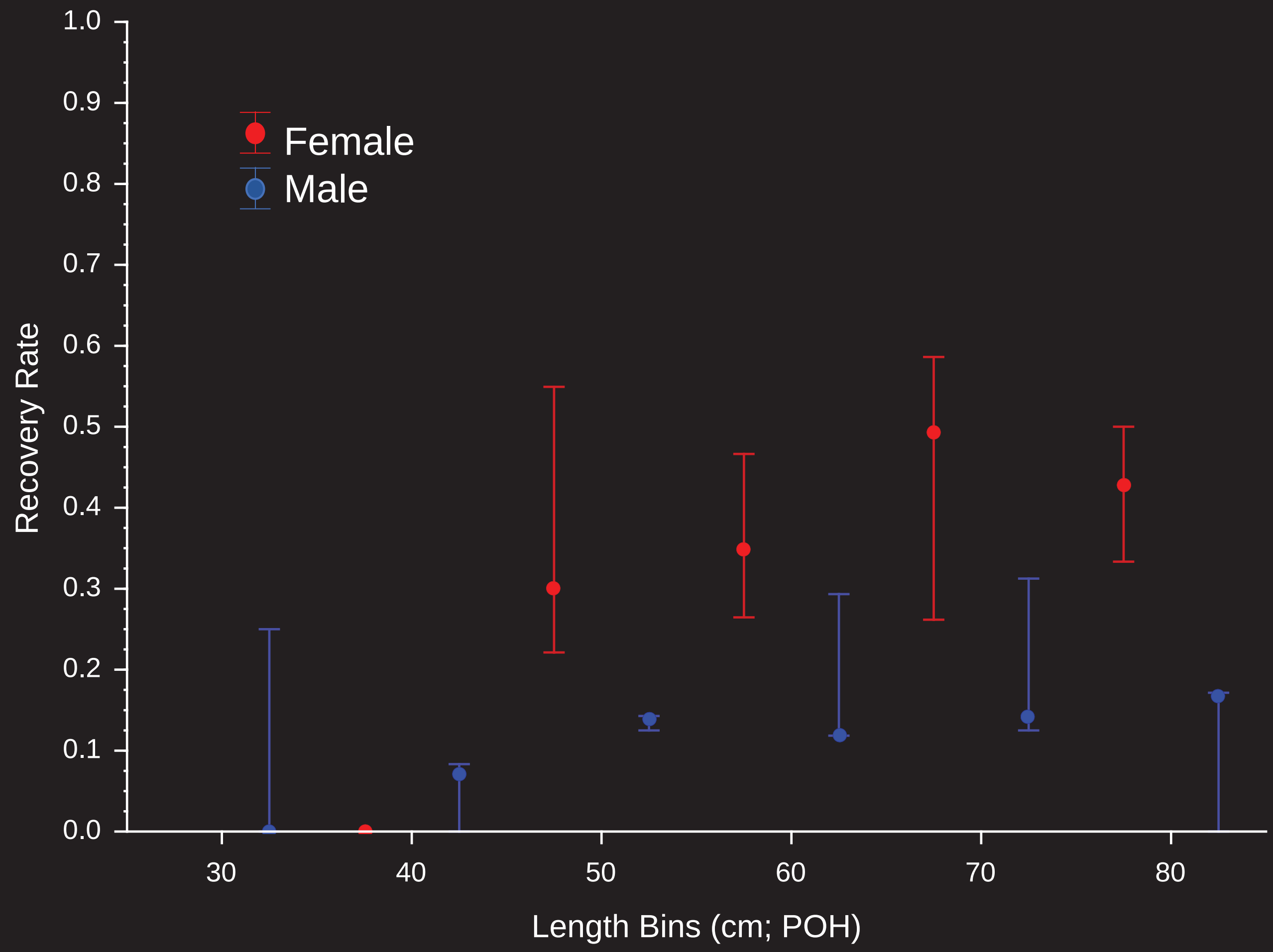
Recovery rates by channel type



Recovery rates by year & sex



Recovery rates by length and sex



Factors that influence recovery rates

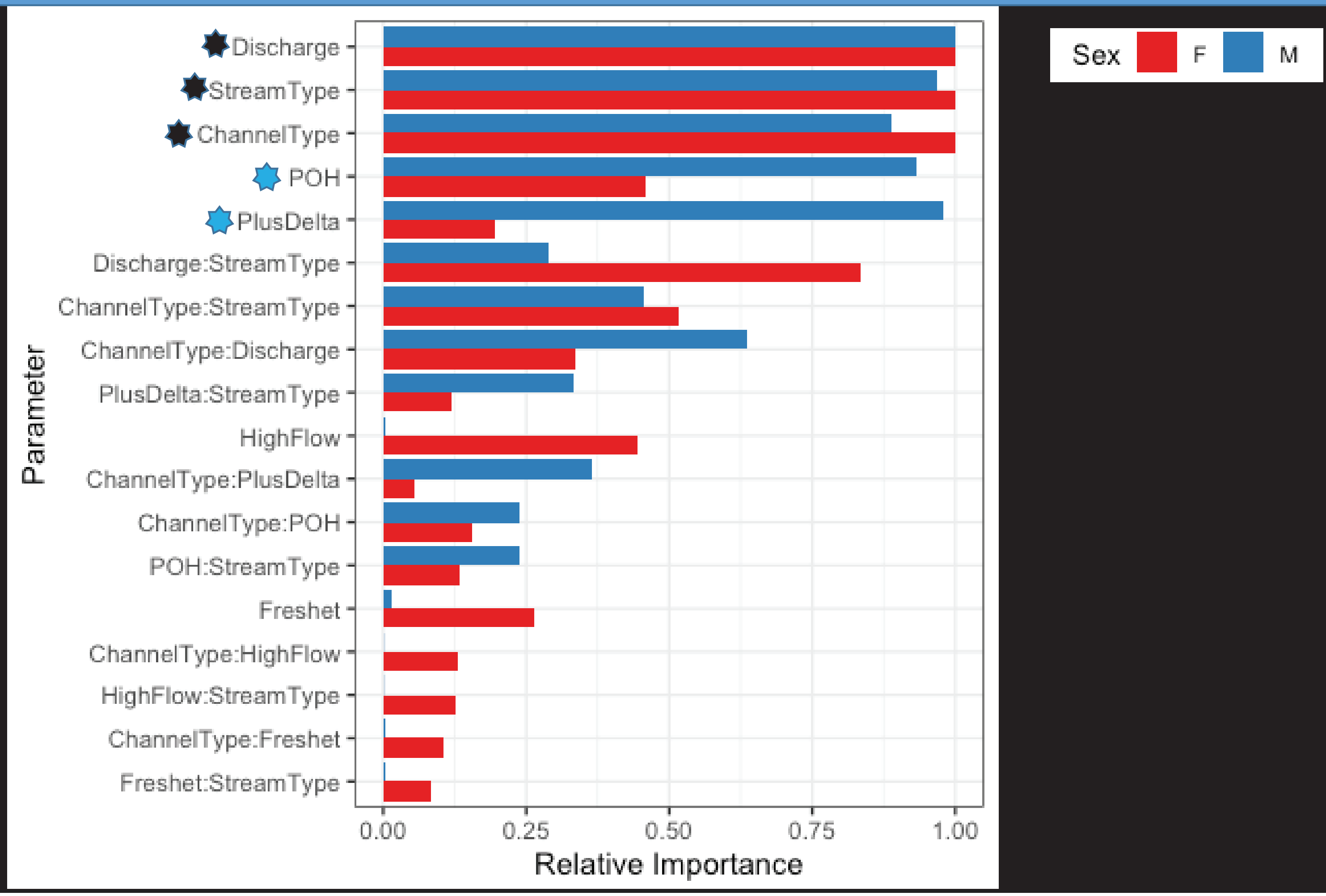
Environmental characteristics

- River discharge:
  - Year-to-year variation:
    - Mean discharge
  - Within year variation:
    - Number of freshet events flow increased by greater than 10%
    - Number of days flows elevated by greater than 20%
    - Number of days flows increased relative to the prior day
- Stream characteristics:
  - Glacial and non-glacial streams
- Channel type:
  - Pool-riffle and plane-bed reaches

Fish characteristics

- Sex: spawning behaviors
- Fish size: carcass detection and movement
- Origin: Size differences and differential spawning distributions

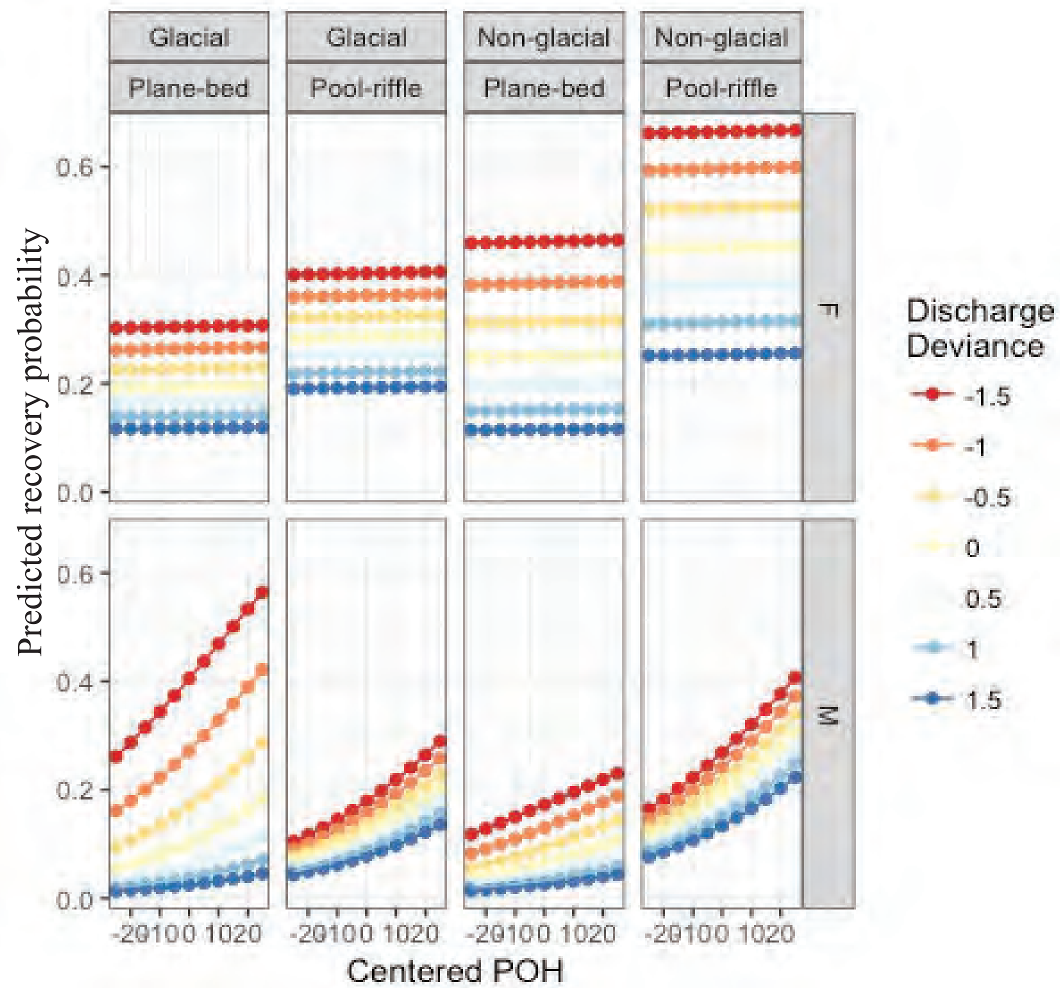
Binomial GLM with logit Link separately by sex: Importance of variables within Models



Predicated recovery probabilities

Recovery probabilities for both sexes were:

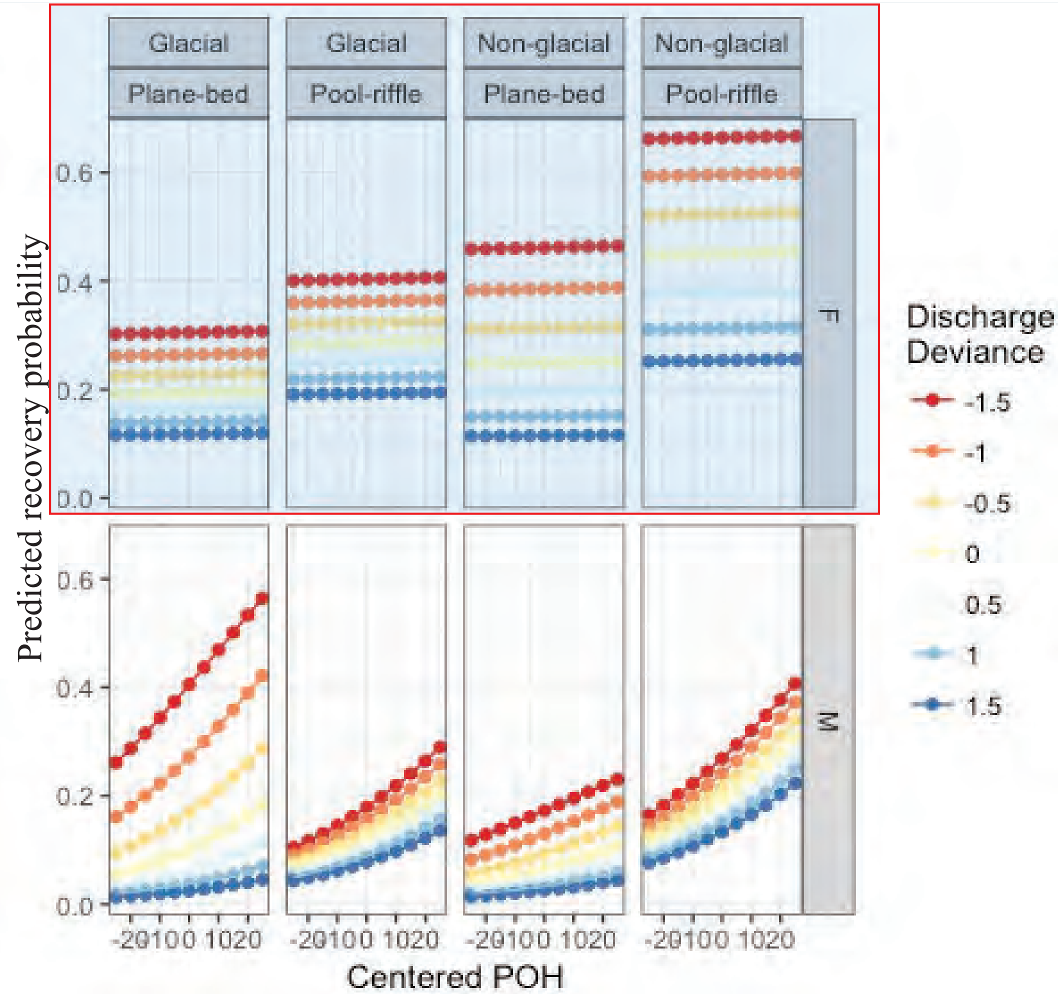
- Lower in years were discharge was higher
- Lower in glacial streams relative to non-glacial streams
- Lower in plane-bed channels compared to pool-riffle



Predicated recovery probabilities

Female recovery probabilities:

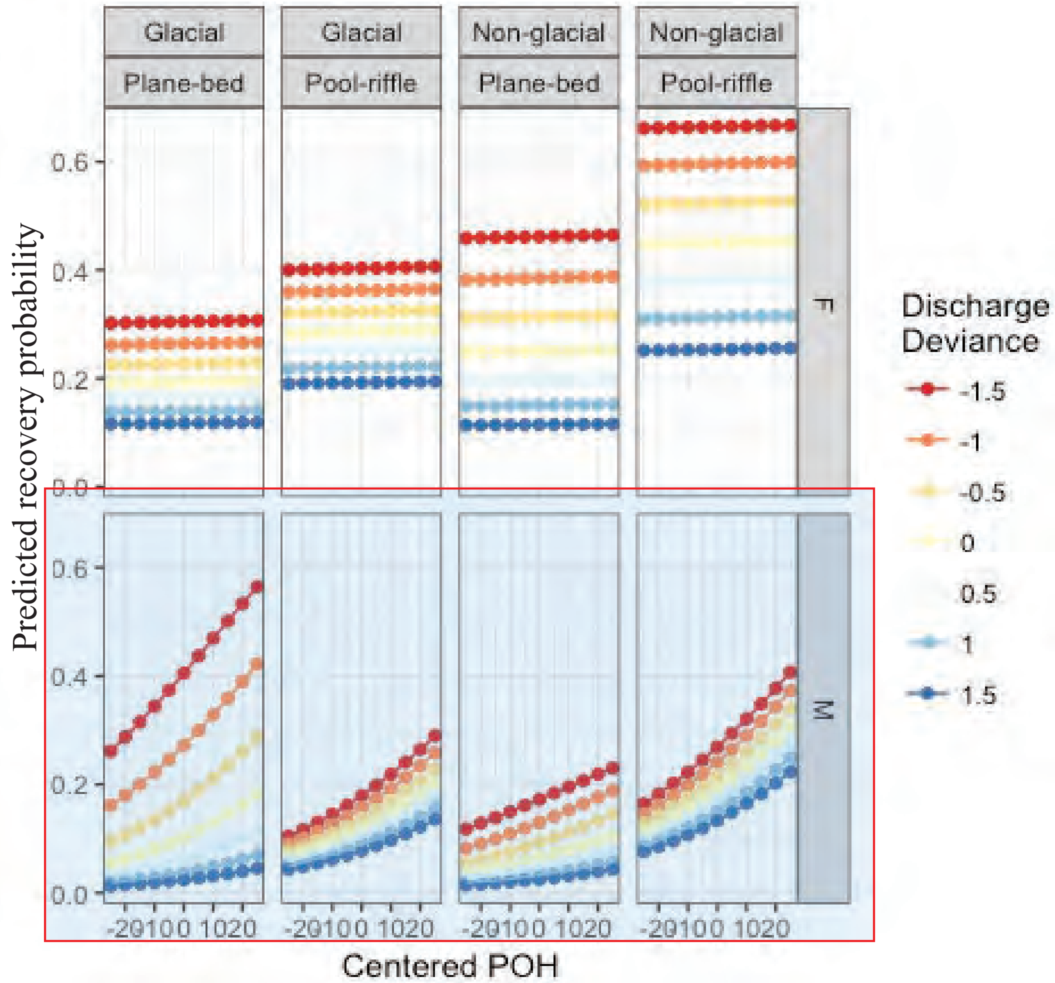
- POH had very little effect on recovery
- Interaction between discharge and stream-type
  - Lower in years were discharge was higher,
  - But decreased at a greater rate in non-glacial stream
- Additionally, recoveries decreased as the number of days that flows were elevated (>20%) increased



Predicated recovery probabilities with modeled average coefficients

Male recovery probabilities were:

- Higher for larger-sized males
- Additionally, recoveries were lower as the number of days discharge increased



Corrected vs non-corrected recoveries: 2011

Sex	Age	Carcass recoveries		Bias (%)
		Observed	Corrected	
Male	3	30	50	-67
	4	21	16	24
	5	31	16	48
Female	3	3	4	-33
	4	44	44	0
	5	34	33	3

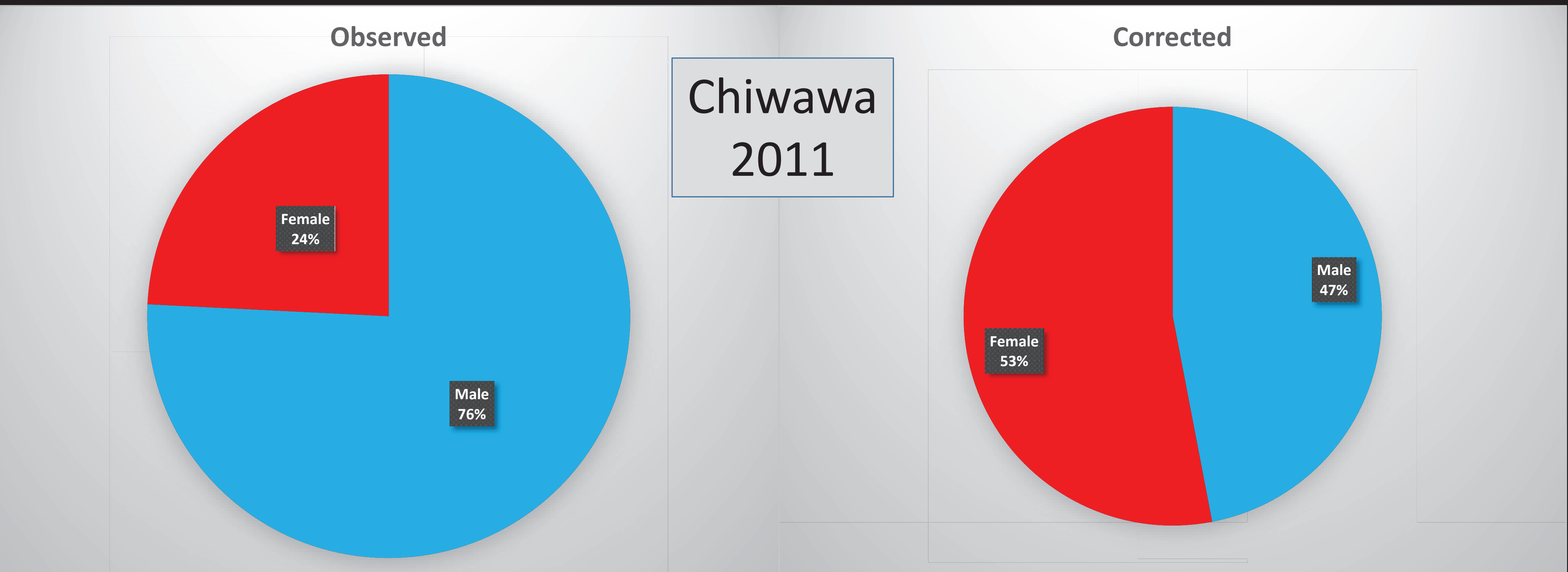
Corrected vs non-corrected recoveries: 2013

Sex	Age	Carcass recoveries		Bias (%)
		Observed	Corrected	
Male	3	39	53	-36
	4	70	62	11
	5	16	10	38
Female	3	4	4	0
	4	200	202	-1
	5	43	41	5

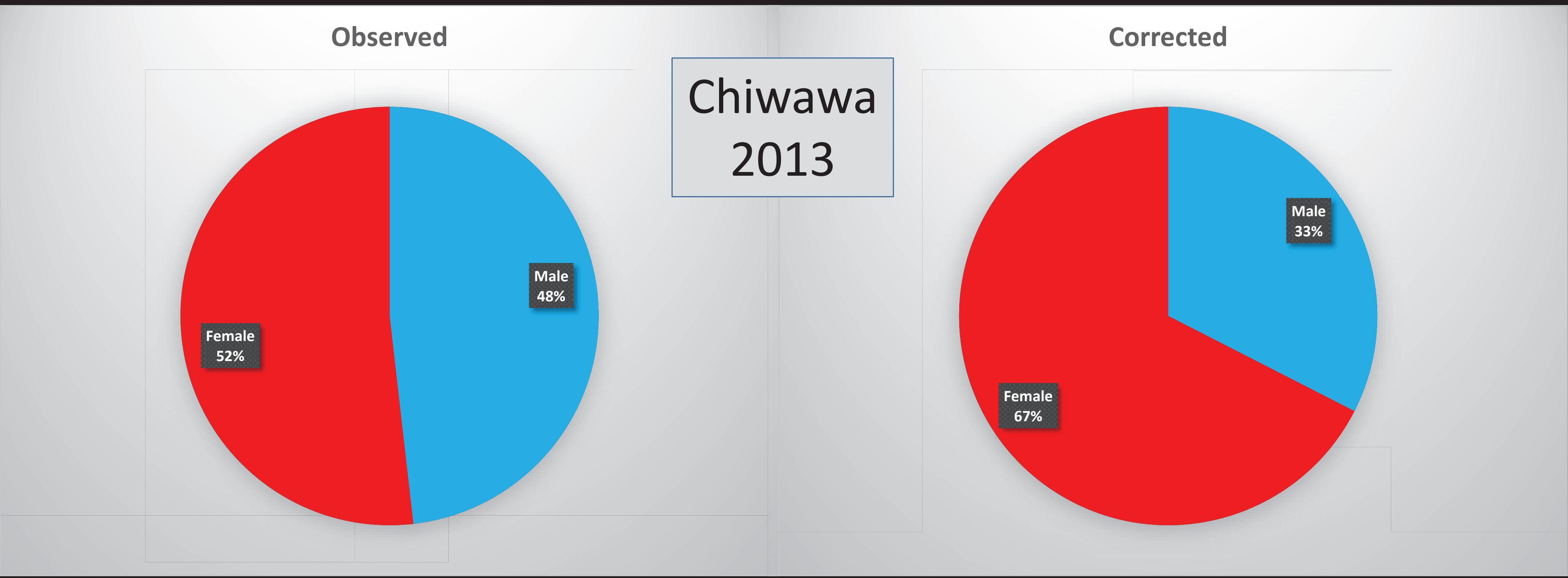
Fish per redd and spawning abundance

Year	Metric	Tumwater Ratio	Observed Carcasses	Corrected Carcasses by Channel Type	
				Plane Bed	Pool Riffle
2011	Fish per redd	4.13	2.01	4.10	1.26
	Redd count	474	474	104	370
	Spawner Abundance	1,958	953	894	
2013	Fish per redd	1.93	2.01	1.68	1.43
	Redd count	687	687	142	545
	Spawner Abundance	1,326	1,381	1,018	

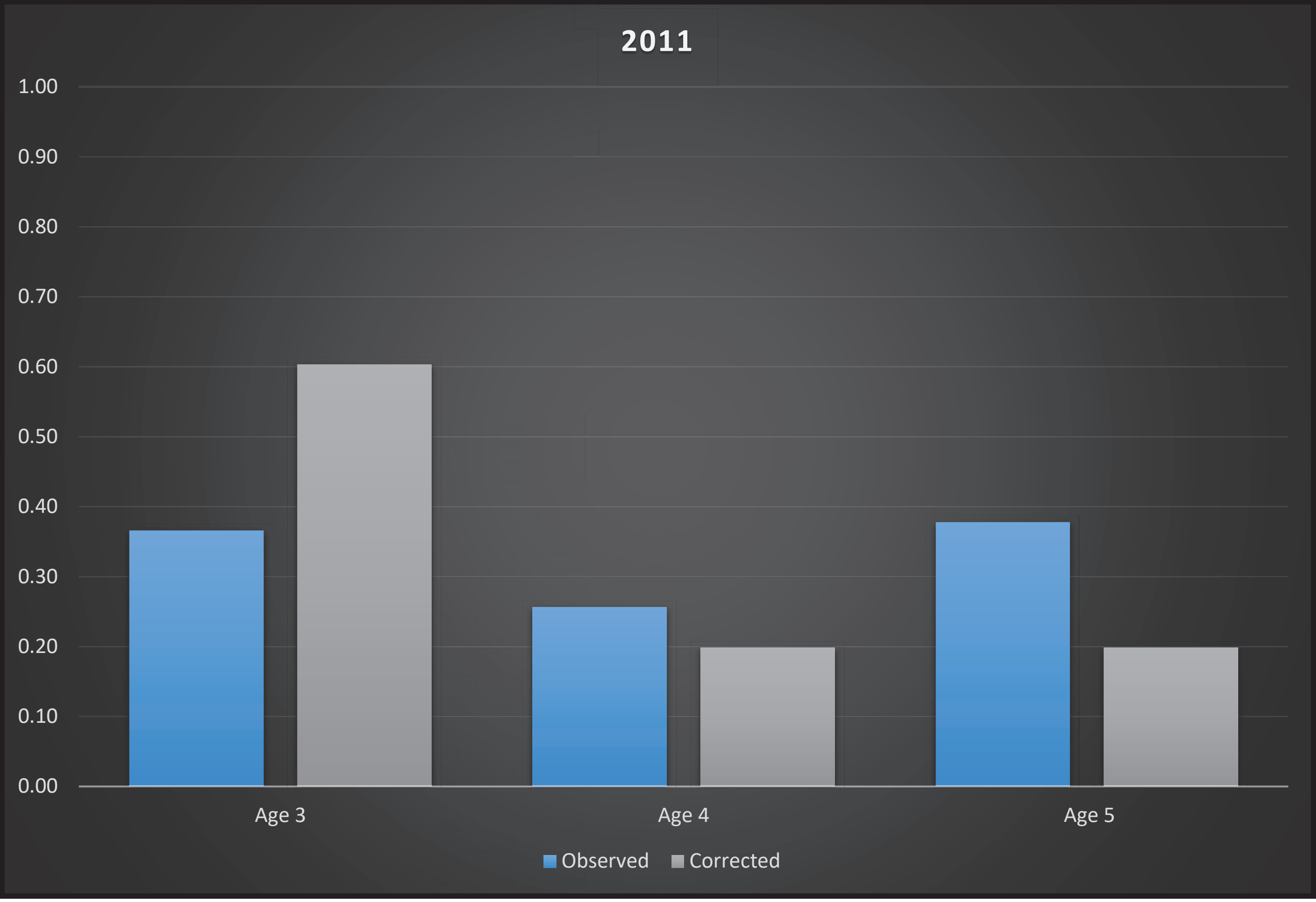
Sex ratios: estimated spawning abundance



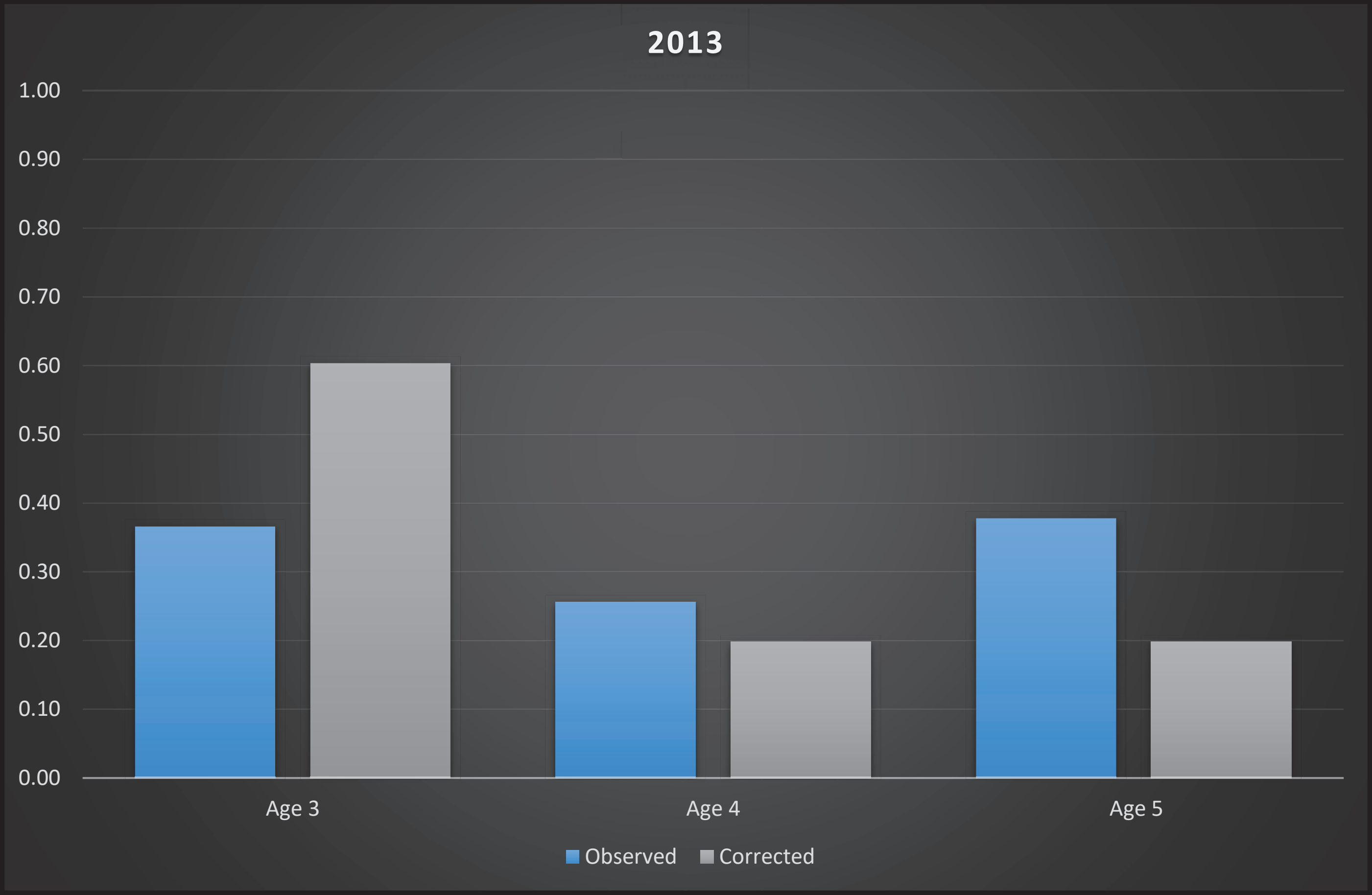
Sex ratios: estimated spawning abundance

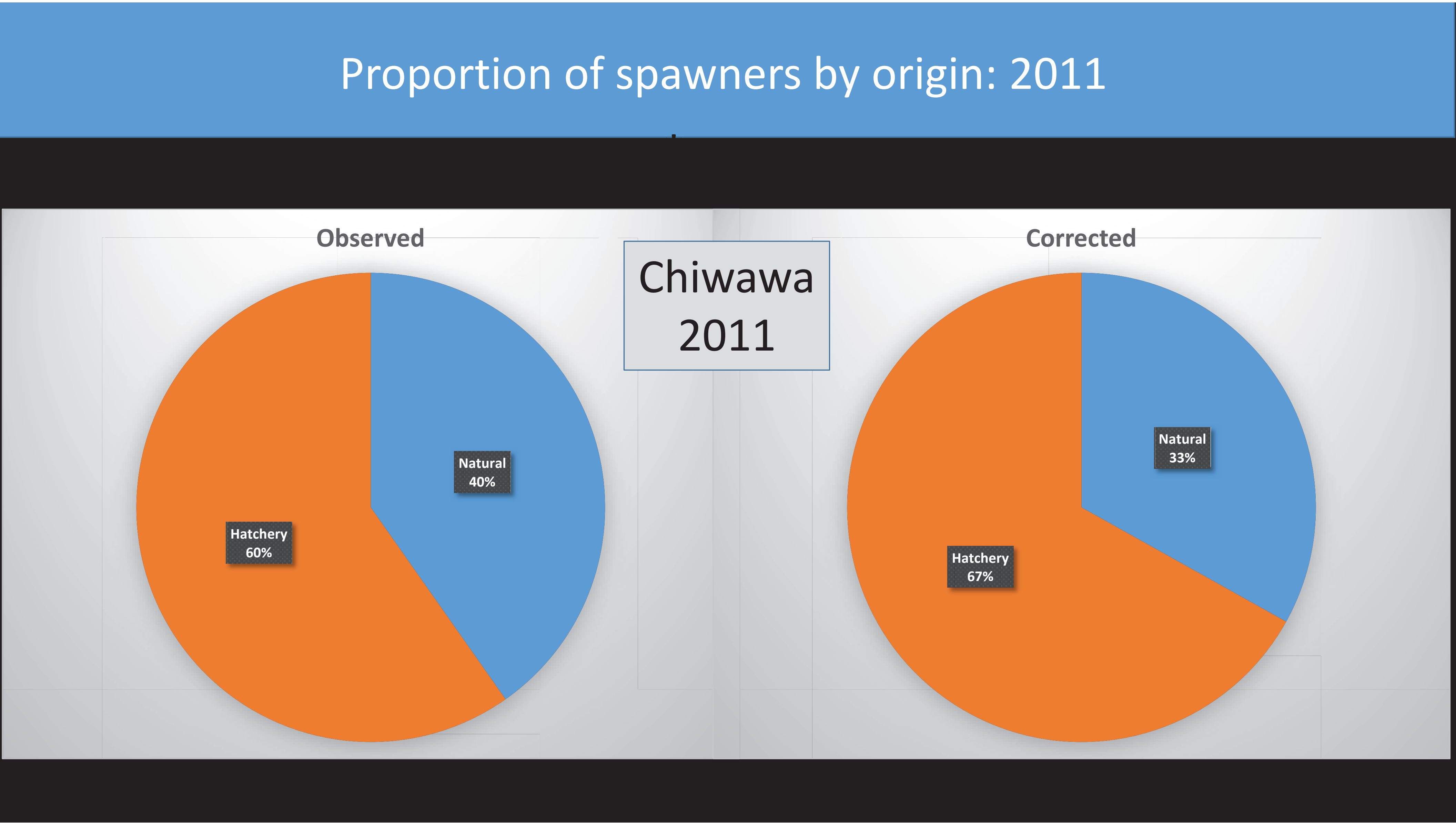


Male Ages: estimated spawning abundance

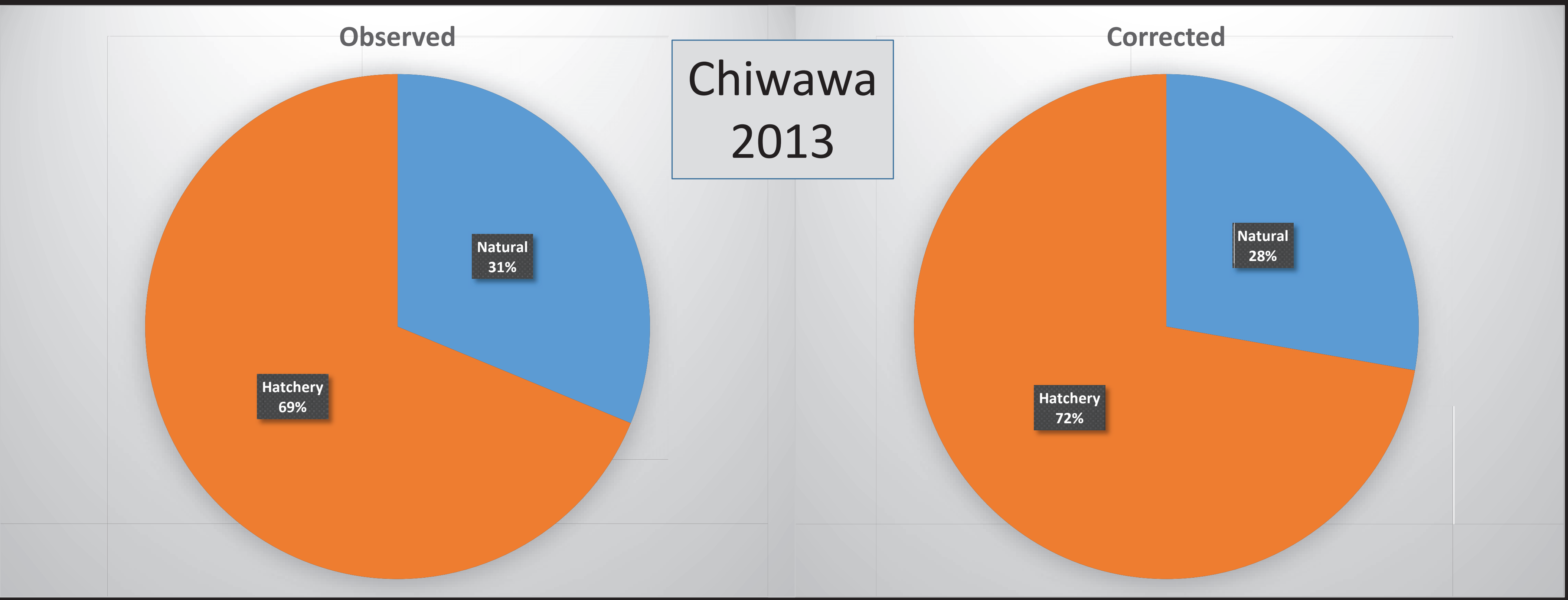


Male Ages: estimated spawning abundance




Proportion of spawners by origin: 2011
Observed
Chiwawa 2011
Corrected
Natural 40%
Hatchery 60%
Natural 33%
Hatchery 67%

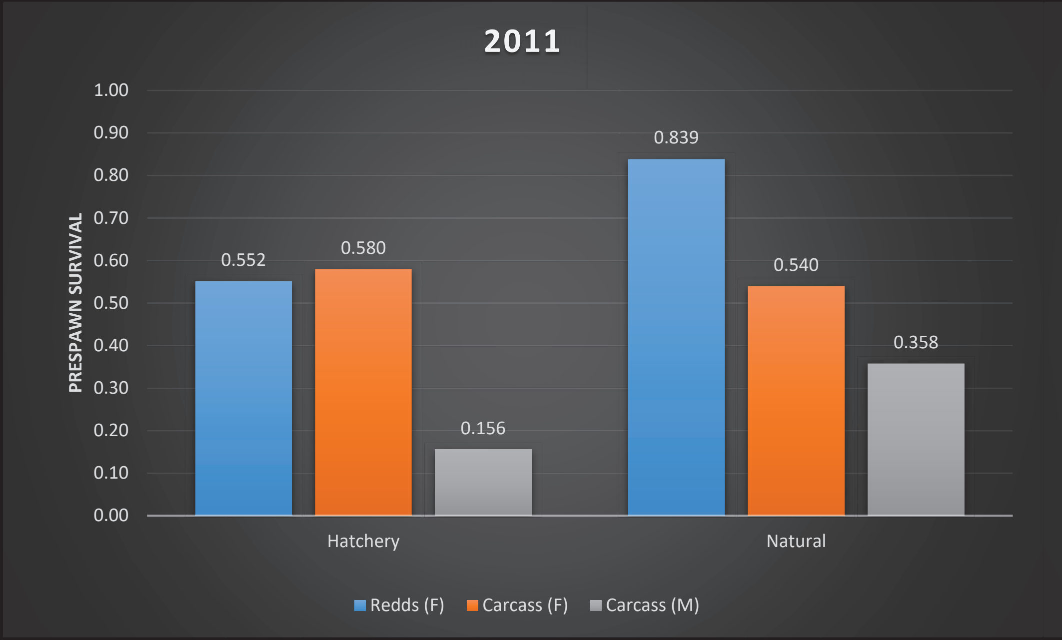
Proportion of spawners by origin

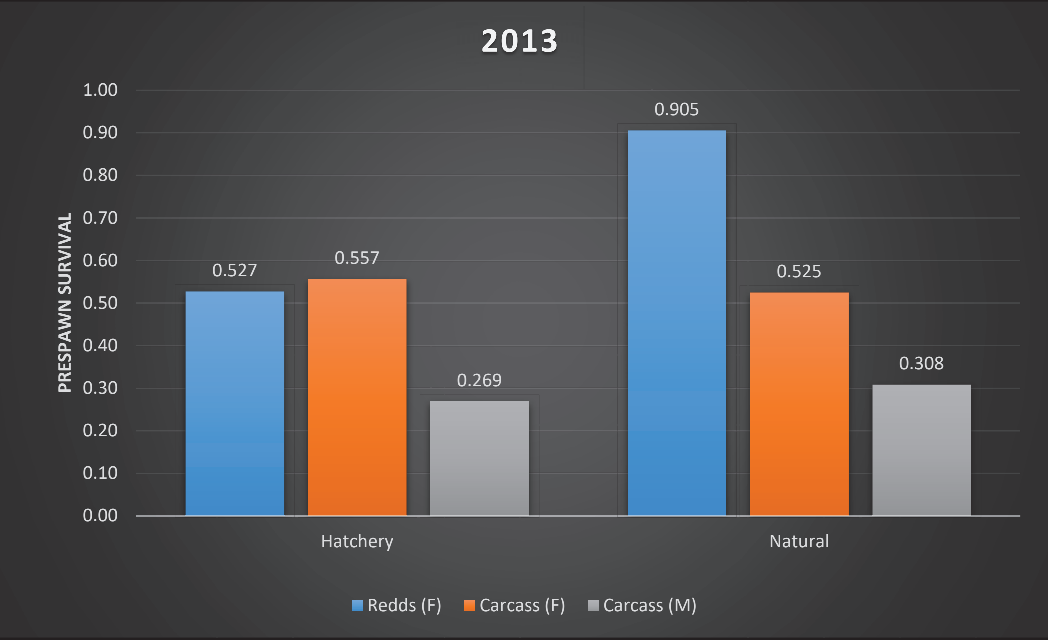


Take Home

- Carcasses often times are the only method for reconstructing a spawning population
- Observed carcass recoveries are biased toward recovering a greater proportion of females and larger-sized males
- This may be of concern when you have differences in body size and spawning distributions between hatchery and natural spawning fish
- Over-estimating abundance and survival of natural spawning fish and/or over representing older age classes

Prespawn Survival





Objectives

- Generate unbiased estimates of spawner escapement with uncertainty
- Develop methods that are transferable and usable by others

Spring Chinook Spawning Escapement

- Old Methods 1.0 (Murdoch et al. 2010)
  - Did not account for observer error (negative bias)
  - No measure of uncertainty
  - Used the same FPR from stock assessment (prespawn) for all streams (unknown bias)
  - Carcass bias included prespawn mortality (unknown bias)
- New method 2.0 (Murdoch et al. in review)
  - GAUC for redds
  - Used the same FPR from stock assessment (prespawn) for all streams (unknown bias)
  - Carcass bias included prespawn mortality (unknown bias)

Spring Chinook Salmon 3.0

1. Conduct weekly redds and carcass surveys
   - New redds from 0 to 0. GPS every redd.
   - Carcasses = 20% per reach…more is better. GPS every carcass.
2. Estimates redds using GAUC (Murdoch et al. in review)
   - Experience, Thalweg CV and redd density
3. Remove bias from carcass sample (Hughes et al. in prep)
   - Assign channel type for each carcass using GPS of carcass
   - Carcass location = spawning location (Murdoch et al. 2010)
   - Estimate stream and channel type specific sex ratio
   - Sex ratio = FPR assuming 1 redd per female (Murdoch et al. 2009)
4. Estimated redds x FPR = Number of spawners by channel type
5. Corrected carcass sample x spawners = H and W spawner abundance ± SE

Steelhead Spawning Escapement

- Old Methods 1.0
  - Did not account for observer error (negative bias)
  - No measure of uncertainty
  - Used the same FPR from stock assessment (prespawn) for all streams (unknown bias)
- New method 2.0 (Murdoch et al. in 2018)
  - GAUC for redds
  - Used the same FPR from stock assessment (prespawn) for all streams (unknown bias)

Steelhead 2.0 (Redd only)

1. Conduct weekly redd counts of all index areas
   - New redds from 0 to 0. GPS every redd.
   - Single peak count of non-index areas
2. Estimate redds using GAUC (Murdoch et al. 2018)
   - 1 or 2 person models and similar covariates
3. Estimate sex ratio (i.e. FPR) from stock assessment data
   - Adjust for harvest and harvest impacts
   - Adjust for broodstock and adult management
   - Adjust for differential prespawn mortality (Fuchs et al. in prep)
4. Estimated redds x FPR = spawners
5. Adjusted stock assessment data x spawners = H and W spawners

Steelhead 3.0 (PIT/Redd Hybrid)

1. Conduct weekly redd counts of mainstem index reaches
   - New redds from 0 to 0. GPS every redd.
   - Single peak count of non-index areas
2. Estimate redds using GAUC (Murdoch et al. 2018)
   - 2 person models
3. Estimate sex and origin ratios from PIT tag data (i.e. FPR)
   - Using PIT tag not assigned to tributaries
4. Estimated mainstem redds x FPR x H/W = H and W spawners
5. Estimate tributary spawner using model (Waterhouse et al. in prep)
6. Add Mainstem and tributary spawners = Population ± SE
   - Origin, sex, length and age derived from PIT data (i.e., R/S)

Comparison of methods

- Spring Chinook (Wenatchee, Entiat and Methow)
  - 1.0: Negatively biased (Redds and FPR)
  - 2.0: Negatively biased (FPR)
  - 3.0: Unbiased or least biased
- Steelhead
  - Entiat are spring run fish (Waterhouse et al. in prep)
  - Methow and Wenatchee
    - 2.0 or 3.0
  - Okanogan
    - 3.1 – PIT for tribs; mainstem (under review). Could try GAUC.

Questions?

FINAL

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Wenatchee, Washington 98801
509.888.2070

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: May 15, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the April 17, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

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The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, April 17, 2019, from 9:00 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan)* based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*

- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will confirm with Andrew Murdoch that Wenatchee spring Chinook salmon DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success Study extension agreement and provide an update to the extension. (Item I-A) *(Note: this item is ongoing.)*
- Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Protocols) (Item I-A). *(Note: this item is ongoing.)*
  - Use of age-3 males in broodstock
  - Use of alternative, non-random mating strategies
  - Establishing ranges around broodstock collection targets
  - Source for Chiwawa spring Chinook salmon broodstock
- Tracy Hillman and Larissa Rohrbach will add review of the Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-A). *(Note: this item is ongoing.)*
- Brett Farman will ask Amilee Wilson and Craig Busack (National Marine Fisheries Service [NMFS]) to clarify the intent of the direction provided in NMFS Biological Opinions (BiOps) for marking Chiwawa and Nason conservation programs juvenile spring Chinook salmon (Item II-A).
- Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion during the April 17, 2019 HCP-HCs meeting (Item II-C). *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the 2017 *Out-planting Surplus Methow Composite Spring Chinook Salmon Adults* memorandum for review and discussion during the May 15, 2019 HCP-HCs meeting (Item II-C).
- Deanne Pavlik-Kunkel will provide Grant PUD's approval of routine distribution of merged PRCC HSC and HCP-HC meeting materials according to the revised meeting protocols (Item II-E).
- Once approved by the HCP-HCs and PRCC HSC, Tracy Hillman will present the revised merged HCP-HC and PRCC HSC distribution list to the HCP-CC for approval (Item II-E).

Wells HCP Hatchery Committee

- Greg Mackey will provide a revised version of Douglas PUD's draft 2019 M&E Implementation Plan for HCP-HC approval by email (Item I-A). (*Note: this item is ongoing.*)

PRCC Hatchery Subcommittee

- Todd Pearsons will finalize the PRCC HSC-approved 2019 Priest Rapids Hatchery M&E Implementation Plan for distribution (Item III-B).
- HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item III-C).

Decision Summary

- The Rock Island HCP-HC and PRCC HSC Parties approved the proposed marking scheme for Chiwawa and Nason Conservation Program fish based on program assignment and parental origin (Item II-A). Chelan PUD, Grant PUD, USFWS, WDFW, CCT, NMFS, and the Yakama Nation (YN) approved during the meeting on April 17, 2019. Grant PUD provided their vote in an email by Tuesday April 23, 2019, with the following three contingencies:
  - It only applies to the brood year 2019 of the Nason Conservation Program until further information is provided (it does not apply to the brood year 2018 Nason Conservation Program because no hatchery by hatchery [HxH] crosses were necessary).
  - It is necessary to mark fish within the conservation portion of the program separately (e.g., if matings are mixed such as hatchery by wild [HxW] or if all crosses are wild by wild [WxW], then an additional tag may not be necessary).
  - Adequate risk management occurs to ensure that a caudal peduncle mark will not injure fish.
- The PRCC HSC approved the 2019 Priest Rapids Hatchery M&E Implementation Plan in today's meeting (Item III-B).

Agreements

- HCP-HCs and PRCC HSC will review the current broodstock collection protocols in September and October to identify changes needed in the next Protocols and determine who will make the revisions (Item II-B). Topics that deserve further discussion and/or Statements of Agreement (SOAs) will be identified on a case-by-case basis.
- The HCP-HCs and PRCC HSC will distribute draft materials only to a primary distribution list that includes representatives, alternates and select participants (Item II-E). Final materials will be sent to a broader/secondary distribution list.

Review Items

- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on April 18, 2019, notifying them that the SOA on development of annual broodstock collection protocols is available for review (Item II-B).

- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on April 18, 2019, notifying them that the updated meeting protocols, distribution lists, and draft Conflict of Interest SOA are available for review (Item II-E).

Finalized Documents

- Mike Tonseth informed Brett Farman and Charlene Hurst of the formal submission of the HCP-HCs, PRCC HSC, and Wells HCP-CC approved final 2019 Upper Columbia River Broodstock Collection Protocols to NMFS on March 28, 2019.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the March 11 Conference Call Minutes and March 20, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the agenda. No changes to the agenda were requested.

The HCP-HCs and PRCC HSC representatives reviewed the revised draft March 11 conference call and March 20, 2019 meeting minutes. Larissa Rohrbach said there were some revisions that the representatives then reviewed. The HCP-HCs and PRCC HSC representatives approved the draft March 11 conference call and March 20, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on March 20, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on March 20, 2019)*:

Joint HCP-HCs and PRCC HSC Topics

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB) Review of Spring Chinook Salmon in the Upper Columbia River under HCP-HCs' purview (Item I-A).* Hillman said this item is ongoing; he is working on statistical analysis for BACI designs, then will switch to reviewing the Independent Scientific Advisory Board material.
- *Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Fish Hatchery (Item I-A).* Mackey said this item is ongoing; he will provide a presentation to the HCP-HCs in an upcoming meeting.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).*
  Tonseth said this item is ongoing pending information that will refine the analysis.

- *Catherine Willard will update the genetics section of the Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan) based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A).*
  Willard said this item is ongoing.
- *Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow FH programs (Item I-A).*
  Truscott said this item is ongoing.
- *Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating the proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said this item is ongoing. Farman said the end result would be a higher PNI than the current targets and asked whether this action item is still relevant. Bill Gale said the multi-population model for PNI provides a more accurate estimation of PNI and if this is being used for other stocks it should be used for the Nason and Chiwawa programs. Farman asked if it is relevant to the current program management. Gale said it might be helpful for NMFS to provide their approval of the use of this tool for the future. Farman agreed to retain the action item.
- *Brett Farman will inform the HCP-HCs of the publication date for public review of the Methow River Steelhead Environmental Assessment (Item II-D).*
  Farman said this item is complete; Larissa Rohrbach forwarded the link to the published plans following the meeting on April 17, 2019.
- *Brett Farman will inform the HCP-HCs on the publication date for public review of the Section 10 permits for the unlisted Chinook salmon bundle (Item II-D). (Note: Larissa Rohrbach distributed an email from Farman and draft permits for the Section 10 programs to the HCP-HCs and PRCC HSC on March 28, 2019.)*
  Brett Farman said this item is complete.
- *Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Methow Hatchery and Winthrop National Fish Hatchery (WNFH) to inform a translocation discussion during the April 17, 2019 HCP-HCs meeting (Item I-C).*
  Tonseth and Bill Gale said this item is ongoing.
- *Mike Tonseth will revise and redistribute the 2017 Out-planting Surplus Methow Composite Spring Chinook Salmon Adults memorandum for review and discussion during the April 17, 2019 HCP-HCs meeting. (Item II-C)*
  This item will be discussed in today's meeting. Tonseth said a revised version will be distributed in the coming weeks.

- *Mike Tonseth will confirm with Andrew Murdoch that Wenatchee Spring Chinook DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success (RSS) Study extension agreement and provide an update to the extension. (Item I-A).*
  Tonseth said this item is ongoing.
- *Mike Tonseth will convene a Joint Fisheries Parties meeting to discuss marking to identify hatchery x hatchery returns from fish used to backfill the Nason and Chiwawa conservation programs (Item II-A).*
  Tonseth said a meeting of the Joint Fisheries Parties (JFP) was held on April 15, 2019, and this item is complete.
- *Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A).*
  Tracy Hillman said this item is ongoing.
- *Tracy Hillman and Larissa Rohrbach will maintain the following list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Protocols) (Item I-A).*
  - *Use of age-3 males in broodstock*
  - *Use of alternative, non-random mating strategies*
  - *Establishing ranges around broodstock collection targets*
  - *Source for Chiwawa spring Chinook salmon broodstock*

  Hillman said this item is ongoing. Greg Mackey said he will present on use of age-3 males in broodstock at an upcoming meeting.
- *Tracy Hillman and Larissa Rohrbach will help the HCP-HCs and PRCC HSC identify co-authors and opportunities to make revisions to the Protocols in advance of 2020 deadlines (Item I-A).*
  This item will be discussed in today's meeting.
- *Greg Mackey will send suggested language on broodstock protocols for the Douglas PUD coho salmon program to Keely Murdoch and Cory Kamphaus (Yakama Nation [YN]) for approval and to Mike Tonseth for inclusion into the 2019 Protocols by end of day March 20, 2019 (Item I-A). (Note: language was incorporated into the 2019 Protocols that were distributed by Larissa Rohrbach on March 21, 2019.)*
  Tracy Hillman said this item is complete.
- *Mike Tonseth will email a final draft of the 2019 Protocols to Larissa Rohrbach for distribution to the HCP-HCs and PRCC HSC by end of day March 21, 2019 (Item I-A) (Note: the 2019 Protocols were distributed by Rohrbach via email on March 21, 2019.)*
  Tracy Hillman said this item is complete.
- *HCP-HCs and PRCC HSC representatives or alternates will vote by email whether to approve the 2019 Protocols by end of day March 22, 2019 (Item I-A). (Note: the 2019 Protocols were*

approved by the Wells, Rock Island, and Rocky Reach HCs and the PRCC HSC Parties by email on March 22, 2019.)
Tracy Hillman said this item is complete.

Wells Hatchery Committee

- *Greg Mackey will provide a revised version of Douglas PUD's draft 2019 M&E Implementation Plan for HCP-HC approval by email (Item I-A).*
  Mackey said this item is ongoing.

Rock Island and Rocky Reach HCP Hatchery Committee

- *Mike Tonseth will email the Hatchery and Genetic Management Plans (HGMPs), biological opinions (BiOps), and permits that give direction on marking spring Chinook salmon in the Chiwawa and Nason conservation and safety-net programs to Larissa Rohrbach for distribution to the HCP-HCs and PRCC HSC and filing on the Extranet site (Item II-A). (Note: Relevant documents were distributed and filed by Rohrbach on March 21, 2019).*
  Tracy Hillman said this item is complete.
- *Mike Tonseth will confirm the timeline for tagging juvenile Chiwawa spring Chinook salmon in 2019 (Item II-A).*
  Tonseth said this was discussed in the JFP meeting; tagging will occur the week of May 6, 2019.
- *Brett Farman will ask Amilee Wilson and Craig Busack (National Marine Fisheries Service [NMFS]) to clarify the intent of the direction provided in NMFS BiOps for marking Chiwawa and Nason conservation program juvenile spring Chinook salmon (Item II-A).*
  Farman said this item is ongoing. This item will be discussed in today's meeting.

PRCC Hatchery Subcommittee

- *Tracy Hillman will ask the PRCC to provide specific instructions in writing regarding what they want the PRCC HSC to do with the White River spring Chinook salmon hatchery memorandum (Item V-C). (Note: Hillman sent an email to the PRCC Chair regarding this topic.)*
  Hillman said this item is complete. Hillman confirmed that the PRCC Facilitator has shared this information with the PRCC.
- *PRCC HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item V-C).*
  Hillman said this item is ongoing.

II. Joint HCP-HCs and PRCC HSC

A. DECISION: Tagging Chiwawa/Nason Conservation Program Spring Chinook Salmon

Mike Tonseth said the Joint Fisheries Parties (JFP) met on Monday, April 15, 2019. He said that the issues that the JFP deals with include making sure programs are consistent with permit terms and conditions, US v Oregon, and management plans.[1] The JFP came up with an interim fish marking solution that balances the programmatic needs to incorporate the offspring of HxH crosses into the conservation program (to meet program target numbers). The solution is to add a secondary tag that differentiates the offspring of HxH crosses (HxH fish) from offspring of WxW crosses (WxW fish).

The JFP agreed that the HxH fish used to satisfy the shortfall in the number of conservation program fish will be tagged with coded wire tags (CWT) in the snout, blank wire tags (BWT) in the caudal peduncle, and will be ad-present (adipose fin unclipped); HxH fish snout wire CWT will have a different code than the WxW fish. Tonseth said the JFP recognizes this is not a preferable approach given the potential for injuries in the dorsal spine when injecting the caudal tag. Tonseth said all other HxH fish will be ad-clipped (adipose fin absent).

The proposed tagging scheme for all components of the Nason and Chiwawa conservation and safety-net programs was written on the white-board, summarized in the following table:

Number	Program	Origin	Adipose Mark	Snout Mark	Body Mark
144,000	Chiwawa Conservation	WxW	Ad +	CWT	None
		HxH	Ad +	CWT	Caudal BWT
123,000	Nason Conservation	WxW	Ad +	None	Dorsal CWT[a]
		HxH	Ad +	CWT	Caudal BWT
98,000	Nason Safety-Net	HxH	Ad -	CWT	None

Note:
a. Prior to 2016, Nason Conservation Program WxW fish were marked with a snout CWT and a caudal CWT

[1] Conditions include those stipulated under NMFS Biological Opinion Consultation number NWR-2013-9707 issued July 3, 2013, and reinitiated May 29, 2015; NMFS Permit numbers 18118 and 18121 issued July 3, 2013, and amended May 29, 2015; and the following Hatchery and Genetic Management Plans:

- Chelan County Public Utility District No. 1 and Washington Department of Fish and Wildlife (WDFW), 2009. *Hatchery and Genetic Management Plan (HGMP) Wenatchee Upper Columbia River Spring Chinook: Chiwawa Spring Chinook*. October 14, 2009.
- Colville Confederated Tribes, National Marine Fisheries Service, U.S. Fish and Wildlife Service (USFWS), WDFW, and Yakama Nation, 2010. *Wenatchee Basin Spring Chinook Management Plan*. November 4, 2010.
- Public Utility District No 2 of Grant County (Grant PUD), WDFW, and Yakama Nation, 2009. *Hatchery and Genetic Management Plan (HGMP) Upper Columbia River Spring-Run Chinook Salmon – Nason Creek Supplementation Program*. September 15, 2009.
- Grant County PUD, WDFW, USFWS, and Yakama Nation, 2009. H*atchery and Genetic Management Plan (HGMP) Upper Columbia River Spring-Run Chinook Salmon – White River Supplementation Program*. September 15, 2009.

Tonseth said this will allow the programs to prioritize WxW fish for spawning ground and safety-net programs. Keely Murdoch said this is the most parsimonious solution.

Catherine Willard asked if monitoring technicians will be able to tell the difference between the caudal and dorsal tags when handling adult fish? Tonseth said yes, in an adult fish the tags are far enough apart. Tonseth said the most important thing is to bring the snout CWTs back from carcass surveys to identify the differential codes and program. He said it can be noted in the field whether a fish is ad-clipped or ad-present, then whether it has a wire tag. Tonseth said when identifying adults during surveys there will be some overlap between Chiwawa program HxH fish and Nason program HxH fish, because they will both be marked ad-present and with caudal BWTs, but they will be differentiated by the snout codes. Murdoch said it will be helpful to note dorsal versus caudal tags when handling fish or carcasses during the spawning season.

Murdoch said there may be different ways of tagging in the caudal region that can minimize injuries. Tonseth intends to discuss tag placement with Chuck Aldrich (WDFW) to ensure techniques minimize injury to juveniles.

Peter Graf asked Tonseth to clarify if and how the JFP considered the guidance provided in the various permitting and management documents. Graf said the proposed tagging scheme seems inconsistent with the BiOp. Tonseth said there was not a safety-net program considered for the Nason program in the BiOp. Tonseth said another conflict was deference to the HGMPs and Spring Chinook Salmon Management Plan; he said the Management Plan has much more detail. Murdoch noted that the section where marking direction was given in the BiOp was in the proposed program, not in the terms and conditions section. Tonseth and Murdoch noted that the Spring Chinook Salmon Management Plan was cited as an addendum to the permits.

Bill Gale said a minimum number of Leavenworth Hatchery fish are tagged with CWTs to make escapement calculations (approximately 200,000 fish or 17% of the program). Todd Pearsons asked what the risk would be of picking up Leavenworth program adult fish (strays) at Tumwater Dam and mistaking them for Chiwawa or Nason fish (they could be confused with Nason safety-net fish during handling). Gale said less than 3% of the adult return of the 200,000 CWT tagged fish are observed going over Tumwater Dam. Matt Cooper said very few strays are observed on the spawning grounds. Gale said an analysis was done for the HGMP if people would like to see more detail. Pearsons said if a Nason fish loses its CWT, it would likely be removed at Tumwater Dam because it would be assumed to be a Leavenworth stray. Gale said that an ad-present fish without CWT observed at Tumwater Dam is more likely a Nason program fish that has shed its tag than a Leavenworth stray.

Pearsons said one topic he wrestles with is whether the work done to keep these populations separate will be a positive, or if the added handling will counteract the positive aspects. Murdoch said the scanning and handling would be the same (as with previous tagging schemes); for the conservation program fish the tag is in a different location (depending on origin; caudal versus dorsal body tag).

Graf said he has a broader question on the Nason program: if adult management is done for escapement goals that prioritize wild fish, then WxW fish, and then HxH fish, why is a separate designation needed for safety-net fish?

Murdoch said the main difference is the safety-net fish are ad-clipped and subject to the fishery. Graf asked if the concern is that not enough may make it back in low return years. Murdoch said yes, we are in the middle of considering reducing program sizes and Committee representatives will need to consider and agree to the direct use of safety-net fish in the conservation programs. Murdoch said the safety-net program also has a hierarchy for broodstock selection—the first choice is hatchery-origin conservation program fish (identified by snout CWT and caudal CWT) and then safety-net fish.

Pearsons asked if there was discussion in the Nason program about whether to blend the groups rather than segregate them by marking. That is, is it better to separate WxW fish from HxH fish, or better biologically to mix the progeny among the conservation program and safety-net program and go forward with the same total number of fish? Graf said this could be done by using wild females for both programs. Tonseth said no, this was not considered for the 2018 brood due to the expediency of the issue with the brood on hand. Gale noted sometimes these decisions are made on the spawning day; the priority should be that all wild fish are spawned no matter the sex or sex ratio on hand on a given spawning day. Gale said a fish with a wild parent should just be tagged as wild for simplifying spawning work in the hatchery. Gale said the goal should be to make as many wild crosses as possible. Tonseth said this conversation can be had in coming months as spawning does not occur until August. Tonseth agreed the WxW pairings should be prioritized but would want to review the permits, HGMPs, and Spring Chinook Management Plan again in case there is not continuity between documents.

Hillman asked whether the HCP-HCs and PRCC HSC are ready to vote on the proposed marking scheme. Pearsons said Grant PUD is not ready to vote. Tonseth said this marking scheme only affects the brood year 2018 Chiwawa conservation program (permit held by Chelan PUD only) since the Nason program has enough WxW to meet brood year 2018 conservation program targets, but this problem may occur for brood year 2019 for the Nason program. Tonseth said Chiwawa fish will be marked May 1, 2019. Gale said he would prefer to allow all members the time to review and vote by email for both brood years. Tonseth said this cannot wait for a vote to prepare for marking the Chiwawa program this year and requested that a vote be made as soon as possible.

Pearsons said Grant PUD wants more information before locking into a long-term approach to determine how frequently a caudal peduncle CWT could be necessary for marking HxH fish, because the success depends heavily on marking techniques. Gale said this scheme only locks the program into marking HxH fish and WxH would be marked as wild fish. Murdoch said the YN coho salmon program has used this caudal peduncle tagging technique without any injury.

Hillman called for a vote by the Rock Island HC on the proposed marking scheme for Chiwawa program brood year 2018 fish and brood year 2019 fish, and the Nason program brood year 2019 fish. Hillman said today's votes are contingent on Grant PUD's vote, which they will submit by end of day Tuesday. The marking scheme was approved in the meeting by Chelan PUD, YN, USFWS, CCT, WDFW, and NMFS. Grant PUD will provide a vote on the marking scheme for Nason program brood year 2019 fish by end of day Tuesday, April 23, 2019.

B. Broodstock Collection Protocols Development Timeline

Tracy Hillman introduced the topic of discussion and said the issue is that Mike Tonseth does most of the work that work could be more evenly shared among Representatives, and the existing drafting schedule does not provide enough time to discuss topics that may require more extensive discussion in the Committees. One option is for the permit holders to start developing the broodstock collection protocols (Protocols) in November. Run projections would not yet be available; however, many topics could be initiated earlier.

Todd Pearsons suggested going forward with the previous year's protocols as the default condition and it would be the responsibility of members to bring up potential changes and major issues early enough to start discussions ahead of drafting the actual protocols. Pearsons said there are a number of items that could be discussed before November without the need for run predictions. Pearsons said a topic that has major implications for a given program would be sponsored by a member and discussed within the Committees.

Bill Gale said the Protocols is the wrong vehicle for making some of the changes that have been proposed in draft Protocols. Some changes should not be viewed as a change to the Protocols but a change to a program that gets recorded in an SOA. Gale suggested having a discussion about what types of changes are appropriate for the Protocols and what are not, and said that marking and program size, for instance, are not an issue to bring forth in the Protocols. Greg Mackey agreed with both Pearsons' and Gale's points. Pearsons said the Protocols should not be the decision-making document. Gale said it is unfair for the responsibility of decisions to fall to Tonseth as he drafts the Protocols. Keely Murdoch agreed to the points raised, but also noted that developing the Protocols does act as a catalyst for raising issues to be discussed.

Hillman suggested revisiting the protocol earlier, in October or November, to determine whether there are unresolved issues. He also suggested discussion of a demarcation that would guide what should be raised to the level of an SOA. Mackey said if it's a deviation from the BiOp or permit that controls the program, an SOA is the vehicle for formal agreement. Mackey said there would be some judgement call on the level of importance (of a topic to require an SOA). Pearsons said with regards to an SOA, it seems that different Members or Committees have different sensitivities to what should be elevated to the level of an SOA and should be handled on a case-by-case basis. Catherine Willard agreed.

Gale said the Protocols should be viewed as a document that is a convenient source for annual broodstock collection, trapping, and geneflow management information, and useful as a living document. Gale said there should be separation of the information that could change annually.

Mackey said in the old Section 10 permits, it actually stated that WDFW should develop the Protocols annually. Mackey said the new approach to permitting is to state that the permit-holders (WDFW and PUDs) would produce the Protocols.

Hillman said the HCP-HCs and PRCC HSC will start in September and October to identify changes needed in the Protocols and by whom. Hillman said all topics should be discussed, then the Committees can decide which ones are topics that deserve further discussion and/or SOAs.

Larissa Rohrbach agreed to add review of the Protocols to the September agenda. Rohrbach also agreed to distribute the SOA on the Protocols drafting timeline[2] to the HCs and HSC to consider whether this SOA is acceptable to all committees. Committee members agreed to provide revisions to the Protocols drafting timeline SOA back to Tonseth for discussion during the June HCP-HC and PRCC HSC meeting.

C. Out-Planting Surplus Adult Methow Spring Chinook Salmon

Mike Tonseth said the 2017 *Out-Planting Surplus Methow Composite Spring Chinook Salmon Adults*[3] memorandum will be updated with details in the coming weeks but that returns are looking extremely low for 2019, so this may not be implemented this year.

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[2] Habitat Conservation Plan Hatchery Committees and Coordinating Committees, 2014. *Final Statement of Agreement Annual Broodstock Collection Protocols*. October 28, 2014.

[3] Chelan PUD, 2017. *Out-planting Surplus Methow Composite Spring Chinook Salmon Adults.* Prepared for the HCP Hatchery Committee. April 19, 2017.

D. NMFS Consultation Update

Brett Farman said the Methow Steelhead EA is out for public comment.[4] Farman said for the WNFH program EA, they are waiting for internal NMFS review before it can go out for comment, which is no change to the status from the last meeting.

Tracy Hillman asked how long the public comment period is. Farman said 30 days. Emi Kondo (NMFS) said the comment period closes May 2, 2019. Kondo said one general comment was received so far. Hillman and Catherine Willard asked what the comment was. Kondo said it's from a group that has submitted a generic paragraph about how hatchery fish are impacting other animals, but it is not well supported and will be noted for the record.

Farman said the Methow Steelhead EA and all summer Chinook salmon program HGMPs are out for public comment.[5] Once the comment period closes the decisions can be made and determination letters and permits finalized. Farman said Kondo has received requests to extend the permit review period—she has asked that everyone return comments as soon as possible. Kondo will attend the next meeting to discuss and resolve any comments.

Bill Gale said he has not seen language about the 4d determination. Kondo said she will follow up with Charlene Hurst to obtain the status of the 4d determination. Kondo said the 4d determination is less prescriptive so it may be that there would not be any additional terms and conditions added to those in the BiOp. Farman said Hurst is in the process of drafting the 4d determinations following the process for Evaluation and Recommend Determinations (ERD). Farman said he will also attend the May meeting.

Kirk Truscott said when he reviewed the unlisted Chinook salmon bundle, he found a typo—in the Douglas WDFW permit there was a reference to Grant PUD. Kondo said she will make note. Greg Mackey said Douglas PUD has flagged it and will send it in their responses to Kondo.

E. Streamlining HCP-HCs and PRCC HSC Meetings

Tracy Hillman reminded the committees that the protocols have been revised to streamline the HCP-HCs and PRCC HSC processes and materials.

Todd Pearsons asked if the conflict of interest SOA has been revised. Hillman noted that members discussed the idea of reducing and simplifying the SOA, but at this time the SOA has not been revised. Hillman noted it would be helpful to agree to the distribution method and lists.

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[4] NOAA Fisheries public comment website: https://www.westcoast.fisheries.noaa.gov/hatcheries/UCRHatcheries_fall_summer-stlhd/UCR_smr-fall_hatch_rvw.html.

[5] NOAA Fisheries public comment website: https://www.westcoast.fisheries.noaa.gov/hatcheries/UCRHatcheries_fall_summer-stlhd/UCR_smr-fall_hatch_rvw.html.

Mike Tonseth supports the method of sending draft materials to primary representatives and alternates. Bill Gale agreed as long as USFWS can add a small set of specific people to the "primary" list. These people need to be on the primary list because they work on draft materials. Pearsons suggested developing a primary list that consists of representatives, alternates, and active participants, who receive all draft and final materials. Members suggested the primary distribution list include the addition of Betsy Bamberger, Shane Bickford, Deanne Pavlik-Kunkel, Pat Wyena (Wanapum Tribe), Charlie Snow, McClain Johnson, Michael Humling, and Cory Kamphaus. Hillman noted that the addition of Pavlik-Kunkel and Wyena would require approval by the HCP-CC.

Hillman said he will inform John Ferguson and Kristi Geris (facilitator and support staff for the HCP-CC, respectively) of the plan to develop a primary distribution list for distributing draft materials, and to add select participants to the primary distribution list, and a broader/secondary list for distributing only final versions of materials. Once the distribution lists are approved by the HCP-HCs and PRCC HSC, one the of representatives to the HCP-CC will advance the list to the HCP-CC for their approval.

Pearsons said Grant PUD has reservations about most of the issues discussed in the existing HCP-HC Conflict of Interest SOA that involve contracting, which should be discussed outside the PRCC HSC. Grant PUD is generally in favor of having a Conflict of Interest SOA, with revisions.

Larissa Rohrbach will re-distribute a revised Conflict of Interest SOA, meeting protocols, and updated distribution list for HC for approval in the May 2019 HCP-HCs and PRCC HSC meeting.

III. PRCC HSC

A. Approve the March 11 and March 20, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the draft March 11 conference call and March 20, 2019 meeting minutes as revised.

B. DECISION: Approve the 2019 Priest Rapids Hatchery M&E Implementation Plan

Todd Pearsons said no comments or revisions were received on the Draft 2019 Priest Rapids Hatchery M&E Implementation Plan. Tracy Hillman called for a vote to approve the Draft 2019 Priest Rapids Hatchery M&E Implementation Plan. All Parties of the PRCC HSC approved the Draft 2019 Priest Rapids Hatchery M&E Implementation Plan.

Grant PUD will finalize and Larissa Rohrbach will distribute the Draft 2019 Priest Rapids Hatchery M&E Implementation Plan to the PRCC HSC.

C. White River Memorandum Progress Update

Tracy Hillman said he asked for more direction from the PRCC on the development of the memorandum on the future of the White River Spring Chinook Salmon program. Hillman said Denny Rohr (PRCC facilitator) will have feedback for the PRCC HSC. Keely Murdoch said in the PRCC meeting, little progress was made in discussion because there was confusion about the status of the memo and program. Murdoch said some representatives thought there was agreement on developing a small technical group to issue a request for proposals. Murdoch said that Rohr requested more time to review past meeting summaries to understand the status of the memo and report back to the HSC. Bill Gale asked whether the plan is to discuss the topic further in the PRCC; Murdoch said yes but an agenda hasn't been issued for the next meeting. Murdoch said there was consensus agreement to extend the timeline to allow Craig Busack (NMFS) to participate.

Hillman noted this topic will remain ongoing.

IV. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are on May 15, 2019, at Grant PUD; June 19, 2019, at Grant PUD; and July 17, 2019 (TBD).

V. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Todd Pearsons‡	Grant PUD
Brett Farman*‡º	National Marine Fisheries Service
Emi Kondoº	National Marine Fisheries Service
Matt Cooper*‡	U.S. Fish and Wildlife Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Alf Haukenes	Washington Department of Fish and Wildlife
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Pat Wyenaº	Wanapum Tribe
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
º Joined by phone

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: July 17, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the May 15, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, May 15, 2019, from 9:00 a.m. to 11:00 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is going)*
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan)* based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*

- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will confirm with Andrew Murdoch that Wenatchee spring Chinook DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success Study extension agreement and provide an update to the extension. (Item I-A) *(Note: this item is ongoing.)*
- Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols. (Item I-A) *(Note: this item is ongoing.)*
  - Use of age-3 males in broodstock
  - Use of alternative, non-random mating strategies
  - Establishing ranges around broodstock collection targets
  - Collection sites for Chiwawa spring Chinook salmon broodstock
- Tracy Hillman and Larissa Rohrbach will add review of the Broodstock Collection Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-A). *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the HCP-HCs Annual Broodstock Collection Protocols development timeline Statement of Agreement (SOA) (Item II-A). *(Note: this item is ongoing.)*
- Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow spring Chinook salmon returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion in a future HCP-HCs meeting (Item II-B). *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the 2017 *Out-planting Surplus Methow Composite Spring Chinook Salmon Adults* memorandum (Item II-B). *(Note: this item is ongoing.)*
- Emi Kondo (National Marine Fisheries Service [NMFS]) will confirm the status of the draft Wells Hatchery Methow Steelhead Program permit with Charlene Hurst (Item II-D).

Wells HCP Hatchery Committee

- Greg Mackey will provide a revised version of Douglas PUD's draft 2019 M&E Implementation Plan for HCP-HC approval by email (Item I-A). (*Note: This item is ongoing*)

PRCC Hatchery Subcommittee

- PRCC-HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item III-B). (*Note: This item is ongoing*)

Decision Summary

- The HCP-HCs and the PRCC HSC approved the updated meeting protocols and distribution lists in today's meeting (Item II-C).
- The HCP-HCs and the PRCC HSC will not re-activate the expired HCP-HCs Conflict of Interest Policy SOA (Item II-C).

Agreements

- There were no agreements discussed during today's meeting.

Review Items

- The *Draft Grant County PUD Hatchery Monitoring and Evaluation Implementation Plan for Spring and Summer Chinook in the Wenatchee Basin and Summer Chinook in the Methow Basin 2020* was provided by Todd Pearsons on June 6, 2019 for a 30-day review period, as distributed by Larissa Rohrbach via email that same day. The review period ended on July 7, 2019.
- The *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs Draft 2018 Annual Report* and appendices was provided by Tracy Hillman on June 17, 2019 for a 30-day review period, and revised on June 20, 2019 as distributed by Larissa Rohrbach via emails the same days. The review period ends on July 17, 2019.

Finalized Documents

- The PRCC HSC-approved 2019 Priest Rapids Hatchery M&E Implementation Plan was finalized and distributed on May 20, 2019.
- The HCP-HCs and the PRCC HSC-approved Meeting Protocols and Distribution Lists were finalized and distributed on May 20, 2019.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the April 17, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the agenda. No changes to the agenda were requested.

The HCP-HCs and PRCC HSC representatives reviewed the revised draft April 17 meeting minutes. Larissa Rohrbach said there were some minor revisions that the representatives then reviewed. The HCP-HCs and PRCC HSC representatives approved the draft April 17, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on April 17, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on April 17, 2019)*:

Joint HCP-HCs and PRCC HSC

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under HCP-HCs' purview (Item I-A).*
  Hillman said this item is a long-term ongoing item.
- *Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A).*
  Tom Kahler said this item is ongoing. Mackey indicated in an email to Larissa Rohrbach that he may give a presentation on this topic during the June meeting.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).*
  Tonseth said this item is ongoing.
- *Catherine Willard will update the genetics section of the Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan) based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A).*
  Willard said she has made progress on this item and that it is ongoing.
- *Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).*
  Truscott said he has made progress on this topic and a memorandum will be provided to the Committees within a week with potential approaches for elemental signature analysis for 2019. Truscott reminded the Committees the goal is to distinguish Okanogan spring Chinook

salmon from Methow spring Chinook salmon. In the memorandum, the CCT will propose an approach for analyzing scales, fin rays, and otoliths (otoliths require lethal sampling). He said some samples may be used for retrospective analysis to see how prevalent Methow fish may have been in the Okanogan brood in the past. He said the goal will be to minimize the number of Methow fish integrated into Okanogan brood in the future. He said spring Chinook salmon broodstock are already scale- and DNA-sampled but there is potentially a need to collect additional scales in 2019 for elemental signature analysis. He said water samples collected in the Okanogan and Methow rivers are also readily available for this type of assessment. He said these methods could be implemented in 2021 for the returning natural-origin adults so it's not too early to start testing whether these methods could be used to discern a difference between these populations.

- *Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said this item is ongoing.
- *Mike Tonseth will confirm with Andrew Murdoch that Wenatchee spring Chinook salmon DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success Study extension agreement and provide an update to the extension. (Item I-A)*
  Tonseth said this item is ongoing. He said the table in the memorandum is accurate, but he has identified language in the memorandum that is confusing. He said that he and Murdoch will revise the memorandum to clarify the agreement.
- *Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A).*
  Rohrbach said this item is ongoing. Several representatives noted they will be absent in June.
- *Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Protocols) (Item I-A).*
  - *Use of age-3 males in broodstock*
  - *Use of alternative, non-random mating strategies*
  - *Establishing ranges around broodstock collection targets*
  - *Source for Chiwawa spring Chinook salmon broodstock*

  Hillman said this item is ongoing. Greg Mackey said in an email he may provide an update on alternative mating strategies during the June meeting. Catherine Willard reminded the Committees that these topics relate to 2020 brood collection, not 2019 brood collection.
- *Tracy Hillman and Larissa Rohrbach will add review of the Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-A).*

Hillman said this item is ongoing. The revisions to the development timeline SOA will be discussed in today's meeting.

- *Brett Farman will ask Amilee Wilson and Craig Busack (National Marine Fisheries Service [NMFS]) to clarify the intent of the direction provided in NMFS Biological Opinions (BiOps) for marking Chiwawa and Nason conservation programs juvenile spring Chinook salmon (Item II-A).*
  Farman said this item is complete.
- *Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow spring Chinook returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion (Item II-C).*
  Tonseth said USFWS provided new information, which he is currently reviewing. Matt Cooper said Winthrop National Fish Hatchery has a lot of fish coming in as of this morning. Cooper said that Michael Humling ran the 3-population model looking at several out-planting scenarios and he sent the results to Tonseth for consideration. Cooper said the scenarios were designed to maintain high PNI on spawning grounds while still supplementing the number of fish on spawning grounds with hatchery-origin fish. For example, Humling modeled out-planting females only to avoid hatchery by hatchery spawning from occurring on the spawning grounds. Cooper said this is the likely proposal from USFWS.
- *Mike Tonseth will revise and redistribute the 2017 Out-planting Surplus Methow Composite Spring Chinook Salmon Adults memorandum (Item II-C).*
  Tonseth said this item is ongoing (see update to the previous action item).
- *Deanne Pavlik-Kunkel will provide Grant PUD's approval of routine distribution of merged PRCC HSC and HCP-HC meeting materials according to the revised meeting protocols (Item II-E).*
  Pavlik-Kunkel said this item is complete and will be discussed in today's meeting.
- *Once approved by the HCP-HCs and PRCC HSC, Tracy Hillman will present the revised merged HCP-HC and PRCC HSC distribution list to the HCP-CC for approval (Item II-E).*
  Hillman said during the last HCP-CC meeting, it was decided that it was acceptable for Hillman to propose the list to the CC rather than a representative. He said he will propose the list approved in today's meeting to the HCP-CC.

Wells HCP Hatchery Committee

- *Greg Mackey will provide a revised version of Douglas PUD's draft 2019 M&E Implementation Plan for HCP-HC approval by email (Item I-A).*
  Tom Kahler said this item is ongoing. Mike Tonseth said it is unlikely that spring Chinook salmon PIT tagging at the Priest Rapids Dam off-ladder adult fish trap will occur in 2019, because the Bonneville Power Administration has requested more time and background materials to review WDFW's proposal to shift from PIT tagging steelhead to PIT tagging

spring Chinook salmon. Tonseth said it is likely that WDFW will continue to PIT tag steelhead at the Priest Rapids Dam off-ladder adult fish trap in 2019.

PRCC Hatchery Subcommittee

- *Todd Pearsons will finalize the PRCC HSC-approved 2019 Priest Rapids Hatchery M&E Implementation Plan for distribution (Item III-B).*
  This item is complete. Larissa Rohrbach will distribute the final 2019 Priest Rapids Hatchery M&E Implementation Plan following the June meeting.
- *HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item III-C*).
  Hillman said he received feedback from Denny Rohr (Chair of the PRCC) and will discuss it during today's meeting.

II. Joint HCP-HCs and PRCC HSC

A. Broodstock Collection Protocols Development Timeline SOA Update

Tracy Hillman reminded the Committees that in the previous version of the Broodstock Collection Protocols (Protocols) development SOA,[1] the final draft is due for HCP-HCs approval 10 days prior to their February meeting (meeting occurs approximately February 15). Mike Tonseth said he will provide revisions to that SOA in June. Todd Pearsons said this should be based on the previously discussed approaches to addressing changes to the Protocols. Hillman reminded the Committees of their agreement to review the Protocols starting in September.

B. Out-Planting Surplus Adult Methow Spring Chinook Salmon Update

Mike Tonseth said the 2017 *Out-Planting Surplus Methow Composite Spring Chinook Salmon Adults*[2] memorandum will be updated based on progress described in the review of Action Items (Item I-A).

C. DECISION: Streamlining HCP-HCs and PRCC HSC Meetings

Distribution Lists

Tracy Hillman started the discussion by projecting and reviewing the proposed distribution lists that he and Larissa Rohrbach compiled. Hillman said there are two separate distribution lists: a primary list and a secondary (cc) list for each group (HCP-HCs and PRCC HSC) for a total of four distribution lists. He said it would be convenient if there were only two distribution lists (a primary list and a

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[1] Habitat Conservation Plan Hatchery Committees and Coordinating Committees, 2014. *Final Statement of Agreement Annual Broodstock Collection Protocols*. October 28, 2014.

[2] Chelan PUD, 2017. *Out-planting Surplus Methow Composite Spring Chinook Salmon Adults.* Prepared for the HCP Hatchery Committee. April 19, 2017.

secondary list), but consolidation of the four lists into two lists requires agreement from all parties. Hillman said alternatively, it would be nice to at least have one primary list and two secondary lists (one secondary list for the HCP-HC and one secondary for the PRCC HSC). Hillman said this will reduce the number of emails members receive.

Hillman started by reviewing the proposed primary lists to indicate which recipients are identified on one list but not on the other and asked members if they agree on the inclusion of recipients on a single primary distribution list. Hillman recorded decisions on the revised distribution list.

Hillman reviewed the proposed secondary lists and asked members if they prefer to maintain separate secondary lists. Tom Kahler said that because those on the secondary lists are receiving only final versions of documents, and final documents are publicly available on PUD websites, there should be little concern combining the secondary lists. Hillman reviewed each recipient and noted approval or revisions by the HCP-HCs and PRCC HSC.

Following review of individuals on the primary and secondary lists, Hillman asked the HCP-HCs and PRCC HSC if they approved the two lists. Members approved the two lists. Individuals on the primary list will receive all communications, while individuals on the secondary list will receive only final documents. Hillman will present the approved distribution lists to the HCP-CCs for their approval during their meeting on May 28 (the final updated distribution list is included in Attachment B).

Conflict of Interest SOA

Hillman said that the Conflict of Interest SOA has been revised and simplified considerably to be able to maintain an SOA but allow for more flexibility. Todd Pearsons said Grant PUD has some concern with what is being described as a conflict of interest. Pearsons said he can see the value of having an SOA, but the PRCC HSC doesn't make funding decisions, so the content needs to be represented correctly. Mike Tonseth said he had a similar concern with this content and suggested revisions to the language pertaining to the mission of the Committees members.

Keely Murdoch said she has some concerns about the need for recusing oneself from discussions. Murdoch said because the committees operate by consensus, a party that proposes a project could have a conflict of interest but would need to recuse themselves from discussion and voting on the project. However, this would not matter because the recused person would likely have given a positive vote and it would not change the outcome if all other members voted in favor of the project. Murdoch said a consensus-based committee minimizes the effect of conflicts of interest. Murdoch said that perhaps what is needed is an agreement to identify potential conflicts for the record in the notes. Hillman gave an example of when different entities respond to a request for proposals and respondents include voting members. Under this scenario, would there be a conflict of interest?

Murdoch and Catherine Willard said the Committees do not make funding decisions. Rather, the PUDs make those decisions.

Matt Cooper said Bill Gale (USFWS) wanted an SOA or a statement in the meeting protocols in case an outside party asks about the Committees' policy regarding conflicts of interest. Murdoch said these points could be summarized in the meeting protocols. Members agreed that there is no need for a conflict of interest SOA and noted that adding language to the meeting protocols stating that because decisions are consensus based in the Committees' and they do not make funding decisions, there is no need for members to recuse themselves from discussing and voting on decision items. Hillman said he would add language to the meeting protocols summarizing these points.

The HCP-HCs and PRCC HSC agreed to incorporate language on conflicts of interest into the meeting protocols document and not reactivate the lapsed conflict of interest SOA.

Meeting Protocols

Hillman said there are no new changes to the way the Committees operate; the revisions are intended to streamline the Protocols because all committees are now chaired or facilitated and supported by the same staff. Hillman projected and reviewed a draft version of the meeting protocols that included revisions from Grant PUD.

Cooper asked if the meeting protocols can be reviewed annually. Hillman said, yes, they can be reviewed annually or at any time. Kahler noted that the HCP Tributary Committees review their protocols annually and it would be appropriate for the HCP-HCs and PRCC-HSC to do the same.

Rohrbach and Hillman noted differences between HCP-HCs and PRCC HSC protocols, particularly that the HCP-HCs requires a 10-day notice of a decision item on an agenda. Rohrbach suggested meeting the requirement for a 10-day notice by including proposed agenda items and noting decision items in the call for agenda items that will be routinely sent 2 weeks in advance of the meetings.

Kirk Truscott noted that the HCP-HCs are more autonomous than the PRCC HSC. Truscott asked if decisions or SOAs made by the PRCC HSC require approval by the PRCC. Pearsons noted that not all SOAs become approved by the PRCC and that it is noted on the SOAs whether they are HSC-approved and/or PRCC approved. Murdoch asked what the difference is between declining to approve or abstaining from approval at the level of the PRCC. Pearsons said all SOAs go to the PRCC, but it is the PRCC's decision to weigh in whether to approve or not to vote at all. Tonseth suggested this level of detail may not be necessary for the meeting protocols.

Pearsons asked if it should be assumed that all SOAs go to the HCP-CCs and the PRCC HSC. Hillman said within the HCPs, it is possible that an SOA approved by the HCs (or the HCP Tributary

Committees) could be contested by the HCP-CCs and the CCs could then ask the HCs to reevaluate an agreement. Kahler noted that the attitude of the HCP-CCs has been deference to the HCs and Tributary Committees.

Hillman called for a vote on the revised version of the streamlined meeting protocols and all representatives of the HCP-HCs and PRCC HSC approved (the final updated meeting protocols are included in Attachment C).

D. NMFS Consultation Update

Emi Kondo provided an update on the Steelhead and Summer and Fall Chinook Salmon National Environmental Policy Act documents (Environmental Assessments). She said NMFS is still completing the Finding of No Significant Impact (FONSI) for the Steelhead and Summer and Fall Chinook Salmon Environmental Assessments. She said NMFS is crafting a FONSI document that states the action will not have a significant impact to the environment; therefore, an Environmental Impact Statement will not be necessary. She said that James Archibald (NMFS) is helping with the FONSI. She said there were no major comments on the Steelhead or Summer and Fall Chinook Salmon permits language. She said the major change is that permits will be extended to 2030. She said that after the FONSI is completed, the internal processes include two layers of internal review and West Coast regional review.

Kirk Truscott asked about the Wells Hatchery facility draft steelhead permit because the applicants haven't received a draft permit for review. Mike Tonseth said a BiOp is available but they have not received the draft permit from NMFS for review. Kondo said she will check with Charlene Hurst on the status of the Wells Hatchery program permit for Methow Steelhead.

Kondo also said there is an effort at NMFS to document and streamline the primary recipients for required reporting products and they could provide updates in future meetings. Brett Farman said another goal is to combine the reporting to meet permit conditions with bull trout encounter reporting for more accurate encounter tracking.

Todd Pearsons asked to whom at NMFS reports and protocols are submitted. Tonseth noted that different people at NMFS are recipients of different reports. Catherine Willard said it is her assumption that all materials are provided to the NMFS representative for appropriate distribution within NMFS. Tracy Hillman noted that all reports, plans, and materials are available in the HCP-HCs and PRCC HSC annual reports and those can be submitted to the NMFS representative on the Committees. He added it would be helpful if there is written guidance that all materials should be provided to the "NMFS representative" (rather than to a named individual), so that if there is turnover within the position, it will still be clear to whom those materials should be sent. Pearsons said it would be helpful to note in the permitting documents that it is the NMFS representative that is the single point of contact.

Kondo said NMFS will ultimately have an internal database-style list indicating which individuals are responsible for receiving which materials. She said it is NMFS's responsibility to ensure reports are received and reported in a timely manner. Farman said NMFS is making an effort to track this better.

Kondo then shared the two comments that were received on the upper Columbia steelhead and spring Chinook salmon hatchery programs and said they were noted for the record but did not contain substance that required action to be taken. Truscott asked how often it happens that no comments are submitted on hatchery permit environmental reviews, but those programs are later contested or litigated. Kondo said it is rare for comments to be submitted on hatchery permit environmental reviews and confirmed that no communication was received from entities who have contested hatchery programs in the past.

III. PRCC HSC

A. Approve the April 17, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the draft April 17, 2019 meeting minutes as revised (Item I-A).

B. White River Memorandum Progress Update

Tracy Hillman provided an update from Denny Rohr on the PRCC's response to the PRCC HSC's memorandum regarding the White River Hatchery Program. Hillman read from an email from Denny Rohr and said the PRCC direction is still under discussion within the PRCC. Hillman said the PRCC HSC will withhold from further discussion until further direction is provided from the PRCC HSC. Hillman said it would be ideal to receive direction soon to take advantage of Craig Busack's (NMFS) participation prior to his retirement. Keely Murdoch said this was an accurate summary of the status of the PRCC progress.

IV. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are on July 17, 2019, August 21, 2019, and September 18, 2019, at Grant PUD in Wenatchee, WA.

V. List of Attachments

Attachment A   List of Attendees

Attachment B Final Updated HCP-HCs and PRCC HSC Distribution Lists

Attachment C Final Updated HCP-HCs and PRCC HSC Meeting Protocols

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Tom Kahler*	Douglas PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Todd Pearsons‡	Grant PUD
Brett Farman*‡	National Marine Fisheries Service
Emi Kondo	National Marine Fisheries Service
Matt Cooper*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

Attachment B
Final Updated HCP-HCs and PRCC HSC Distribution Lists

HCP HCs and PRCC HSC Distribution Lists

Primary Distribution List:

HCP-HCs and PRCC HSC Members and Active Participants List

(Receive all email communications.)

Organization	Name	HCP-HCs Role	PRCC-HSC Role
BioAnalysts	Tracy Hillman	Chair	Facilitator
Anchor QEA	Larissa Rohrbach	Support	Support
Anchor QEA	Sarah Montgomery	Support	Support
Anchor QEA	Kristi Geris	HCP-CC Support	HCP-CC Support
CCT	Kirk Truscott	Representative	Representative
CCT	Casey Baldwin	Alternate	Alternate
CPUD	Catherine Willard	Representative	HCP-HC Representative
CPUD		Alternate	HCP-HC Alternate
DPUD	Greg Mackey	Representative	HCP-HC Representative
DPUD	Tom Kahler	Alternate	HCP-HC Alternate
DPUD	Betsy Bamberger	Fish Health Expert	HCP-HC Health Expert
DPUD	Shane Bickford	Policy Lead	HCP-HC Policy
GPUD	Todd Pearsons	PRCC HSC Representative	Representative
GPUD	Peter Graf	PRCC HSC Alternate	Alternate
GPUD	Deanne Pavlik-Kunkel	PRCC HSC Alternate	Alternate
Wanapum	Pat Wyena	PRCC HSC Interested Party	Interested Party
NMFS	Brett Farman	Representative	Representative
NMFS	Charlene Hurst	Alternate	Alternate
USFWS	Matt Cooper	Representative	Alternate
USFWS	Bill Gale	Alternate	Representative
USFWS	Michael Humling	Technical Support	Technical Support
WDFW	Mike Tonseth	Representative	Representative
WDFW	Chad Jackson	Alternate	Alternate
WDFW	Charles Snow	Technical Support	Technical Support
WDFW	McLain Johnson	Technical Support	Technical Support
YN	Tom Scribner	Representative	Representative
YN	Keely Murdoch	Alternate	Alternate

Attachment B
Final Updated HCP-HCs and PRCC HSC Distribution Lists

Secondary Distribution List:

HCP-HCs and PRCC HSC Broader Distribution List

(Receive only email communications that include final versions of meeting materials and documents, unless otherwise indicated by HCP-HCs and PRCC HSC members.)

Organization	Name	Reason for Inclusion	HCP-HCs Distribution	PRCC-HSC Distribution
Anchor QEA	John Ferguson	HCP-CCs Chair	Yes	Yes
CPUD	Alene Underwood	CPUD Policy Lead	Yes	Yes
CPUD	Becky Gallaher	HCP Coordinator for CPUD	Yes	Yes
CPUD	Bill Towey	CPUD Science/Policy	Yes	Yes
CPUD	Ian Adams	CPUD Hatchery Specialist	Yes	Yes
CPUD	Lisa Mattix	HCP Coordinator for CPUD	Yes	Yes
DPUD	Amber Nealy	HCP Coordinator for DPUD	Yes	Yes
GPUD	Curtis Dotson	GPUD PRCC Lead	Yes	Yes
GPUD	Dave Duvall	GPUD Monitoring	Yes	Yes
GPUD	Eric Lauver	GPUD Monitoring	Yes	Yes
GPUD	Tom Dresser	GPUD Science/Policy	Yes	Yes
Independent	Dennis Rohr	PRCC Facilitator	Yes	Yes
NMFS	Emi Kondo	EA and Permit Lead	Yes	Yes
WDFW	Brian Lyon	Hatchery Manager	Yes	Yes
WDFW	David Clark	Hatchery Manager	Yes	Yes
WDFW	Megan Finley	Fish Health Expert	Yes	Yes
WDFW	Ryan Fortier	WDFW Monitoring	Yes	Yes
WDFW	Alf Haukenes	WDFW Monitoring Coordinator	Yes	Yes
WDFW	Chris Moran	WDFW Monitoring	Yes	Yes
WDFW	Denise McCarver	Hatchery Staff	Yes	Yes
WDFW	Travis Maitland	WDFW Monitoring	Yes	Yes
WDFW	Charles Frady	WDFW Monitoring	Yes	Yes
YN	Cory Kamphaus	YN Monitoring	Yes	Yes

HCP Hatchery Committees and PRCC Hatchery Subcommittee Meeting Protocols

Last modified: May 15, 2019
HCP-HC and PRCC HSC Approval: May 15, 2019

Habitat Conservation Plans Hatchery Committees' Responsibilities

The Habitat Conservation Plans Hatchery Committees (HCP-HC) oversee development of recommendations for implementation of the hatchery elements of the three Habitat Conservation Plans (HCPs) for which Chelan and Douglas public utility districts (PUDs) have responsibility for funding. This includes overseeing the implementation of improvements, and monitoring and evaluation relevant to the PUDs' hatchery programs, as identified in the HCPs, the Permits, and Agreements.

Priest Rapids Coordinating Committee Hatchery Subcommittee Responsibilities

The Priest Rapids Coordinating Committee (PRCC) Hatchery Subcommittee (HSC) provides the primary forum for implementing and directing hatchery mitigation measures stipulated in the Priest Rapids Project Biological Opinion, May 3, 2004, outlined in Actions 26 to 31 of the Priest Rapids Project Salmon and Steelhead Settlement Agreement. The focus of the HSC is to resolve technical issues associated with the design, operation, and monitoring and evaluation of Grant PUD's hatchery mitigation program as identified in the Settlement Agreement. In fulfilling this purpose, HSC members will represent the policy directions of their organizations.

The HCP-HCs and PRCC HSC also coordinate in-season information sharing and discuss unresolved issues. HCP-HCs' and PRCC HSC's decisions shall be based upon the likelihood of biological success, time required to implement, and cost-effectiveness of solutions.

Members of the Wells, Rocky Reach, and Rock Island HCP-HCs and the PRCC HSC (collectively Members) represent a variety of federal, state, and tribal governments, and PUDs (collectively Parties).

Decision Making

1. The HCP-HCs and the PRCC HSC are decision-making bodies and make decisions or recommendations by consensus. Consensus is the unanimous consent of all respective committee members. Abstention does not prevent a unanimous vote.[3]
2. Decisions are made and recorded in two ways. The first is recorded in the meeting minutes and the second is recorded in a Statement of Agreement. In general, the most consequential decisions are recorded in Statements of Agreement.
3. If a Party or its designated alternative cannot be present for an agenda item to be voted upon, then the Party must notify the Chair/Facilitator, who shall delay a vote on the agenda item for up to five (5) business days. A Party may invoke this right only once per delayed agenda item.[1]
    a. The HCP-HCs and PRCC HSC have historically been amicable to a Party requesting additional time for internal vetting prior to a vote (within reason). This request and agreement typically have occurred during the meeting following contentious discussions and the inability to reconcile differences at that time.

[3] The identified protocol comes from the Anadromous Fish Agreement and HCPs for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects and the Priest Rapids Project Salmon and Steelhead Settlement Agreement for the PRCC HSC.

Attachment C
Final Updated HCP-HCs and PRCC HSC Meeting Protocols

Disputes and Conflicts

1. Dispute Resolution will follow the protocols and timelines defined in the HCPs and the Priest Rapids Salmon and Steelhead Settlement Agreement.
2. Conflict of Interest: Decisions and agreements made by the HCP-HCs and PRCC HSC require consensus, and funding and contracting issues are under the authority of the PUDs (not the HCP-HCs and PRCC HSC), therefore there is no need for a conflict of interest statement. There are no topics evaluated, discussed, or voted on by the HCP-HCs and PRCC HSC that would require recusing members due to conflicts of interest.

Meeting Protocols

1. The HCP-HCs and PRCC HSC shall meet monthly, or at least two (2) times per year, to conduct business and resolve disputes. In addition, any Committee Member can request to hold a special meeting of the Committees if at least one other Committee Member agrees to the meeting (requires two Committee Members). Every effort will be made to give Committee Members at least seven (7) days' notice of a special meeting. The Committee recognizes that sometimes unusual circumstances may result in fewer than seven (7) days' notice.
2. Agendas
    a. The Chair/Facilitator or Coordinator will distribute a draft list of agenda items and a request for additional agenda items fourteen (14) days before each meeting.
    b. Final agendas will be distributed seven (7) days before the next meeting.
3. Minutes
    a. Draft meeting minutes for review will be distributed within fourteen (14) days of the next meeting.
    b. Revised draft minutes for approval will be distributed within seven (7) days of the next meeting.
    c. Final meeting minutes will be distributed within three (3) days following approval.
4. Decision Items
    a. Decision items will be noted in the draft list of agenda items and draft decision documents (e.g., draft Statements of Agreement) will be distributed with the request for agenda items, or at least ten (10) days before a meeting at which the decision item is voted upon. This provision can be waived by agreement of all relevant Committee Members.
5. Action Item Summary
    a. Final action items, decision items, and agreements resulting from the meeting will be distributed within three (3) days of the completed meeting.
6. Final documents and other reports
    a. Documents approved as final, documents to support meeting discussion (e.g., journal articles), and other final reports (e.g., monthly hatchery reports) will be distributed with the final agenda or with final meeting minutes and action item summary unless otherwise indicated by Members.

Meeting logistics

Attachment C
Final Updated HCP-HCs and PRCC HSC Meeting Protocols

1. The meeting location will be the Grant PUD office in Wenatchee, Washington, unless agreed otherwise.
2. If a meeting is canceled, the regular schedule will remain unchanged.
3. Agenda items will be grouped by Committee (Wells, Rock Island/Rocky Reach, Priest Rapids or "Joint" if pertaining to the HCP-HC and PRCC HSC). Joint items will always be discussed first. Items relevant to the specific Committees will typically be presented in reverse order of the length of time required for discussion (i.e., Committees with agenda items requiring less time to discuss will go before Committees requiring more time for discussion). Agenda items will be listed under each Committee according to the order in which they were received. Revolving agenda items are covered last under each Committee.

Review of Plans and Reports

1. All Studies, Implementation Plans, and Reports prepared under the HCPs or Priest Rapids Project Salmon and Steelhead Settlement Agreement will be available for at least a 30-day review period unless decided otherwise.[1]
2. Plans shall be approved by a vote and reports will be finalized after review deadlines are exceeded and edits and comments addressed.

Document Distribution

1. SharePoint/Extranet Site and Email Distribution List Access
    a. The HCP-HCs agreed on a system requiring HCP Coordinating Committees review and approval to provide non-Members access to HCP Extranet Sites and email distribution lists. For example, if a Washington Department of Fish and Wildlife non-Member requests access to the HCP Hatchery Committees Extranet Site or email distribution list, the Washington Department of Fish and Wildlife HC Representative needs to pass the request to the Washington Department of Fish and Wildlife Coordinating Committee Representative, who then needs to request Coordinating Committee approval.
    b. Historically, administrative access (i.e., Chair or support) has been granted without Coordinating Committee approval; however, it is discussed with the Coordinating Committee at the next possible Coordinating Committee meeting.
    c. Materials relevant to the HCP-HCs will be saved to an Extranet site maintained by Douglas PUD. Materials relevant to the PRCC HSC will be saved to a SharePoint site maintained by Grant PUD.
2. Draft materials and requests for agenda items will be distributed to the Primary Distribution List that includes Representatives, Alternates, and a select group of recipients approved by Members. Final meeting materials and reports will be distributed to the Primary Distribution List and the Secondary Distribution List that includes a broader list of interested recipients.

FINAL

23 S. Wenatchee Avenue, Suite 220
Wenatchee, Washington 98801
509.888.2070

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: August 21, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the July 17, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, July 17, 2019, from 9:00 a.m. to 2:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under HCP-HCs' purview (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan)* based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*

- Mike Tonseth will revise the Relative Reproductive Success (RRS) Study extension agreement memorandum for clarity (Item I-A). *(Note: this item is ongoing.)*
- Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics, as follows, for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
  - Use of age-3 males in broodstock
  - Use of alternative mating strategies
  - Establishing ranges around broodstock collection targets
  - Source for Chiwawa spring Chinook salmon broodstock
- Tracy Hillman and Larissa Rohrbach will add review of the Broodstock Collection Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the HCP-HCs Annual Broodstock Collection Protocols development timeline Statement of Agreement (SOA; Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion in a future HCP-HCs meeting (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will revise and redistribute the 2017 *Out-planting Surplus Methow Composite Spring Chinook Salmon Adults* memorandum (Item I-A). *(Note: this item is ongoing.)*
- Larissa Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (Item I-B). (*Note: this language was added to the protocols under the section titled "Disputes and Conflicts." The updated version was saved to the HCP-HC Extranet Site and PRCC HSC SharePoint sites, dated July 17, 2019.)*
- Betsy Bamberger and Greg Mackey will distribute a draft 2020 study plan for *The Control of Saprolegnia Sp. Growth on Summer Chinook (Oncorhynchus tshawytscha) Eggs* (Item II-E).
- Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item II-D). *(Note: this item is ongoing.)*

Wells HC

- Mike Tonseth will prepare a proposal for the Wells HCP-HC on the use of surplus summer Chinook collected from the Wells Volunteer Trap for the production of subyearling smolts to support the Southern Resident Killer Whale population (Item III-B).

PRCC Hatchery Subcommittee

- HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item V-B). (*Note: this item is ongoing.*)
- Keely Murdoch and Peter Graf will ask the PRCC whether members of the HSC can participate in the PRCC meeting when Jeff Jorgensen (National Marine Fisheries Service [NMFS]) discusses the Wenatchee life-cycle model and data needs (Item V-B).
- Tracy Hillman will compile questions from the PRCC HSC for Jeff Jorgensen during the August 21, 2019 meeting (Item V-B).

Decision Summary

- The Wells HCP-HC voted to approve the *Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs in 2019* in today's meeting (Item I-A).
- The PRCC HSC voted to approve the revised *Grant County PUD Hatchery Monitoring and Evaluation Implementation Plan for Spring and Summer Chinook in the Wenatchee Basin and Summer Chinook in the Methow Basin 2020* in today's meeting (Item V-C).

Agreements

- The Wells HCP-HC agreed to recommend to the Wells HCP-CC that Douglas PUD mark subyearling summer Chinook used for the Douglas PUD 2020 Survival Verification Study with coded wire tags (CWTs) with a unique code, in addition to passive integrated transponder (PIT) tags and adipose clips (Item III-A).

Review Items

- There are no items available for review.

Finalized Documents

- The Wells HCP-HC-approved plan for *Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs in 2019* was finalized in the meeting on July 17, 2019, and distributed via email by Larissa Rohrbach on July 22, 2019 (Item I-A).
- The PRCC HSC-approved *Grant County PUD Hatchery Monitoring and Evaluation Implementation Plan for Spring and Summer Chinook in the Wenatchee Basin and Summer Chinook in the Methow Basin 2020* was finalized in the meeting on July 17, 2019, and distributed via email by Larissa Rohrbach on July 22, 2019 (Item V-C).

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the May 15, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the revised agenda. Hillman requested the addition of a Policy Committee Update to the agenda to follow the review of past minutes and action items. Catherine Willard requested a change to the Joint HCP-HCs and PRCC HSC topics to move an update on genetics monitoring to next month and to add a discussion on the film "Artifishal." The HCP-HCs and PRCC HSC approved revisions to the agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised draft May 15, 2019 meeting minutes. Larissa Rohrbach said there were some minor revisions that the representatives then reviewed. The HCP-HCs and PRCC HSC representatives approved the draft May 15, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on May 15, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on May 15, 2019)*:

Joint HCP-HCs and PRCC HSC

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under HCP-HCs' purview (Item I-A).*
  Hillman said this item is ongoing.
- *Greg Mackey will continue researching broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A).*
  Mackey said he will provide an update in today's meeting. This item is ongoing.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).*
  Tonseth said this item is ongoing.
- *Catherine Willard will update the genetics section of the Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan) based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A).*
  Willard said this item is ongoing.
- *Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from*

other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).
Truscott said this item is ongoing.

- *Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said this item is ongoing. Tracy Hillman said that Ford et al.'s[1] (NMFS) iterative approach for estimating PNI was used in the *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs Draft 2018 Annual Report* (Chelan and Grant PUD's M&E Report) rather than the simple approach that is identified in the permits. Catherine Willard and Hillman asked if NMFS would concur that use of this approach is suitable. Farman said, yes, he concurs that the approach taken in the Chelan and Grant PUDs M&E report is suitable.
- *Mike Tonseth will confirm with Andrew Murdoch (WDFW) that Wenatchee spring Chinook DNA sampling of the 2018 to 2023 returns is still consistent with the original Relative Reproductive Success (RRS) Study extension agreement and provide an update to the extension (Item I-A).*
  The RRS study extension agreement memo was revised by Mike Tonseth and distributed to the HCP-HCs and PRCC HSC via email by Rohrbach on July 16, 2017. Bill Gale noted that the memo requests that the Rock Island HCP-HC approve the updated memo. This will be added as a decision item will be added to the August agenda. This item is ongoing.
- *Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A).*
  Rohrbach said this item is ongoing.
- *Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Protocols) (Item I-A).*
  - *Use of age-3 males in broodstock*
  - *Use of alternative, non-random mating strategies*
  - *Establishing ranges around broodstock collection targets*
  - *Source for Chiwawa spring Chinook salmon broodstock*

  Hillman said this item is ongoing. Greg Mackey will discuss the use of alternative mating strategies in today's meeting.
- *Tracy Hillman and Larissa Rohrbach will add review of the Broodstock Collection Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-A).*
  Hillman said this item is ongoing.

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[1] Ford, M. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16:815-825.

- *Mike Tonseth will revise and redistribute the HCP-HCs Annual Broodstock Collection Protocols development timeline SOA (Item II-A).*
  Tonseth said this item is ongoing.
- *Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion in a future HCP-HCs meeting (Item II-B).*
  Tonseth said this item is ongoing.
- *Mike Tonseth will revise and redistribute the 2017 Out-planting Surplus Methow Composite Spring Chinook Salmon Adults memorandum (Item II-B).*
  Tonseth said this item is ongoing.
- *Tracy Hillman and Larissa Rohrbach will distribute HCP-HC and PRCC HSC-approved distribution lists and meeting protocols (Item II-C).*
  Rohrbach distributed the updated meeting protocols and distribution lists by email on May 20, 2019. This item is complete.
- *Tracy Hillman will present the HCP-HC and PRCC HSC-approved distribution lists to the HCP-CC for their approval (Item II-C).*
  The HCP-CC approved the updated HCP-HC meeting protocols and distribution lists on May 21, 2019. This item is complete.
- *Emi Kondo will confirm the status of the draft Wells Hatchery Methow Steelhead Program permit with Charlene Hurst (Item II-D).*
  Brett Farman said he will provide an update in today's meeting. This item is complete.

Wells HCP Hatchery Committee

- *Greg Mackey will provide a revised version of the Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs in 2019 (Douglas PUD's 2019 M&E Plan) for HCP-HC approval by email (Item I-A).*
  Mackey said Douglas PUD would like to finalize a version of the plan that excludes edits regarding potential changes to methods for estimating steelhead spawner abundance and distribution [that currently rely on detections of upstream-migrating steelhead that are PIT tagged at the Priest Rapids Dam Off-ladder Adult Fish Trap (OLAFT)]. Mike Tonseth said steelhead sampling at the OLAFT is still taking place this year. Keely Murdoch said the edits were written to alert the committee that changes to the run-size modeling approach should be retained so they can be revisited in Douglas PUD M&E Plan for 2020 (next year's plan). Mackey said the language in the plan should be more specific and said the edits provided were too vague. Edits were made during the meeting to specify the run-size modeling methods for brood year 2020 fish (to be carried out in 2019). Tracy Hillman called for the Wells HCP-HC to vote to approve Douglas PUD's 2019 M&E Plan and all parties approved.

PRCC Hatchery Subcommittee

- *HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item V-B).* Hillman said there has been no feedback and this item is ongoing.

B. Policy Committee Update

Tracy Hillman provided a summary of HCP Policy Committees guidance directed toward the HCP Hatchery Committees regarding the process and criteria for elevating topics from the HCs to the Policy Committees. Hillman summarized a situation regarding a dispute in the HCP Tributary Committees where a project was deemed biologically relevant, but a policy-level consideration overrode the selection criteria at the technical level. Hillman said a formal dispute was pulled back because the parties acknowledged they would not come to resolution by following the HCP dispute resolution process. The Yakama Nation (YN) asked to convene the HCP Policy Committees to determine a path forward.

Hillman said the HCP Policy Committees provided guidance to all technical groups, including the HCP Hatchery Committees and HCP Coordinating Committees. Hillman said that HCP Hatchery Committees will base decisions on the technical merits of the issue. Any policy-level concerns impeding decision making will be elevated to the HCP Policy Committees for review and a decision.

Bill Gale asked if these recommendations from the HCP Policy Committees will be documented somewhere. Hillman said they will be recorded in the Policy Committees meeting minutes. Gale asked if this guidance changes the dispute resolution direction given in the HCPs. Hillman said no, this guidance does not pertain to official disputes. Gale said this could result in HCP Hatchery Committees members asking for an issue to bypass the Coordinating Committees and go directly to the Policy Committees. Hillman said if it's disagreement or dispute regarding a technical issue, it should still go to the HCP Coordinating Committees. Kirk Truscott said this guidance was developed by the Policy Committees because if it's a policy issue, meaning if it's a top-down issue with direction from existing policy, it is a waste of time to take the issue through the HCP dispute resolution process. Truscott gave the example when recalculation of the Chiwawa program size was not agreed to on a policy level due to *US v. Oregon*, the issue was resolved at the policy level first in order for changes to go forward on the technical level. Gale asked if the HCP Hatchery Committees are solely technical committees and if policy should not be discussed. Hillman said the guidance from the Policy Committees is to evaluate issues based on technical merits. Gale said he wants to ensure the guidance provided by the HCP Policy Committees is aligned with the HCPs. Hillman said the Policy

Committees do not want to change the HCPs. Tom Kahler said the intent of the HCP Policy Committees decision was not to change the operation of the technical committees, but was intended to provide a means to resolve policy conflict resolution outside of the technical committees.

Gale asked how the HCP Tributary Committees issue was resolved. Hillman said the issue is to be resolved by asking leadership of the member parties in conflict to meet and come to resolution with the biological merits in mind. Hillman said the Policy Committees intend to educate tribal council members on the purpose and objectives of the HCPs. Gale said the solution to any issue that may rise to the HCP Policy Committees could be rooted in both groups (technical and policy) by providing a technical workaround. Keely Murdoch agreed but said that providing a technical workaround, in this case, did not get to the core policy issue that had no nexus to the resource and was going to continue to be a problem if the Policy Committees were not engaged.

Murdoch suggested memorializing this development in a place that is more accessible for new committee members and future uses. She said it should be incorporated into the operating protocols. Larissa Rohrbach will add the HCP Policy Committee guidance to the HCP-HC and PRCC HSC protocols files (*Note: this language was added to the protocols under the section titled "Disputes and Conflicts." The updated version was saved to the HCP-HC Extranet Site and PRCC HSC SharePoint sites, dated July 17, 2019.)*

II. Joint HCP-HCs and PRCC HSC

A. Goat Wall Acclimation Site Performance Update

Tracy Hillman welcomed Rick Alford (YN) who gave the presentation, "*Goat Wall Acclimation Site, Methow Valley*" (Attachment B). Alford shared a PowerPoint presentation on operations and outcomes of acclimation activities for spring Chinook salmon at the Methow Valley Goat Wall site in the upper Methow River from 2017–2019.

Slides 1–8: Alford presented background information about the Goat Wall Acclimation Site. It is located 25 miles up the Methow River on Cold Creek, a disconnected side channel of the Methow River. Todd Pearsons asked if it is Methow River water; Alford said yes. Water temperatures range from the 30s°F to 40s°F, depths 1 to 1.5 meters, and capacity is about 30,000 fish with a conservative stocking density. The habitat is more complex in the downstream area than upstream area of the side channel. Snow and access can be challenging.

Slides 9–16: Alford described the activities to set up the acclimation site in spring. Snorkel surveys are conducted to identify other fish. Pearsons asked if it is completely enclosed; Alford said yes, the sites have custom nets. Best efforts are made to secure the nets so no fish escape. Fish transport trucks bring juveniles. Methow Fish Hatchery staff support the collection of the fish from the hatchery. Snorkel surveys are done to monitor fish and three PIT-tag detection systems are used to monitor for escapees. During rearing, staff visit up to five times a day to feed and haze predators. Growth monitoring and fish health samples are taken. All activities are done by boat. Feed is kept off site and the site is maintained in a clean condition to meet the landowners' needs. The landowners have been very supportive. Pearsons asked if the side channel has been blocked off. Alford said they have to maintain connectivity of the side channel to the Methow River.

Slides 17–18: Alford summarized the outcomes of three years of activities (2017–2019). The beginning of acclimation depends on flow and ability to access the site through snow. Releases are timed to coincide with Methow Fish Hatchery releases to compare survival between these two groups. Pearsons asked if fish are ushered out of the side channel at the time of release. Alford said release is completely volitional. Fish may move upstream or downstream once the nets are dropped. PIT-tag arrays are monitored for 2 to 3 days following release to ensure all fish have moved out. Net security was good with 1.2% fish escaping pre-release.

Slides 19–21: Alford summarized in-river survival and travel time results. Survival is calculated using PIT tags and the Cormack-Jolly-Seber mark-recapture model. Survival of Goat Wall-acclimated fish to Rocky Reach Dam is similar to Methow Fish Hatchery releases. This year, survival to McNary Dam may not be as good as other programs due to low flow conditions [in the Methow River].

Slide 22: Alford showed adult return data for the first returning cohort from brood year 2015 based on PIT tags detected at Wells Dam this spring. He said 2019 is the first year of 4-year-old fish returning from this acclimation site to the Methow Basin. Estimated smolt-to-adult return rates to Wells Dam were presented in comparison to other production groups.

Hillman asked if the acclimation site is spring-fed. Alford said the geology in the area is interesting. The side channel is fed by a type of underground river. When the water level in the Methow River goes down, water level in this site goes down and vice versa.

Bill Gale asked if the YN is monitoring site-fidelity to observe whether the project encourages more upstream distribution of spawners. Alford said yes, that adult distribution monitoring will start this year. Alford said PIT tags will not be monitored upstream of Winthrop. Keely Murdoch said data will be collected from CWTs collected in spawner surveys. Murdoch added there will be a small run this year and data may be limited. Gale said it may be difficult to observe a shift in distribution due to small samples sizes. Gale added the combination of small releases, low return rates, and low observation rates in the carcass sampling may make it difficult to have confidence in a potential shift in distribution.

Pearsons asked if there is a model to estimate predation effects on survival during acclimation. Alford said yes, they use a model based on literature and predators observed on site. Pearsons said the survival rates presented are unusually high for a natural site. Alford said yes, they haven't seen many predators on site.

Catherine Willard asked how long it takes for fish to leave the site volitionally. Alford said spring Chinook leave quickly, in approximately 5 days. Alford added the fish overwhelm the PIT-tag readers and PIT-tag detection efficiency can be low during the release period [due to tag collisions].

Pearsons asked about the duration of the study. Murdoch said it is a 5-year study; however, the HCP-HCs will need to evaluate the preliminary outcomes of the study prior to the complete adult return record to decide on the future of the site. Murdoch said the HCs should discuss whether they should move forward with evaluating site performance with a partial return dataset or wait for a more complete set. Gale said the understanding site fidelity of returning adults is important, but work can proceed without the complete dataset of returns as long as juvenile survival estimates are available to evaluate.

B. 2018 Egg Treatment Study Update

Betsy Bamberger presented the results of the study (Attachment C) and said the 2018 Egg Treatment study plan was originally brought to the HCP-HCs in July 2018 as a proposed pilot study to test various treatment methods for preventing infestation with the water mold *Saprolegnia spp.* with the goal of reducing formalin use [by Douglas PUD programs to preemptively address potential future regulation and health and safety issues].

Bamberger said the treatments tested were formalin, salt, hydrogen peroxide, and no treatment (water). She said no difference was observed between the treatments, indicating that all treatment methods were equally effective. She hypothesized that the pathogen load was too low in the water source [at Methow Fish Hatchery] to observe a difference if one exists. She said follow-up work is needed to determine the best egg treatment protocol at Methow Fish Hatchery.

Bamberger said some differences between the pilot study and real world uses are that summer Chinook salmon were used in the study instead of the target species, spring Chinook salmon, due to limitations on spring Chinook salmon availability and permitting issues. Bamberger said another difference was that incubation trays were used that are different from the incubation isobuckets used for rearing spring Chinook salmon embryos.

Greg Mackey said the experiment was run until embryos reached the eyed-egg stage, per study design. Further, the HCP-HCs later approved observing a subset of the fish to the alevin stage to examine if treatment effects carried past hatch. However, no additional effects were observed at the alevin stage. Bamberger said salt had an effect on the alevin stage in other published studies.

Bamberger said staff reported that non-treated eggs were stickier than formalin treated eggs.

Mike Tonseth asked if the treated eggs were subjected to the same shocking and handling as eggs in the spring Chinook salmon production program. Bamberger said yes, in fact they were probably handled more because eggs from different females were mixed to reduce familial effects on egg survival.

Bill Gale asked if the intent is to repeat the study in a place where there is a higher *Saprolegnia* load. Bamberger said yes, they intend to repeat the study at Wells Fish Hatchery with summer Chinook salmon this fall (2019). Tonseth said that implementing the study in a hatchery with a low *Saprolegnia* load was an original critique of the study, but due to facility modifications, Wells Hatchery wasn't prepared to house the study in 2018. Mackey said implementation of this first year was an opportunity to develop the methods.

Gale asked if the problem with hydrogen peroxide is that it's difficult to procure. Bamberger said yes, the Department of Homeland Security has to be informed, but it's easier if there is a plan to use it on a short timeline and it is easier to acquire in smaller volumes.

C. 2019 Egg Treatment Study Plan

Betsy Bamberger said the Egg Treatment Study will be repeated in 2019 using summer Chinook salmon with the addition of another treatment group. Greg Mackey said they plan to eliminate the use of hydrogen peroxide because it is difficult to handle.

Mike Tonseth asked if the plan is to use the existing broodstock or to collect additional broodstock for the study. Mackey said if a treatment doesn't work, an egg stack could be lost to *Saprolegnia*, but if the risk is low, existing program production fish could be used. Mackey said formalin is already used on the production fish so for formalin, production fish would be used as per the usual treatment at the hatchery. He added that at this time the study will be kept small to make it easier to collect enough eggs.

Bamberger and Mackey will provide another draft study plan in August for review and approval by the Wells HCP-HC.

Tracy Hillman asked if there will be replication at other sites. Bamberger said no, not at this time. Tonseth said implementation of these types of studies will depend on the relative risk to each program.

D. Alternative Broodstock Composition and Mating Strategies

Greg Mackey summarized how this topic was originally raised. Mackey said the original question was whether to use jacks in the broodstock, focusing on spring Chinook in the Methow basin. He said the policy so far has been to exclude jacks in the broodstock, but that in the recent Broodstock Protocol allowance was made to use wild jacks if wild male broodstock were in short supply. Mackey said in researching this topic he determined that the question is actually about constructing the mating strategies overall, of which jacks are one component.

Mackey said the following pertains mostly to the conservation programs. Mackey said there are two major themes for maintaining a conservation broodstock:

1. A "genetically benign" approach that attempts to collect random sample to match the genetic composition of the broodstock with the wild stock. Mating is random to the extent possible. The male to female ratio could be 1:1 or a spawning matrix can be used. There are efforts made to minimize domestication selection. There are guidelines to cull (equalize) families to maximize effective population size. The goal is to have no effect on the natural population with what is done with the hatchery population.

   Mackey noted two relevant publications. He said Don Campton (USFWS) wrote a paper[2] about sperm competition, though much of the paper discusses the genetically benign approach in broader terms. Tom Quinn wrote a response paper[3] comparing what hatcheries actually do compared to what fish do in the wild.

2. Dave Hankin's paper[4] focuses on counteracting the directional selection for younger age at maturity in hatchery populations, especially if there is a fishery that tends to select the older, larger fish. Hankin modelled an approach using non-random mating. Hankin prescribed an approach where jacks are not used. Instead, for each female, a male that is equal size or greater is used to fertilize eggs, which [practically] guarantees that the male and the female are the same age or the male is older. This practice would drive the population toward older age at maturity, countering the effects of hatchery production and fisheries.

Mackey said the Methow Fish Hatchery uses a spawning matrix for spring Chinook. Mackey said the Busack and Knudsen paper[5] does a great job describing matrix-based spawning methods. The

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[2] Campton, D. E. 2004. "Sperm Competition in Salmon Hatcheries: The Need to Institutionalize Genetically Benign Spawning Protocols." *Transactions of the American Fisheries Society* 133:1277–1289.

[3] Quinn, T. P, 2005. "Comment: Sperm Competition in Salmon Hatcheries: The Need to Institutionalize Genetically Benign Spawning Protocols." *Transactions of the American Fisheries Society* 134:1490–1494.

[4] Hankin, D. G., J. Fitzgibbons, and Y. Chen, 2009. "Unnatural Random Mating Policies Select for Younger Age at Maturity in Hatchery Chinook Salmon (Oncorhynchus Tshawytscha) Populations." *Canadian Journal of Fisheries and Aquatic Sciences* 66(9):1505–1521.

[5] Busack, C., and C.M. Knudsen, 2007. "Using factorial mating designs to increase the effective number of breeders in fish hatcheries." *Aquaculture* 273:24–32.

question remains whether jacks should be used. Warm Springs National Fish Hatchery is using an approach where they use jacks in proportion to their natural occurrence in the wild, but decrease their use in the hatchery in proportion to their relative reproductive success as compared to large males in the wild. One way to approach this would be to estimate their contribution [to the offspring] as done in the Berejikian paper[6] and multiply the average contribution of jacks by their occurrence [in the total population?].

The Committees discussed the current genetic health of the Methow Spring Chinook population. Mackey said there are often spinal deformities in hatcheries. Deformities have been observed over the years at Wells Hatchery for summer Chinook, but the reporting has been spotty. Betsy Bamberger looked into the causes of spinal deformities and there are different types and the causes are not well-understood. Mackey talked to Ron Hardy (University of Idaho; animal nutrition expert), who says it's always a nutrition issue (a phosphorous limitation). Douglas PUD contracted with the WDFW Molecular Genetics Laboratory to genotype a sample of 50 of the deformed fish at Methow Hatchery for the 2018 brood to determine whether it could be a genetic problem. Mackey said Sewel Young et al. (WDFW 2019)[7] used the results of this analysis to compare the homozygosity of hatchery-origin Twisp River spring Chinook salmon with all of the Snake River basin spring Chinook salmon populations. He found that the Twisp River hatchery-origin fish had lower homozygosity than the entire Snake River population. By this preliminary measure it would appear that the Twisp River component of the Methow Hatchery program has done a good job for maintaining genetic integrity.

Mackey said the Methow River basin hatchery program appears to be doing a good job but there could be other, better ways for doing things. Bill Gale said there may be some programs that follow Hankin's concept and it should be contemplated but programs should avoid being overly selective for a few spawners that meet the criteria. Gale said there is value in maintaining the criteria for random mating. Mackey said Jennifer McLean (University of British Columbia) studied the effectiveness of program random mating and found that unconscious bias results in mating that actually isn't very random.[8]

Mackey said he will provide a white paper to the HCP-HCs and PRCC HSC and a presentation during the August meeting to summarize his conclusions. *(Note: Mackey's white paper will be distributed following PUD review.)*

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[6] Berejikian, B.A., D.M. Van Doornik, R.C. Endicott, T.L. Hoffnagle, E.P. Tezak, M.E. Moore, and J. Atkins, 2010. "Mating success of alternative male phenotypes and evidence for frequency-dependent selection in Chinook salmon, Oncorhynchus tshawytscha." *Canadian Journal of Fisheries and Aquatic Sciences* 67(12):1933-1941.

[7] Young, S. F., A. Terepocki, and C. Bowman. 2019. Parentage analysis of deformed Chinook salmon juveniles from brood year 2018, Methow Hatchery. WDFW Molecular Genetics Laboratory. Report to Douglas PUD, 2019.

[8] McLean, J.E., P. Bentzen, and T.P. Quin, 2005. "Nonrandom, Size- and Timing-Biased Breeding in a Hatchery Population of Steelhead Trout." *Conservation Biology* 19:446–454.

E. Out-planting Spring Chinook Salmon Adults in Chewuch 2019 Status Update

Greg Mackey said this year the Methow spring Chinook salmon run was predicted to be quite small. Mackey said out-planting depends upon whether there are extra fish available and whether adult management should be done this year following the protocols for surplusing fish. Mackey said the Methow Fish Hatchery has collected all their broodstock for this year. Bill Gale said broodstock is available at Winthrop but is not meeting the Methow Hatchery-origin adult target for the Winthrop program. Mackey said fish continue to trickle in at Methow Hatchery. Keely Murdoch asked if USFWS knows how many more fish are needed to meet natural-origin fish targets. Matt Cooper said they have less than half of the target of Methow Hatchery-origin brood pairs but have plenty of WNFH-origin returns to backfill the program.

Rick Alford asked where the out-planting sites on the Chewuch River are located. Mackey said they were based on preliminary surveys to identify sites that were not already occupied by wild fish and allowed access for planting trucks. Tom Kahler said release sites were identified at river kilometer (RKM) 29 and RKM 14 on the Chewuch River.

Tracy Hillman summarized that it is unlikely that the out-planting of spring Chinook salmon will occur this year.

The HCP-HCs will continue to move forward with updating the Methow spring Chinook salmon translocation plan. Murdoch said this was originally intended as an alternative to acclimation. Murdoch said the intent was to compare the results of out-planting with acclimation. Mike Tonseth said if there are not sufficient conservation program fish, it may be worth experimenting with Winthrop National Fish Hatchery HOR program fish to study behavior and success, though it would affect PNI on the spawning ground.

Gale asked how much of the Methow Spring Chinook Salmon Conservation program fish are remote acclimated. Mackey said of the approximately 224,000 juveniles, more than half are acclimated remotely. Gale said, so only half of the program is being acclimated at the Methow Fish Hatchery because they are being remotely acclimated. Murdoch said Twisp acclimation sites are not necessarily remote acclimation.

Gale asked if the Methow program is trying to do too much with a small number of adults returning to Methow Fish Hatchery. Gale said even in an average return year there may not be enough fish for translocation. Gale suggested reviewing smolt-to-adult return rates (SARs) to determine what would actually be needed to implement the translocation plan. Tonseth said the determination may not be on total Methow spring Chinook SARs, but rather a comparison of the number of adults returning to the out-plant sites versus the hatchery.

F. Artifishal

Catherine Willard said that the Cascade Columbia Fisheries Enhancement Group (CCFEG) is showing the movie "Artifishal" at the Snowy Owl Theater in Leavenworth on August 8. CCFEG asked if local entities would be willing to participate on a panel discussion after the movie.

Willard said the movie is quite biased. Bill Gale said USFWS asked for the ability to watch the movie and determine who would be on the panel first. Gale said USFWS has not responded yet but is willing to consider participating. Keely Murdoch said YN would require approval from their media committee and the Tribal Council to participate. Murdoch said YN is discussing it and have told CCFEG that a person will likely participate but has not determined who that will be. Murdoch said they will likely review the movie first and determine their approach to answering questions. Gale said a screening in the Methow community went well (in Winthrop, WA). Tom Kahler said he questioned whether the panel will happen with or without their participation. Gale said he is concerned about the screening of the film without a panel to provide context.

Tracy Hillman asked if the CCT will participate. Kirk Truscott said they would have to ask approval of their media council. Truscott said the CCT response was that it was a bad idea to give any time to the film because it appears to be propaganda. Gale said it is unfair to be asked to be on a panel without being able to view the material for discussion. Todd Pearsons said Grant PUD has no plan whether or not to participate at this time. Brett Farman said NMFS had an internal screening but no formal response that he is aware of. Willard said Chelan PUD prefers that CCFEG do not show the movie because it is biased and does not accurately reflect the hatchery programs in the upper Columbia, but feels they need to participate to provide a balanced view. However, Chelan PUD feels there will not be enough time during the panel discussion to describe how these programs are different from what is being shown in the movie. Gale said they conflate net-pen rearing of Atlantic salmon with hatchery rearing across the entire landscape. Gale asked if anyone knows CCFEG's motivation for bringing this movie to the valley. Chelan PUD read from an email that CCGEG feels this provides an opportunity to have a balanced discussion. Mike Tonseth said screening the film and panel time are not an adequate way to provide a balanced discussion. Greg Mackey said asking to stifle the film is worse that participating in a biased discussion.

Willard asked if the participants should prepare a letter asking for better explanation of the intent of showing the film and an opinion on a joint response for preparing a more balanced discussion. Peter Graf suggested asking for some speaking time to introduce how the HCP programs are different from what is shown in the film. Willard agreed it would be helpful to be able to explain the programs before taking questions. Hillman asked if the HCP-HCs and PRCC HSC would like support to facilitate participation of members. Potential participants will coordinate outside of the committees.

G. Wenatchee Spring Chinook Salmon Broodstock Collection Update

Mike Tonseth gave an update on the number of adults that have been retained for Wenatchee spring Chinook salmon broodstock. Tonseth said there are currently:

- Nason Creek spring Chinook salmon: 52 NOR, 77 HOR (129 total)
- Chiwawa River spring Chinook salmon: 37 NOR, 40 HOR (77 total)

The program is 25 fish below target numbers for Chiwawa NOR. Collection of NOR is continuing at Tumwater Dam and any that assign genetically to the Chiwawa population with 95% surety will be retained. Ten fish collected at Tumwater Dam are awaiting assignments. The numbers arriving at Tumwater Dam are declining rapidly for the season.

Tonseth said this year the number of fish captured at Tumwater Dam that did not assign to Nason nor Chiwawa populations was almost double the number sent back to the river compared to previous years due to non-assignment to either population. Tonseth said there were 14 non-Nason/non-Chiwawa-assigning fish and an unusually high number of those assigned genetically back to Leavenworth National Fish Hatchery. Bill Gale said there could have been a problem with the cutoff for the genetic stock identification criteria. Peter Graf asked for clarification whether fish that do not assign with at least 95% surety to either program would be allocated to the safety net program. Tonseth said no, they would be released back to the river.

Tracy Hillman summarized that both Nason and Chiwawa programs have met the overall brood goals, but the NOR target has not been met for the Chiwawa program.

H. National Marine Fisheries Service Consultation Update

Brett Farman said that the Steelhead and Summer and Fall Chinook Salmon Environmental Assessments Finding of No Significant Impact (FONSI) is still in internal review. Farman said the Winthrop Steelhead permit is waiting for a signature. Farman said the permit for the Methow Steelhead program was sent out by Charlene Hurst at the end of May, comments were received by mid-June, and it is awaiting signature when the FONSI is finalized. Farman said there are no hard dates for completion once permits go into internal review.

III. Wells HC

A. Wells Hatchery Summer Chinook Salmon Tagging for the 2020 Survival Study

Tom Kahler said that every 10 years Douglas PUD implements a survival verification study (survival study). The next study will be conducted in 2020 using Wells Hatchery summer Chinook salmon. In May 2009, the Wells HCP-HC decided not to tag the 2010 survival study fish with CWTs because they would already be PIT tagged for the survival study. The primary difference between then and now was that in 2010, the entire study fish group was in addition to the hatchery production numbers. In 2020, the study fish (110,000 fish) would be taken from the total yearling summer Chinook hatchery production of 320,000 fish. The study fish would receive PIT tags and would be adipose fin-clipped (ad-clip). The remaining 210,000 production fish would receive CWTs and would be ad-clipped. The HCP Coordinating Committee asked whether there would be any adverse effect on the monitoring and evaluation activities and *US v. Oregon* agreements due to not tagging 110,000 fish with CWTs. The HCP Coordinating Committee was interested in getting input from the HCP-HC on this issue.

Kahler said CWTs are used by Douglas PUD for determining age structure, harvest, and stray-rates. An assumed mark-retention rate is applied to the numbers. One challenge would be calculating a different mark-retention rate for 2020 because there would be a different mark rate.

Mike Tonseth said ocean harvest cannot be calculated without CWTs. Tonseth said the concern is whether PIT tags would suffice as a surrogate for CWTs. The upper Columbia is the only place where PIT tags are interrogated in the recreational fishery.

Kirk Truscott said the Wells Hatchery stock is the indicator stock for harvest on upper Columbia summer Chinook salmon, including in the Alaskan and Canadian fisheries. In approximately 2005, the HCP-HCs determined that 100% tagging is needed to provide sufficient rigor to estimate ocean harvest.

Bill Gale said fish frequently dip into numerous different tributaries. The problem with PIT tags is that you don't know if they stay. Gale asked why Douglas PUD is using production fish for the survival study and not additional fish as in 2010. Kahler said the Coordinating Committee decided this in February 2019.

Tonseth said the consultation with NMFS is moving forward without the additional fish. He said that in the *US v Oregon* tables, the survival study fish were removed.

Kahler said that of the 110,000 survival study fish, 50% will be released downstream from Wells Dam from a barge (the release methodology used in the survival studies to ensure similar fish handling and release protocols for all release groups, above and below the dam), 25% will be released at the mouth of the Methow River, and 25% will be released at the mouth of the Okanogan River (approximately 50,000 fish released upstream from Wells Dam).

It was asked if the HCP-HC is subordinate to the HCP-Coordinating Committee. Truscott said in the case of planning the survival studies they are.

Tonseth said that not tagging production fish with CWTs would deviate from *US v. Oregon*. This would require a revision to the *US v. Oregon* tables, then revising them back in the future. Gale said that *US v. Oregon* also stipulates fish be released on station.

Keely Murdoch said there is a need to CWT 100% of the fish to achieve adequate sample sizes to determine ocean harvest rates. Gale said there are two problems. One is the deviation from *US v. Oregon*, and the second is the deviation from the preferred tagging method determined by the HCP-HC.

Kahler said a decision on double-tagging has not been made; it is up to the HCP-HC to provide that determination.

Tonseth said it would be prudent for the survival study fish to have a unique CWT code. Tonseth said in looking ahead to 2030 to track spring Chinook salmon survival, PIT tagging production fish may be necessary, but they should have similar performance as non-PIT tagged fish. A unique CWT number would allow for estimating differential survival of PIT-tagged fish.

Kahler asked whether the Comparative Survival Study found differential survival of PIT-tagged fish (reported in the 2018 annual report). Kahler said the HCP Coordinating Committee did agree that spring Chinook salmon should be the study fish in 2030.

AGREEMENT: The direction from the HCP Hatchery Committee to the HCP Coordinating Committee is to tag all 2020 survival study fish with CWTs that have a unique group code in addition to tagging with PIT tags and ad-clipping.

Kahler will report the agreement back to the HCP Coordinating Committee.

Peter Graf asked if using a unique CWT code for a smaller number of fish still meets the need of an adequate sample size for estimating harvest. Tonseth said harvest requires a smaller number; estimating SARs requires a larger number.

B. Request for Broodstock to Expand Wells Hatchery Subyearling Production

In an email on July 15, 2019, Mike Tonseth outlined a request to the Wells HCP-HC to support the collection and spawning of an additional 350 adult hatchery summer Chinook salmon from the Wells volunteer channel to support an additional production of 500,000 subyearlings in brood year 2019 for the benefit of Southern Resident Killer Whales.

Tonseth said the decision being requested does not pertain to how to allocate surplus fish, but rather asks the Wells HCP-HC to approve that there is capacity at the Wells Fish Hatchery to accommodate rearing of the additional subyearling summer Chinook salmon.

Keely Murdoch said there are three issues with the request:

1. This should be a Joint Fisheries Parties (JFP) discussion.
2. The YN feels that existing programs such as the Yakima Basin summer Chinook salmon program should be filled prior to meeting new program needs. Earlier this year, the HC declined a request to send surplus summer Chinook salmon to the Yakima Basin program that perhaps should have been discussed not in the HC but in the JFP. The YN feels allocation of additional fish to the Yakima Basin is a better use for meeting the need of providing prey to Southern Resident Killer Whales.
3. The management considerations of additional fish returning to the upper Columbia Basin have not been considered, which is also a JFP issue.

Tracy Hillman asked if this is still an HC issue or should it be discussed and resolved by the JFP. Murdoch said there is inconsistency about how allocating surplus is handled in the HC and that is creating a conflict. Greg Mackey said the HC is responsible for approving documents and making decisions related to the PUDs' HCP programs. In the case of the Yakima Reintroduction program for instance, it is not an HCP-HCs or PRCC HSC program and allocation to the program should not be decided within the Committees setting. Tonseth said with regard to the HCs the nexus is that the fish would be reared at Wells Fish Hatchery. The allocation of surplus adult returns should be decided outside the HCP process.

Murdoch said that last week there was a discussion over email about planning for the approved uses of surplus fish from Wells Fish Hatchery, and now there is a sudden higher need outside of the approved surplus fish uses. Tonseth said this is not a higher need but an additional need that is a new legislative mandate. Murdoch said the intent of the mandates should be met, and can be met by allocating fish to the Yakima Basin, which has been permitted for this action. Wells Fish Hatchery has not been permitted for this action.

Bill Gale said the issue is about hatchery production at Wells Fish Hatchery. Gale said a concern is that there were proposals developed for rearing fish at Wells Hatchery without involvement of the HC. The proposals that were developed by Douglas PUD and WDFW should have gone through the HC prior to the time of broodstock collection. Proposals need to be discussed in Committee prior to planning.

Tonseth disagreed. Tonseth said WDFW reached out to multiple facilities to identify places where additional capacity would be available for rearing the fish. Tonseth said WDFW does not need approval to implement the program. Gale said they do if it involves Wells Fish Hatchery. Murdoch said only the element of whether there is capacity requires HC approval. Gale said it's not just about rearing capacity, it's also about whether this proposed program impacts the existing HCP programs.

Gale said a proposal should be created with more consideration than the existing email request.

Murdoch said there has to be concurrence by the JFP that the new proposed use of the surplus fish is the most beneficial use for the program.

Gale asked about bull trout permit compliance. Tonseth said that would be part of the permitting process. Gale asked if this is going to be proposed as a new program under *US v. Oregon*. Tonseth said no, because there is only funding for two years, so it is not WDFW's intent to include this program under *US v. Oregon*. Hillman asked if Brett Farman had a comment. Farman declined to comment on the issue of use of surplus fish. Murdoch said NMFS has been engaged regarding obtaining permits. Kirk Truscott asked what would happen if permits are not approved and there is a surplus at the juvenile stage. Tonseth said juveniles would be out-planted to non-anadromous waters.

Truscott said allocation of surplus adults to the tribes and collection of broodstock for this new proposal can be done concurrently. Tonseth agreed there appears to be enough surplus for all programs this year.

Catherine Willard asked whether the 500,000 juveniles needed is for one year or two years. Tonseth said the funding is for $175,000 per year, which roughly equates to rearing 500,000 subyearlings annually.

Truscott said last week over email he asked the HC to concur that there is now a surplus at Wells Fish Hatchery to allow for fairness in allocation to the programs receiving surplus.

Hillman said the issue is that there is no proposal for the HCP-HC to evaluate whether there is an effect on HCP production programs. Murdoch said the issue is that a proposal was developed but wasn't brought forward formally to the Wells HC. Hillman asked how quickly this needs to be resolved. Tonseth said the critical piece is having adults on hand and suggested having a brief discussion after the HCP HC meeting among WDFW, Douglas PUD, CCT, and YN members to establish a temporary path forward to ensure broodstock are not lost during a period in which WDFW develops a more formal proposal.

Murdoch said at Wells Hatchery there hasn't been space in the past and a formal resolution to that problem hasn't been provided. Tom Kahler noted that the hatchery has been under construction for approximately 5 years, and has limited space.

Todd Pearsons asked how this would affect downstream programs. For instance, how this would affect recalculation. Tonseth said smolts produced for the orca program should not be added into the mitigation obligation for operating the hydro-projects. Recalculation looks at SARs and total adult returns. Returns from the orca program would need to be subtracted from the number used for calculating SARs, otherwise they would count against survival through the projects.

Truscott said he has confidence that Douglas PUD has done a complete evaluation about rearing space; however, he hasn't heard whether this proposal would require removing a certain number of potential adult returns. The expectation is that it would, but this calculation hasn't been formalized.

WDFW, Douglas PUD, YN, and CCT convened during the lunch break to establish a short-term path forward for retaining broodstock.

Tonseth said WDFW will prepare a 1-page proposal for the Wells HC to outline the impacts of the additional subyearling production, which are expected to be negligible. Hillman said the Wells HC will then evaluate the proposal to ensure the proposal does not adversely affect the HCP production programs. Once there is agreement to the proposal, the JFP will determine the allocation of surplus summer Chinook salmon broodstock.

Truscott said CCT will expect advance notification from WDFW if a surplussing day will occur. Tonseth agreed that coordination will occur.

IV. Rock Island/Rocky Reach HC

A. Relative Reproductive Success Study Extension Memo Update

Catherine Willard said that in 2014, WDFW asked the Rocky Island HC to extend the scope of the Relative Reproductive Success (RRS) Study to include brood years 2014 through 2018. Mike Tonseth clarified that DNA sampling of adults would be required through 2023 for NOR fish; the juvenile DNA sampling would be terminated after 2019.

Bill Gale asked if the intent would be to sample 100% of the adults passing over Tumwater Dam. Willard said trapping at Tumwater would be consistent with the approved trapping operation plan at Tumwater Dam. Tonseth said this is mostly done during broodstock collection and adult management. Tonseth said fish are sampled for DNA, are PIT tagged, and then passed above the dam. Tonseth said although the Operating Plan allows for trapping 24 hours a day, trapping is not actually carried out 24 hours a day; there would still be some passage at night. Tonseth said this year's activities would be indicative of what will be done through 2023 for the RRS study. (*Note: On August 21, 2019, McLain Johnson [WDFW] confirmed via email to Catherine Willard and Mike Tonseth that the Tumwater Dam trap is currently being operated 24 hours a day)*.

Todd Pearsons asked how many NOR fish would be sampled. Tonseth said he didn't know. The intent is to sample as many as possible within the operating constraints. Pearsons said the issue is to ensure there is representative sampling.

Gale asked if the activities are contingent on funding. Tonseth said no, it is fully funded through 2023.

Peter Graf asked if juvenile sampling is continuing at the Wenatchee River screw trap. Tonseth said yes, sampling would occur through 2020 to capture the outmigrants.

The current RRS study extension memo requests the HCP-HC to approve the revised memo. Tonseth said there are additional clarifications needed in the memo. He will retract the memo, revise it, and resend it for review and approval during the August meeting.

V. PRCC HSC

A. Approve the May 15, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the May 15, 2019 meeting minutes as revised.

B. White River Memorandum Progress Update

Tracy Hillman reminded the PRCC HSC that he asked Denny Rohr for specific direction from the PRCC on the intent of the White River memorandum. Hillman has not yet received direction from the PRCC.

Keely Murdoch said the issue has been discussed in the PRCC but there remains some confusion over the original intent of the PRCC request to the HSC.

Scott Carlon (NMFS representative to the PRCC) invited Jeff Jorgensen (NMFS life-cycle modeler) to the PRCC meeting to discuss data needs for life-cycle modeling; however, Jorgensen is unavailable until September so the issue will be delayed until the September PRCC meeting. Murdoch suggested that members of the HSC attend to view Jorgensen's presentation and ask questions of him.

Bill Gale asked if anyone has heard from Craig Busack regarding his ability to re-engage with the group on this topic. Brett Farman will follow up with Busack.

Todd Pearsons asked if the HSC should develop some questions for Jorgensen for a more productive discussion. For instance, asking what data needs there are, to understand why certain existing data are insufficient.

Murdoch and Graf will make a request to the PRCC that HSC members participate in the September meeting for Jorgensen's presentation and that they are able to identify specific questions for Jorgensen prior to the meeting. Hillman will compile the questions to be sent to Jorgensen.

C. Finalize the Grant PUD 2020 M&E Implementation Plan for Wenatchee and Methow Basins

Todd Pearsons reviewed minor changes made to the draft "*Grant County PUD Hatchery Monitoring and Evaluation Implementation Plan for Spring and Summer Chinook in the Wenatchee Basin and Summer Chinook in the Methow Basin 2020*."

Pearsons identified one substantive change. Pearsons said forced releases limit their ability to use PIT tags to monitor releases at Carlton Pond and Nason Acclimation Facility. Kirk Truscott asked if there are predation problems that affect calculation of survival of the fish reared at Carlton Pond. Pearsons said no.

Mike Tonseth asked to review a passage on residualism. Pearsons updated a section of estimating residualism by monitoring PIT-tag detections post-release. Tonseth said there should be language consistent with draft permits for pre-release sampling; an edit may not be needed in this document as long as there is an understanding that what was written in the permits will be implemented.

Tracy Hillman asked the PRCC HSC to vote on the Priest Rapids M&E plan; all parties approved.

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are August 21, 2019, September 18, 2019, and October 16, 2019, at Grant PUD in Wenatchee, Washington.

Bill Gale asked if there are agenda items for the PRCC HSC meeting in August such as broodstock protocol issues. Mike Tonseth said there was not a proposal for real-time otolith reading to be discussed, and there is now an alternative strategy in use so PRCC HSC broodstock protocols will not be modified.

VII. List of Attachments

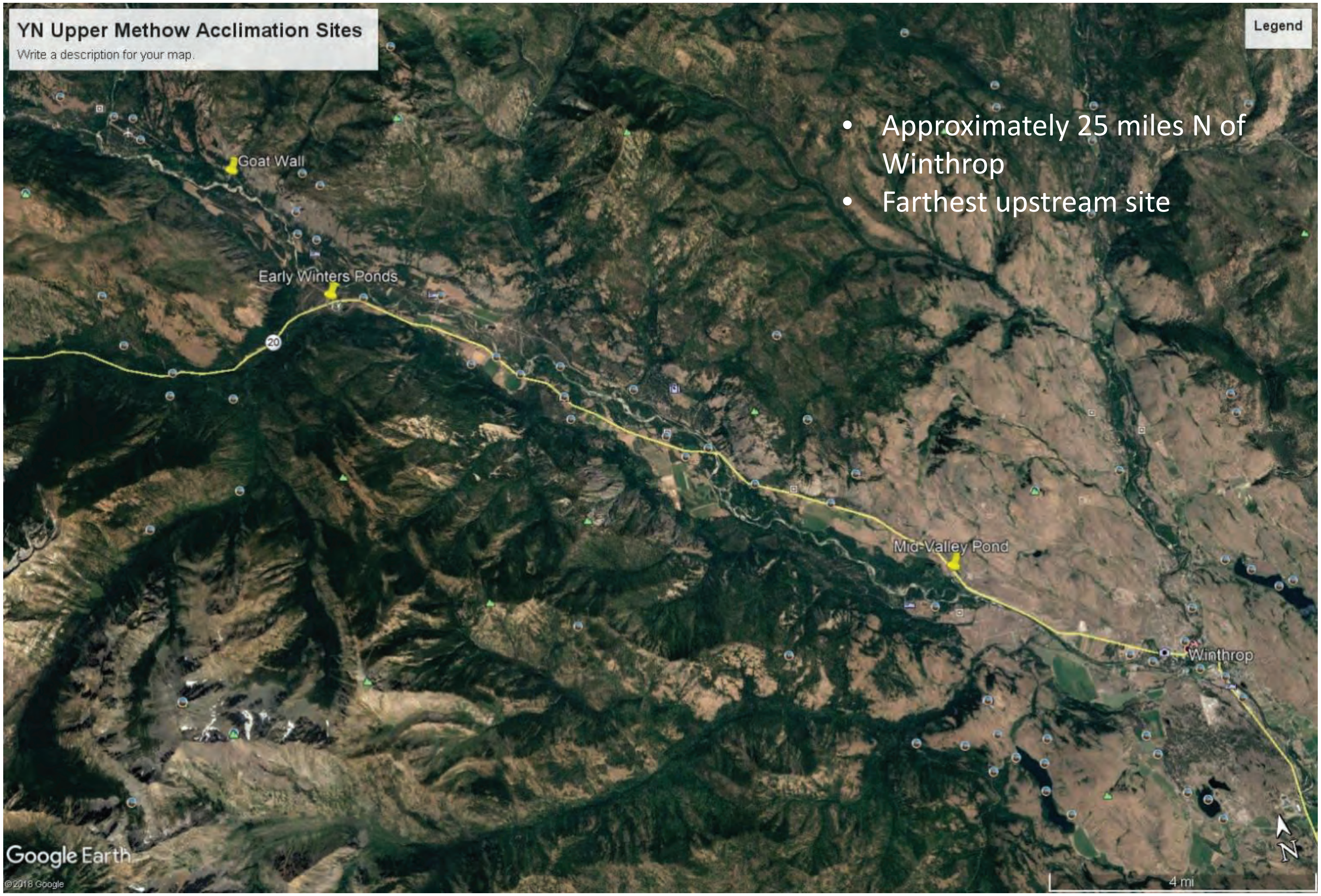
Attachment A	List of Attendees
Attachment B	Presentation: Goat Wall Acclimation Site, Methow Valley
Attachment C	*Control of* Saprolegnia sp. *Growth on Summer Chinook (*Oncorhynchus Tshawytscha*) Eggs*

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Betsy Bamberger	Douglas PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Todd Pearsons‡	Grant PUD
Brett Farman*‡	National Marine Fisheries Service
Matt Cooper*‡	U.S. Fish and Wildlife Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Rick Alford	Yakama Nation
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
º Joined by phone

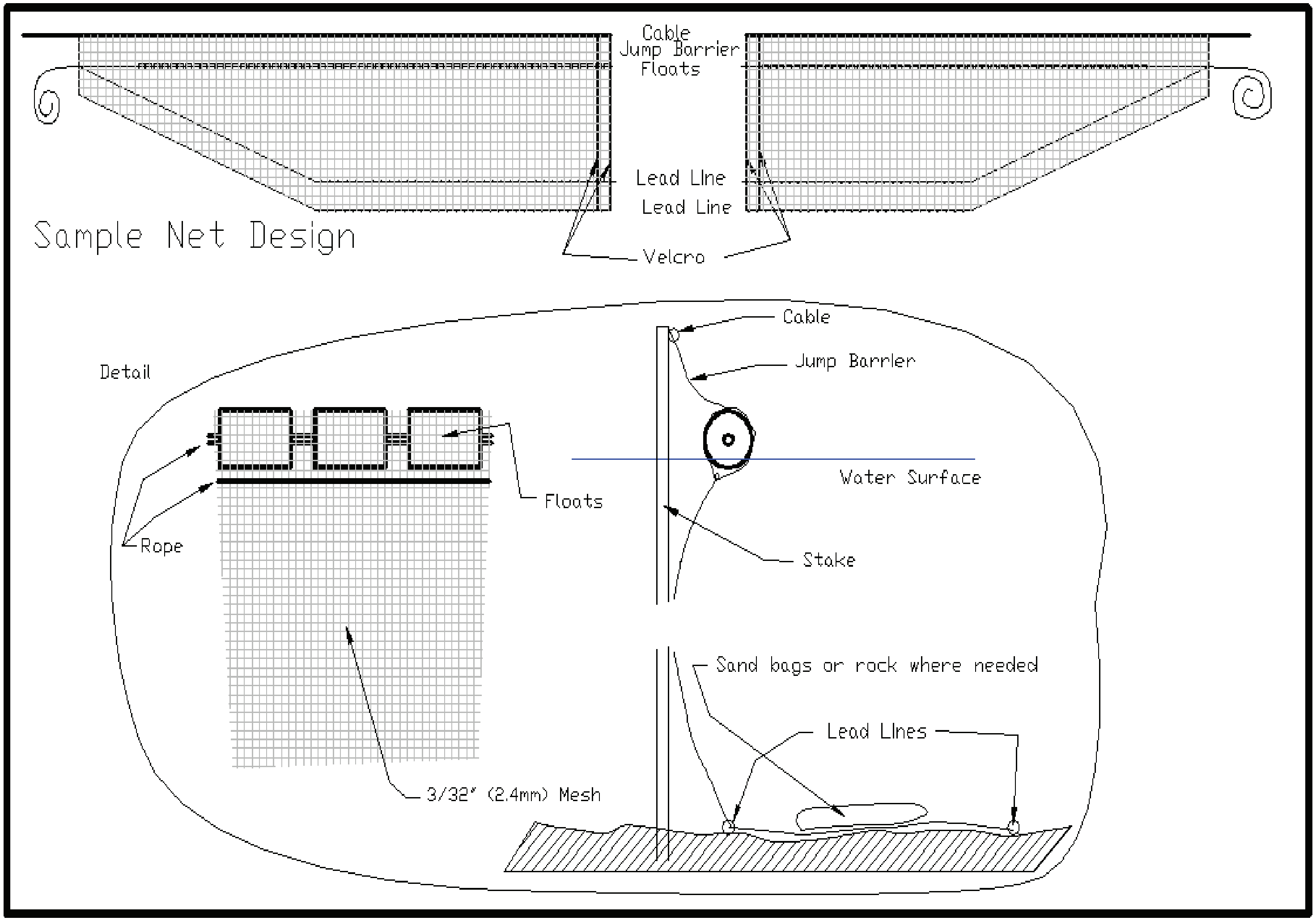
Goat Wall Acclimation Site
Methow Valley


YN Upper Methow Acclimation Sites
Write a description for your map.
Legend
Approximately 25 miles N of Winthrop
Farthest upstream site
Goat Wall
Early Winters Ponds
20
Mid Valley Pond
Winthrop
Google Earth
©2018 Google
4 mi
N


Untitled Map
Write a description for your map.
Legend
Goat Wall
• "Cold Creek"
• Disconnected side channel
Water sources:
• Natural groundwater seepage, Gate Creek diversion
• Typically waters up mid-March; upper Methow at approx. 100 CFS
Lost River Rd
9140
Goat Wall
Google Earth
500 ft
N


Untitled Map
Write a description for your map.
Legend
Pond Area
• 0.08 Acres (30'x110')
• Avg. depth 3'
• High 30's to mid-40's F°
• Approx. 3-15 CFS
• Capacity for 30,000 @ 16 fpp , density >0.06
Google Earth
©2018 Google
N
100 ft

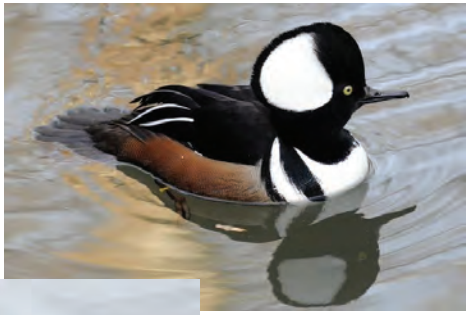

Snow can be challenging!


Cable
Jump Barrier
Floats
Lead Line
Lead Line
Sample Net Design
Velcro
Cable
Jump Barrier
Detail
Floats
Water Surface
Rope
Stake
Sand bags or rock where needed
Lead Lines
3/32" (2.4mm) Mesh

Attachment B

Acclimation activities

- Fed 2 to 3 times per day
- DO and Temp
- Growth samples and health monitoring
- Periodic snorkel surveys
- Predator hazing



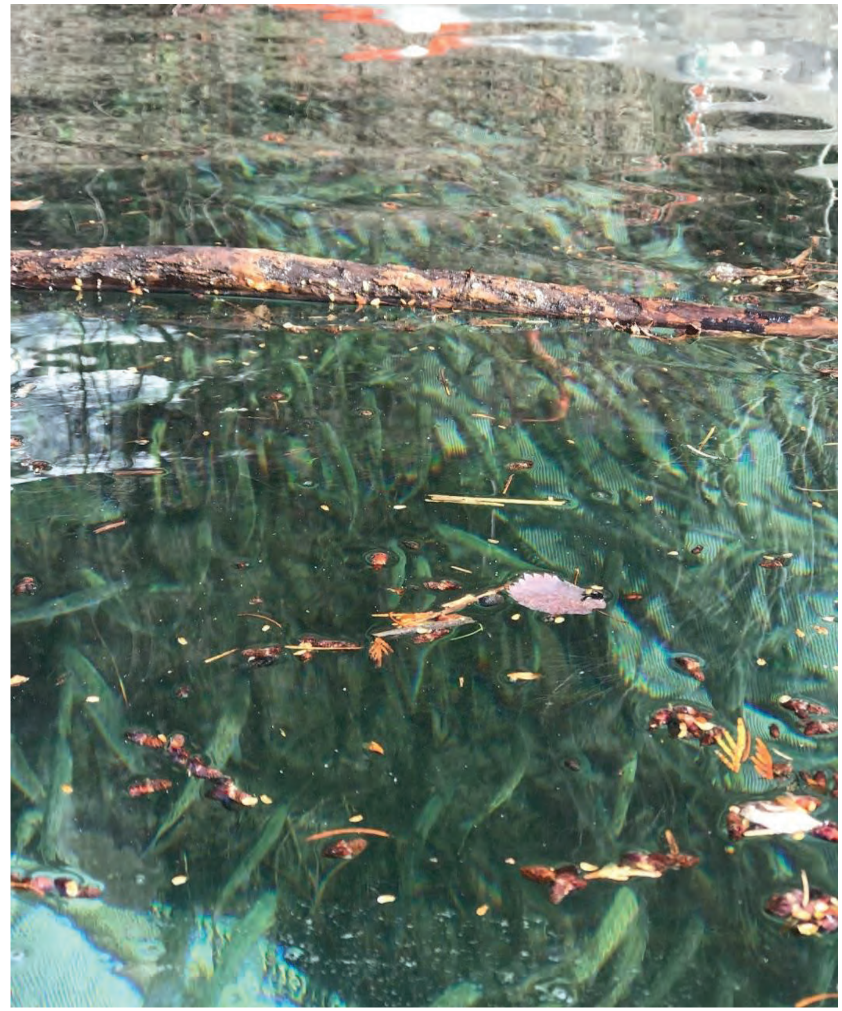

All activities done by boat!

Release Summary 2017 - 2019

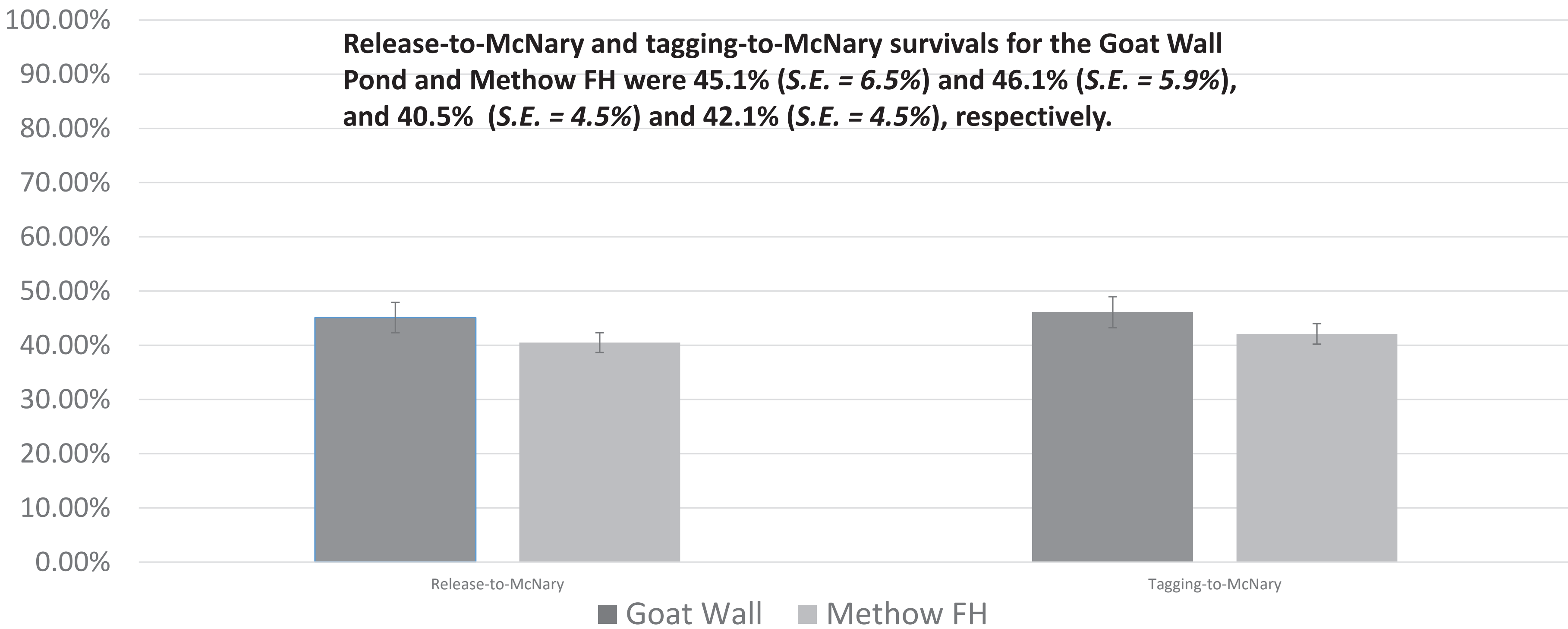
Release Year	# Received	# Released	Transfer Date	Start Release	End Release	PIT tags Released
2017	25,978	25,894	3/30	4/17	4/26	4,934
2018	28,535	27,970	3/15	4/18	4/29	4,425
2019	29,810	29,777	4/2	4/22	4/30	4,971

Results so far?

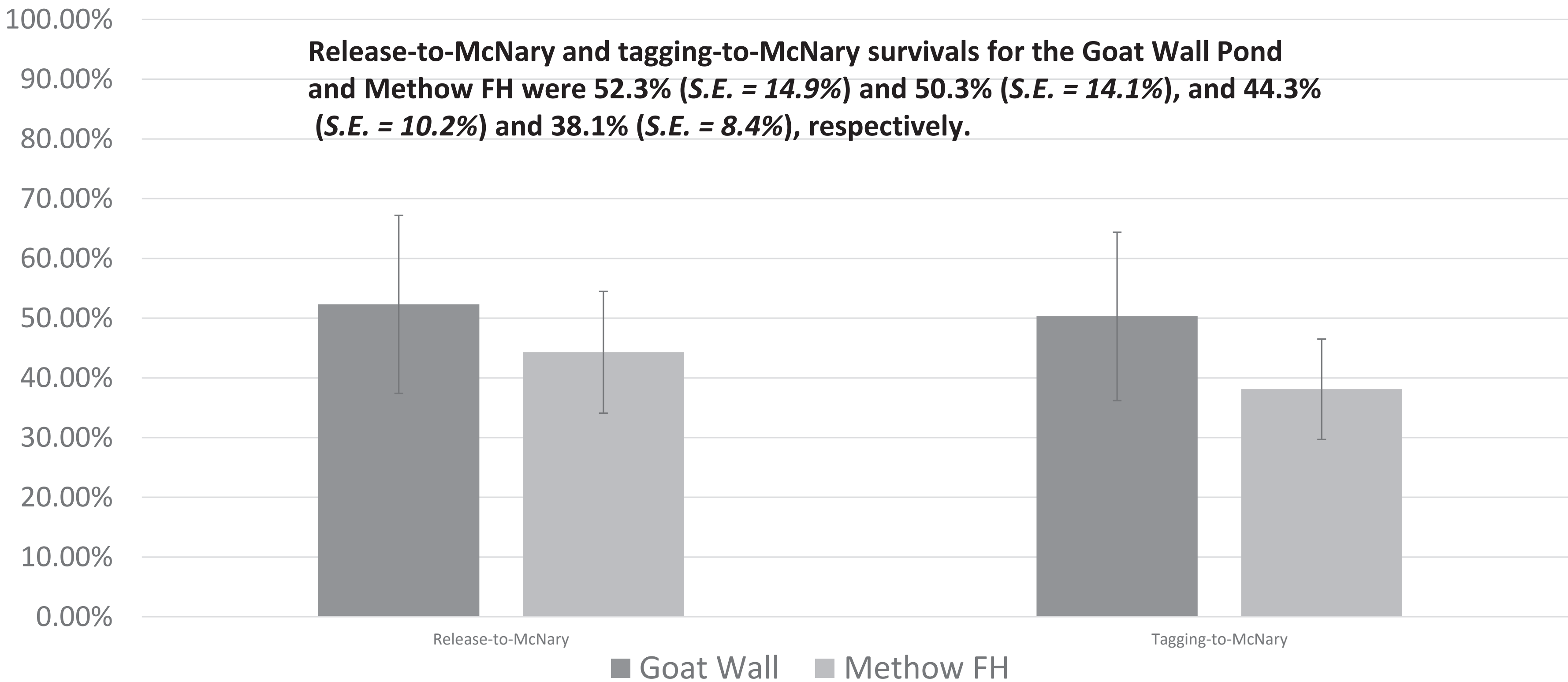
- Meet target size 15-18 fpp
- High in-pond survival
  - 2017 - 99.7%
  - 2018 - 98.0%
  - 2019 - 99.9%
- Minimal pre-release escapement - 1.2 %
- Similar outmigration survival to other release groups
- Similar travel time

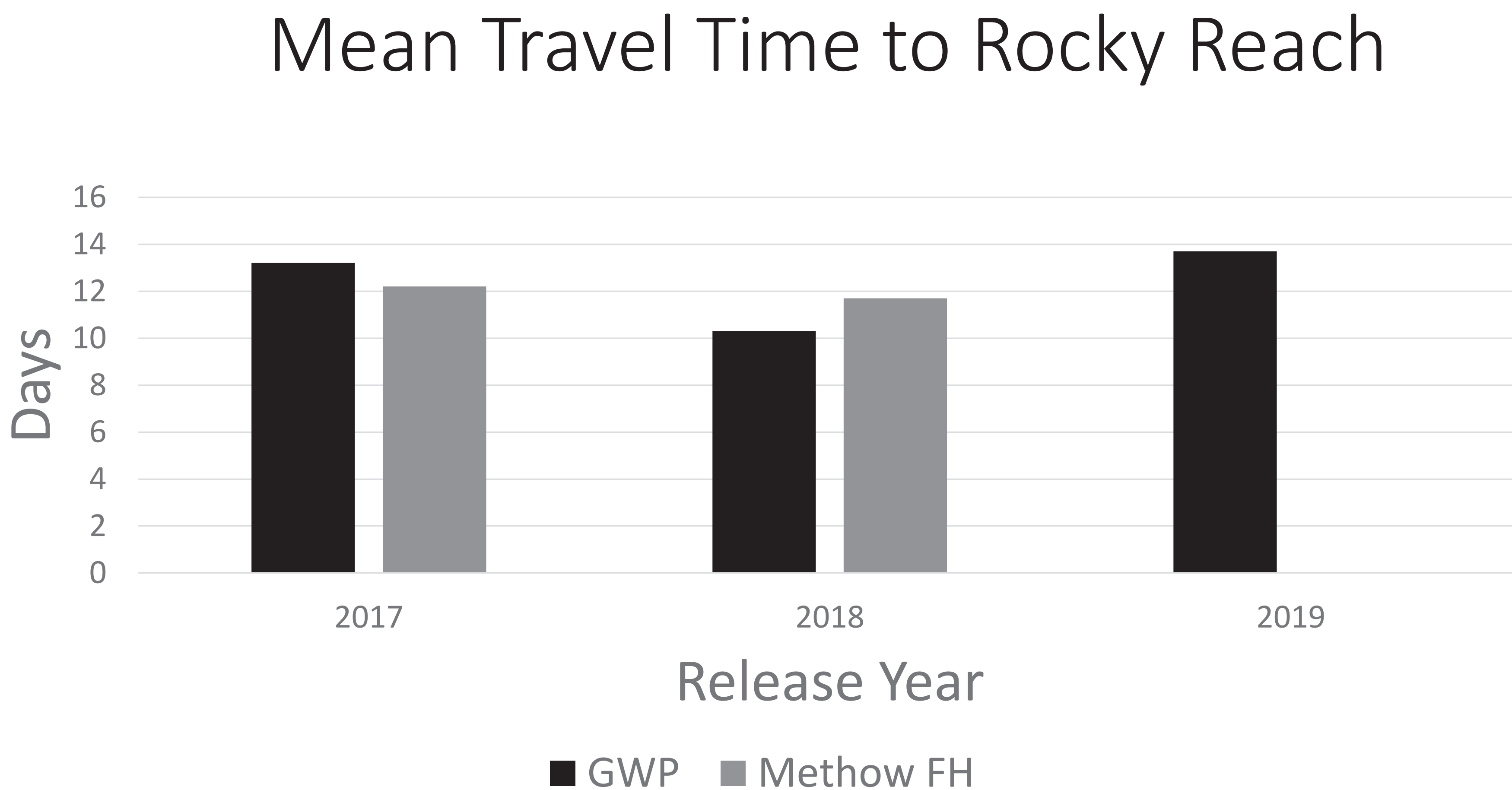


2017 Outmigration Survival



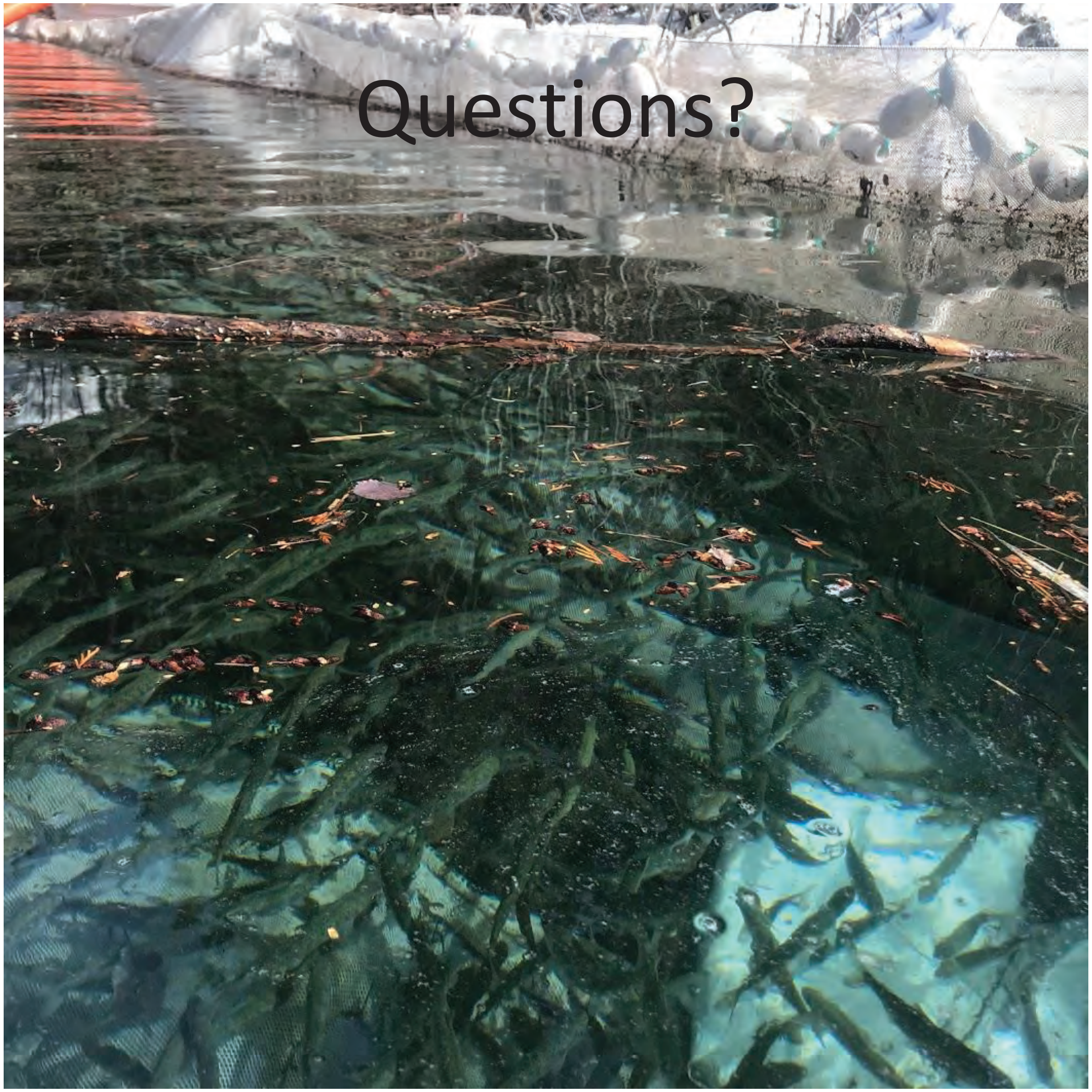
2018 Outmigration Survival




Mean Travel Time to Rocky Reach
16
14
12
10
8
6
4
2
0
Days
2017
2018
2019
Release Year
GWP
Methow FH

Available adult return data for BY2015 based on PITs over Wells Dam

Release Location	# Released	Tag Rate %	Est. over Wells	SAR to Wells(%)
Goat Wall Pond	25,894	19.1	79	.30
Winthrop NFH	424,591	4.7	1364	.32
Methow FH	59,260	8.4	166	.28
Chewuch AF	65,621	7.6	210	.32
Twisp Weir	40,351	12.4	65	.16


Questions?

CONTROL OF *SAPROLEGNIA* SP. GROWTH ON SUMMER CHINOOK (*ONCORHYNCHUS TSHAWYTSCHA*) EGGS

EXPERIMENTAL PROTOCOL – PILOT STUDY

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

May 21, 2019

Prepared by:
Dr. Betsy Bamberger
DCPUD Fish Health and Evaluation Specialist

Public Utility District No. 1 of Douglas County
East Wenatchee, Washington 98802

ABSTRACT

Summer Chinook (*Oncorhynchus tshawytscha*) eggs were treated with hydrogen peroxide, sodium chloride (salt), formalin, and ambient water for the prophylactic management of Saprolegniasis (water mold infestation) at Methow Fish Hatchery (MFH) in Winthrop, Washington. This pilot study detected no difference in apparent effect on viability or survivability of eggs and alevins among the treatments described. However, the relatively few number of water mold-infected eggs in the treatment groups suggests *Saprolegnia* sp. was present in the water supply in insufficient amounts to cause substantial infection, pathology, and/or loss. This result questions the historic and future need for preventative measures to be implemented for "fungus" control during egg incubation at MFH.

1.0 INTRODUCTION

Water mold (*Saprolegnia* sp.) is a common pathogen of salmonid eggs in fish hatcheries. Traditionally, hatcheries have used formalin for prophylactic management of *Saprolegnia* sp. infection in incubating eggs. However, formalin has long been associated with worker safety and environmental hazards, and is expected to be met with increasing scrutiny by regulatory agencies in the immediate future. In this study, we investigate the efficacy of purported alternatives to formalin that can be used as safe therapeutic substitutes. These alternatives include hydrogen peroxide (H_2O_2) and salt (NaCl), as well as no treatment (i.e., ambient water only), in controlling water mold infestations during salmonid egg incubation under typical hatchery conditions at the Methow Fish Hatchery (MFH) (located in Winthrop, Washington). The study described here is a pilot study to develop and evaluate the mechanics of delivering treatment and to gain preliminary results to guide future work. We tested the null hypothesis that there will be no difference found among test treatment groups (hydrogen peroxide, sodium chloride, no treatment [water]) and the formalin group, using egg mortality caused by Saprolegniasis as the basis for the analysis.

2.0 METHODS

Twenty-four (24) females and fourteen (14) males of Wells Hatchery-origin (hatchery) summer Chinook were collected at Wells Fish Hatchery (WFH) in mid to-late July, 2018. Once sexually mature, the adult fish were stripped of eggs and milt at WFH on October 16, 2018. All gametes were harvested on the same day to eliminate temporal bias. Once all were harvested, green eggs and ovarian fluid from spawned females were collected directly into a communal, approximately 65 L plastic tub, and gently mixed to control for potential maternal effects across the treatments. Eggs were then divided into twenty-four approximately equal portions (each deposited into a separate, numbered large Ziploc® bag) and placed in an ice-filled cooler lined with burlap. Milt from each male was collected in separate, small Ziploc® bags and stored in the same chilled cooler. Later that same day, all gametes were transported to MFH, approximately a one hour drive away. Upon arrival at MFH, the unfertilized eggs were split into two sets of twelve (each bag of eggs deposited into a separate plastic bucket) to accommodate the hatchery staff's preferred work methods. The eggs were combined with the milt from an individual male, used for primary fertilization, and then milt from a second male used as backup several minutes after initial fertilization by the primary male. Each male served as a primary male for at least one female and a backup male for one or more females, thus providing greater probability of successful fertilization and allowing identification of an individual male with reduced viability or non-viable gametes. All eggs were mixed prior to fertilization so detection of an individual female with reduced viability or non-viable eggs was not possible.

Eggs and milt were stirred together, gently rinsed with water, and then placed in a designated individual Heath vertical incubator tray and within a stack assigned to one of four treatment groups (formalin, salt, hydrogen peroxide, and water [no treatment]).

Eight incubation stacks were used, two for each of the four treatment groups. The topmost tray of each stack was kept empty to allow for ease of chemical introduction; three staggered trays below were reserved for eggs (see treatment-specific information and schematic representation of experimental set-up in Figure 1, below). The formalin stacks were located in a separate incubation room to avoid potential adverse chemical reactions between formalin and hydrogen peroxide, but otherwise the stacks and trays were identical to the other treatments. Each tray was numbered in advance to identify treatment type and tray position in the stacks. Egg clutches were placed within trays in sequential order until all trays were occupied. For all treatments, the fertilized eggs in the trays within the stacks were water-hardened and disinfected in a 100 ppm buffered iodophor (Ovadine®) solution (static bath) for 60 minutes. Following water hardening and surface disinfection, fresh well water (averaging 8°C, [47°F]) was introduced into the stacks, effectively draining away the used iodophor solution from each tray. Flow was set at 3 gallons per minute (gpm) except in the salt treatment stacks, where it was set at 3.2 gpm to accommodate the added volume of saline solution to be introduced into the system.

Formalin, salt, and hydrogen peroxide were added to the topmost (empty) tray of the incubation stacks and delivered via a metered peristaltic pump (INTLLAB™ or MasterFlex easy-load® II). Dosages of hydrogen peroxide, formalin, and salt were calculated to consider flow rate, treatment time, final desired concentration of chemical treatment, and chemical strength. As such, treatments were consistent with FDA-label instructions or previously published data (see Figure 1). Salt was pre-dissolved before administration; salinity was monitored during treatment with an Apera 5052 saltwater salinity tester with the probe placed in the topmost empty tray and recorded at multiple time points during administration (0, 5, 10, 15, and 20 minutes).

Daily 15-minute flow-through treatments with hydrogen peroxide, well water, and salt were initiated on the day following fertilization (October 17, 2018). Treatments continued on alternate days until November 22, 2018, providing 19 days of treatment, and ceased just prior to the initiation of hatching. Formalin treatments were administered on the second day following fertilization (October 18, 2018) to avoid undesirable exposure to other oxidizing compounds used in this study, and continued on alternate days until November 23, 2018, providing 19 days of treatment.

A total of 975 mL of hydrogen peroxide and 1,539 mL of formalin were used for each treatment day (volume accounts for both treated stacks). Salt concentrations varied during treatments before stabilizing but reached above 30 ppt on Oct 17th, Oct. 19th, Oct. 27th, Oct 29th, Nov 6th, and Nov 18th for 5-10 minutes.

On November 24, 2018, the incubator trays in the hydrogen peroxide, well water, and salt stacks were opened and eggs photographed; the eggs were shocked by mechanical agitation within the trays and then dead eggs were removed and counted before trays were returned to the stacks. The same occurred on November 25, 2018 for the formalin group (photographed on November 26, 2018). On November 27, 2018, five live eggs from each treatment group (trays 1-4) were fixed in 10% neutral buffered formalin and sent to the Washington Animal Disease Diagnostic Laboratory (WADDL) for histological analysis.

On December 1, 2018, the trays for all groups were again opened and any dead and *Saprolegnia*-infected eggs were removed by hand and counted. An average individual egg weight was estimated from a 100 egg sample of the remaining live eggs in each tray that were carefully dried (via Wypall shop towels) and weighed. This total dried egg weight from each female was divided by the average egg weight to estimate the number of live eggs for each tray (note: total weights were reduced by 3% to approximate the weight of residual water). All trays were disinfected with Ovadine® for 10 minutes at 100 ppm before being placed back in the stacks.

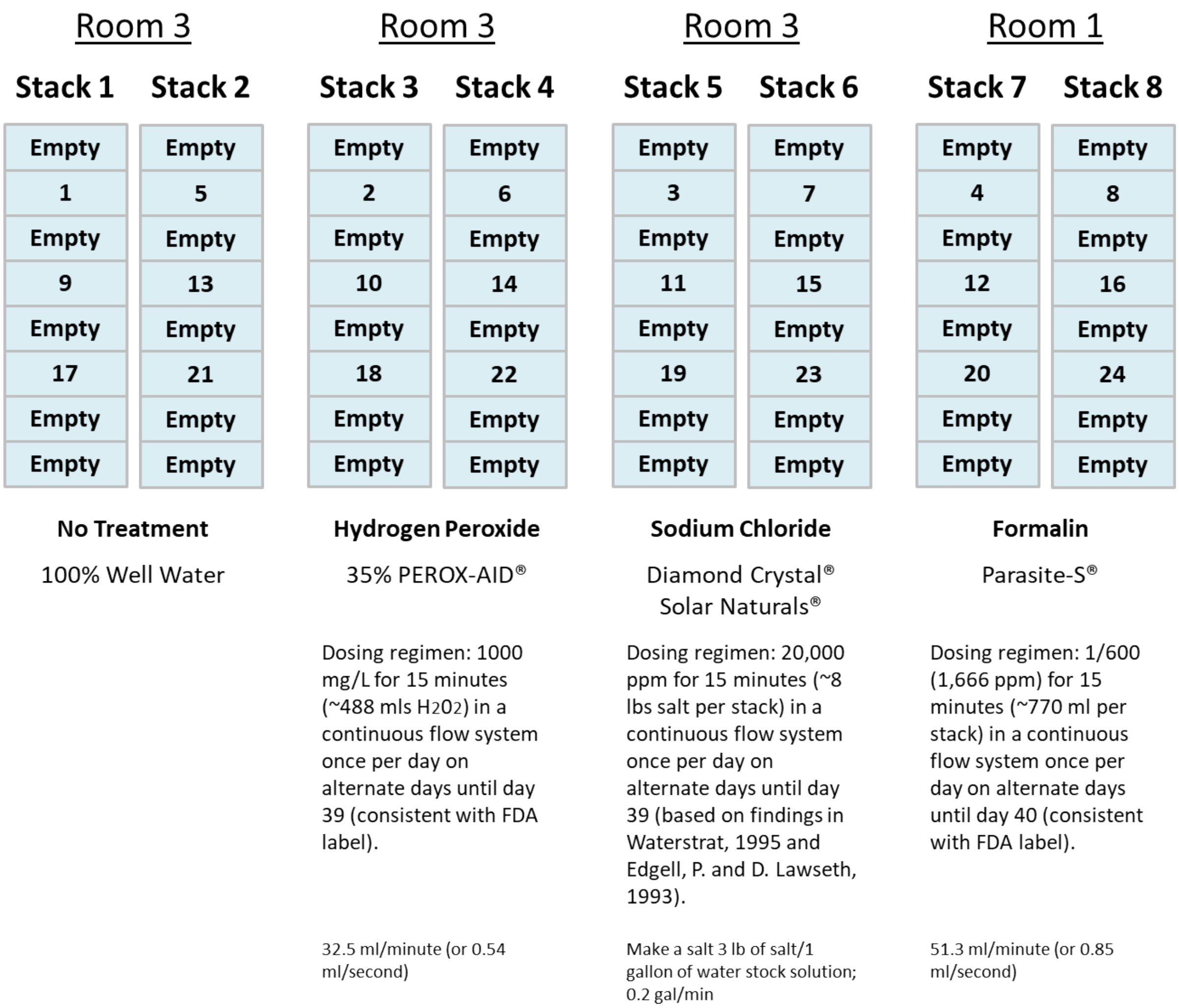


Figure 1: **Schematic representation of incubation room, stack and tray assignment, and dosing regimen per treatment group.**

Fifty (50) eggs from each tray were combined into one tray for each treatment group (5th tray from the top in stack 7, and 7th tray from the top in stacks 1, 3, and 5) on December 8, 2018 and incubated until the alevin stage (50 eggs x 6 trays per treatment group = 300 per group x 4 groups = 1200 eggs total). All other remaining eggs were destroyed, per the study design.

Mortality from eyed egg to unfed fry for each treatment was assessed when the unfed fry were determined to be near ponding readiness on January 22, 2019. Staff checked for discernable morphological differences in unfed fry from each group to determine if histological analysis was warranted.

All alevins were destroyed before the first feeding, per the study design.

The criteria used to evaluate the efficacy of each compound was mortality from fertilization through eyed egg (which includes both water mold-infected eggs and dead uninfected eggs throughout the 40 day incubation period and after shocking) and eyed egg to unfed fry survivability. In addition, the extent of water mold infection was qualitatively (via photography) and quantitatively (via the number of eggs that appear infected) estimated and enumerated, respectively.

3.0 STATISTICAL ANALYSIS

One-way ANOVA was used to examine similarities or differences between treatment groups. We verified that the assumptions (equal sample sizes, independence, etc.) were maintained in order to justify the application of the ANOVA. Further, in order to verify that tray position had little or no influence on experimental results, we compared mean egg survival to the eyed egg stage (%) against tray position number within each stack using a one-way ANOVA. Further, to insure there was no interaction between tray position and treatment, we ran a 2-WAY ANOVA using these predictors and percent egg loss as the response variable. P-values were assessed at $\alpha = 0.05$. Had the response variable not satisfied the assumption of homogeneous variance, an alternative analysis such as beta regression would have been used. All statistical analysis was conducted in JMP (8.0.2 SAS Institute Inc.).

4.0 RESULTS

All treatments had high average egg survival in excess of 92.9%, suggesting that there was little difference among the treatments (Figures 2-8 and Table 1). The vast majority of egg mortality occurred between fertilization and the eyed egg stage, accounting for approximately 95% of total egg loss. Conversely, less than 5% of all egg loss occurred between the eyed egg stage and emersion from the egg (first and second picks).x Similarly, the survival of alevins revealed no difference among treatments (Table 2). Notably, the no treatment (water only) group was not statistically different from the other treatment groups during the egg or the alevin stages of the study.

Upon opening the trays to assess mortality and perform the first pick, a scant amount of grey flocculent material (*Saprolegnia* sp. mycelia) was found surrounding white-to-tan (nonviable) individual eggs in trays 1 (two eggs), 9 (two eggs), 17 (four eggs), and 21 (four eggs) of the no treatment group; 10 (three eggs), 18 (three eggs), and 22 (one egg) of the hydrogen peroxide group; and 19 (one egg) and 23 (one egg) of the salt group (see Figure 6). These eggs were readily apparent at first glance and situated on top of the egg pile; the trays were not mixed or otherwise disturbed to ascertain if any affected eggs were hidden. No eggs were observed to be infected in the formalin group.

Total mortality per sample (tray) ranged from 4.22-9.28% regardless of treatment. One-way ANOVA verified that there were no significant differences between treatment groups when we examined average percent loss in each treatment ($p = 0.66$, $df = 3$, $f\ ratio = 0.55$; Figure 2).

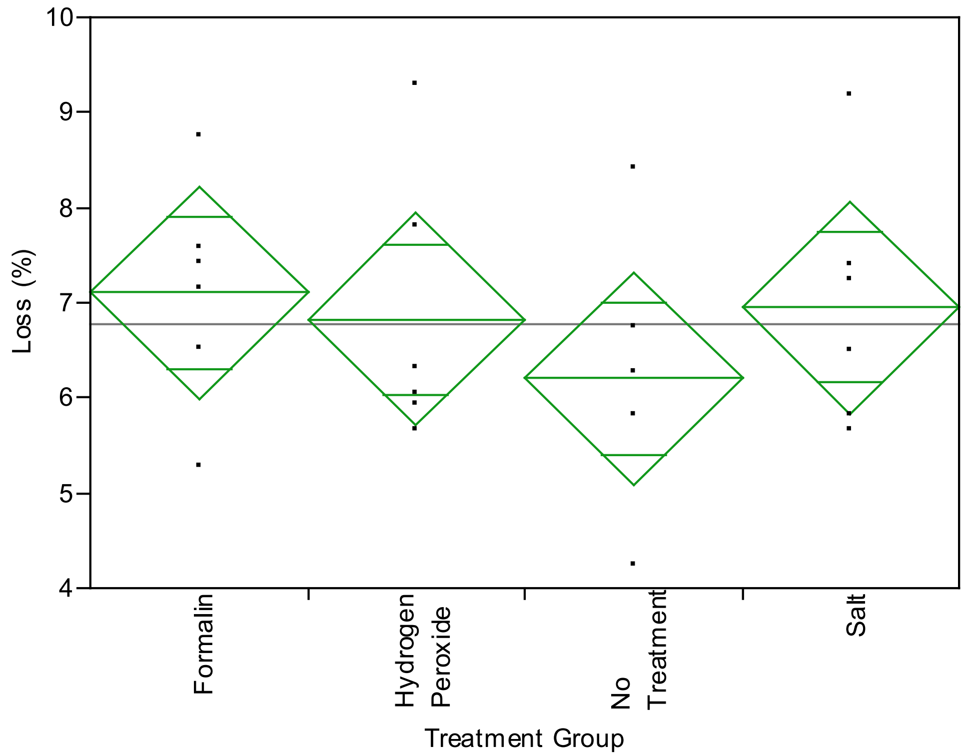


Figure 2. **One-way ANOVA comparing total egg loss as a percentage of available eggs (y-axis) for each treatment group (x-axis). Green triangles represent 95% confidence intervals, the middle green line represents the group mean, and the gray horizontal line represents the mean of all replicates regardless of treatment. Results were somewhat variable within each treatment group and, as such, no significant differences were observed. (*p* = 0.66, *df* = 3, *f ratio* = 0.55).**

To test that our handling procedures, or in this case the order of tray placement, did not influence egg survival, we examined tray location category with average egg loss at those positions (%). This ANOVA yielded no relationship ($p = 0.59$, $df = 2$, $f\ ratio = 0.55$, $\eta^2 = 0.082$; Figure 3), giving us confidence that tray position was unimportant in predicting egg loss and our husbandry of trays was appropriate. Finally, our 2-way ANOVA that used tray position and treatment as predictor variables that may interact with each other to have an effect on percent egg survival yielded no interaction ($p = 0.48$, $df = 6$, $f\ ratio = 0.96$, $\eta^2 = 0.75$).

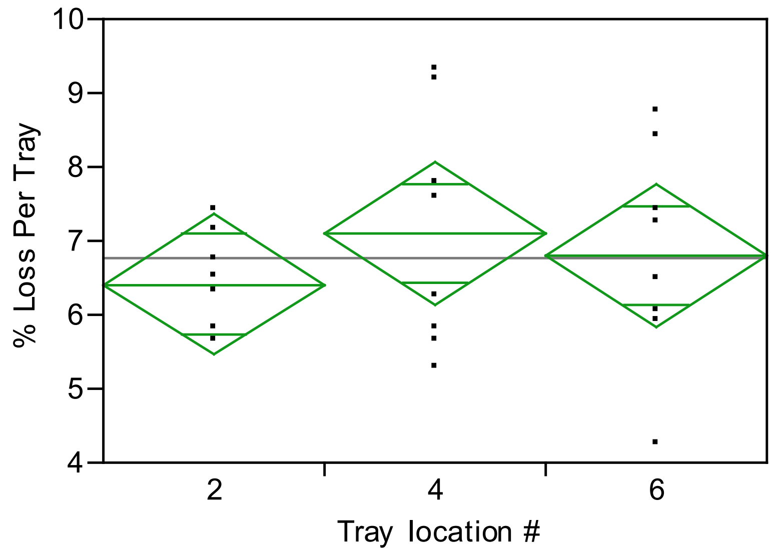


Figure 3. **One-way ANOVA comparing average total egg loss as a percentage of available eggs (y-axis) relative to tray location (x-axis). Green triangles represent 95% confidence interval, the middle green line represents the group mean, and the gray horizontal line represents the mean of all replicates regardless of treatment. Results suggest tray location did not influence egg loss (p = 0.59, *df* = 2, *f ratio* = 0.55, η^2 = 0.052).**

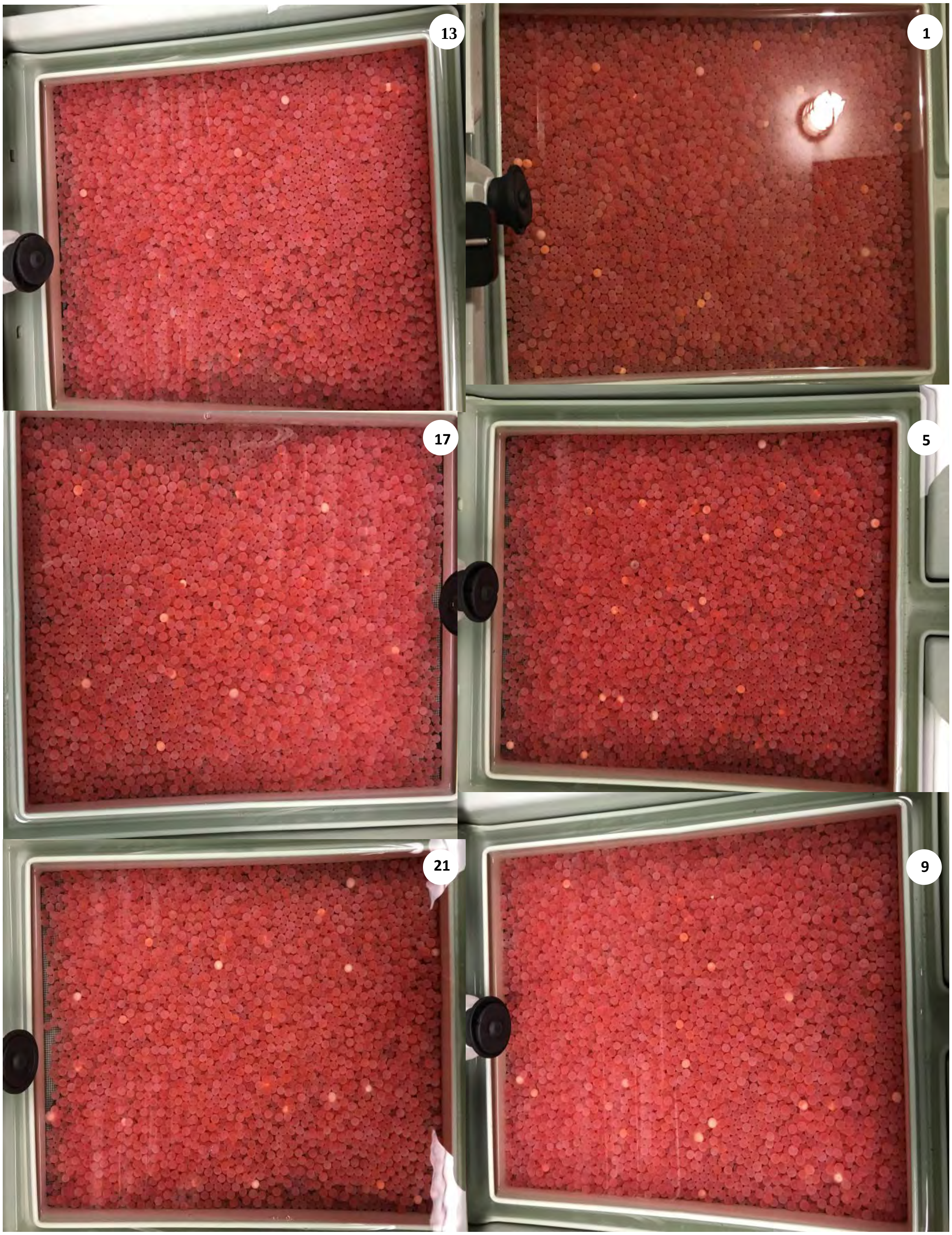


Figure 4: **Pictures of Egg Trays (No Treatment Group); tray numbers in upper right corner.**

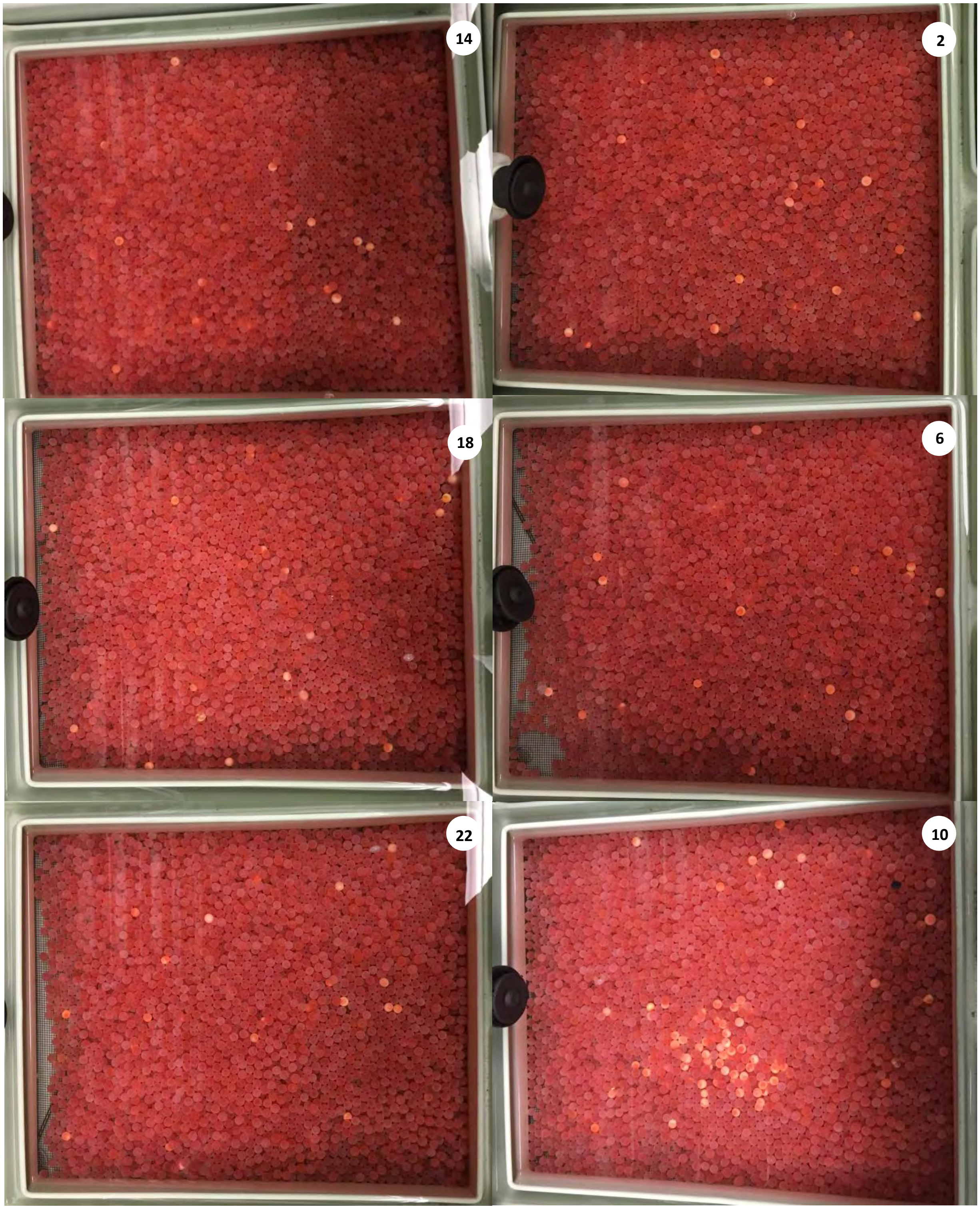


Figure 5: **Pictures of Egg Trays (Hydrogen Peroxide [35% PEROX-AID®]); tray numbers in upper right corner.**

Figure 6: Pictures of Egg Trays (Sodium Chloride [Diamond Crystal®]); tray numbers in upper right corner.

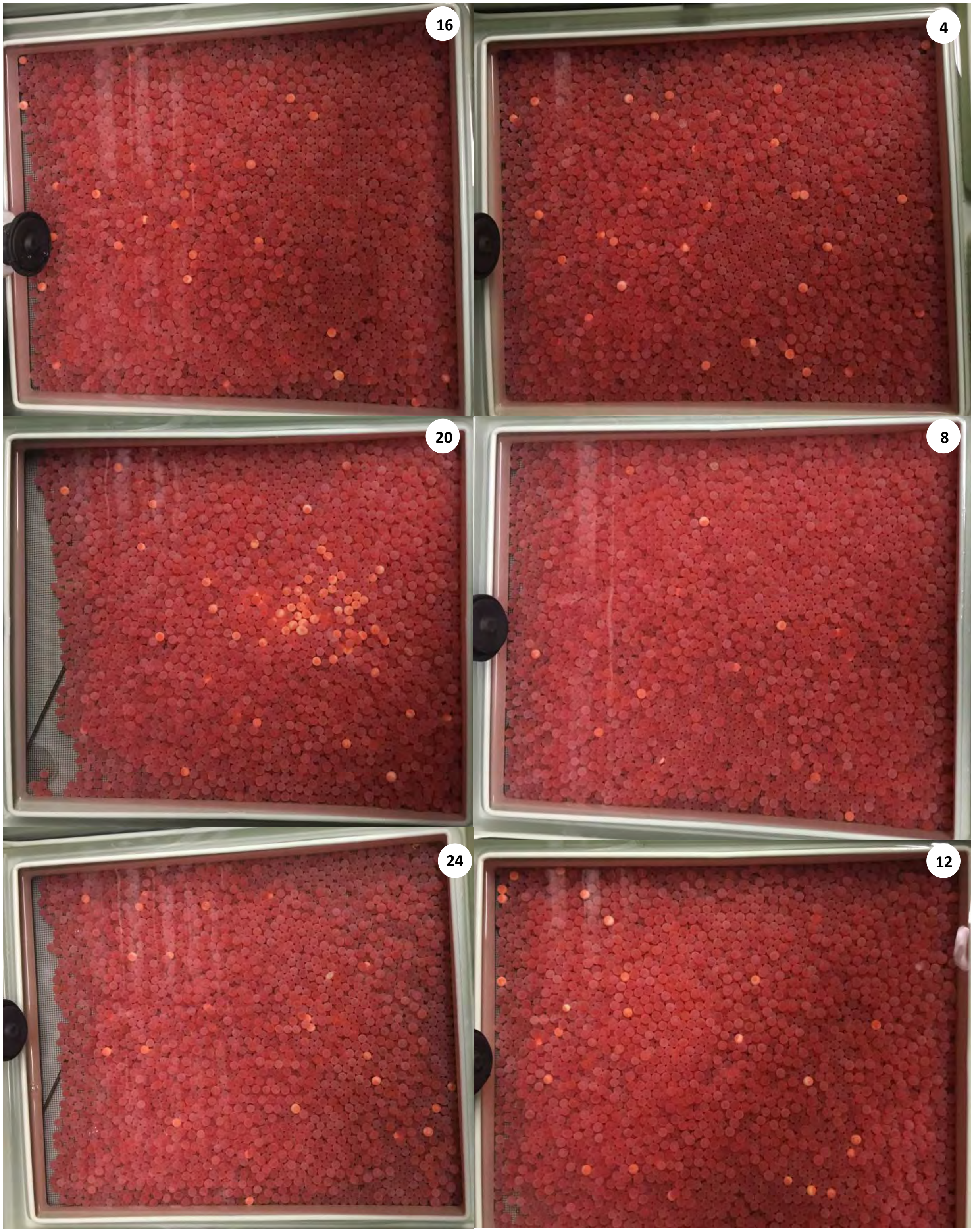


Figure 7: **Pictures of Egg Trays (Formalin [Paraside-S®]); tray numbers in upper right corner.**

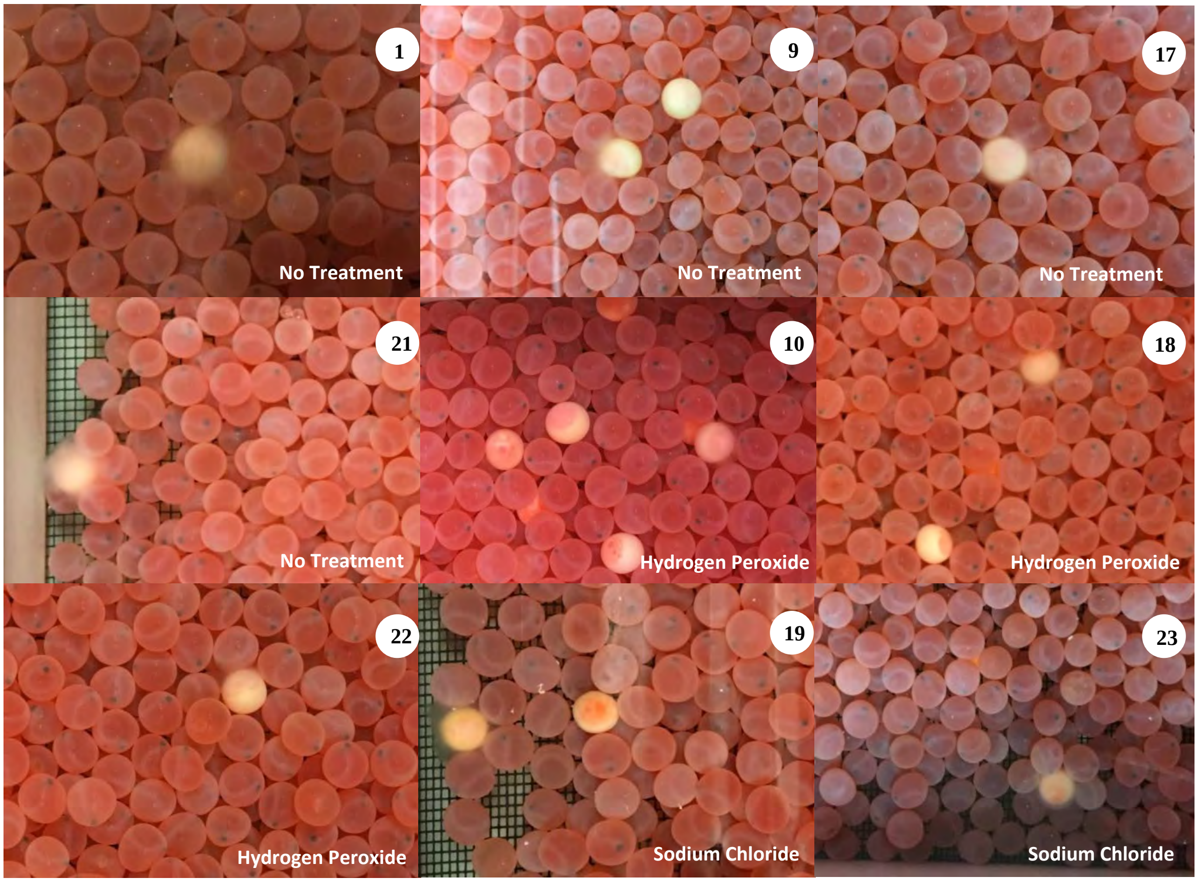


Figure 8: ***Saprolegnia*** **sp.-infected eggs on the day of the first pick; tray numbers in upper right corner.**

Table 1: **Egg loss per tray from fertilization to eyed egg (first pick) and during the eyed egg stage (after second pick).**

Treatment Group	Female #	Shock Date	1st Pick Date	Egg Loss	2nd Pick Date	Egg Loss	Total Loss	Total Eggs	% Loss Per Tray	Average % Loss
No Treatment	1	24-Nov	25-Nov	251	1-Dec	2	253	3,758	6.73	6.200781296
No Treatment	9	24-Nov	25-Nov	266	1-Dec	3	269	4,636	5.80	
No Treatment	17	24-Nov	25-Nov	156	1-Dec	3	159	3,770	4.22	
No Treatment	5	24-Nov	25-Nov	238	1-Dec	3	241	4,147	5.81	
No Treatment	13	24-Nov	25-Nov	218	1-Dec	9	227	3,633	6.25	
No Treatment	21	24-Nov	25-Nov	324	1-Dec	13	337	4,016	8.39	
Hydrogen Peroxide	2	24-Nov	25-Nov	250	1-Dec	13	263	4,173	6.30	6.826897426
Hydrogen Peroxide	10	24-Nov	25-Nov	310	1-Dec	8	318	4,086	7.78	
Hydrogen Peroxide	18	24-Nov	25-Nov	234	1-Dec	7	241	3,998	6.03	
Hydrogen Peroxide	6	24-Nov	25-Nov	220	1-Dec	7	227	4,018	5.65	
Hydrogen Peroxide	14	24-Nov	25-Nov	410	1-Dec	8	418	4,503	9.28	
Hydrogen Peroxide	22	24-Nov	25-Nov	239	1-Dec	6	245	4,142	5.92	
Salt	3	24-Nov	25-Nov	240	1-Dec	2	242	4,175	5.80	6.948034887
Salt	11	24-Nov	25-Nov	226	1-Dec	15	241	4,276	5.64	
Salt	19	24-Nov	25-Nov	284	1-Dec	11	295	4,560	6.47	
Salt	7	24-Nov	25-Nov	278	1-Dec	6	284	3,841	7.39	
Salt	15	24-Nov	25-Nov	308	1-Dec	7	315	3,437	9.17	
Salt	23	24-Nov	25-Nov	264	1-Dec	3	267	3,694	7.23	
Formalin	4	25-Nov	26-Nov	247	1-Dec	4	251	3,863	6.50	7.100103437
Formalin	12	25-Nov	26-Nov	218	1-Dec	3	221	4,192	5.27	
Formalin	20	25-Nov	26-Nov	360	1-Dec	5	365	4,178	8.74	
Formalin	8	25-Nov	26-Nov	314	1-Dec	1	315	4,414	7.14	
Formalin	16	25-Nov	26-Nov	261	1-Dec	2	263	3,478	7.56	
Formalin	24	25-Nov	26-Nov	232	1-Dec	5	237	3,204	7.40	

Table 2: Total egg/alevin loss in combined trays before destruction.

Treatment Group	Pick Date	Egg/Alevin Loss	% Loss per Tray
No Treatment	22-Jan	0	0
Hydrogen Peroxide	22-Jan	3	6
Salt	22-Jan	2	4
Formalin	22-Jan	1	2

5.0 DISCUSSION

There was no significant difference in survival among treatment groups to the eyed egg or the alevin stages. The spatial pattern of loss within trays, as evidenced by the photos taken after shocking, was more or less consistent between trays. Most often, nonviable eggs were evenly distributed throughout the tray, indicating that mortality was ostensibly sporadic and not necessarily associated with pathogen epicenters or water flow irregularities. The two exceptions were trays 10 (hydrogen peroxide–treated group) and 20 (formalin-treated group) with dead eggs clumped in the center of the trays. The phenomenon may have been coincidental. The egg/alevin losses were almost negligible and consistently low among all groups. The relatively few numbers of water mold-infected eggs suggests *Saprolegnia* sp. was present in the water supply in insufficient amounts to cause substantial infection, pathology, and/or loss. This result questions the historic and future need for preventative measures to be implemented for "fungus" control during egg incubation at MFH.

In 2015, the percent survival of unfertilized egg-eyed was 96.1 and 98.8 for the Methow Composite spring Chinook and Twisp spring Chinook, respectively, while in the Wells summer Chinook yearling program (reared at WFH and the source of the eggs used in this study) the percent survival of unfertilized egg-eyed was 90.0. The mean percent survival of brood years 1999 through 2015 was 95.0 and 94.2 for the Methow Composite spring Chinook and Twisp spring Chinook, respectively. The egg survival percentage in this study (on average equal to or in excess of 92.9% for all treatments) is comparable to those historically recorded at Methow, if slightly lower. This disparity may be attributable to the difference in stock (summer versus spring-run Chinook), incubation vessel (trays versus the standard isolation buckets used at the hatchery), or quality of eggs (study eggs were attained near the tail-end of the spawning season at Wells Hatchery and underwent additional handling during transport to Methow Hatchery). Compared to the egg mortality rates at Wells, the eggs in this study had slightly higher survival, but it is difficult and perhaps unproductive to compare losses across facilities with different water sources, set-ups, and other variables.

The chemicals themselves appear to have made little impact on the eggs in terms of survivability. Indeed, the eggs collected and submitted on November 27, 2019 for histological analysis were found to have no differences in cellular structure (see Attachment 1 for the report from the Washington Animal Disease Diagnostic Laboratory). Hatchery staff did notice that the formalin-treated eggs felt the "hardest" (re: most rigid) among all groups and that the salt-treated eggs were perceived to be the tackiest. Additionally, when trays were tapped (presumably to better sift through and inspect the eggs within), the eggs in the hydrogen peroxide, salt, and no treatment groups did not move within the trays as effortlessly as was thought to be normal for formalin-treated eggs. The hatchery staff also noted that the eggs in the salt treatment group hatched a day or two early; it is theorized that the saline mixture dissolved in hot water the day before may have warmed the ambient well water in the salt-treated stacks and influenced the rate of development in treated eggs. This seems unlikely but no other explanation to account for this observation is readily apparent.

6.0 CONCLUSION

There was no appreciable difference in egg mortality or hatch-out viability between treatment groups. There was no apparent effect on viability or survivability of eggs and alevins associated with the treatments described. Notably, the use of ambient water (i.e., no treatment) was as effective as treating with any of the three chemicals tested, suggesting that in some situations chemically treating eggs may not be necessary to achieve high survival during egg incubation at MFH. However, it is unclear if the treatments attempted in this pilot would control *Saprolegnia* sp. infestations if tried in a system with infectious levels of pathogen present.

Future work should include conducting a similar study in a facility with a greater likelihood of high levels of *Saprolegnia* sp. A follow-up pilot study is planned for the fall of 2019 at MFH. Untreated spring or summer Chinook eggs (if available) will be incubated in isolation buckets and compared to formalin-treated eggs of the same run reared in similar containers. Based on the findings found here, it is hypothesized that there will be no difference in egg mortality and hatch-out survivability between the two groups. These findings could help inform future egg management strategies and reduce chemical use at MFH.

Another follow-up study will be attempted on summer Chinook in the fall of 2019 at WFH, where levels of *Saprolegnia* sp. may be higher. The study protocol will greatly resemble this one with provisions and accommodations appropriate for that facility.

7.0 ACKNOWLEDGEMENTS

Special thanks to the Methow Fish Hatchery staff (Brandon Kilmer, Dave Dinsmore, Matt Moore, and Emily Vinge); Greg Mackey and Andrew Gingerich for their help in completing this pilot study; and review by Tracy Hillman.

Attachment 1

Attachment C

Washington Animal Disease Diagnostic Lab

P.O. Box 647034 • Pullman, WA 99164-7034
Tel: (509) 335-9696 • Fax: (509) 335-7424

Case#: **2018-14837**
Report Date: 11 Dec 2018
Received: 30 Nov 2018
Owner: Methow Fish Hatchery
Animal: Experimental Eggs
Species: Chinook Salmon
Breed:
Sex/Age: ,

Betsy Bamberger
Douglas County PUD
1151 Valley Mall Parkway
East Wenatchee, WA 98802

Histopathology Report

Embryonated summer chinook salmon eggs from 4 treatment groups are received fixed in formalin. Eggs are bisected and processed into 4 slides for histologic examination as follows:

- Slide 1. Hydrogen peroxide
- Slide 2. No treatment
- Slide 3. Formalin
- Slide 4. Salt

All eggs are histologically similar and unremarkable.

HISTOLOGIC DIAGNOSIS:

1. Histologically normal embryonated eggs (see comments)

COMMENTS: There was no discernable difference between the treatment groups on histologic examination. However, the lack of histologic changes does not necessarily rule out functional or physiological differences or viability between groups. Chemical changes (e.g. on yolk proteins and lipid) associated with different treatments may not result in a corresponding histologically appreciable change.

WORK PENDING: None

Histopathology Report

Pathologist: Dr. Allan Pessier
Report authorized by: Dr. Allan Pessier, Senior Pathologist

FINAL

23 S. Wenatchee Avenue, Suite 220
Wenatchee, Washington 98801
509.888.2070

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: September 23, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the August 21, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

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The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, August 21, 2019, from 9:00 a.m. to 1:15 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman and Larissa Rohrbach will add review of the Broodstock Collection Protocols (BCPs) to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-F). *(Note: this item is ongoing.)*
- Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A). *(Note: this item is ongoing.)*

FINAL

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- Larissa Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (version dated May 15, 2019; Item I-A).
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation Plan for PUD Hatchery Programs (Update to the 2017 Plan)* to reflect revisions that were suggested in the August 21, 2019 meeting (Item II-D).

PRCC Hatchery Subcommittee

- HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item I-A). (*Note: This item is ongoing.*)
- Brett Farman will ask Craig Busack (National Marine Fisheries Service [NMFS]) to participate in the Wenatchee Basin life-cycle modeling discussion at the PRCC meeting on September 25, 2019, at Wanapum Dam, Washington (Item V-B).

Decision Summary

- Larissa Rohrbach sent an email to the Wells HC on September 11, 2019, noting that all parties voted by email in concurrence that there is sufficient capacity at Wells Fish Hatchery for WDFW’s additional production of subyearling Chinook salmon for southern resident orca prey, without compromising the existing, on-station HCP programs (Item III-A).

Agreements

- There were no agreements made in today’s meeting.

Review Items

- Larissa Rohrbach sent an email to the Rock Island and Rocky Reach HCP-HCs on August 21, 2019, notifying them that WDFW’s revised *Relative Reproductive Success Study Extension Memorandum* (RRS memorandum) is available for review and approval in the September 18, 2019 meeting (Item II-A).
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on August 19, 2019, notifying them that Douglas PUD’s *2019 Egg Treatment Study Plan* is available for review and approval in the September 18, 2019 meeting (Item II-B).
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on August 21, 2019, notifying them that the revised *Broodstock Collection Protocols Development Timeline Statement of Agreement* (SOA) is available for review, with edits due to Mike Tonseth by September 6, 2019 (Item II-F).

- Larissa Rohrbach sent an email to the Rock Island and Rocky Reach HCP-HCs on August 21, 2019, notifying them that *Chelan PUD's 2020 Draft Monitoring and Evaluation Implementation Plan* is available for review, with edits due to Catherine Willard by Friday August 30, 2019 (Item IV-A).

Finalized Documents

- There were no documents finalized in today's meeting.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the July 17, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and asked for any additions or changes to the agenda. Greg Mackey asked to remove Item II-D, "Alternative broodstock composition and mating strategies," to prepare for more discussion in a future meeting. Bill Gale asked to add a fish health update for Leavenworth National Fish Hatchery (LNFH) to the Joint HCP-HCs and PRCC HSC topics (new Item II-C). The HCP-HCs and PRCC HSC members approved the agenda as revised.

The HCP-HCs and PRCC HSC representatives reviewed the revised July 17, 2019 meeting minutes. Larissa Rohrbach said there were some revisions that the representatives then reviewed. Additional revisions were made in the meeting. The HCP-HCs and PRCC HSC members approved the July 17, 2019 meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on July 17, 2019, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on July 17, 2019)*:

Joint HCP-HCs and PRCC HSC

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under HCP-HCs' purview (Item I-A).*
  Hillman said this item is ongoing. Hillman said his contract is set up to prepare the 10-year Comprehensive Reports and then move on to updating the PUDs' Monitoring and Evaluation Plan (M&E Plan; Update to the 2017 Plan) per the Independent Scientific Advisory Board's guidance. Hillman requested that this action item be set aside until he re-initiates work to update the M&E Plan. Greg Mackey said the M&E Plan must be updated every 5 years and updates should be brought to the HCP-HCs for consideration at that time. This item will be removed from the action items list.

- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).*
  Tonseth said this item is ongoing, pending additional information from Jeff Jorgensen (NMFS).
- *Catherine Willard will update the genetics section of the Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (Update to the 2017 Plan) based on the genetics panel recommendations and will append the recommendations from the panel to the plan (Item I-A).*
  The 2017 PUDs' M&E Plan was updated by Willard and distributed by Sarah Montgomery via email on August 9, 2019. This item will be discussed in today's meeting. This item is complete.
- *Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).*
  Truscott said this item is ongoing.
- *Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said this item is ongoing. In the July HCP-HCs meeting Farman noted NMFS's approval for use of the iterative approach of estimating PNI for annual M&E reporting; however, the use of the multi-population model has not been discussed with his NMFS colleagues.
- *Mike Tonseth will revise the* Relative Reproductive Success (RRS) Study extension agreement memorandum *for clarity (Item II-A).*
  Tonseth said this item will be discussed in today's meeting. This item is complete. *(Note: the revised memorandum was distributed immediately following the meeting for review.)*
- *Larissa Rohrbach will add sizing of upper Columbia River conservation programs as a periodic agenda item (Item I-A).*
  Rohrbach said this item is complete. Rohrbach said a schedule for the next discussion of this topic will be determined in today's meeting (Item I-F).
- *Tracy Hillman and Larissa Rohrbach will maintain a list of outstanding topics, as follows, for consideration in HCP-HCs and PRCC HSC meetings prior to development of the 2020 Broodstock Collection Protocols (Item II-F). (Note: this item is ongoing.)*
  - *Use of age-3 males in broodstock*
  - *Use of alternative mating strategies*
  - *Establishing ranges around broodstock collection targets*
  - *Source for Chiwawa spring Chinook salmon broodstock*

Rohrbach said this item is complete. Rohrbach said a schedule for the next discussion of this topic will be determined in today's meeting.

- *Tracy Hillman and Larissa Rohrbach will add review of the Broodstock Collection Protocols to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item I-A).*
  Rohrbach said this item is ongoing.
- *Mike Tonseth will revise and redistribute the HCP-HCs Annual Broodstock Collection Protocols development timeline Statement of Agreement (SOA; Item II-F).*
  Tonseth said this item will be discussed in today's meeting. *(Note: the revised SOA was distributed immediately following the meeting for review.)*
- *Mike Tonseth will ask Michael Humling (U.S. Fish and Wildlife Service [USFWS]) and Charlie Snow (WDFW) to estimate the number of Methow returns that are likely to return to Winthrop National Fish Hatchery to inform a translocation discussion in a future HCP-HCs meeting (Item I-A).*
  Tonseth said this item is ongoing. Larissa Rohrbach said a schedule for the next discussion of this topic will be determined in today's meeting (Item II-F). This item will be removed from the action item list.
- *Mike Tonseth will revise and redistribute the 2017 Out-planting Surplus Methow Composite Spring Chinook Salmon Adults memorandum (Item I-A).*
  Tonseth said this item is ongoing. Larissa Rohrbach said a schedule for the next discussion of this topic will be determined in today's meeting (Item II-F). This item will be removed from the action item list.
- *Larissa Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (version dated May 15, 2019; Item I-A).*
  Tracy Hillman said this item is ongoing, pending finalization of the July 23, 2019 HCP-Coordinating Committee meeting minutes.
- *Betsy Bamberger and Greg Mackey will distribute a draft 2020 study plan for The Control of Saprolegnia Sp. Growth on Summer Chinook (Oncorhynchus tshawytscha) Eggs (Item II-B).*
  Bamberger and Mackey distributed the draft 2020 study plan, as distributed by Larissa Rohrbach via email on August 19, 2019. This item is complete.
- *Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A).*
  Mackey said he prepared a draft white paper that he recently edited and sent to a few HC members for review. He will prepare a presentation and distribute a revised version of the white paper for a future HCP-HCs meeting.

Wells HC

- *Mike Tonseth will prepare a proposal for the Wells HCP-HC on the use of surplus summer Chinook collected from the Wells Volunteer Trap for the production of subyearling smolts to support the Southern Resident Killer Whale population (Item III-A).*
  Tracy Hillman said Tonseth sent this updated proposal and a request for the Wells HC to vote in concurrence that sufficient capacity exists at Wells Fish Hatchery via email to Larissa Rohrbach and Hillman on August 20, 2019. This topic will be discussed in today's meeting. *(Note: the proposal and request for vote via email was distributed by Rohrbach immediately following the meeting.)*

PRCC Hatchery Subcommittee

- *HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item V-A).*
  Hillman said he has not received any responses from PRCC HSC members yet.
- *Keely Murdoch and Peter Graf will ask the PRCC whether members of the HSC can participate in the PRCC meeting when Jeff Jorgensen (National Marine Fisheries Service [NMFS]) discusses the Wenatchee life-cycle model and data needs (Item V-A).*
  Graf said the PRCC agrees the HSC members can attend the discussion with Jorgensen during the next PRCC meeting on September 25, 2019, at Wanapum Dam. This item is complete.
- *Tracy Hillman will compile questions from the PRCC HSC for Jeff Jorgensen during the August 21, 2019 PRCC HSC meeting (Item V-B).*
  Hillman said this item will be addressed in today's meeting. Hillman asked if Craig Busack is still interested in engaging with the HSC regarding the White River program. Brett Farman said he will ask Busack. Hillman suggested inviting Busack to participate in the conversation with Jorgensen in the September 25, 2019 PRCC meeting at Wanapum Dam.

II. Joint HCP-HCs and PRCC HSC

A. *Relative Reproductive Success Study Extension Memorandum* Update

Mike Tonseth provided the revised RRS memorandum via email and Tracy Hillman projected it for review during the meeting. Tonseth said the revisions included updating dates and updating language about the need for approval. The most important update is to note the last year of juvenile sampling is 2020 and the last year of adult sampling is 2023. Hillman asked if revisions to this memorandum need to be approved today. Tonseth said the memorandum states that WDFW requests approval from the Rock Island HCP HC for the clarifications in scope. Larissa Rohrbach will distribute the revised memorandum following the meeting for review. Bill Gale asked if discussion and the vote whether to approve the revisions could be delayed to the September HCP-HCs meeting. Tonseth said yes, the activities were already implemented in 2019, so approval of revisions would pertain to activities in 2020 and beyond. Tonseth said the memorandum was directed at the Rock Island committee because the Rock Island HCP utilizes Tumwater Dam's fishway and trapping facilities. Catherine Willard said both the Rock Island and Rocky Reach HCPs utilize Tumwater Dam's fishway and trapping facilities.

B. *2019 Egg Treatment Study Plan*

Betsy Bamberger said in last month's meeting the 2018 Egg Treatment Study results were reviewed. The proposed 2019 study at Wells Hatchery is very similar to what was done at Methow Fish Hatchery last year with minor changes. One new treatment group was added: placing copper-covered pot scrubbers in the egg trays. The proposed list of treatment groups are as follows:

- Elemental copper
- Formalin
- Hydrogen peroxide
- 2% salt
- Ambient water (control)

The same dosages as were used last year at Methow Fish Hatchery would be used in 2019. There would be 5 egg stacks (1 stack per treatment) holding eggs from 7 females per stack. The eggs from a total of 35 females would be required and likely to require milt from 35 males with a 1:1 mating.

Bamberger said copper pot scrubbers are laid in the topmost egg tray of the treated stack. Over time the elemental copper leaches out of the pot scrubber and has an antimicrobial effect similar to other copper-based treatments like copper sulfate.

Bill Gale asked if the leaching of the copper depends on water quality. Bamberger said it is very dependent on water quality and she theorizes the effect may depend on the location of the hatchery relative to its water supply or that the effect will change over time.

Gale asked, at the production scale, what the effluent quality or National Pollutant Discharge Elimination regulation concerns are related to discharging copper into the Columbia River. Bamberger said they have discussed concerns with the Washington State Department of Ecology (Ecology) and they did not know of any restrictions on copper in effluent. Bamberger said in Idaho where Idaho Fish and Game hatcheries are implementing production-scale use of the copper pads, the discharge of copper in effluent was well below limits. Bamberger said Ecology does not necessarily have a method for categorizing this type of effluent.

Greg Mackey said this approach cannot be used to treat alevins due to its toxicity to fish after they have hatched.

Kirk Truscott said one concern is whether the copper may be toxic to the eggs as well, and if this treatment is scaled up, toxicity to eggs should be considered. Truscott said another concern is the potential effect of copper on homing. He said some heavy metals can interfere with homing fidelity. Bamberger agreed these are valid concerns. She said in Idaho the copper pads were used on resident trout [not on anadromous species that home to a natal stream]. She said the first step would be to test the method to find out if it even works. She said Idaho Fish and Game did some work to look at whether the copper is absorbed by the egg [embryo] and found it is only absorbed into the chorion. Gale asked if anyone has tested the copper mats with anadromous species. Bamberger said she is only familiar with its use with resident trout.

Gale asked how many eggs would be used. Bamberger said all the eggs from 35 females would be used regardless of the exact number. Truscott asked if all eggs would be destroyed except for those treated with formalin. Mackey said the hatchery-production fish would be used as the formalin-treated group because formalin treatment is the typical treatment at this time and the other groups would be housed separately and destroyed at the end of the experiment. Bamberger said the eggs treated with copper should be destroyed because of FDA regulations.

Tracy Hillman asked if Douglas PUD would like approval of the study plan from the Wells HCP-HC. Mackey said it would be acceptable to ask for approval in the September meeting.

C. Leavenworth National Fish Hatchery Fish Health Update

Bill Gale asked to provide a fish health update about Leavenworth National Fish Hatchery. Gale said the hatchery is experiencing a columnaris disease outbreak in its spring Chinook salmon broodstock. He is not sure of exact numbers of fish affected but 27 adults died yesterday; fewer died today. He said these were fish that were not actively spawning yet. He said many fish have been spawned that would have died [if they were not taken for spawning]. Gale said USFWS is asking if any HCP-HC and PRCC HSC members have experience treating columnaris. Kirk Truscott asked how USFWS is currently treating the fish. Gale said the disease is affecting predominantly the males. He said the water temperatures can only be brought as low as 54°F. Catherine Willard said one fish that was collected for the Chelan Falls summer Chinook program exhibited signs of columnaris. She said it was returned to the river and was not brought to Eastbank Hatchery. However, Eastbank Hatchery is treating the fish prophylactically with Diquat as a preventative measure. Gale said USFWS was surprised because they haven’t seen it in a long time and haven’t had to treat it at LNFH. Betsy Bamberger said the well-water at Wells Fish Hatchery is also 54°F and she was also surprised to see the disease at this low temperature.

Bamberger suggested using chloramine-T and oxytetracycline as early treatments. Bamberger said once the disease is expressed, the disease may be beyond the phase when these treatments are effective. Bamberger said she prefers using Diquat to treat columnaris to minimize handling. Bamberger said that Douglas PUD has treated their summer Chinook salmon with Diquat.

D. Genetics Updates to the Monitoring and Evaluation Plan for PUD Hatchery Programs

Tracy Hillman reminded the committees that Catherine Willard took on the task of incorporating feedback from the invited panel of geneticists (provided in a memorandum dated December 13, 2018) into the genetic monitoring objective in the PUDs' M&E Plan (Update to the 2017 Plan).

Willard said the three PUDs are planning to conduct the genetic analyses for the 10-year Comprehensive Report. She said not all of the objectives in the genetics section of the M&E Plan were relevant to the current conservation programs and the objectives did not address the potential for changes in genetic diversity in natural populations as a result of a hatchery program. Willard worked with Todd Seamons (WDFW geneticist) to ensure her revisions were accurate.

Willard said the major changes were as follows:

1. An evaluation of linkage disequilibrium was added.
2. Beginning with brood years 2017 and 2018, testing of statistical hypotheses associated with genetic components (Hypotheses 3.1, 3.2, and 3.3) will be conducted with natural-origin baseline samples (the earliest genetic samples available for each program) and natural-origin contemporary samples. Testing will be repeated every ten years (approximately two generations). If significant differences between baseline samples and contemporary samples are found, contemporary hatchery-origin samples will be analyzed to evaluate if the difference can be attributed to the hatchery programs.

Seamons proposed the stepwise approach for analyzing hatchery-origin samples only if there is a deviation observed between the contemporary natural-origin fish and baseline natural-origin fish.

Kirk Truscott asked if DNA samples would be archived for every brood year. He said a concern might be that if this analysis is carried out only every 10 years, a major change could be observed that could have been headed-off earlier with a change in operations. He suggested there may be incremental changes in allele frequencies that could be observed with more frequent analysis. Willard said the original question was whether hatchery programs are affecting the natural population. She said Truscott's question may be an additional question. Truscott said this may be a different question of minimizing risk of hatchery operations to the natural populations. Truscott said perhaps over several decades a deviation from the natural population could be prevented. Willard asked what the contemporary hatchery samples would be compared against. Truscott suggested comparing the contemporary hatchery-origin fish against the contemporary natural-origin fish and to the natural-origin baseline.

Peter Graf said in most cases the natural-origin fish would be tested anyway for the conservation programs. Truscott said any hatchery-origin fish should be tested because hatchery-origin fish are on the spawning grounds and some gene flow would occur every year. Bill Gale agreed, if hatchery-origin fish are being used for brood. Gale asked if it would be necessary to test the hatchery-origin fish in the conservation programs and safety net programs to identify divergence. Gale said the additional effort may be reasonable with newer genetic analysis techniques. Graf said that may triple the number of samples if we test natural-origin conservation program fish, hatchery-origin conservation program fish, and hatchery-origin safety-net program fish.

Hillman said the revisions could be made in the hypotheses in Section 7.1.1. of the M&E Plan. Hillman also suggested rephrasing the hypotheses in terms of bioequivalence testing. This requires the Committees to identify a biologically meaningful effect size.

Greg Mackey said Douglas PUD also talked with Seamons. Mackey said that neutral markers are used to look for genetic drift; these genes should not be related to selective traits. Mackey said that Seamons said geneticists really want to understand what the markers of selective traits are. Mackey said that especially for small hatchery programs such as the Twisp component of the Methow spring Chinook salmon population that uses a broodstock of 30 fish, the reproductive success is variable and the returns from that small population are likely to be different from the larger population, making genetic monitoring results hard to interpret. In this case, Seamons suggested monitoring only the wild population to ensure its genetic baseline is stable in time. The point is that a lot of samples could be analyzed, and the results may still not provide information that can be used to inform management decisions.

Graf said if the hatchery fish are not a separate population, there should not be divergence from the wild population because of genetic mixing within the broodstock and on the spawning grounds. He said the difference year-over-year depends on which part (e.g., subsample) of the population is taken for broodstock. Truscott said yes, that may be true if the proportion of natural-origin brood is 1 every year. Gale agreed but said the degree that the populations are mixed is different every year.

Gale asked if it would help if the hypotheses were rephrased to look for a genetic difference, then ask the geneticists to review the hypotheses again to determine what difference is meaningful. Willard suggested asking the geneticists to provide an effect size. Gale and Mackey said they interpreted that the genetics panel would indicate that it depends upon things like population size. Truscott said he would expect more deviation to occur with a small population.

Hillman said in terms of bioequivalence testing, the hypotheses statements would be reversed from the current version and refined with an effect size. Willard said it is not likely that the committees could agree to a level of biological significance in genetic divergence for making management decisions. Gale suggested establishing a threshold for re-evaluating whether there is a biologically relevant difference. Hillman said a similar situation occurred in observed differences between adult hatchery-origin and natural-origin sizes and the Committees determined the observed difference was not biologically significant.

Willard said she would ask Seamons, and Gale said he would ask Christian Smith (USFWS geneticist) for their opinions on an effect size.

Mackey said the intent of the report is to provide information that can be used by managers for making decisions. Mackey said the results need to be put into context with the significance of the results.

Hillman asked Truscott if the change [to compare genetics of contemporary hatchery-origin fish to contemporary natural-origin fish and the natural-origin fish baseline] should be made to several of the genetic analysis approaches in the M&E Plan. Truscott said yes, this would be a recommended revision.

Hillman revised a hypothesis to compare contemporary hatchery-origin fish to the natural-origin contemporary broodstock and baseline. Willard said she would take this hypothesis and discussion regarding bioequivalence back to Todd Seamons and would provide an update at the next meeting.

E. 2019 Broodstock Collection Updates

Bill Gale said Entiat National Fish Hatchery has a few summer Chinook salmon coming in and expects a bigger pulse.

Greg Mackey said Wells Fish Hatchery had collected most of the summer Chinook salmon broodstock to support production for the orca program and surplused a lot of fish for tribal consumption. Mackey said some fish were also held for transport above Grand Coulee Dam. Gale asked about the Yakima Basin summer Chinook salmon program. Mackey said the Yakama Nation (YN) has taken fish for food but have not taken adults for broodstock. Gale said he thought adults could not be transferred from the Columbia River to the Yakima Basin for fish health reasons; this is the reason the YN has historically taken eggs.

F. Broodstock Collection Topics: Discussion Plan

Tracy Hillman asked Mike Tonseth to identify the draft timeline for BCP production described in the existing SOA. Tonseth said that unlike the previous SOA that was specific to HCP programs, this version would include the PRCC HSC programs as well. Tonseth said parts of the SOA were brought into the bulleted timeline and it reflects when discussions of major topics should occur and when deliverables should be available for review to ensure that work on any major issues starts in September, well in advance of the draft BCP review. This would also be the time that individuals would be tasked with leading discussions. That is, assignments would be made in November. Discussions and agreements would be finalized in December. The draft document would be finished by January 10 for internal permit holder review. By February, the draft would be available for all committee members. The March and April dates are the standard schedule used in past years for delivery to NMFS and USFWS. Tonseth said the previous SOA only identified NMFS as the recipient; he included USFWS because of their role in permit review.

Peter Graf noted that the issues for early discussion would be related to programmatic changes that are not dependent upon run-size projections, which are rarely available until spring. Graf suggested adding placeholders to the BCPs for content that depends on run-size projections. Tonseth said it is correct that the *US v. Oregon* Technical Advisory Committee (TAC) forecast is typically available in December for fall Chinook salmon, sockeye salmon, and steelhead, and a more localized approach is being used for spring Chinook salmon because the TAC projection is not very accurate for spring Chinook salmon at the local level. Topics like marking plans and trapping locations, operations, and methods can be resolved earlier. Tonseth said this should not preclude having some discussions later in the timeline as opinions can change.

Bill Gale asked when Tonseth would like information submitted from HCP parties. Tonseth requested that information be received by mid-November and noted it could be brought forth sooner but receiving it by mid-November allows for the document to be developed in a timely manner.

Gale suggested adding language to re-valuate the timeline after the first year of implementation.

Deanne Pavlik-Kunkel said that a separate SOA may be required for the different committees. Tonseth said that’s acceptable but suggested starting with one document and replicating them later for the separate PUDs, and Pavlik-Kunkel agreed.

Graf said one consideration is that broodstock collection for fall Chinook salmon programs occurs much later in the year than other species, so discussions could occur later than for other programs. Tonseth agreed and said the content is mostly consistent from one year to the next, but the BSPs are a living document that can be modified within the year as an adaptive management tool.

Hillman projected and read through the list of topics that would require early discussions to support BCP revisions (Attachment B). Committee members were identified to lead discussions of individual topics. Gale suggested identifying items that require deliberation and decision in the Committees but are not necessary for development of the BSPs, such as conservation program sizing, source for

Chiwawa spring Chinook salmon broodstock, and out-planting Methow spring Chinook salmon spawners. Graf asked if it is possible to identify the timing for the discussions that may affect program sizing. Tonseth said for some topics, dates must remain flexible because the programs are waiting for information (e.g., to resolve program sizing based on the results of Wenatchee Basin life-cycle modeling or spring Chinook salmon pre-spawn mortality estimates) and some of that information will become available with development of the 10-year Comprehensive Report in 2020.

Hillman assigned meeting dates to topics that could be addressed for the next annual BCP and noted topics where decisions are pending additional information.

Tonseth said per the conversations on conservation program resizing that have been ongoing in the HCP-HC meetings, the first program for consideration is Nason Creek. Methow programs may be discussed later.

Kirk Truscott said for identification of natural-origin Okanogan spring Chinook salmon to distinguish them from natural-origin Methow spring Chinook during trapping at Wells Dam, the method would need to be determined for 2021. Truscott said there may be a desire to carry out some work to start establishing the baseline this year.

Greg Mackey suggested adding a line for identifying requests for adults for research or non-routine use of fish. Tonseth said needs can be identified in the BCP for programs that want to lock in their requirements, but these non-routine requests could also be considered later in the year. Requests may require a Joint Fisheries Parties (JFP) discussion first to determine whether there is an effect on HCP programs, then incorporation into the BCPs, if possible. Gale asked if the need for JFP discussion would pertain to additional requests for adults that are surplus to production. Tonseth said the JFP discussion is to determine the use of adults that are surplus to the production to meet requests prior to distribution for consumption. Tonseth said one consideration which may involve HC discussion is whether a surplus request (once surplus is identified) for a study or evaluation that benefits an HCP program would have priority before other considerations. Mackey said the intent of his suggestion was simply to make sure these requests are considered ahead of time.

Tonseth suggested sending the SOA to the HCP-HCs and PRCC HSC for review and final approval in the October 16, 2019 meeting. *(Note: Rohrbach distributed the* Broodstock Collection Protocols Development Timeline Statement of Agreement *following the meeting, requesting that edits be returned to Mike Tonseth by September 6, 2019.)*

G. National Marine Fisheries Service Consultation Update

Brett Farman said Emi (Kondo) Melton has sent the Chinook salmon and steelhead permit bundle for internal signature, and then it will be sent out for countersignature by the program managers.

Greg Mackey said he received a note that there could be a request for signatures from NMFS within two weeks.

III. Wells HC

A. Wells Hatchery Subyearling Production Expansion

Mike Tonseth said last month a discussion was initiated in which WDFW asked for concurrence from the Wells HC that the existence of a 500,000 subyearling summer Chinook salmon program reared at Wells Fish Hatchery for orca prey would not compromise the existing, on-station HCP programs. He said the discussion was initiated to demonstrate what capacity exists at Wells Fish Hatchery and what additional capacity would be needed. Tonseth sent an email on August 20, 2019, to Tracy Hillman and Larissa Rohrbach that breaks those requests out. *(Note: Tonseth's email was distributed by Rohrbach to the Wells HC following the meeting.)* The original proposal was for 1 million smolts per year to be reared at a cost of $350,000. The Washington State legislature responded to the proposal with funding for $350,000 for the biennium, allowing for only half the number of smolts, but ultimately WDFW would like to achieve the production of 1 million smolts from the Upper Columbia River. Tonseth calculated the needs for both the 500,000 and 1 million-smolt production size. His conclusion was that even with an addition of 1 million subyearlings, only about 85% of the capacity of Wells Fish Hatchery would be in use. He said the limitations pertained to the adult holding capacity rather than juvenile rearing capacity.

Hillman asked Tonseth if the conclusion was that this production would not adversely affect the Wells Fish Hatchery production. Tonseth said yes, even if this program were held in common rearing vessels, densities would be well below the management protocols of 0.06 lbs/ft^3/inch. Hillman asked if these fish would be reared separately. Tonseth said no, these would be reared in common in the same dirt ponds, allowing the program to use the coded wire tag data associated with the Wells production fish to track success of the 500,000-smolt orca prey program.

Tonseth said the additional production may result in an increase of surplus adult returns of up to 1,500 fish. Tonseth said funding will be requested for additional years but at this time there is only funding for 2 years.

Kirk Truscott asked if there is any concern about chilled water availability. Greg Mackey said there is plenty of chilled water incubation space available, beyond what is commonly used.

Tonseth requested that the Wells HC vote on the additional subyearling production via email within 10 days from today, by September 4, 2019. Truscott said CCT is prepared to vote now in the affirmative.

(Note: Bill Gale responded to the Wells HC via email on September 3, 2019, stating USFWS's vote in concurrence is based on the following understanding,

> *"Our understanding is that [brood year] BY 19 production can move forward because surplus adults are available and that there was consensus among the fishery co-managers about distribution of surplus for this portion (i.e. this productions (sic) is sourced through WDFW's share of surplus). However, production in [brood year] BY 20 will depend on 1) the designation of surplus brood being available, and 2) the distribution of that surplus in a manner that has the approval and consensus of the fishery co-managers.")*

(Note: Additional information on Wells Hatchery rearing capacity was provided by Greg Mackey, and distributed by Larissa Rohrbach, to the Wells HCP-HC on September 9, 2019, included as Attachment C to these minutes.)

IV. Rock Island/Rocky Reach HC

A. 2020 Draft Monitoring and Evaluation Implementation Plan

Catherine Willard said there were no major changes regarding activities to be implemented in 2020 compared to 2019. Willard said changes including improving wording, permit number updates, and updates to Table 1 to show who is doing what activities.

Willard said methods used to estimate brood year 2020 steelhead spawner abundance by tagging at the Off-Ladder Adult Fish Trap that had been historically done by WDFW would be carried out by Chelan PUD. Greg Mackey asked whether there would be any spawner surveys at all. Willard said they will still do spawner surveys in the lower Wenatchee River. She said Chelan PUD is looking at are other methods that could be used to estimate spawner abundance without spawning surveys in future years.

Kirk Truscott said Objective 7 for collecting genetic samples does not appear in the summary tables. Willard said she would revise the tables to add that objective. Truscott said there was a reference to methods consistent with the 2018 steelhead release plan and said that release plan should be appended to the document. Willard agreed to append the steelhead release plan.

The draft 2020 Chelan PUD M&E Implementation Plan was revised by Willard and distributed by Larissa Rohrbach on August 21, 2019, to the HCP-HCs via email for review through August 30, 2019.

V. PRCC HSC

A. Approve the July 17, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the July 17, 2019 meeting minutes as revised.

Bill Gale asked if there were any updates to the ongoing broodstock collection activities. Deanne Pavlik-Kunkel said no, everything is following the typical routine and plans. Pavlik-Kunkel said there is a new plan for surplusing fish. Gale asked if the surplussing plan has been shared with other parties. Mike Tonseth said it has not been shared outside of the requestors for surplus. Pavlik-Kunkel said it had not been shared more broadly because it was about logistics, schedule, and where and when surplus fish would be distributed.

B. Wenatchee Spring Chinook Salmon Life-Cycle Model: Data and Questions

Tracy Hillman projected a draft list of questions for Jeff Jorgensen in preparation for Jorgensen's presentation in the September 25, 2019 PRCC meeting. Hillman added to and revised the questions during the discussion.

Bill Gale asked if the focus would be on modeling the effect of re-implementation rather than the effect of the previous program implementation. Peter Graf responded that the intent was to identify questions that would prepare Jorgensen for the discussion in the next PRCC meeting such as how well the model reflects reality based on modeling of the Nason and Chiwawa rivers and how the model could be applied to the question of restarting a hatchery program.

Gale asked what Jorgensen has been asked to talk about specifically. Hillman said the model was designed to evaluate the effects of different factors, including hatchery programs, on the survival of the Wenatchee spring Chinook salmon population.

Kirk Truscott reiterated the question of what data would be required to develop a model for a White River component of the spring Chinook salmon population in general; for instance, what level of predation occurs in the lake, where in the lake does it occur, what are the major predators, etc. Truscott said there is a decision pending in 2026 whether to implement the program or not. Truscott said he does not believe it is acceptable to walk away from implementing a White River hatchery program if NMFS advocates that the program is important for recovery of the Wenatchee population. Truscott said there could be other management actions, such as predator reduction, as an alternative to hatchery production.

Graf said the difficulty in moving the issue forward in the PRCC and the PRCC HSC has been determining what the targets for mitigation should be. Graf said, of course, any information on factors like predation would benefit the model but pursuing that information may not help lead to a decision related to hatchery mitigation.

Gale said he supports implementing the model, but to answer the question of whether to start a hatchery, as a collective group, the PRCC HSC would want to be in the position of determining what Grant PUD's mitigation obligations are. A perfect model of the life cycle is not the only solution to answering those hard questions. Graf agreed and said the model will inform all the programs, but it won't answer the main questions of whether to construct a hatchery in the White River, what the broodstock would be, whether to composite the broodstock, etc.

Truscott said if you could quantify predation by bull trout, for example, the likelihood of reducing or eliminating bull trout predation is low, and the model will inform you that no matter how many fish are produced in a hatchery, survival would be low. Graf said that a model of the White River may not necessarily be needed to inform the outcome of a potential hatchery program because information on Nason and Chiwawa survival exists, and Lake Wenatchee survival estimates exist.

Hillman said Jorgensen's life-cycle model isn't built to estimate predation in the lake. To do so, it would need estimates of predator abundance, prey abundance, consumption rates, digestion rates, temperatures, etc. Graf said the model downstream of Lake Wenatchee is the same for the Nason and Chiwawa populations. Truscott said that further work to characterize predation was proposed but not approved by consensus in the PRCC. Truscott said if the predator is pikeminnow, for instance, the problem could be managed and a hatchery program may be viable. Gale said it is more complex than that. For example, bull trout may increase predation on smolts if the number of competing pikeminnow is reduced. Gale said his view is that the White River population may be unique because it has co-evolved with other species in Lake Wenatchee. Gale said he would hesitate to recommend knocking down predator abundance in this ecosystem. Graf said identifying the source of predation in the lake is a food-web study, which would be a different study than a survival study to support Jorgensen's model. Truscott said his concern is arriving at 2026 without data supporting a decision on how to recover the White River spawning aggregate.

Gale said he would like to hear more about why the White River spawning aggregate is so important to the recovery of the species. Graf said a status review will occur soon that may inform that question. Truscott said diversity is one reason. Hillman said the importance of White River spring Chinook salmon goes back to the Quantitative Analysis Report and the development of the HCPs. At that time, the National Oceanic and Atmospheric Administration (NOAA) and others struggled with determining the importance of the White River group. Because of its genetic divergence from the Wenatchee population, some thought it should be identified as an independent population (separate from the Wenatchee population). It was decided, however, that White River spring Chinook salmon should be designated as an important aggregate of the Wenatchee population. In the recovery plan, White River spring Chinook salmon were designated as a separate spawning aggregate, which is needed to maintain diversity and allow local adaptation. Recently, Craig Busack has said they (NOAA) need to evaluate the importance of White River spring Chinook salmon for recovery. Truscott said White River natural-origin spawners are still the most divergent of all the spawning aggregates in the basin. If there was no survival benefit of having White River genes, wouldn't they have the same genetic profile as the Chiwawa fish? Chiwawa fish have been spawning in the White River as long as the program has existed and for some reason they are not as successful as the White River fish. There's still enough genetic differentiation that they can be identified during broodstock collection to differentiate from Chiwawa and Nason fish. Gale said he'd like to know if the genetic differentiation has already been lost due to over-escapement of Chiwawa fish into the Nason and White rivers and he would like to see a comparison using modern genetic analyses to past analyses. Graf said genetics work to be completed in 2019 and 2020 will answer some of those questions. Gale asked if White River fish will be sampled on the spawning grounds. Graf said yes, carcasses in the White River will be sampled. Hillman said there have been about 25 years of genetic influence of the Chiwawa program on the White River aggregate.

Hillman said Jorgensen's model evaluates the effects of hatchery production on survival using proportion of hatchery origin spawners (pHOS) in the Wenatchee Basin. Graf said the model worked by discounting the spawning success of that natural population based on the influence of hatchery fish. Truscott recalled that Jorgensen was adamant that food-web information in the lake would be necessary to model the population survival. Graf agreed if you want that level of information. However, if you want a simple survival number, it's not necessary.

Gale said the best thing managers could do would be to prevent Chiwawa fish from over-escaping into the White River. Truscott said changes have been made in that direction by carrying out adult management at Tumwater Dam and reducing jack rates because jacks stray more than older fish.

Hillman asked Brett Farman if he had any questions for Jorgensen. Farman said that he did not. Tom Scribner said he would like to ask NOAA (Busack) how important the White River is to recovery, if in fact modeling shows that the impacts in Lake Wenatchee are insurmountable for sustaining a hatchery population. Hillman suggested Busack participate in the September PRCC meeting so he can address some of those questions. Farman said he will invite Busack.

Graf said Grant PUD would send more questions to Hillman for Jorgensen before the end of the month. Hillman requested that members provide any additional questions for Jorgensen by August 30, 2019. Hillman will then forward questions to Jorgensen.

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are September 18, 2019, October 16, 2019, and November 20, 2019, at Grant PUD in Wenatchee, Washington.

VII. List of Attachments

Attachment A List of Attendees
Attachment B Broodstock Collection Protocols Discussion Topics for 2020
Attachment C Information for the Wells Orca Production Discussion and Vote Request

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Ian Adams	Chelan PUD
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Betsy Bamberger	Douglas PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡°	Washington Department of Fish and Wildlife
Tom Scribner*‡°	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

Attachment B
Broodstock Collection Protocols Discussion Topics for 2020

Topic	Discussion Lead	Meeting Date for Discussion
Review of the Broodstock Collection Protocols to identify major revisions needed and assign co-authors	Tracy Hillman	September
Elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs	Kirk Truscott	
Sizing of upper Columbia River conservation programs**	All	TBD—Based on prespawn survival (currently working on Nason Spring Ch)
Use of age-3 males in broodstock Use of alternative mating strategies	Greg Mackey	Sept
Establishing ranges around broodstock collection targets	Greg	Sept-Oct
Source for Chiwawa spring Chinook salmon broodstock	Catherine	Oct
Outplanting surplus Methow Composite Spring Chinook Salmon Adults**	Mike	Sept-Oct
Request for HCP surplus adults for research or other requests	All	Sept-Feb
Revised Broodstock Collection Protocols Development Timeline SOA	Mike Tonseth	

**Programs in part independent of BSP.

Attachment C
Information for the Wells Orca Production Discussion and Vote Request

Wells Hatchery Capacity
September 9, 2019

The following provides information on incubation and rearing space allocation and chilled water supply. This demonstrates that Wells Hatchery has sufficient capacity to incubate and rear the Orca summer chinook program in addition to programs already in production. The Dirt Pond 3 "sink hole" that developed in 2017 was likely caused by a leak in the old liner at a location where an old buried (previously unknown) concrete structure existed. We believe, after excavating this area, that the concrete structure exacerbated the erosion. Dirt Pond 1 has been relined and is currently in service. By September 26, 2019 Dirt Ponds 3 and 4 will be lined with a new heavy duty Coletanche liner. Dirt Pond 2 is not currently in active use but is still operational if needed. All other incubation and rearing facilities are 100% operational.

1. Trout:
    a. Incubation in old building September – March. Shallow Troughs. No chilling required.
    b. Early Rearing in old building.
    c. Grow Out: Bureau Ponds, Above Ground Ponds, Dirt Pond 3B. Final Grow Out in Dirt Pond 3B.
2. Sturgeon:
    a. Early rearing in Sturgeon Room circulars. No chilling.
    b. Grow Out in Sturgeon Room circulars.
3. Summer Chinook Yearlings:
    a. Incubation in one large Incubation Room. Chilled for ~240 days to slow down growth (October – May).
    b. Early Rearing in Production Room spring.
    c. Transitional rearing in Above Ground Ponds or Bureau Ponds
    d. Grow Out in Dirt Pond 1 September – April.
4. Summer Chinook Subyearlings:
    a. Incubation in one large Incubation Room. Chilled briefly to synch up egg take dates (October-November).
    b. Early Rearing in Production Room late winter.
    c. Transitional rearing in Above Ground Ponds or Bureau Ponds
    d. Final Grow Out in Dirt Pond 1 April - May.
5. Steelhead Columbia Safety New and Methow Safety Net:
    a. Incubation in one small incubation room April-June. Chilling as needed to synch up egg take dates.
    b. Early Rearing in Production Room in summer.
    c. Transitional rearing in Circular Ponds
    d. Final Grow Out in Dirt Ponds 4A and 4B.
6. Okanogan Steelhead:
    a. Incubation in one small incubation room April-June. Chilling as needed to synch up egg take dates.
    b. Early Rearing in Production Room in summer.
    c. Transitional rearing in Circular Ponds
    d. Final Grow Out in Circular Ponds.

Attachment C
Information for the Wells Orca Production Discussion and Vote Request

7. Twisp/Methow Conservation Steelhead:
    a. Early incubation at WNFH – eyed eggs to Wells Hatchery in summer – one small room.
    b. Early Rearing in Production Room in summer.
    c. Rearing in Circular Ponds
    d. Final Grow Out in Circular Ponds.
8. Coho:
    a. Early incubation at WNFH – eyed eggs to Wells Hatchery in December – one small room. Chilling December – April.
    b. Early Rearing in Production Room in summer.
    c. Transitional rearing in Circular Ponds
    d. Final Grow Out in Dirt Pond 3A.
9. Summer Chinook Subyearlings Orca Program:
    a. Incubation in one large Incubation Room with HCP Subyearlings. Chilled briefly to synch up egg take dates (October-November).
    b. Early Rearing in Production Room late winter.
    c. Transitional rearing in Above Ground Ponds or Bureau Ponds
    d. Final Grow Out in Dirt Pond 1 April - May.

Incubation: Wells Hatchery has 7 new incubation rooms. Chilling capacity is 250 gpm to 38 F from a pair of new Daiken chillers. Wells Hatchery also has an additional incubation facility in the old building with 672 trays and a separate chiller that supplies 40 gpm of 38 F water (This is the chiller that was sufficient to produce the entire Wells Hatchery Summer Chinook production prior to the modernization project. We service and operate this chiller annually to keep it in full operational condition). The maximum incubation chiller demand is 190 gpm when Subyearling Chinook (HCP and Orca), Yearling Chinook, and Coho all use chilled water (Subyearlings and Coho may not overlap), resulting in at least 60 gpm of surplus chilled water capacity in the new building and 40 gpm in the old building summing to 100 gpm total. Regarding the 7 incubation rooms in the new building: During the October – May incubation period all summer Chinook production may use up to the 2 large rooms, Coho 1 small room, steelhead 2 small rooms (in spring). There will be at least 2, and normally 4 empty rooms at any one time. Thus, there is plenty of capacity to meet incubation needs.

Rearing : Dirt Ponds 3, and 4 are in the process of being re-lined and will be complete by September 26, 2019. Dirt Pond 1 is already complete and is in use. Dirt Ponds 3 and 4 have each been split into two sections (3A, 3B, 4A, 4B) with separate release structures for each. The ponds are being re-lined with a heavy duty Coletanche liner. Dirt Pond 2 is not required for production but is available and supplies a massive amount of rearing space. Rearing in all of the Dirt Ponds is at very low fish densities.

All other rearing vessels (Bureau Ponds, Above Ground Ponds, Adult Ponds, Circular Tanks, Production Room, old Production Room, Sturgeon Room) are in 100% operational capacity.

Contingency Plan: As illustrated above, Wells Hatchery has sufficient and redundant capacity to meet the fish rearing needs. Should a portion of the facility become unusable, the unused capacity of the facility will be used to compensate. The new Hatchery Building has extra incubation space if needed. Production Room space typically is open expect for fairly short periods when Chinook are present, and we added 4 new large start tanks in 2019 to increase capacity and flexibility. Another 4

Attachment C
Information for the Wells Orca Production Discussion and Vote Request

will be installed in 2020. The old Hatchery Building has enough incubation and early production space to compensate for an event in the new building. The facility has multiple rearing options, and fish can be moved around as needed. For large groups fish can be moved to Dirt Pond 2. Dirt pond 2 has been surveyed using geologic electro-resistivity techniques and no voids were detected. In the case of a loss of water supply due to an electrical or pump outage, we have a detailed Emergency Action Plan for hatchery staff to follow to quickly restore the water supply, and contingency actions to take with aerators and oxygen, as needed.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: October 16, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the September 18, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, September 18, 2019, from 9:00 a.m. to 2:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is going.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will discuss with Charlene Hurst (NMFS) and Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A). *(Note: this item is ongoing.)*
- Larissa Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (version dated May 15, 2019; Item I-A).
- Tonseth will distribute a suggested drafting plan for the Broodstock Collection Protocols (BCPs) assigning specific members to address topics for discussion; Tracy Hillman will determine

whether there is a need for an additional conference call in early October to discuss research needs to address given topics (Item II-B).
- Catherine Willard will coordinate with other HCP-HC and PRCC HSC members to draft separate sets of genetic monitoring hypotheses that are specific for the individual hatchery programs to monitor for changes in population genetics over time (Item II-C).

PRCC Hatchery Subcommittee

- PRCC HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item I-A). *(Note: This item is ongoing.)*
- Brett Farman will ask Craig Busack (National Marine Fisheries Service [NMFS]) to participate in PRCC HSC process for identifying data needs and making a decision on the White River spring Chinook salmon hatchery program (Item I-A).

Decision Summary

- The Wells HCP-HC voted to concur that there is sufficient capacity at Wells Fish Hatchery for WDFW's additional production of subyearling Chinook salmon for southern resident orca prey, without compromising the existing, on-station HCP programs, confirmed via an email by Larissa Rohrbach on September 11, 2019 (Item I-A).
- The Rock Island and Rocky Reach HCP-HCs voted to approve the *Relative Reproductive Success Study Extension SOA Memorandum* in today's meeting (Item II-A).
- The HCP-HCs and PRCC HSC voted to approve the *Broodstock Collection Protocols Development Timeline Statement of Agreement* in today's meeting (Item II-B).
- The Wells HCP-HC voted to approve Douglas PUD's 2019 Egg Treatment Study Plan in today's meeting (Item III-A).
- The Rock Island and Rocky Reach HCP-HCs voted to approve Chelan PUD's 2020 Draft Monitoring and Evaluation Implementation Plan in today's meeting (Item IV-A).

Agreements

- The HCP-HCs and PRCC HSC agreed to describe the alternative method of equivalence testing in the narrative in the genetic monitoring objectives of the PUDs' Monitoring and Evaluation Plan (M&E Plan).

Review Items

- Larissa Rohrbach sent an email to the Wells HCP-HC on September 16, 2019, notifying them that Douglas PUD's draft 2018 Monitoring and Evaluation Report for the Wells and Methow programs is available for 60-day review with edits due by Friday November 15, 2019 (Item I-A).

- Rohrbach sent an email to the Wells HCP-HC on September 20, 2019, requesting a vote by email to indicate agreement with Douglas PUD that releasing surplus fish from the Methow Safety-Net and Columbia Safety-Net Programs into a non-anadromous lake will not prevent the HCP steelhead programs from meeting the target production.

Finalized Documents

- The Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2018 Annual Report was distributed via email by Larissa Rohrbach on September 16, 2019.
- The Rock Island and Rocky Reach HCP-HCs-approved *Relative Reproductive Success Study Extension SOA Memorandum* was distributed via email by Rohrbach on September 23, 2019 (Item II-A).
- The Rock Island and Rocky Reach HCP-HCs-approved *Broodstock Collection Protocols Development Timeline Statement of Agreement* was distributed via email by Rohrbach on September 23, 2019 (Item II-B).
- The Wells HCP-HC-approved *Broodstock Collection Protocols Development Timeline Statement of Agreement* was distributed via email by Rohrbach on September 23, 2019 (Item II-B).
- The Wells HCP-HC-approved *2019 Egg Treatment Study Plan* was distributed via email by Rohrbach on September 23, 2019 (Item III-A).

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the August 21, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC and reviewed safety procedures on safe egress and first aid, should an emergency occur during the meeting.

Hillman asked for any additions or changes to the revised agenda (distributed via email by Larissa Rohrbach on September 17, 2019). The HCP-HCs and PRCC HSC members voted to approve the revised agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised meeting minutes. Rohrbach said there were some revisions that the representatives then reviewed. Additional revisions were made in the meeting. The HCP-HCs and PRCC HSC members approved the meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on August 21, 2019, were reviewed, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on August 21, 2019)*:

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (WDFW) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).
  Tonseth said this item is ongoing. Tonseth said pre-spawn mortality has been estimated for females but not yet for males. Todd Pearsons asked if this topic is going to be discussed by Jeff Jorgensen in the September 25, 2019 PRCC meeting. Keely Murdoch said Jorgensen gave a presentation to the Regional Technical Team (RTT) last week that will probably be similar to what will be presented to the PRCC. Tracy *Hillman said that in the RTT meeting, Jorgensen did note that model results were sensitive to pre-spawn mortality. Murdoch said Jorgensen compared the Wenatchee populations with others, particularly Willamette River spring Chinook, and he said the pre-spawn mortality observed in the Wenatchee River is not atypical compared to other basins. Pearsons asked if pre-spawn mortality estimates are needed for the long-term need to discuss changes to conservation program sizing. Murdoch said yes, pre-spawn mortality is needed for the crude back-casting she has done to work on conservation program sizing. It was suggested that the life-cycle model could be used to inform a new model to forecast sizing of the conservation programs. Murdoch said she believed that early estimates of pre-spawn mortality included in program-size back-casting are too low; the data that were used were from the original Wenatchee spring Chinook management plan that was written early in the process of collecting pre-spawn mortality data. Tonseth said he did not know if pre-spawn mortality information would be passed to Jorgensen for inclusion in the Wenatchee life-cycle model.*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).
  Truscott said this item is ongoing.
- Brett Farman will discuss with Charlene Hurst and Tonseth the potential use of a multi-population model for estimating PNI for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).
  Farman said this item is ongoing.
- Hillman and Larissa Rohrbach will add review of the BCPs to the September meeting agenda to help the HCP-HCs and PRCC HSC identify co-authors and opportunities to discuss major revisions in advance of 2020 deadlines (Item II-F). *This item will be discussed in today's meeting. This item is complete.*
- Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A).

Mackey said this item is ongoing. Mackey said the paper is complete and will be distributed after the meeting. He will give a presentation on this topic in today's meeting.

- Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (version dated May 15, 2019; Item I-A).
  Hillman said this item is ongoing, pending finalization of the HCP Policy Committee meeting minutes. He said the draft meeting minutes were distributed a few days ago asking for a couple of weeks for meeting attendees to review.
- Catherine Willard will update the genetics section of the *Monitoring and Evaluation Plan for PUD Hatchery Programs (Update to the 2017 Plan)* to reflect revisions that were suggested in the August 21, 2019 meeting (Item II-D).
  Willard sent an updated version to the HCP-HCs and PRCC HSC as distributed by Rohrbach on September 17, 2019. This topic will be discussed in today's meeting. This item is complete.

PRCC Hatchery Subcommittee

- HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item I-A).
  Hillman said this item is ongoing.
- Brett Farman will ask Craig Busack (NMFS) to participate in the Wenatchee Basin life-cycle modeling discussion at the PRCC meeting on September 25, 2019, at Wanapum Dam, Washington (Item V-B).
  Farman said neither he nor Busack will be able to participate in the September 25, 2019 PRCC meeting due to an internal conflicting meeting. Hillman asked if Busack will be able to re-engage with the HSC. Farman said he will discuss this with Busack on Friday. This item is complete.

II. Joint HCP-HCs and PRCC HSC

A. DECISION: Relative Reproductive Success Study Extension SOA Memorandum Update

Mike Tonseth said Catherine Willard provided suggested edits to the section on ESA Take and Permitting via email between meetings. Tonseth said Willard's changes were incorporated for clarity but no substantive changes were made to the plan from the previous version.

Todd Pearsons said it seems like there was concern about the adult sampling rate at Tumwater Dam and how that sampling rate may affect the PUD programs. Pearsons said for example the Relative Reproductive Success (RRS) Study Plan is written for a 100% sample rate of returning natural-origin adults, and the PUDs don't need a 100% sample rate and may only need to sample 3 to 4 days per week, which could be a source of conflict. Tonseth said the permit allows a 100% sample rate.

Tonseth said he does not see the connection to the PUD programs. Pearsons asked whether this SOA summarizes what is ongoing in the RRS Study. Pearsons said he thought the sampling rate was intended to collect a representative subsample versus a 100% sample, at least during the main portion of the adult spring Chinook sample run.

Tonseth said the goal of the study has always been to sample up to 100% of the natural-origin adults based on the assumption that a larger sample size would provide better data. Tonseth said they recognize that sampling all adults is not always possible. For instance, achieving an 80% sample rate is acceptable. Tonseth said the focus of the RRS Study extension memorandum is natural-origin adults; the hatchery-origin adults are not part of this memorandum.

Pearsons asked whether it is necessary to have 80% to 100% of the offspring of the RRS Study fish genetically typed back to the parents. Pearsons said he thought this would be analogous to sampling the smolts at the smolt trap; to capture a subsample of the total population. Tonseth said it is correct that the intent is to collect an adequate number of genetic samples from the progeny of the parents who are the focus of the RRS Study analysis. Tonseth said the smolt trap is only capable of sampling a portion of the river and smolts at one time, whereas at Tumwater Dam they have the ability to sample nearly all fish.

To clarify, Willard asked whether the original RRS study plan did state the goal was to sample 100% and the reason for this revised SOA was to extend the duration of the study? Tonseth said yes, and to ensure the focus of the study was on natural-origin adults.

Hillman asked Pearsons whether his question was to clarify management goals or to determine potential effects of RRS Study sampling on PUD programs? Pearsons said clarity should be provided in the SOA revisions that the goal is to sample 80% to 100% or a representative sample of the natural-origin returns. Pearsons said when a study requires 100% sampling or a relative subsample, it has been communicated in committee in the past.

Hillman suggested adding a sentence to the Proposed Action stating the permit allows for sampling up to 100% of adults. Pearsons suggested adding a sentence about the intent, not just what is allowed. Tonseth said the intent is to sample 100% of the population, if possible. Bill Gale suggested adding a sentence that reads, for example, "the goal of the study is to sample the maximum amount of the natural-origin population as possible, up to 100% of adult fish passing over Tumwater Dam."

Hillman called for a vote of the Rock Island and Rocky Reach HCP-HCs and PRCC HSC to approve the revised *RSS Extension SOA Memorandum*, including the revisions suggested in today's meeting. All members of the Rock Island and Rocky Reach HCP-HCs and PRCC HSC voted to approve the memorandum.

Tonseth said he will finalize the *RRS* Study *Extension SOA Memorandum* by including today's revisions and distribute it to the HCP-HCs and PRCC HSC (Attachment B).

B. DECISION: Broodstock Collection Protocols Development

Broodstock Collection Protocols Timeline SOA

Mike Tonseth said there are no major revisions to the Annual BCP timeline SOA compared to the version distributed last month.

Bill Gale suggested adding some language that the committees will re-evaluate the effectiveness of the new timeline on a given date and determine if changes are necessary. Tonseth said he did not include specific dates in this SOA because he was trying to avoid having to develop multiple SOAs over several years. Greg Mackey asked Gale what direction he thinks the schedule could shift? Gale said given how complicated developing the BCPs has become over the past years, he is suggesting adding flexibility in the future and a point for deciding that changes to a given topic may not be made in time for that year's BCP. Gale and Mackey agreed one check-in date should be stated in the SOA and the BSP schedule would be evaluated on an as needed basis only, after the first year.. Tracy Hillman added language to the draft SOA in the meeting to allow for the schedule to be re-evaluated in August 2020.

Tonseth said there is a need to develop several versions of this SOA for each of the HCP-HCs and the PRCC HSC. Hillman will send the revisions made to the BSP timeline SOA in today's meeting to Tonseth. Tonseth will then develop three SOAs, one for each committee (Attachment C).

The HCP-HCs and PRCC HSC voted to approve the generic version with the knowledge that it will be used as a template for developing three separate SOAs for the different committees.

Tasks and Co-Authors

Tracy Hillman asked for a review of the BCP drafting plan to assign people to lead discussions and to draft revisions on specific topics. Mike Tonseth said he will distribute a suggested BCP topics assignment list next week for all to consider. Bill Gale asked if a conference call should be scheduled to review the list between meetings. Todd Pearsons suggested discussing the list in the October meeting. Hillman said he will determine whether there is a need for an additional conference call after Tonseth sends the draft list.

Greg Mackey said he is prepared to give a presentation on establishing ranges around broodstock collection targets in October.

Gale said Michael Humling (USFWS) is available to help Tonseth develop the content on out-planting surplus Methow spring Chinook. Mackey said Douglas PUD would be happy to help with that topic.

Catherine Willard said she is waiting for data to be able to discuss the sources for Chiwawa spring Chinook topic. Discussion of this topic will be moved to the November meeting.

Hillman said Kirk Truscott's task on elemental signature analysis to differentiate Okanogan spring Chinook from other stocks is not relevant to this year's BCP but progress should be made this year to prepare for collecting samples in subsequent years.

Keely Murdoch said the Yakama Nation typically provides the Coho broodstock collection plan as an appendix.

C. Genetics Updates to the Monitoring and Evaluation Plan for PUD Hatchery Programs

Catherine Willard said two additions were made to the PUDs' Monitoring and Evaluation Plan (M&E Plan) based on feedback from geneticists and discussions in last month's meeting. [1) adding hypotheses for tests of equivalence and 2) analyzing hatchery-origin fish in addition to natural-origin fish.]

Equivalence Testing

Catherine Willard said hypotheses were added based on an equivalence testing approach. These hypotheses are in addition to the standard null-hypothesis testing approaches. Equivalence testing was recommended by the Independent Scientific Advisory Board and the writers of the original M&E Plan. Changes were made to the M&E Plan by Willard and Tracy Hillman.

Willard said she discussed the M&E updates with Todd Seamons, WDFW geneticist, and Christian Smith, USFWS geneticist, to receive the geneticists' perspective on determining important effect sizes. Willard read from an email response provided by Seamons. Seamons wrote that to his knowledge there is no existing deterministic biological meaning for effect sizes for these genetic metrics; there is solid evidence for increasing genetic diversity but no evidence for determining the importance of the size of the difference between stocks or populations. Seamons wrote that knowledge of genomes is insufficient to determine the importance of the genetic differences.
Bill Gale said Christian Smith's response was very similar. Hillman said the topic of how much genetic difference between hatchery and natural-origin fish is significant in terms of the recovery of the stocks has been discussed for many years. Gale said, simplistically, the M&E Plan will have to determine a value for deciding what is significant. Hillman said at this time, the M&E Plan allows simple statistics to determine if there is a difference between hatchery and natural-origin fish, noting that statistical significance may have nothing to do with biological or management importance. He indicated the Committees should try to determine a difference that is biologically important. Hillman said, however, it is difficult for managers to make a decision on effect size if geneticists can't decide what is a significant genetic difference.

Greg Mackey said when geneticists make a phylogenetic tree, they use a clustering algorithm. The main clustering algorithm is a bootstrap support tool to estimate the of the phylogenetic groups in the tree and also the [genetic] distance between clusters, which gives information on the confidence of how far apart different groups are [similar to effect size and statistical support]. Mackey said the post-hoc interpretation of these results is analogous to what managers have to use to identify what difference is important to the fish and program goals.

Kirk Truscott said re-occurring assessments should show the trend in assessments to look for greater and greater divergence over time. Truscott said managers also need to know the effective population size for interpretation, to decide whether effects are from hatchery influence, or are natural.

Hillman asked if a departure from the genetic baseline is observed, whether that is really a bad thing. He said it is possible that the baseline is not the ideal state because of past hatchery effects on the population. Hillman said the equivalence-test hypotheses were included in the M&E Plan for use in the future, when we have information on biological significance.

Mackey said for some metrics, we know what is a good or bad direction, e.g., it is always negative for a population when effective population size goes down. Mackey said causes for linkage disequilibrium or allele frequency shifts may be variable and not necessarily a negative impact of the hatchery population. Todd Pearsons said losing alleles is a bad thing generally. Mackey said, yes, generally an overall loss of allelic diversity would be bad, but if some alleles are lost and some are gained over time, it's hard to say whether it's bad for the program or not. Gale asked if low allelic diversity is necessarily a bad thing? Hillman said no, in his recollection of discussions with geneticists during the writing of the recovery plans, some loss of alleles happens when a population becomes locally adapted. Gale said perhaps at the scale of evolutionarily significant unit (ESU), there should be greater allelic diversity but at the local population scale, specialization would be better.

Tom Kahler asked if there is a different metric that should be used [besides allelic diversity]. Truscott said the ultimate goal is to evaluate whether the hatchery program is having a good or bad effect on the natural population. Truscott said the Committees should consider multiple aspects of a program (e.g., genetics, stray rate, productivity) to answer this question. Mackey said analyses should look for evidence for retention of genetic diversity, but also for evidence of homogenization across subpopulations from genes introduced by another subpopulation. Pearsons said there has now been a lot of review [of genetic monitoring objectives in the M&E Plan] and still there is a lot of uncertainty around the utility of the sampling and data. Pearsons agrees that it's hard to interpret the genetics data by itself, for instance (an extreme example), a population may have a very high proportion of hatchery origin spawners (pHOS) present on spawning grounds, but if the fish are not effective spawners there may be no genetic impact. You would not know this unless you looked at all the data together. Willard said once this document is updated, it can be reviewed in the future to add new metrics. Pearsons suggested adding some details to note whether it's possible to establish a prescriptive effect size. Hillman said the standard statistical effect sizes can be included, but they may not be biologically relevant; he suggested including these but adding information that the biological relevance should be reviewed in the future. Pearsons said he is fine with editing the document either way. Willard noted that in Seamons' email, he said he would not be comfortable prescribing an effect size unless it was in a publication and peer reviewed.

All agreed decisions would not be made based on one metric. Hillman said the M&E Plan was written with this in mind. Pearsons said the problem may be that the HCP-HC and PRCC HSC programs are pushing the envelope on using data from long-term genetic monitoring.

Hillman said the monitoring questions are written such that we need to demonstrate no difference between hatchery and natural-origin fish. Equivalence testing is set up to evaluate these kinds of questions. Currently, however, the hypotheses are written to demonstrate differences. We can never prove the null hypotheses to be true. Therefore, we added additional hypotheses that allow equivalence testing even though we have not yet identified important biological differences.

Hillman asked if the Committees want to retain the edits, keeping in mind the plan will change after the completion of the Comprehensive Report and the Before-After-Control-Impact analyses. Pearsons asked if we could resolve the equivalency testing issue with a note stating there is no pre-determined effect size or take these equivalency hypotheses out completely. Hillman said the original M&E Plan included this language and we can add it back into the M&E Plan.

Gale said he sees value in leaving the equivalency hypotheses in the report, using the standard statistical approaches for testing but noting that it is unknown whether statistical differences are biologically meaningful. Gale said doing the analysis may provide information that could be used in the future. Hillman said standard thresholds identified in statistical text books could be used; for instance, the probability of a small difference could be 5%, a medium difference could be 10%, and a large difference could be 20%. Pearsons suggested performing a power analysis, given the data and the amount of variability, to identify the percent difference that can be detected without using predetermined thresholds of importance. Mackey agreed and said that a power analysis answers whether the test is able to detect a difference that could be large enough to be biologically meaningful (e.g., 10%).

All Members agreed to leave the alternative method of equivalence testing in the genetic monitoring objectives of the M&E Plan. Mackey said he would like the explanation [of effect size] in the main body of the text instead of just a footnote. Hillman said he would add text in the introductory sections pointing the reader to the nature of the interpretation.

Hillman said adding hypotheses to support equivalency tests makes sense for several other objectives of the M&E Plan that do not have specific targets (in addition to the genetic monitoring objectives). Pearsons said this may be a larger process for generating biologically significant effect sizes for other metrics and he needs more time to think about including effect size for all the objectives in the entire M&E Plan. Hillman suggested writing the hypotheses generically, since an equivalence test would not be appropriate for all metrics. Hillman said this was done originally but was later eliminated. Pearsons said general hypotheses make the decision-making of biological significance more difficult because more interpretation is needed. Pearsons said relevant effects sizes for objectives could also be informed by the comprehensive report after the end of next year.

Inclusion of Hatchery-Origin Fish in Genetic Monitoring

Tracy Hillman said the second question is about allelic frequency and whether it is appropriate to test hatchery-origin fish in addition to natural-origin fish. Todd Pearsons presented slides prepared by Grant PUD to expand on the discussion (Attachment D).

Slide 2: Pearsons said the focus is on integrated programs with a conservation component and a safety-net component. Integrated programs attempt to facilitate gene flow between natural-origin and hatchery-origin fish. Safety-net programs are one-generation removed from conservation programs and [ideally] don't spawn in nature; safety-net program fish are kept separate from the conservation program fish unless a population bottleneck occurs. Pearsons said this is because programs are willing to take more genetic risk if population abundance falls below a certain level. It's highly unlikely that there are any true wild fish over time.

Slide 3: A diagram shows the likelihood of having completely wild fish by descent (i.e., no hatchery ancestry) over seven generations of conducting an integrated hatchery program. The diagram showed Wild, Hatchery, and Safety-net fish. Safety-net fish are a "dead end" and not used in the integrated program typically. The Chiwawa spring Chinook program is on approximately the fifth generation. The intent of the figure is to show that when there is a high degree of mixing between natural-origin and hatchery-origin fish, it is difficult to discern genetic differences between the two groups. Pearsons said recent events [low natural-origin returns requiring the use of safety-net fish in broodstock] suggest the use of the safety-net fish may be different in the future. Keely Murdoch said this figure doesn't show what proportion of the natural-origin fish are going into the hatchery broodstock, which in some years is a lot lower than targets. Pearsons said yes, the diagram assumes equal reproductive success of hatchery and wild fish. Kirk Truscott said this also assumes the hatchery-origin and natural-origin fish occupy the same habitat and we know that's not true. Truscott said the level of mixing can be variable. For instance, a high proportion of hatchery-origin fish spawn next to the hatchery or acclimation facility. Murdoch asked if a different approach would be taken for integrated and segregated programs. Pearsons said yes, the sampling could be different for integrated and segregated programs.

Greg Mackey said that in programs using all wild fish in broodstock, there is no hatchery lineage to test in that population. Mackey said the genetic samples would come from wild fish that could be the offspring of hatchery fish, except they would be influenced by only one generation of hatchery effects; there's no long-term hatchery lineage. Pearsons agreed and said that is at the heart of the discussion. If you were to compare hatchery and natural-origin fish, you are only comparing the effect of one generation, not six or seven generations of hatchery rearing. Tom Kahler said when it comes time to sample, one would ask "what are the hatchery fish?"

Slide 4: Pearsons said natural-origin fish are a good integrator of previous spawnings between hatchery- and natural-origin fish and reproductive success resulting from processes in nature. Pearsons said, for instance, in the Chiwawa many of those fish are not passing on genes to the next generation due to environmental conditions. He said integration of datasets on productivity with genetic analysis would inform decisions about the health of the natural-origin population. The Independent Scientific Advisory Board identified that the hypotheses were not necessarily structured to focus on the natural-origin population and so were inconsistent with the goal stated in the text.

Slide 5: Pearsons said programs are actively trying to minimize genetic differences between natural-origin and hatchery-origin fish (see Slide 5 of Attachment B for specific methods). Pearsons said early identification of divergence between hatchery-origin and natural-origin fish is addressed by monitoring PNI, stray rates, and other phenotypic measures. He asked, even if differences were detected, would it matter if it wasn't reflected in the population at large? For example, one may detect a genetic difference between hatchery-origin and natural-origin fish that are one generation removed, but all other metrics indicate the population is healthy and the natural-origin population sample does not indicate a problem. Truscott agreed these are good questions. The original perspective on genetic analysis of hatchery-origin fish was on how to sample, which analyses maximize the ability to assess a change caused by hatchery effects on the natural population, and to provide management options though we don't know what those management options would be. Truscott said a difference in genetics of hatchery and natural-origin fish may be an early indicator of a potential issue later. If the samples are not collected until decades later, the opportunity to make management changes [to limit or prevent adverse effects on natural-origin fish] may be lost. Truscott said the effort needed to collect additional hatchery-origin samples is relatively small and could be done as a preventative measure. Truscott said, for instance, proportion of natural origin fish in the broodstock (pNOB) is below the program targets and we don't know whether this is posing a demographic risk. Bill Gale said there is a limited ability to control safety-net fish spawning. For instance, in the Methow River, there is not a good barrier (like Tumwater Dam) to control their passage. Pearsons suggested running the samples from the natural-origin baseline and contemporary natural-origin fish, and if no difference is detected then do not analyze the hatchery-origin fish. On the other hand, if a difference is detected it would be important to know if the difference was due to the hatchery. Pearsons said he supports a stepwise approach that may tell you the effect of the hatchery. Pearsons said the change may also be due to some other impact like a founder effect [in the broodstock for a given year].

Catherine Willard asked how big the difference would need to be between the natural-origin baseline and contemporary natural-origin fish. Pearsons said at this time the intent would be to test the null hypothesis and see if there is a difference. Truscott said it would still be a retrospective analysis on causation every 10 years to provide the confidence that there is no difference between the conservation programs or, alternatively, trigger an analysis of the program practices.

Slide 6: Pearsons said the alternative perspective is to ask whether it is worth investing in something that has limited utility on making management decisions for the program. Pearsons said if there are two completely separate lineages as in other programs, divergence in the genetic identities could be determined to be a result of gene flow over multiple generations.

Slide 7: Pearsons said in the outcomes of the last genetic assessment when hatchery and natural-origin samples were collected, there were no significant differences between hatchery and natural-origin fish. Pearsons said analyzing the hatchery-origin samples didn't add a lot to the discussion or work as an early warning system. Truscott said if there was no difference between hatchery and natural-origin fish, managers would be satisfied with the outcome of the hatchery programs from the genetic perspective. Willard said the previous sampling was a mixture of hatchery and natural-origin fish that may not be representative of the ideal statistical comparison. Hillman said the results from past genetic analyses are in the back of the annual report, which was finalized last week.

Slide 8, Conclusions: The first conclusion states, "*Unless significant differences are detected between baseline and contemporary natural-origin samples, there may be little benefit of running hatchery-origin genetic samples to address genetic M&E objectives*." Pearsons said Grant PUD supports a proposal to follow a stepwise approach. The second conclusion states, "*In cases where differences [between baseline and contemporary natural-origin samples] exist, then it may be worthwhile to run hatchery samples to help evaluate the mechanism of change*." Pearsons said segregated hatchery programs will be monitored differently.

Gale asked whether these samples have already been collected and analyzed for Parentage-Based Tagging (PBT) by CRITFC. Gale said the genotypes have been run and SNP data are available for these programs, perhaps it's just a matter of performing the analyses. Willard said yes, for some but not all populations. Pearsons said natural-origin samples are available for Upper Columbia fall

Chinook, if the Committees chose to run hatchery-origin samples, the samples are probably available.

Kahler said for Methow spring Chinook it would not be obvious what the hatchery-origin fish would be. Would they be hatchery-origin fish sampled on the spawning grounds? Hatchery-origin fish that return to the hatchery? Hatchery-origin fish used in broodstock? Gale said it would include all of those.

It was agreed that sampling of upper Columbia programs for PBT analysis is somewhat comprehensive already for the Chinook and steelhead programs. In the past there has been open sharing of data between CRITFC and USFWS geneticists, and there may be opportunities to analyze data that are already available. Hillman suggested coordinating with geneticists to determine whether samples are available. Pearsons suggested making a decision now about the genetic analysis approach and then determining whether samples are already available. Gale said it will save time to identify where sampling has already been done.

Hillman asked members for their individual perspectives on the need to analyze hatchery-origin fish genetically. Gale said the question of which fish to test as hatchery-origin fish is a major one but tends to agree that that the analysis of hatchery-origin fish should go forward. Murdoch said she supports analyzing hatchery-origin fish when it informs the programs. Mike Tonseth supported analysis of hatchery-origin fish for some programs, but not all. For instance, it may not be necessary for segregated programs, nor non-conservation programs. Tonseth said the Wenatchee steelhead program should be analyzed to determine if there has been an influence because of the inclusion out of basin (Wells stock) fish in the broodstock historically. Brett Farman agreed that collecting more information from hatchery-origin fish in the near-term may prevent long-term genetic impacts. Mackey said he does not see the value of including hatchery-origin fish that are only one generation separated from the natural-origin parents and said it’s complicated because the different programs have different bounds around including natural-origin fish in the broodstock. Mackey said we already have a better dataset on Methow steelhead for a long-term trend analysis using the Twisp RRS study data with 10 years of detailed data available, and there is a valuable long-term data set for analysis of spring Chinook in Methow using microsatellites. Willard said she understands the problems at hand regarding genetic distance resulting from only one generation of hatchery rearing and discerning which fish to test; however, if SNPs are already available, she agreed the samples could be analyzed.

Gale asked if the timing is aligned for analysis of the Methow and the Wenatchee fish? Mackey and Willard said yes, the timing of this analysis is now aligned. Gale said USFWS would like to do similar analyses and follow the same timeline so the outcomes and reporting are aligned for the entire Upper Columbia. He requested to be kept informed on the timeline for analysis.

Hillman summarized that there is a need to discern which programs should be analyzed, what would be compared for each type of program, and whether samples already exist.. Willard said for next year's HCP-HCs Comprehensive Report, collecting new samples is not possible, as that would have to occur now.

Pearsons asked Tonseth whether he was suggesting analyzing listed programs and not analyzing the unlisted programs. Tonseth said yes. Gale said for segregated programs, if the question is whether hatchery-origin fish differ from the natural-origin fish, the answer is yes. Willard said the question is different for segregated programs. Pearsons said the most relevant question is whether or how the hatchery-origin fish are affecting the natural-origin fish. Mackey said there can be multiple causes for differences in the genetics and it's difficult to identify those causes after the fact in order to make management decisions.

Hillman asked if the plan is to analyze the samples that have already been collected and use those to determine genetic differences over time? Truscott said yes, the original intent of genetic analyses was to track changes over time. Truscott said monitoring PNI using the multi-population model was undertaken because it was suspected there were differences between the hatchery-origin and natural-origin fish.

Mackey said the difference is that genetic monitoring evaluates neutral markers and doesn't inform the phenotypic changes between groups that are the result of selection. For instance, traits under selection can change while neutral markers show no change. Conversely, neutral markers may show a shift while traits under selection have remained stable. Truscott asked if this analysis would help us make a different decision about pNOB or pHOS or stray rate targets? Mackey said no, because the PNI concept is concerned with fitness traits that are under selection, but if there were major shifts in neutral allele frequency observed between groups you might be concerned that selective traits were also changing. Or, the neutral marker frequencies may shift while the trait under selection has not changed. The PNI concept is not (directly) concerned with neutral markers. It is focused on traits that are under selection.

Pearsons proposed incorporating the samples that were already analyzed by CRITFC. Willard agreed that this could be done for the Chiwawa spring Chinook program. Pearsons proposed keeping the hypotheses in the M&E Plan focused on natural-origin fish; however, the narrative could report on comparisons to hatchery-origin fish.

Tonseth said there is one disclaimer. DNA is collected on all broodstock except for summer Chinook (Methow and Wenatchee). There is no hatchery-origin lineage for those programs because they are achieving their pNOB targets of 1 and no samples are taken on hatchery-origin fish. Tonseth said natural-origin fish are identified as unclipped without wire tags and origin is confirmed by scale analysis. Gale asked whether hatchery fish returning to Wells Dam for instance, are being bio-sampled. Tonseth said yes, samples are taken to confirm run composition, but the only biological samples taken are scales. Gale said for fish returning to USFWS facilities, they are collecting biological samples.

Hillman suggested following Pearsons' suggestion to delete the hypotheses on sampling hatchery-origin fish for programs in which genetics of hatchery-origin fish is not needed. Thus, the evaluation of hatchery-origin fish would be program specific. Hillman pointed out the section of the M&E Plan, which indicates that hatchery and natural-origin fish from "all programs" will be evaluated for genetics. Gale suggested editing it to say, "all integrated programs." Truscott asked what the nexus would be for genetic sampling if not included in this plan? Truscott asked if the comparison to hatchery-origin fish could begin with the 2017/2018 brood. Willard said yes. Truscott said there were samples collected for the Chief Joseph Hatchery Program that could be included with the Methow summer Chinook analysis. Pearsons agreed there is a need for coordinating the inclusion of all samples. Gale said if only natural-origin fish are included, USFWS would only contribute the samples from steelhead captured in winter and spring for broodstock; if hatchery-origin fish are included, it expands the scope to other programs.

Hillman recorded a placeholder in the target species or populations section of the M&E Plan to focus the hatchery-origin analysis on specific program types. Mackey said he needs time to map out what the relevant programs are and what samples are available. Pearsons asked how the Committees could complete this in time to discern what samples need to be sent for analysis. Hillman said the discussion so far indicates that segregated and unlisted programs would be excluded. Gale said he still questions whether segregated programs should be excluded. He said it may be useful to track whether the contemporary segregated broodstock is similar to or different from the natural-origin baseline and whether the population genetics are shifting over time. Willard said she agrees with Gale and there is a whole set of other questions for segregated programs. Gale said he would rather get this correct rather than rush these revisions and have a report that does not answer the questions at hand.

Pearsons asked whether there is support for moving the completion date for the genetics portion of the comprehensive plan? Kahler said the programs are ready to get started with analyses and it may not require a lot of time to determine which samples are analyzed.

Hillman said this may require identifying and categorizing the different hatchery programs within the M&E Plan and then writing specific hypotheses for each program category. Hillman suggested members craft specific hypotheses for each program category. Willard volunteered to coordinate with other members to develop a draft set of hypotheses for the various programs.

D. Alternative Broodstock Composition and Mating Strategies

Greg Mackey gave a presentation entitled, "*Review of Hatchery Broodstock and Mating Practices for Conservation Programs.*"

Mackey said in previous years a problem originated when encountering limitations on broodstock availability and asking whether jacks should be included in the broodstock. He said the answer to this question became a more comprehensive review of advancements in thinking about broodstock selection and mating strategies.

Slide 2: Mackey reviewed the purpose of conservation programs, which are the following:

- Conserve and rebuild populations
- Minimize negative ecological impacts
- Conserve diversity
- Minimize negative genetic impacts

Slide 3: Mackey said problems have been encountered if the ideal conditions are not met and problems must be worked around; artificial selection is inevitable when fish are propagated in hatcheries.

Slide 4, 5: Mackey identified key factors that contribute to artificial selection in broodstock collection and interaction with fisheries.

Slide 6: Mackey presented data showing the proportion of PIT-tagged Methow spring Chinook lost between Bonneville and McNary dams. Mackey said the data show larger (older) fish are being removed by the fishery, potentially changing the age structure of the populations. Bill Gale asked if jacks are being lost to fisheries, noting that the gill-net fishery is selecting older fish but are jacks kept in the recreational fishery? Mackey said these are spring chinook and there is not a recreational fishery on them that might remove jacks.

Slide 7: Mackey showed that Wells summer Chinook fecundity is on a downward trend in both the wild and hatchery fish and suggested it may be an effect of hatcheries, fisheries, or both. Mackey said he and Mike Tonseth have discussed whether this could be a factor of reduction in size or age at return.

Slide 8: Mackey reviewed published literature on jack contributions to a spawning population. Gale said information from a study by NMFS with steelhead using the Winthrop spawning channel could inform this work. Results are in a Bonneville Power Administration report. Tonseth said the Wenatchee RRS Study data could be leveraged. Mackey agreed getting the best available data to make decisions on incorporation of jacks into the broodstock would be good.

Slides 9 & 10: Mackey provided an example of the potential method for prescribing the contribution by jacks in a broodstock by multiplying jack rate by the typical rate of offspring produced by jacks in the natural environment.

Slide 11: Mackey presented a figure showing the complexities of steelhead mating systems in nature.

Slide 12: Mackey said genetic analysis done to determine if fish deformities observed in Twisp River spring Chinook were isolated to a small number of parents, suggesting a genetic family effect. He said the results showed there did not appear to be a tight connection to a genetic issue. However, in an extension of the original study, Sewell Young (WDFW) found that the Twisp River, a tiny population and a tiny program, has lower rates of homozygosity compared to all Snake River subpopulations. Mackey said small programs are often assumed to carry more genetic risk than large programs, but the population status may not be as bad as is often assumed.

Slide 13: Mackey summarized a large body of literature on strategies for broodstock management.

Slide 14: Mackey said the first general strategy, which he calls the genetically benign approach, seeks to use sufficient numbers of fish to minimize genetic drift and domestication, wild fish in the broodstock (though not necessarily a pNOB of 1), and randomized broodstock selection and spawning to minimize artificial selection.

Slide 15: Mackey said the second general strategy, which he calls emulating natural processes approach, seeks to actively counter artificial selection in hatcheries and fisheries for younger age at maturity, and to emulate mate choice in nature.

Slides 16–19: Mackey presented several other aspects of broodstock management including reviews of the following:

- Typical hatchery mating processes versus typical wild mate choices
- Production of early maturing males increases with use of wild broodstock
- Minimizing kinship
- Equalizing family sizes
- Various potential mating schemes
- Studies showing that humans do not do a great job of "randomly" selecting broodstock

Slides 20: Mackey described the current broodstock collection methods at Methow Hatchery:

- Broodstock collection is (somewhat) random
- Mating follows a 2x2 matrix with males used as backup reciprocally
- Culling only done to control bacterial kidney disease; not to control family size

Tonseth said jacks are not targeted because a size cutoff is used to differentiate age 3 and age 4 males, though some are inadvertently included in the broodstock at rates that could be similar to background levels. Mackey said he and Charlie Snow (WDFW) looked at the Methow spring Chinook data and did not think this was happening. Tonseth said it may be more common in the summer Chinook.

Slide 21: Mackey presented a possible path forward for the Methow Hatchery spring Chinook program, specifically, with several suggestions for consideration:

- Continue to collect brood at random to the best of our abilities
- Continue to use factorial mating protocols with backup males
- Include jacks at a rate they occur in the wild and fertilize eggs from one female at a percent observed in the wild (e.g. 20% of one female's eggs). Todd Pearsons said in some places the practitioners would add milt from one male (jack) in a small area of the mixing container [representative of the typical contribution from jacks on the spawning ground], allow it to fertilize, then mix in milt from full-size males to the rest of the container.
- Ensure time intervals between primary and back-up fertilization to minimize sperm competition
- Follow the model developed by Hankin to preferentially mate females with males that are larger to drive the population toward older age at maturity and larger individuals; however, its unknown the extent to which this can be applied in smaller programs because some fish ripen on different days resulting a numerous smaller spawns than fewer larger ones.
- Use genotypes to avoid close relatedness in matings

Gale said experience suggests that hatchery managers may resist changes because they tend to follow the protocols that provide them the best eye-up rates. Mackey said he talked to Brandon Kilmer (Douglas PUD Methow Hatchery Supervisor) and would work closely with hatchery staff. Mackey said staff at the Methow Hatchery are open to ways to improve.

Pearsons asked how the effects could be measured, for instance, could you select for some trait other than size like the Hankin model? Mackey said they were unaware of any other way to spawn fish together by a phenotype. Pearsons said there are some other patterns informed by the RRS Study work. Mackey said yes, the risk is it would cause really uneven family sizes, magnified by the hatchery process, and potentially exacerbate a Raiman-Laikre effect. Mackey said he would like to try a lot of different things but a constant challenge is balancing the need to stabilize spawning practices while trying to implement something new.

Gale asked if anyone has studied the difference in progeny produced in a spawning channel versus typical controlled hatchery spawning. Mackey said he is not familiar with any such study. Gale said the Winthrop spawning channel produced a significant number of offspring in one study, more than he expected from a relatively small area.

Mackey suggested they would be trying some of this novel approach in the Methow Hatchery program. Gale said there has been a swing toward asking if the genetically benign approach recommended by the Hatchery Scientific Review Group (HSRG) is still the best path forward.

Hillman suggested Committees members share Mackey's review with hatchery managers to start informing them of a desire to improve broodstock selection and mating processes, and to bring them along in the discussion.

Mackey will send the literature review to Larissa Rohrbach for distribution.

E. National Marine Fisheries Service Consultation Update

Brett Farman provided one update. Farman said the permits that Emi (Kondo) Melton (NMFS) had reviewed (the unlisted summer and fall Chinook bundle and steelhead) were sent out for countersignature by WDFW and the PUDs.

III. Wells HC

F. DECISION: 2019 Egg Treatment Study Plan

Greg Mackey reminded the Wells Committee of the components of the draft 2019 Egg Treatment Study that were reviewed in the August 21, 2019 meeting. Mackey said he addressed comments provided by Mike Tonseth regarding oversights or areas that were not written clearly. He said the main goals are to reduce *Saprolegnia* infection and to reduce formalin use at the hatchery. The test carried out at Methow Hatchery in 2018 showed that plain water worked as well as other treatments; however, the eggs may not have been exposed to *Saprolegnia* fungus in the water supply at levels that cause infection. He reminded the Committee that the 2019 study includes a new treatment introduced using elemental copper ions that has worked in other trout hatcheries.

Mackey said he added a table that helped define the treatment groups and their ultimate fate. Mackey said they will try to reduce family effects on the study results by pooling eggs and dividing them into separate groups. He also clarified that 50 eggs from each treatment group tray will be retained and grown to the fry stage to observe latent effects of the treatments.

Study eggs could be surplus to the Wells Hatchery program and made available for other programs, or could be included in the Wells Hatchery production if needed to meet program targets. Fish treated with elemental copper cannot be released due to FDA regulations. Betsy Bamberger inquired with Ecology and FDA to determine rules for releasing fish from copper treated eggs but it was decided that the fish grown from copper treated eggs would not be released. Mackey said he added a column titled "Available for Transfer" to Table 1 that indicates whether eyed eggs at that stage should be available for transfer to other programs or used in the Wells Hatchery program if treated with formalin, water or salt. Keely Murdoch asked if the copper-treated eggs are the only fish that could not be transferred. Mackey said yes, that was their determination at this time.

The Wells HC voted to approve Douglas PUD's draft *Control of* Saprolegnia sp. *Growth on Summer Chinook (*Oncorhynchus tshawytscha*) Eggs, Experimental Protocol – Pilot Study* as final.

IV. Rock Island/Rocky Reach HCs

A. Draft 2020 Monitoring and Evaluation Implementation Plan

Catherine Willard said no additional feedback on Chelan PUD's *Draft 2020 Monitoring and Evaluation Implementation Plan* was received after last month's meeting. Willard added Objective 7 to Table 5 as recommended in the last meeting. Hillman asked if there were any additional edits or comments; there were none.

The Rock Island and Rocky Reach HCs voted to approve Chelan PUD's *Draft 2020 Monitoring and Evaluation Implementation Plan* as final.

V. PRCC HSC

A. Approve the August 21, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the August 21, 2019 meeting minutes as revised.

Tracy Hillman reminded the committees that they are invited to attend the PRCC meeting on September 25, 2019, when Jeff Jorgensen will present aspects of his Wenatchee spring Chinook life-cycle model and respond to questions from the PRCC and PRCC HSC. Keely Murdoch confirmed the meeting is scheduled for 10 a.m. at Wanapum Dam and usually outside presenters are scheduled for the beginning of the day. Hillman said he has requested that a call-in number be provided as well.

Hillman asked whether discussion of any other administrative business was necessary.

Todd Pearsons said the King of the Reach fishing derby will occur on October 25 through 27 [for the collection of Priest Rapids Hatchery Fall Chinook Salmon]. Pearsons said Grant PUD limited entries to 100 boats and the limit was reached in the first week after registration was open.

Tonseth said he has identified an additional topic for the PRCC HSC that should be considered during development of the BCPs. Tonseth said WDFW is still interested in reducing the reliance on the Priest Rapids Dam Off-Ladder Adult Fish Trap for collecting broodstock for the Priest Rapids

Hatchery Fall Chinook Program. Tonseth said WDFW is working toward determining whether enough broodstock could be collected by other means, such as in the King of the Reach derby.

No other business was discussed. Hillman adjourned the meeting.

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are October 16, 2019, November 20, 2019, and December 18, 2019, at Grant PUD in Wenatchee, Washington.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Rationale for using natural-origin fish for genetics monitoring in hatchery conservation programs
Attachment C	Review of Hatchery Broodstock and Mating Practices for Conservation Programs
Attachment D	Relative Reproductive Success Study Extension SOA memorandum
Attachment E	Broodstock Collection Procotols Development Timeline SOA Revised
Attachment F	*Control of* Saprolegnia sp. *Growth on Summer Chinook (*Oncorhynchus tshawytscha*) Eggs, Experimental Protocol – Pilot Study, 2019*

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Ian Adams	Chelan PUD
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Deanne Pavlik-Kunkel	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

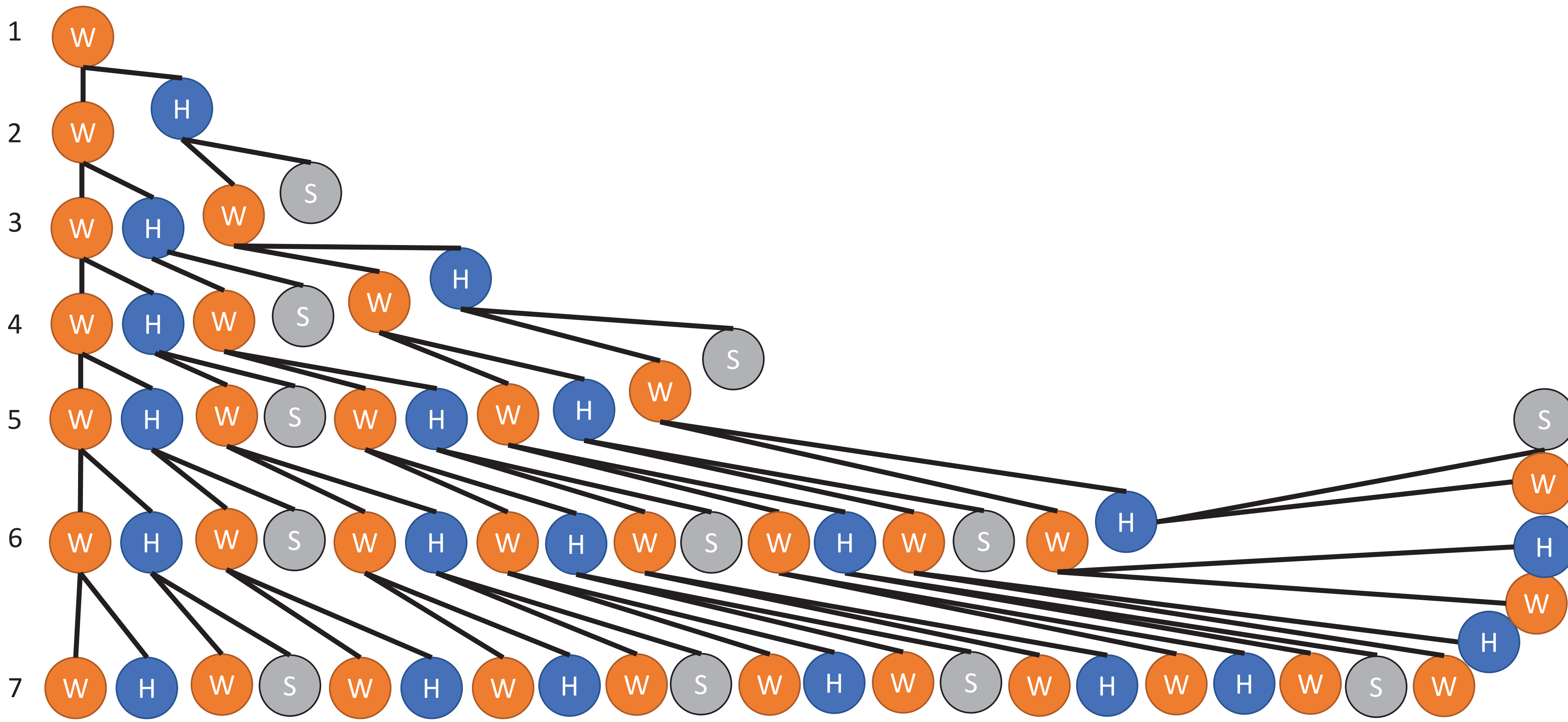
Rationale for using natural origin fish for genetics monitoring in hatchery conservation programs

HC/HSC Meeting, 9/18/2019

Integrated hatchery program definition

- In an integrated hatchery program the hatchery and natural spawning population are part of the same population (they are mixed)
- We attempt to monitor the effects of gene flow from hatchery and natural origin matings
- Our safety net programs are one generation removed from an integrated program and generally don't spawn in nature
- It is highly unlikely that "wild" fish still exist because of all of the mixed matings with different origins

Attachment B



Why natural origin fish?

- The natural origin fish are a good integrator of previous H and N spawnings and they also integrate differences in reproductive success that might occur
- They are the focus of the M&E plan

Genetic risk containment practices reduce the potential for H vs N differences

- Use of natural origin fish as first priority and 1st generation hatchery as second priority for broodstock - Integrated
- Prioritize adult management of returning safety net fish
- Domestication – PNI
- Factorial mating – effective size
- Complex marking and tagging to allow discrimination of different aggregates and conservation/safety net
- Genetic sampling of some broodstock to eliminate strays
- Other

Would sampling of hatchery origin fish give an early warning of differences?

- Unlikely for reasons discussed
- Also, even if differences were detected, how much would it matter if it wasn't reflected in the population at large?
- If differences were detected between H and N, what management actions could be taken?
- Phenotypic measures and genetic indices (PNI, straying) provide early warnings and are estimated annually
- Other

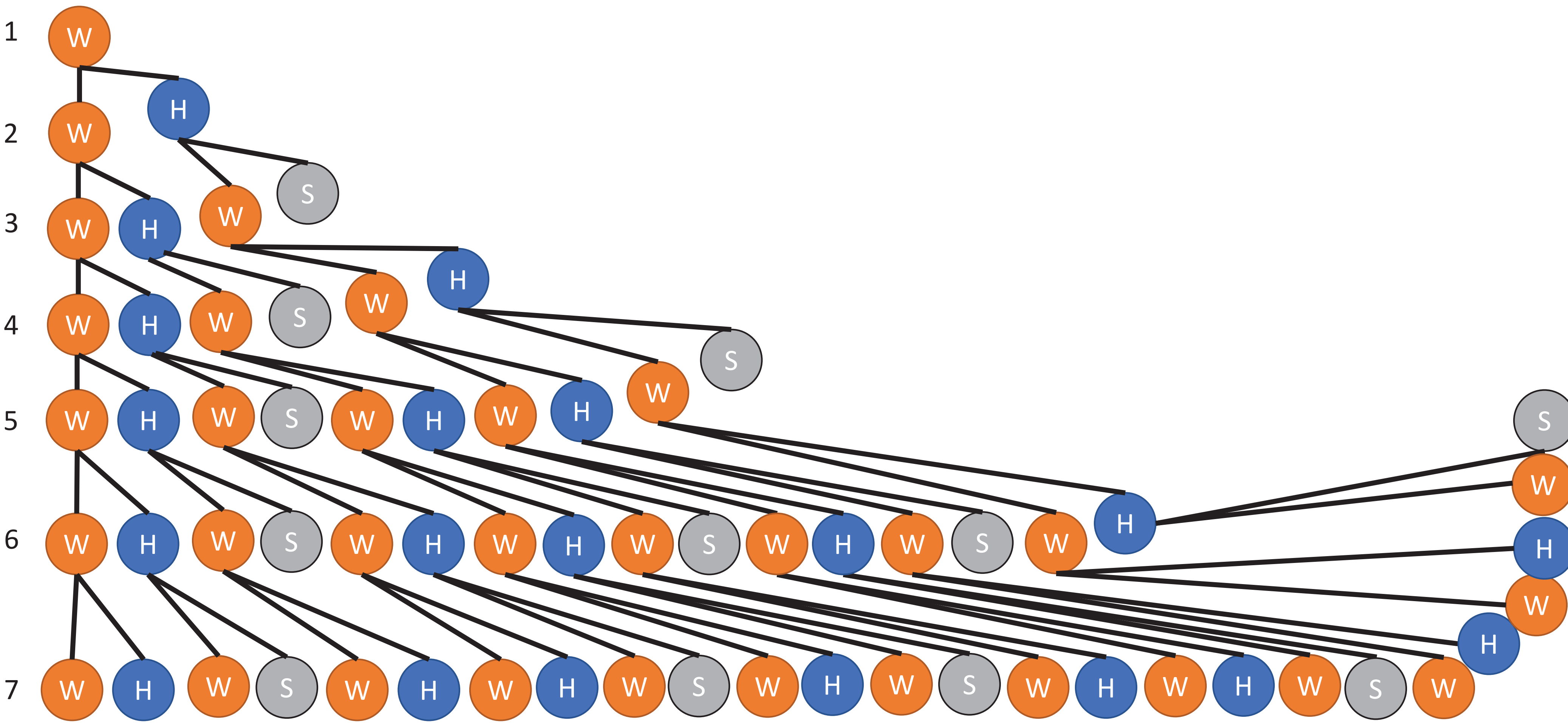
Lessons from last genetic analysis

- Did the presence of H samples in the last genetic analysis increase our understanding of the effects on natural origin fish?
- Did it result in an early warning of problems?
- Did it result in changes in management?

Conclusion

- Unless significant differences are detected between baseline and contemporary natural origin samples, there may be little benefit of running hatchery origin genetic samples to address genetic M&E objectives
- In cases where differences exist, then it may be worthwhile to run hatchery samples to help evaluate the mechanism of change (phased approach)
- Segregated hatchery programs will be monitored differently

Attachment B



Review of Hatchery Broodstock and Mating Practices for Conservation Programs

Greg Mackey
Douglas PUD

September 18, 2019

Conservation Programs

- Conserve and rebuild populations
- Minimize negative ecological impacts
- Conserve diversity
- Minimize negative genetic impacts

Minimize Negative Genetic Impacts

- Artificial selection is inevitable in hatcheries
- How to counter?

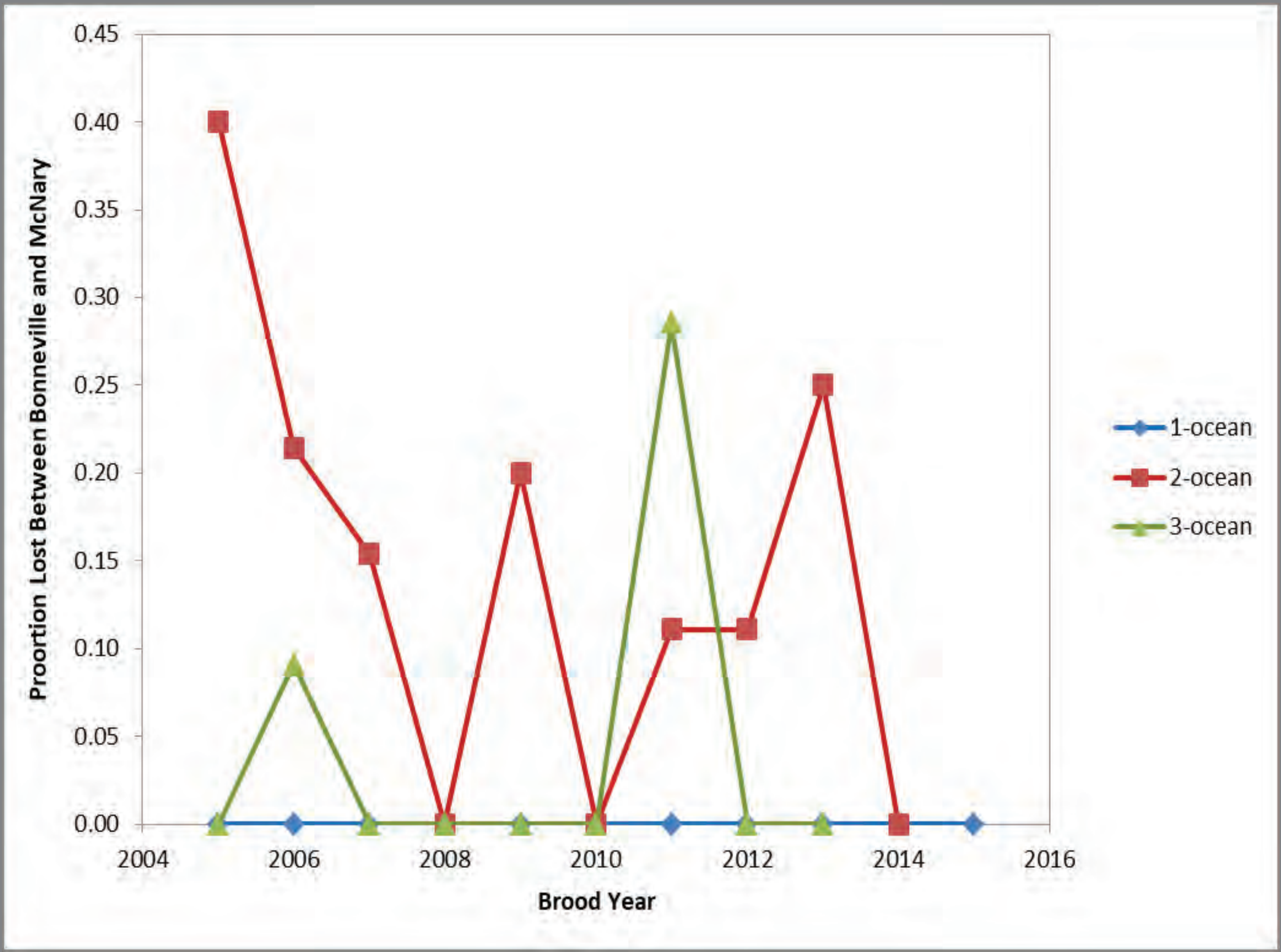
Key Factors

- Broodstock Collection
  - Run timing
  - Selection for size, age, sex, appearance, etc.

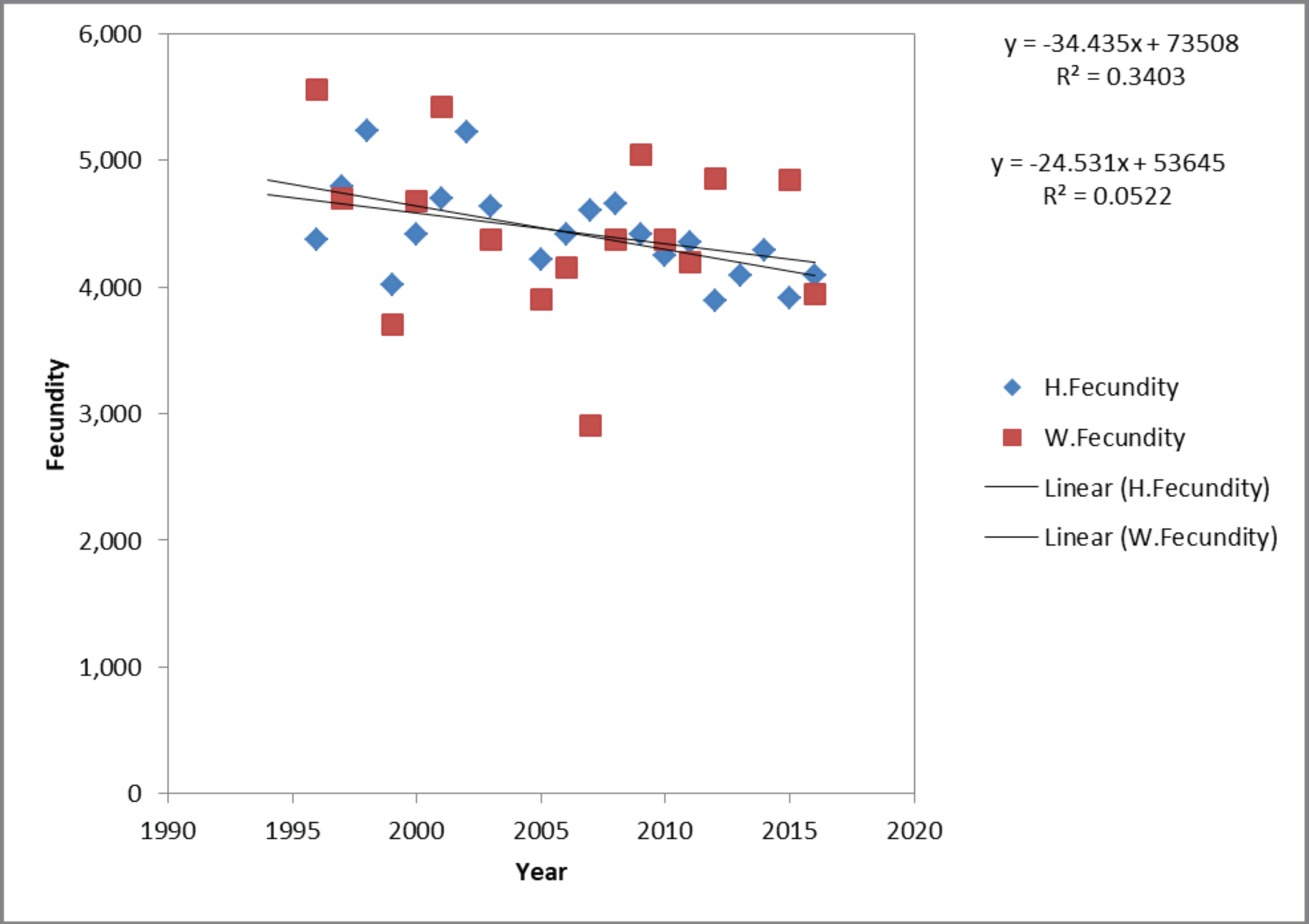
Key Factors

- Fisheries and Hatcheries
  - Select for younger age at maturity
  - Synergistic because hatcheries allow greater exploitation of mixed stocks which can increase selection on size and age of fish

Key Factors


0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Proortion Lost Between Bonneville and McNary
2004
2006
2008
2010
2012
2014
2016
Brood Year
1-ocean
2-ocean
3-ocean

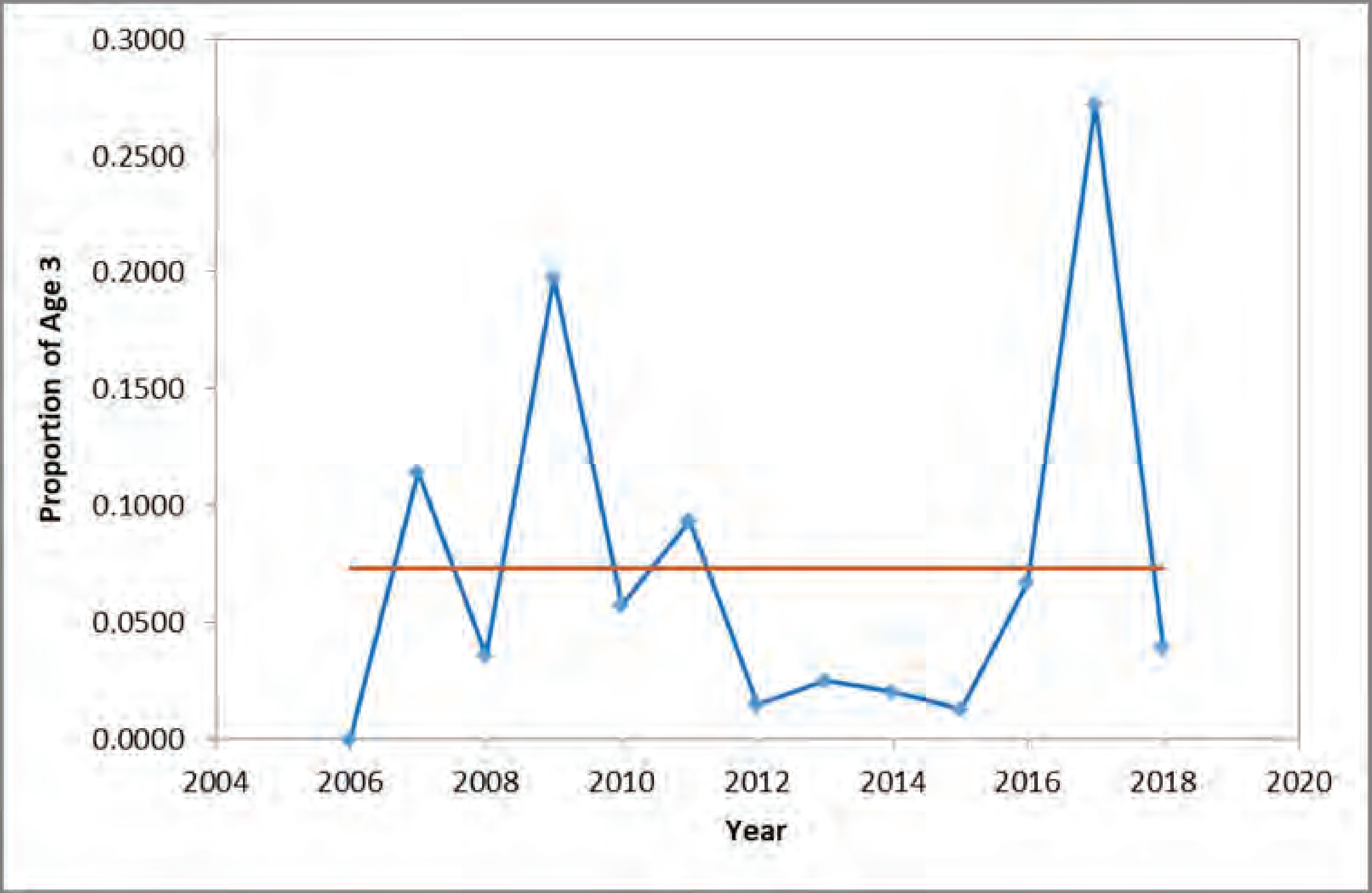
Key Factors


y = -34.435x + 73508
R² = 0.3403
y = -24.531x + 53645
R² = 0.0522
6,000
5,000
4,000
3,000
2,000
1,000
0
Fecundity
1990
1995
2000
2005
2010
2015
2020
Year
H.Fecundity
W.Fecundity
Linear (H.Fecundity)
Linear (W.Fecundity)

Stating the Obvious – Question of Jacks in Broodstock

- Methow Basin wild jack rate = 7%
- Reproductive success compared to multi-sea winter males:
  - Berejekian et al. (2010) = 20%
  - Schroder et al. (2012) = 3%

Wild Jacks at Wells Dam



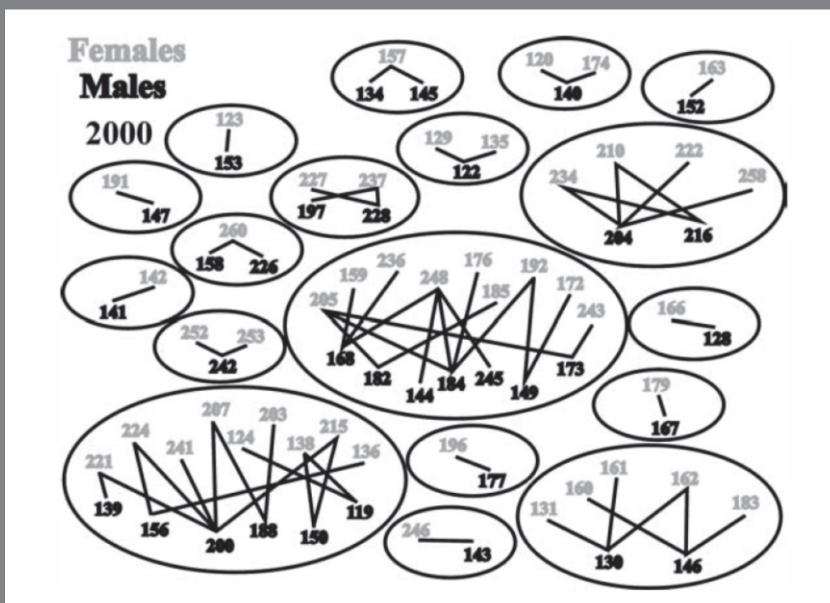
Example: Jacks in Broodstock

- 7% * 20% = 1.4% contribution
- 7% * 3% = 0.2% contribution

Attachment C

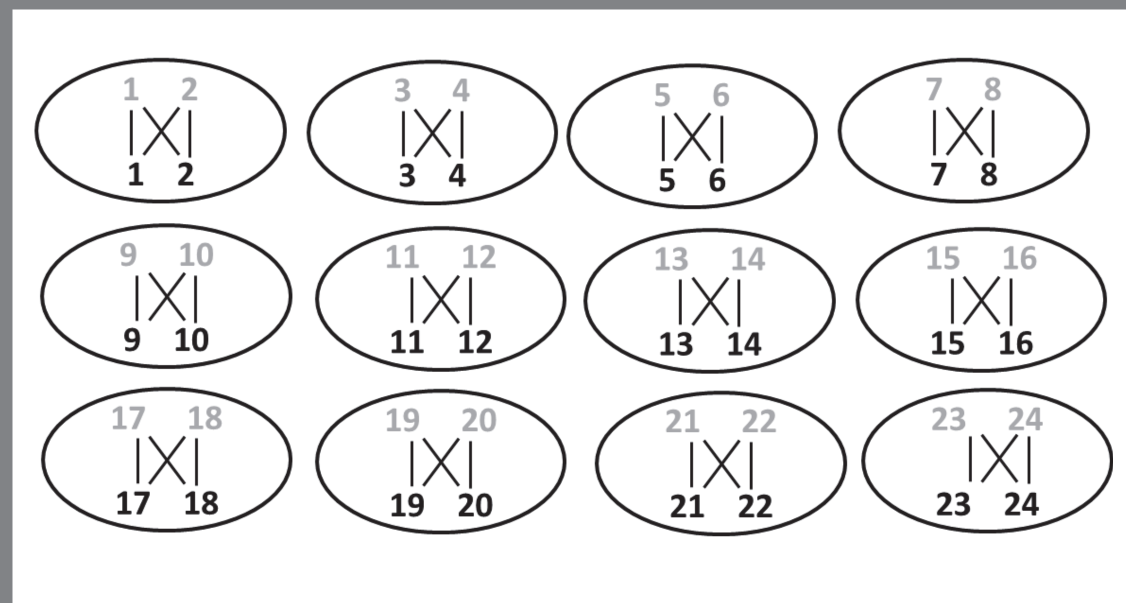
Mating Systems

Wild



Monogamy
Polygany
Polygynandry

Hatchery

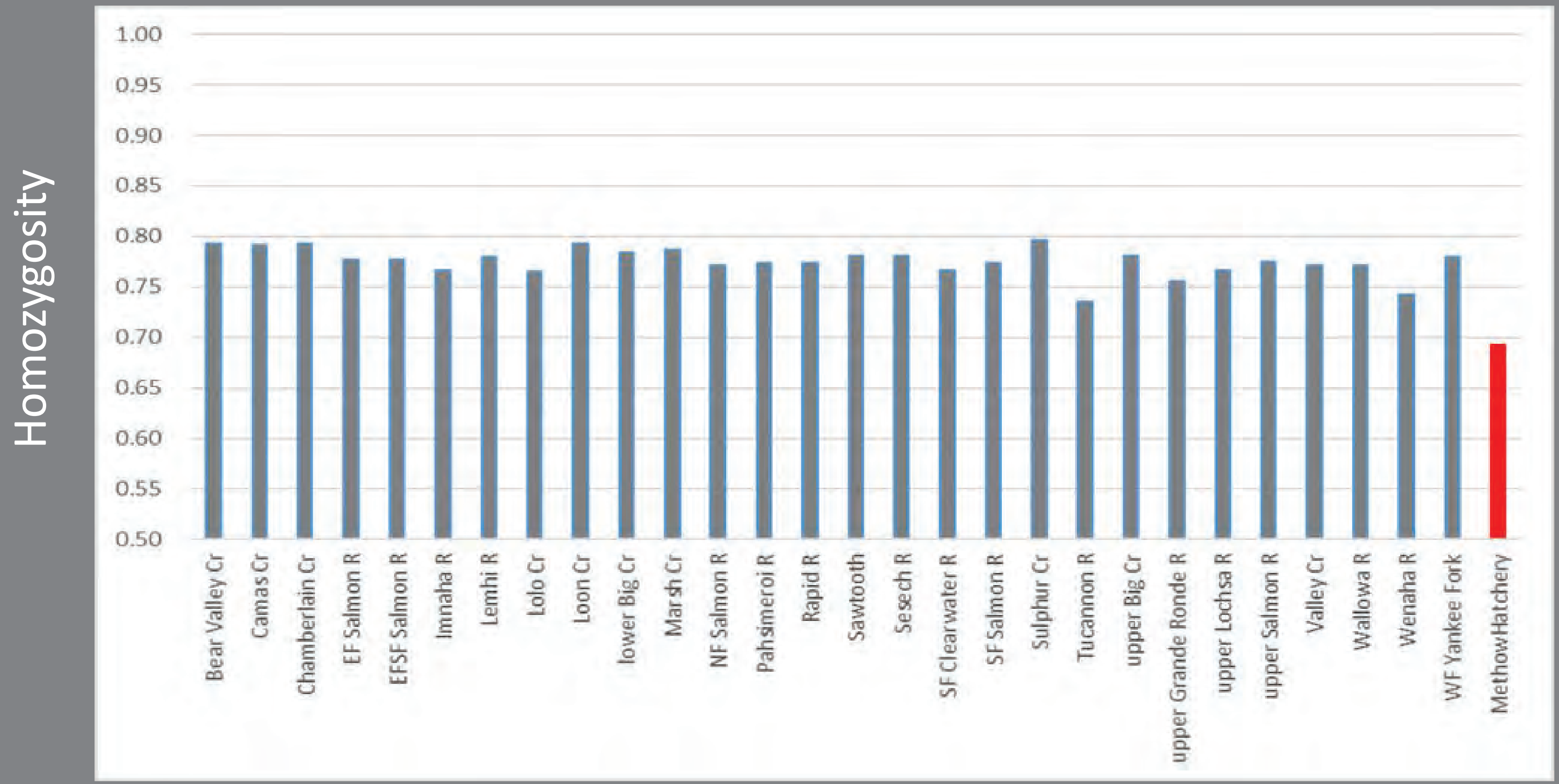


Polygynandry

Adapted from Seamons et al. 2004

Attachment C

Population Size and Genetics
Twisp River



Young et al. 2019

Strategies for Broodstock Management

- Two overall Strategies:
  - Genetically Benign Approach
    - Campton 2004; HSRG 2004
  - Emulate Natural Processes Approach
    - Hankin 2009; Quinn 2005

Genetically Benign Approach

- Sufficient broodstock population to overcome drift, domestication.
  - Wild fish used to prevent divergence
- Random broodstock collection without regard for phenotype
    - Run-timing, size, age, etc.
- Minimize artificial selection in hatchery
- Mating Scheme
  - Spawn fish randomly: without regard to age, size, etc.

Emulate Natural Processes Approach

- Counter artificial selection in hatchery for younger age at maturity
- Counter fisheries effect for younger age at maturity
- Emulate mate choice structure found in wild
  - Spawn females with larger males to drive population towards older age at maturity

Other Aspects of Broodstock Management

- Key processes in hatcheries (Quinn 2005):
  - Broodstock collection
  - Mate choice and gamete collection
- Larsen et al. (2019)
  - wild broodstock produced early maturing males at higher rate than broodstock with as little as one generation of hatchery ancestry
- Minimize kinship
  - Best way to maintain genetic diversity in captive programs (Ivy and Lacy, 2012)
- Equalize family sizes

Other Aspects of Broodstock Management

Mating Schemes

a. Random Pairwise 1:1
   i. All adults have equal opportunity to reproduce
b. Overlap Pairwise
   i. Backup male used
   ii. Sperm competition can still occur even 45 s after first fertilization.
c. Pooled
   i. Sperm competition
   ii. Loss of control over mating scheme – not recommended by anyone.

Other Aspects of Broodstock Management

d. Pooled Matrix
   i. Multiple females' eggs mixed and separate into aliquots. Separate males fertilize each aliquot.
   ii. Greater potential for disease transmission
   iii. Cannot track family groups for disease management or performance analysis

e. Nested
   i. For skewed sex ratio 1:2 or more
   ii. Recommendation is to collect more fish so the less abundant sex meets minimum broodstock needs and excess of the abundant sex are discarded.

f. Factorial (Matrix) (Busack and Knudsen, 2007)
   i. 2x2, 3x3, 4x4 etc.
   ii. Maximizes number of family groups and genotypic diversity
   iii. Maximizes effective number of breeders in the hatchery

Other Aspects of Broodstock Management

Random Selection

- Likely during mating, brood are not randomly chosen in terms of phenotypic traits (Mclean et al. 2005).

"Despite efforts by the staff to not spawn selectively, data on steelhead spawned over 7 years revealed selection for large adult body size and early reproductive timing and a tendency for size-assortative mating (i.e., large with large). Selection on size was related to selection on reproductive timing because early returning fish tended to be larger than those returning later."

Current Conditions – Methow Hatchery

1. Broodstock collection is (somewhat) random
   a. Attempt to collect brood across the entire run timing, but the realities of trapping a small population and to minimize the number of fish trapped and handled tend to front load the trapping to ensure enough brood are captured.
   b. Injured or sick fish may not be retained
   c. Jacks are not retained (except in 2019 the Broodstock Protocols)
2. Mating follows a 2x2 matrix with males used as backup reciprocally.
   a. Small program limits the range of possibilities for matrix spawning.
   b. Fish to be mated are chosen at random by staff, but it is likely they are not randomly chosen in terms of phenotypic traits (Mclean et al. 2005).
3. Culling
   a. Families are not culled to equalize family size.
   b. Culling may be performed to control BKD

Possible Path Forward – Methow Hatchery Programs:

1. Broodstock collection
   a. Brood collection to be random (to the best of our abilities).
   b. Jacks included in collection at a pre-determined rate; (e.g., up to 7%; see below).
2. Mating
   a. Continue to use factorial mating protocol with backup male
      i. Ensure enough time has passed between primary and backup fertilization to prevent sperm competition (>>45s).
      ii. Jacks to fertilize only a partial aliquot of each female mate's eggs (e.g., 7% of the females will have up to 20% of their eggs fertilized by jacks [results in about 1.4% of all eggs being fertilized by jacks])
   f. To the extent possible, follow the protocol in Hankin et al. (2009) where larger males are preferentially mated with smaller females to select for older age at maturity to counteract effects of hatchery propagation and fisheries.
3. Use genotypes to avoid close relatedness in matings.

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM -SCIENCE DIVISION
HATCHERY/WILD INTERACTIONS UNIT

3515 Chelan Hwy, Wenatchee, WA 98801
Voice (509) 664-3148 FAX (509) 662-6606

September 19, 2019

To: Rock Island HCP Hatchery Committee
Priest Rapids Hatchery Subcommittee

From: Andrew Murdoch, Research Scientist, Science Division, WDFW
Mike Ford, Director, Conservation Biology Division, NW Fisheries Science Center
NOAA Fisheries

Subject: Clarification of Extension of the Wenatchee spring Chinook RRS Study

Adult management activities at Tumwater Dam began in 2014. As a result, the abundance and proportion of hatchery spawners has and is expected to differ from what has been included in the study thus far (Table 1). For example, the abundance of naturally produced fish has never exceeded that of hatchery fish. In addition, the parental origin of hatchery spawners will also be changing such that only hatchery fish produced by natural origin parents could be allowed upstream to spawn. Furthermore, the sex and age of hatchery fish allowed to spawn naturally may also differ annually if jacks and adult male hatchery fish are disproportionately removed at Tumwater Dam. These significant hatchery reform actions are the reasons we (WDFW and NOAA) proposed extending the duration of study to BPA. These reform actions will be empirically evaluated as these additional brood years are included in the study. WDFW and NOAA is asking for approval from the Rock Island HCP Hatchery Committee for the clarification in change in scope/duration.

Table 1. Summary of the number and percentage of hatchery and naturally produced fish allowed to spawn upstream of Tumwater Dam, 2004 – 2013. Asterisk denotes preliminary numbers that may change after scales are read.

Year	Hatchery		Naturally produced	
	Number	%	Number	%
2004	1,327	0.60	898	0.40
2005	3,217	0.84	594	0.16
2006	1,600	0.74	573	0.26
2007	3,259	0.91	324	0.09
2008	5,338	0.89	631	0.11
2009	4,270	0.85	777	0.15
2010	4,453	0.83	880	0.17
2011	4,792	0.80	1,224	0.20
2012	4,010	0.75	1,370	0.25
2013*	3,274	0.75	1,144	0.25
Mean	3,554	0.79	842	0.21
CV	36	12	39	45

Proposed Action (as clarified)

Extend the scope/duration of the study to include brood years 2014 through 2018. However, comparisons of relative reproductive success will only be made at the smolt stage via DNA sampling of natural origin smolts collected at smolt traps through 2020 and DNA sampling of natural origin adults at Tumwater Dam through 2023 (i.e., 2018 brood). The goal is to sample 100% of the natural origin smolts encountered at smolt traps and as many natural origin adults as possible up to 100% of the return during this period. A comparison of the original proposal and proposed extension is provided in Table 2.

Table 2. A summary of additional impacts directly attributable to the study as a result of the proposal.

Question	Original Project	Proposal
Last brood year in study?	2013	2018
Last year of DNA sampling potential hatchery spawners?[1]	2013	2018
Last year of DNA sampling wild returning adults?[1]	2018	2023
Last year of juvenile DNA sampling?	2015	2020
Last year of intensive spawning ground surveys?	2013	2013

[1] Denotes last year of adult trapping specific to the RRS Study but does change trapping activities that may be associated with adult management, broodstocking, and/or other M&E related activities.

ESA Take and Permitting

Section 10 permit #18121 provides all of the necessary take associated with the extension. Furthermore, because the removal of excess hatchery fish at Tumwater Dam and the collection of DNA from naturally produced fish (i.e., original RRS study) will also require trapping effort (and scheduling) similar to past years efforts under the RRS, the trapping effort for adult management and DNA collection under the original RRS scope of work will be sufficient to conduct the study. The change in scope will result in the additional sampling (i.e., biological data, PIT tag, and DNA) of natural origin adults through 2023 and the DNA sampling of naturally produced juveniles collected at smolt traps that otherwise would already be sampled and PIT tagged through 2020.

Other Logistical Considerations

Results of the study thus far have suggested that spawning location accounts for a significant proportion of variation in reproductive success. Chelan County PUD currently conducts spring Chinook spawning ground surveys in the Wenatchee Basin. As such, WDFW will work closely with PUD staff and supply the equipment and supplies necessary to ensure the any additional data critical to the study (i.e., spawning location of all carcasses not just females and DNA from untagged fish) is collected consistent with past protocols.

Approval of this extension has already been approved by BPA. At this time we are formally seeking approval from the Rock Island HCP Hatchery Committee for the clarification in scope to include natural origin adult DNA sampling at Tumwater Dam through 2023 (2018 brood). If there are any potential questions or issues with the clarification of the study extension/duration please feel free to contact me at your convenience.

Rock Island and Rocky Reach HCP Hatchery Committees
Final Statement of Agreement
Annual Broodstock Collection Protocols

Approved as follows: Chelan PUD, WDFW, USFWS, NMFS, YN and CCT approved on September 18, 2019

In fulfillment of requirements of existing and forthcoming Endangered Species Act permits for the Rock Island and Rocky Reach Habitat Conservation Plan (HCP) Hatchery Programs, the Rock Island and Rocky Reach HCP Hatchery Committees (HCP-HCs) agree to develop and submit to the National Marine Fisheries Service (NMFS) annual Broodstock Collection Protocols each year by April 15. The purpose of this agreement is to provide an annual schedule that allows for adequate discussion and review of plans prior to approval of the protocols.

Process and Schedule: The Permit Holders will prepare a draft Broodstock Collection Protocol for review by the Rock Island and Rocky Reach HCP-HCs no later than 10 days prior to their respective February meetings. Following Committees review and revision, a final Broodstock Collection Protocols will be subject to approval at the March HCP-HCs meetings and submitted to NMFS by April 15. The HCP-HCs will reevaluate this schedule in August 2020 and determine if changes are necessary.

Timeline:

- September HCP-HC meetings: Initial flagging/introduction of major changes/deviations/issues to existing programs/methods/schedules/etc. to the respective committee(s). Individual assignments outlined.
- No later than November 15: Individual BSP assignments due.
- December HCP-HC meetings: Finalization of discussions/agreements relating to major changes proposed in September by the respective committee(s).
- No later than January 10: Internal permit holders draft circulation for review
- No later than 10 days prior to the respective committee(s) February meetings: First draft circulation of Broodstock Collection Protocols for committee representative review/commenting.
- March Rock Island and Rocky Reach HCP-HC committee meetings: Approval of final annual Broodstock Collection Protocols
- No later than April 15: Submission of final approved annual Broodstock Collection Protocols to NMFS and USFWS.

NMFS/USFWS Approval: Participation in the development, submission, and approval of the annual Broodstock Collection Protocols within the Committees by the NMFS/USFWS HCP-HC representatives will constitute NMFS/USFWS acceptance and approval of the annual Broodstock Collection Protocols.

SOA 2019-01

Priest Rapids Coordinating Committee's Hatchery Subcommittee
Final Statement of Agreement
Annual Broodstock Collection Protocols

Submitted to PRCC Hatchery Subcommittee: 8/21/2019
Approved by PRCC Hatchery Subcommittee: 9/18/2019

In fulfillment of requirements of existing and forthcoming Endangered Species Act permits for the Priest Rapids Project Salmon and Steelhead Settlement Agreement (SSA) and National Marine Fisheries Service (NMFS) Biological Opinion, the Priest Rapids Coordinating Committee's Hatchery Subcommittee (PRCC-HSC) agrees to develop and submit to NMFS annual Broodstock Collection Protocols each year by April 15. The purpose of this agreement is to provide an annual schedule that allows for adequate discussion and review of plans prior to approval of the protocols.

Process and Schedule: The Permit Holders will prepare a draft Broodstock Collection Protocol for review by the PRCC-HSC no later than 10 days prior to the February meeting. Following Committee review and revision, a final Broodstock Collection Protocols will be subject to approval at the March PRCC-HSC meeting and submitted to NMFS by April 15. The PRCC-HSC will reevaluate this schedule in August 2020 and determine if changes are necessary.

Timeline:

- September PRCC-HSC meeting: Initial flagging/introduction of major changes/deviations/issues to existing programs/methods/schedules/etc. to the respective committee(s). Individual assignments outlined.
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NMFS/USFWS Approval: Participation in the development, submission, and approval of the annual Broodstock Collection Protocols within the Committees by the NMFS/USFWS PRCC-

HSC representatives will constitute NMFS/USFWS acceptance and approval of the annual Broodstock Collection Protocols.

Wells HCP Hatchery Committee
Final Statement of Agreement
Annual Broodstock Collection Protocols
September 18, 2019 meeting

In fulfillment of requirements of existing and forthcoming Endangered Species Act permits for the Wells Habitat Conservation Plan (HCP) Hatchery Programs, the Wells HCP Hatchery Committee (HCP-HC) agrees to develop and submit to the National Marine Fisheries Service (NMFS) annual Broodstock Collection Protocols each year by April 15. The purpose of this agreement is to provide an annual schedule that allows for adequate discussion and review of plans prior to approval of the protocols.

Process and Schedule: The Permit Holders will prepare a draft Broodstock Collection Protocol for review by the Wells HCP-HC no later than 10 days prior to the February meeting. Following Committee review and revision, a final Broodstock Collection Protocols will be subject to approval at the March HCP-HC and HCP-Coordinating Committee[1] (HCP-CC) meetings and submitted to NMFS by April 15. The HCP-HC will reevaluate this schedule in August 2020 and determine if changes are necessary.

Timeline:

- September HCP-HC meeting: Initial flagging/introduction of major changes/deviations/issues to existing programs/methods/schedules/etc. to the respective committee(s). Individual assignments outlined.
- No later than November 15: Individual BSP assignments due.
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- No later than January 10: Internal permit holders draft circulation for review
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- March Wells HCP-HC and HCP-CC committee meetings: Approval of final annual Broodstock Collection Protocols
- No later than April 15: Submission of final approved annual Broodstock Collection Protocols to NMFS and USFWS.

NMFS/USFWS Approval: Participation in the development, submission, and approval of the annual Broodstock Collection Protocols within the Committees by the NMFS/USFWS HCP-HC and HCP-CC[1] representatives will constitute NMFS/USFWS acceptance and approval of the annual Broodstock Collection Protocols.

[1] HCP-CC approval meets the Wells HCP requirement for approval of broodstock collection and monitoring and evaluation activities involving the Wells Project facilities.

Control of *Saprolegnia* sp. Growth on Summer Chinook (*Oncorhynchus tshawytscha*) Eggs

Experimental Protocol – Pilot Study

Written by Dr. Betsy Bamberger, DCPUD Fish Health and Evaluation Specialist

Abstract: To be completed at the conclusion of the study.

Introduction: Water mold (*Saprolegnia* sp.) is a common pathogen of salmonid eggs in fish hatcheries. Traditionally, hatcheries have used formalin for prophylactic management of *Saprolegnia* sp. infection in incubating eggs. However, formalin has long been associated with worker safety and environmental hazards, and may be met with increasing scrutiny by regulatory agencies in the immediate future. In 2018 we conducted a similar study at the Methow Hatchery and found no differences among treatments. However, it is likely that *Saprolegnia* sp. load was low, limiting the inference that study could provide. We propose a similar study at Wells Hatchery, where it is thought the risk of *Saprolegnia* sp. infection will be higher than at Methow Hatchery, potentially providing more contrast in the results. In this study, we investigate the efficacy of purported alternatives to formalin that can be used as safe therapeutic substitutes. These alternatives include hydrogen peroxide (H_2O_2), salt (NaCl), and slow-release elemental copper (Dr. Nicole Walrath, personal communication, July 11, 2019), as well as no treatment (i.e., chilled or ambient water only), and will be tested for control of water mold infestations during salmonid egg incubation under hatchery conditions at Wells Fish Hatchery (WFH). The study described here is a pilot study. The null hypothesis is there will be no difference found between test treatment groups (hydrogen peroxide, sodium chloride, elemental copper, and no treatment [water]), and the formalin group, using egg mortality caused by Saprolegniasis as the basis for the analysis.

Methods: Thirty-five females and thirty-five males of Wells Hatchery-origin (hatchery) summer Chinook will be collected at Wells Fish Hatchery (WFH) in 2019 and progeny will be incubated as per the Wells hatchery subyearling program. The fish are in addition to the Wells Hatchery subyearling program. Once sexually mature, the adult fish will be stripped of eggs and milt in mid-October 2019. All gametes will be harvested on the same day to eliminate temporal bias. Eggs from each female will be collected in a Ziploc® bag and weighed; these weights will later be added to determine a total egg weight. Once all are harvested, green eggs and ovarian fluid from spawned females will be combined into a shallow communal tub (a 45 in diameter plastic kiddie pool) and gently mixed. Eggs will then be divided into thirty-five approximately equal portions by weight, resulting in each aliquot being similar to typical fecundity of an individual female (each deposited into a separate, numbered large Ziploc® bag) and placed in an ice-filled cooler lined with burlap. Milt from each male will be collected in separate Whirl-Pak® bags and stored in the same chilled cooler. Each bag of eggs will be infused with milt from an individual male, used for primary fertilization, and then milt from a second male used as backup several minutes after initial fertilization by the primary male. Each male will serve as a primary male for at least one female and a backup male for one or more females, thus providing greater probability of successful fertilization and minimizing the effect of an individual with reduced viability or non-viable gametes.

Eggs and milt will be mixed within each bag, placed in a designated individual Heath vertical incubator tray, and then gently rinsed with water, consistent with general hatchery practice for production programs where one female's eggs are loaded per tray Trays will be placed within a stack assigned to one of five treatment groups (formalin, salt, hydrogen peroxide, elemental copper, and ambient water [no treatment]).

The total number of eggs in the formalin, salt, hydrogen peroxide, elemental copper, and no treatment (water) groups is 140,000 eggs (35 * 4,000 average fecundity = 140,000). Of these, 28,000 eggs will be incubated with the subyearling production program and will serves as the formalin treatment, and the remaining 112,000 eggs will serve as the salt, hydrogen peroxide, elemental copper, and no treatment (water) groups (see Table 1).

Table 1. Schedule of summer Chinook broodstock needs, eggs, unfed fry, transfers, euthanization.

Treatment Group	Number of Broodstock Pairs	Number of Eggs	Number Retained to Unfed Fry	Available for Transfer	Number to Transfer (up to)	Number to Euthanize
No Treatment	7	28,000	50	Yes	27,950	50 fry
Formalin	7	28,000	50	Yes	27,950	50 fry
Salt	7	28,000	50	Yes	27,950	50 fry
Hydrogen Peroxide	7	28,000	50	Yes	27,950	50 fry
Elemental Copper	7	28,000	50	No	0	27,950 eggs 50 fry
Total	35	140,000	350		118,000	350 fry 27,950 eggs

Five incubation stacks will be used, one for each of the five treatment groups. The topmost tray of each stack will be kept empty to allow for ease of chemical introduction; the seven trays below will be reserved for eggs (see treatment-specific information and schematic representation of experimental set-up in Figure 1, below). The formalin stacks will be located in a separate incubation room (Incubation Room #5) to avoid potential adverse chemical reactions between formalin and hydrogen peroxide; all other stacks will be located in Incubation Room #7. Egg clutches will be placed within trays in sequential order until all trays are occupied. For all treatments, the fertilized eggs in the trays within the stacks will be water-hardened and disinfected in a 100 ppm buffered iodophor (Ovadine®) solution (static bath) for 60 minutes as per standard procedure. Following water hardening and surface disinfection, fresh well water (averaging 55°F) will be introduced into the stacks, effectively draining away the used iodophor solution from each tray. TidbiT® temperature data loggers will be added to the top most tray of each stack to record and track water temperatures throughout treatment. Flow will be set at 2.5 gallons per minute (gpm). Incubating water temperatures will be cooled from 55°F (well water) to 40.5°F over a 10 day period and then kept at 40.5°F for roughly two weeks, after which the temperatures will be brought back up to 55°F over a three day period (this mimics Wells' standard incubation procedure for subyearling smolts).

Salt and hydrogen peroxide will be added to the topmost (empty) tray of the incubation stacks and delivered via a metered peristaltic pump (INTLLAB™ or MasterFlex easy-load® II). Formalin will be administrated via the flow lines and venosets built into Incubation Room #5. Copper pads will be added into and evenly distributed within the topmost tray of the incubation stack. Dosages of hydrogen peroxide, formalin, and salt will be calculated to consider flow rate, treatment time, final desired concentration of chemical treatment, and chemical strength. As such, treatments will be consistent with FDA-label instructions/allowances or previously published data (see Figure 1). Salt will be pre-dissolved before administration; salinity will be monitored during treatment with an Apera 5052 saltwater salinity tester with the probe placed in the topmost empty tray and recorded twice during administration (5 and 15 minutes).

Daily 15-minute flow-through treatments with hydrogen peroxide, well water, and salt will be initiated on the day following fertilization. Treatments will continue daily and cease just prior to the initiation of hatching, providing approximately XX days of treatment.

When the eggs are at approximately 550 temperature units, the incubator trays in all stacks will be opened and photographed to document the degree and spatial distribution of any *Saprolegnia* sp.-infected and/or dead (opaque) eggs. The eggs will then be shocked by mechanical agitation within the trays and infected and/or dead eggs will be removed and counted before trays containing the remaining live eggs are returned to the stacks. An average individual egg weight will be estimated from a 100 egg sample of the remaining live eggs from 10 random trays. This average egg weight will be used to estimate the number of live eggs for each tray.

From each treatment group, 50 eggs will be from retained each tray and combined into one tray to incubate to the unfed fry stage (350 per group; 4 groups *350 = 1,400 to be destroyed as unfed fry). The remainder of the eggs will be transferred to other programs or destroyed or (see below). Mortality from eyed egg to unfed fry for each treatment will be assessed when the unfed fry are determined to be near ponding readiness. Staff will check for discernable morphological differences in unfed fry from each group to determine if histological analysis is warranted.

Eyed eggs from the salt, hydrogen peroxide, and no treatment groups may be transferred to other programs upon consent from the Hatchery Committee. Eggs from the formalin, hydrogen peroxide, salt, and no treatment groups will either be incorporated into the Wells Hatchery subyearling release group if the program will remain under 110% of the production target, or transferred to other programs. Eggs from the elemental copper treatment must be destroyed according to FDA rules.

The criteria used to evaluate the efficacy of each compound will be 1) mortality from fertilization through eyed egg (which includes both water mold-infected eggs and dead uninfected eggs throughout the incubation period and after shocking) and 2) eyed egg to unfed fry survivability. In addition, the extent of water mold infection will be qualitatively (via photography) and quantitatively (via the number of eggs that appear infected) estimated and enumerated, respectively.

Room 7 **Stack 1**	Room 7 **Stack 2**	Room 7 **Stack 3**	Room 7 **Stack 4**	Room 5 **Stack 5**
Empty	**Empty**	**Empty**	**Empty**	**Empty**
1	**8**	**15**	**22**	**29**
2	**9**	**16**	**23**	**30**
3	**10**	**17**	**24**	**31**
4	**11**	**18**	**25**	**32**
5	**12**	**19**	**26**	**33**
6	**13**	**20**	**27**	**34**
7	**14**	**21**	**28**	**35**
No Treatment 100% Well Water	**Hydrogen Peroxide** 35% PEROX-AID® Dosing regimen: 1000 mg/L for 15 minutes (~488 mls H202) in a continuous flow system once per day (consistent with FDA label). Administration: 32.5 ml/minute (or 0.54 ml/second)	**Sodium Chloride** Diamond Crystal® Solar Naturals® Dosing regimen: 20,000 ppm for 15 minutes (~8 lbs salt per stack) in a continuous flow system once per day (based on findings in Waterstrat, 1995 and Edgell, P. and D. Lawseth, 1993). Administration: Make a 3 lb of salt/1 gallon of water stock solution; 0.2 gal/min	**Elemental Copper** Chore Boy® Copper Scouring Pads Dosing regimen: 12 pads per stack (12.4 g each). Application permissible by the FDA via the Code of Federal Regulations Title 21 pertaining to new animal drugs for investigational use (21 CFR 511.1.a).	**Formalin** Parasite-S® Dosing regimen: 1/600 (1,666 ppm) for 15 minutes (~770 ml per stack) in a continuous flow system once per day (consistent with FDA label). Administration: 51.3 ml/minute (or 0.85 ml/second)

Figure 1: Schematic representation of incubation room, stack and tray assignment, and dosing regimen per treatment group.

Statistical Analysis: One-way ANOVA will be used to examine similarities or differences between treatment groups using trays as a replicate. Tray position will be tested to rule out a tray position effect on mortality prior to analysis of treatment effect.

Results:

Discussion: This study is a pilot study to test the experimental methodologies at Wells Hatchery and to gain preliminary results regarding the efficacy of various treatments that may control *Saprolegnia* sp. infection of Pacific salmonid eggs. The results of this study will be combined with the results of a similar study conducted at Methow Hatchery in 2018 to inform future research direction in pursuit of testing alternatives to formalin for fish health applications in a hatchery setting.

Conclusion:

Acknowledgements: Special thanks to the Wells Fish Hatchery staff; Greg Mackey; and Andrew Gingerich for their help in completing this pilot study.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: November 20, 2019

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the October 16, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, October 16, 2019, from 9:00 a.m. to 3:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery (MFH) programs (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will work with Mike Tonseth to test a modeling approach and prepare a white paper on the method for determining a range for the number of females to be collected for a given broodstock in the upcoming year (Item II-C).
- Brett Farman will confer with Charlene Hurst and confirm whether transfer of surplus spring Chinook salmon eyed-eggs from MFH to the Colville Confederated Tribes' 10j program is consistent with the intent of the 10j permit (Item II-D).
- Bill Gale will confirm whether Winthrop National Fish Hatchery (WNFH) can receive surplus spring Chinook salmon eyed-eggs from MFH (Item II-D).

- Mike Tonseth will prepare, and Larissa Rohrbach will distribute, the Appendices to the Broodstock Collection Protocols (BCPs) for editing by the relevant parties that were identified in the October 16, 2019 meeting (Item II-E).

Decision Summary

- There were no decisions made in today's meeting.

Agreements

- The HCP HCs and PRCC HSC agreed to allow scientists to report the carcass survey data at the historic reach scale for comparison to past results, and also to report the data at a scale that is appropriate for each reach and population to discern distribution trends.

Review Items

- Larissa Rohrbach sent an email to the Wells HCP-HC on September 16, 2019, notifying them that Douglas PUD's draft 2018 Monitoring and Evaluation (M&E) Report for the Wells and Methow program is available for 60-day review with edits due by Friday, November 15, 2019 (Item I-A).
- Larissa Rohrbach sent an email to the PRCC HSC on October 22, 2019, notifying them that Grant PUD's draft 2018-2019 Priest Rapids Hatchery M&E Annual Report is available for 30-day review with edits due by Friday, November 20, 2019 (Item I-A).

Finalized Documents

- There were no documents finalized in today's meeting.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the September 18,2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC to the meeting.

Hillman asked for any additions or changes to the revised agenda (distributed via email by Larissa Rohrbach on October 14, 2019).

Attendees requested to add several items for discussion to the agenda.

- Hillman asked to discuss the scale of carcass survey analysis in the Comprehensive Report (due in 2020). This would follow the discussion of updates to the genetics section of the M&E Plan.
- Hillman added that the Committees would offer performance evaluations for himself and Rohrbach in today's meeting (under administrative business).
- Todd Pearsons added conference announcements to the administrative business.
- Mike Tonseth added consideration for changing start time of the meetings to the administrative business.
- Greg Mackey added a discussion on the disposition of surplus Methow Hatchery spring Chinook salmon eyed eggs. Hillman said this would be discussed as part of the surplus juvenile production discussion (Item II-D).

The HCP-HCs and PRCC HSC members approved the revised agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised September 18, 2019 meeting minutes. Additional minor revisions were made in the meeting. The HCP-HCs and PRCC HSC members approved the meeting minutes as revised.

Administrative business was discussed.

Tonseth asked if the start time could be shifted to 10:00 a.m. to accommodate logistical challenges related to school schedules. Bill Gale suggested accommodating the schedule in the winter but reverting back to a 9:00 a.m. start time in the summer. Gale asked if the school schedule has always been the same and is unlikely to change in the future. Tonseth and Keely Murdoch said it is unlikely to change. All parties agreed to changing the meeting start time to 10:00 a.m. during school months (September through May). During other months, the meeting will start at 9:00 a.m.

Pearsons said the Upper Columbia Science Conference will occur on January 22 and 23, 2020, in Wenatchee, Washington, and abstracts are currently being reviewed. Pearsons said the Western Division American Fisheries Society meeting will be held in Vancouver, BC, on April 12 through 16, 2020, with abstract submission open through November 8, 2019.

Hillman noted that it is time for the HCP-HCs to provide an evaluation of his and Rohrbach's performance. Greg Mackey asked how the Committees members would like to convey feedback to Hillman and Rohrbach. Mackey said generally the feedback was positive. The following feedback was provided to Hillman over email:

Mackey said the HCP-HCs conducted an evaluation of the Chair, Tracy Hillman. Mackey said the PUD representatives polled all the members by email offering opportunity to reply directly or request a conference call or meeting to discuss the Chair's performance. All members replied via email that they were pleased with the Chair's performance and wanted Douglas PUD and Chelan PUD to retain Hillman's services for another three-year term. Hillman agreed to serve as the Chair for the Wells, Rocky Reach, and Rock Island Hatchery Committees for another three years.

Mackey also provided a positive review of the meeting support services provided by Rohrbach in 2019. Pearsons noted that applying the same approach to maintaining the meeting records for the PRCC HSC has been successful for ensuring meeting discussions were accurately summarized.

Action items from the HCP-HCs and PRCC HSC meeting on September 18, 2019, were reviewed, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on September 18, 2019)*:

Joint HCP-HCs and PRCC HSC

- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present pre-spawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).*
  Tonseth said this item is ongoing; there may be pre-spawn mortality values for females but not yet for males.
- *Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).*
  Truscott said this item is ongoing.
- *Brett Farman will discuss with Charlene Hurst (NMFS) and Tonseth the potential use of a multi-population model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said he contacted Hurst and Tonseth to initiate a discussion, but the item is still ongoing.
- *Greg Mackey will distribute a white paper reviewing broodstock composition and mating strategies for conservation programs, focusing on spring Chinook salmon at the Methow Hatchery (Item I-A).*
  This item was distributed by Larissa Rohrbach on October 14, 2019, with a request that any comments or edits be provided to Mackey, and is attached to these minutes as Attachment B. This item is complete.
- *Larissa Rohrbach will add HCP Policy Committee guidance on policy-level issues to the HCP-HC Meeting Protocols (version dated May 15, 2019; Item I-A).*

Tracy Hillman said the final meeting minutes were distributed on September 26, 2019. [Rohrbach updated the HCP-HC and PRCC HSC Meeting Protocols following the meeting and distributed an updated version on October 22, 2019. This item is complete.]

- *Mike Tonseth will distribute a suggested drafting plan for the Broodstock Collection Protocols (BCPs) assigning specific members to address topics for discussion; Tracy Hillman will determine whether there is a need for an additional conference call in early October to discuss research needs to address given topics (Item II-B).*
  Tonseth said this will be discussed in today's meeting. This item is complete.
- *Catherine Willard will coordinate with other HCP-HC and PRCC HSC members to draft separate sets of genetic monitoring hypotheses that are specific for the individual hatchery programs to monitor for changes in population genetics over time (Item II-C).*
  Tracy Hillman said this item will be discussed in today's meeting. This item is complete.

PRCC Hatchery Subcommittee

- *PRCC HSC representatives will submit a list of minimum data or information needs for making a decision on the White River spring Chinook salmon hatchery program to Tracy Hillman (Item I-A).*
  Hillman said this item is ongoing because the PRCC is working on the direction for the HSC. This action will be removed from the list until further direction is provided by the PRCC.
- *Brett Farman will ask Craig Busack (National Marine Fisheries Service [NMFS]) to participate in PRCC HSC process for identifying data needs and making a decision on the White River spring Chinook salmon hatchery program (Item I-A).*
  Farman said Busack is willing to participate to some extent but would like to address focused questions if possible. Farman said Busack's retirement date is in February. Hillman suggested discussing potential questions for Busack in the HSC meeting.

II. Joint HCP-HCs and PRCC HSC

A. Genetics Updates to the Monitoring and Evaluation Plan for PUD Hatchery Programs

Tracy Hillman projected the edited version of the genetics section (Objective 7) of the PUDs' Monitoring and Evaluation Plan (M&E Plan) in the meeting. Catherine Willard said she did not receive feedback on the most recent revisions [distributed by Rohrbach on October 4, 2019] and shared her edits to the document.

Willard summarized the discussion the Committees had in the previous meeting, that there is an interest in analyzing genetic changes of hatchery-origin returns. The original question focused on the analyses of natural-origin returns exclusively. Willard stated that she captured the analyses of hatchery-origin returns by modifying the Objective 7. Willard said the agreement during the last meeting was that different types of programs would ask different questions about genetic changes over time. She shared edits to the M&E Plan narrative about adding segregated programs to the analyses to convey that segregated programs desire to monitor the risk of using multiple generations of hatchery-origin fish in their broodstock. Willard added a monitoring question about segregated programs (Questions 7.1.1 and 7.1.2) with relevant hypotheses that apply to the modified monitoring question. Willard said she removed the equivalence testing hypotheses and added language that states that biologically relevant effects for measured differences in genetic metrics have not been determined to date, and when they are, the equivalence testing hypotheses equations could be added back to the document. Hillman said he had added language to the narrative on the purpose of equivalency testing and application to many of the hypotheses (also in response to Independent Scientific Advisory Board [ISAB] feedback). Hillman asked if the Committees wanted to approve sections of the document as they are completed or approve the entire document once all ISAB feedback is incorporated. Keely Murdoch asked if there could be a need to make more changes after review of the other objectives. Hillman said changes can always be made because it is a living document. Hillman said a benefit of approving this section separately is that it would allow the programs to move forward on planning genetic analyses.

Greg Mackey said he is not ready to approve the section because he still needs to take time to map out the hatchery samples that would be analyzed and whether that type of analysis would inform the Douglas PUD programs. Mackey summarized the conclusion from the last meeting that in conservation programs the parents of the hatchery fish are wild so the “hatchery fish” are the offspring of wild parents such that any changes observed would be stochastic (essentially sampling error) and not necessarily informative of what the neutral markers should tell us (shifts in the genetic status of the population). Mackey agreed that with incorporation of contemporary natural-origin fish into the conservation programs, comparisons of the contemporary natural-origin fish to the natural-origin baseline makes sense to monitor for genetic changes away from the baseline.

Willard summarized the struggle to understand whether hatchery fish should be analyzed but also noted the conclusion from last month’s meeting was to go forward with analyzing hatchery-origin samples. Todd Pearsons said a contingency of voting to approve this section of the M&E Plan may be to allow the Committees to re-evaluate whether to analyze the hatchery samples once the value of that information is better understood.

Mackey said he would be willing to approve the M&E Plan in sections. Pearsons said it would be best to standardize versions with a single publication date so that they are easily referenced in other documents. Mackey said in 2021 there will be another rewrite of the M&E Plan and asked what sections may need changes. Hillman said major changes are not needed, just revisions to respond to

ISAB feedback. The genetics section was different from others because there were major changes to the hypotheses proposed. Mackey asked about the Before-After-Control-Impact (BACI) analysis. Hillman said description of the BACI analysis is in an appendix to the M&E Plan and that descriptions within the M&E Plan should be sufficient. Willard noted that revisions to the genetics sections address a discrepancy in what the M&E Plan said would be done to analyze the effect of hatchery programs on natural populations and the intent of the plan.

Hillman posed a general question. He said salmon adapt to local environmental conditions. In some cases, this may mean that genes coding for non-adaptive phenotypes are lost because of natural selection (i.e., homing and local adaptation reduce genetic variation). He asked if those genes are actually lost, or are they retained but not expressed (the genes or histones or both are methylated). Murdoch asked if Hillman was referring to hatchery-rearing effects or in selective pressures in the wild. Hillman said the question applies to both hatchery and natural rearing. Murdoch said one of the confusing factors is that in a hatchery there shouldn't be genes lost because individuals [or their genes] are not being lost to competition as they would be in the wild. Bill Gale said the testing for allele frequency evaluates changes to the DNA template; however, in other cases, such as age at maturity, gene expression is affected by rearing in the hatchery.

Hillman referred to a case where Chinook salmon ova from the Sacramento River were transplanted to New Zealand (series of publications by T.P. Quinn, M.J. Unwin, and M.T. Kinnison). These fish survived and evolved into several populations, each with unique heritable traits (e.g., different fecundities, age at maturity, length at age, migration timing). Apparently, these fish retain high genetic diversity (or experienced significant positive genetic mutations) and simply express those genes that result in phenotypes that improved survival within the different river systems. Given the founder effect and the rapid rate at which these fish evolved, this seems to be a case of differential gene expression rather than a loss (or increase) in genes or alleles. Hillman said the hypotheses in the M&E Plan focus on gene frequency. Clearly, a loss of genes or alleles is not good, but maybe the genes are not lost. Perhaps they are retained in the nucleus and simply not being expressed. Gale said presentations like that given by Mackenzie Gavery (NOAA Fisheries Northwest Fisheries Science Center; presented to the HCP-HCs on May 17, 2017) on epigenetic changes that can transfer across generations indicate that allele frequencies should not be the only monitoring target.

Mackey said it's important to keep in mind that the genetic monitoring is focused on neutral markers, alleles that are lost by chance (i.e., genetic drift) not by selection, that are used as a proxy for the selection process that causes a loss of diversity that may occur due to hatchery processes. Mackey said selection occurs for genes that confer fitness. He also noted that selection only selects "against" genes, not "for" genes, so genes that are not selected against should remain in the population. Only genes that are selected against would be driven to low levels or lost. Mackey said in summary, genes are unlikely to be lost except in very small populations. Mackey said it would also be interesting to investigate further the co-adapted gene complexes brought into a population when population mixing occurs. Mackey said selection is not perfection, it just has to be good enough.

Hillman said the intent of his question was to help identify effect sizes for equivalence testing. Mackey said the science is progressing rapidly for identifying selective markers in fish.

Spatial Scales for Carcass Survey Analysis

Hillman said another question related to the M&E Plan is what the appropriate spatial scale is for analyzing hatchery and natural-origin female carcass distributions. Currently, carcasses are recorded using GPS in the field and then the spatial distribution of natural-origin and hatchery-origin carcasses are analyzed statistically at the 100-meter (m) scale following criteria in the M&E Plan. Hillman said it is difficult to depict a long reach of river (e.g., 40 kilometers [km]) graphically if carcass distribution is analyzed at the 100-m scale. Hillman said in the last comprehensive report, spring Chinook salmon carcasses were analyzed at the 500-m scale. Hillman also said that the smaller the scale, the more likely it is to observe a statistical difference between groups.

Murdoch said she thought in the previous M&E Plan the data were analyzed by river kilometer. Willard read from the M&E Plan that states spatial analyses should be done at the historic reach scale and at the 100-m scale. Mackey said they have done both scales and that the boundaries of the historic reach designations can be arbitrary, or not biologically relevant (e.g., based on convenient river entry points). Willard said Douglas PUD reported the average of the river kilometer at which hatchery and natural-origin female carcasses were observed, while Chelan PUD reported the frequency distribution of carcasses. Willard and Mackey said it makes more sense to report the frequency. Hillman said management decisions could be different when looking at the data at the 100-m, 500-m, or 1-km scale. Pearsons said it depends on the program. For instance, spatial distribution of fall Chinook salmon would be very different than spring Chinook salmon. The original metrics were developed for spring Chinook salmon and in some cases the metrics have not been a good fit for the other species. Pearsons said it also depends on the reach, and the way that carcasses drift. Using the 100-m level of analysis gives a false sense of confidence in carcass locations. Mackey said the other problem with precision is that the field staff may carry the carcasses before marking their location by GPS. Willard, Gale, and Murdoch said their biologists mark the location by GPS before moving the carcass to collect other biological data (e.g., size, scales). Pearsons said data collection using GPS allows the data to be analyzed in many different ways. Peter Graf agreed and said the data should be binned according to what is appropriate for the population, stream, or reach. Mike Tonseth agreed that there should not be a “one size fits all” approach for all sites and stocks. For instance, a smaller tributary like Nason Creek versus the Hanford Reach of the Columbia River should have different scales of inference. Hillman said that he does not see much value in analyzing carcass data at small spatial scales (e.g., 100 m). Gale asked if the distributions were actually being tested statistically. Hillman said yes. The p-values are generally smaller when analyzing the data at the smaller scales [indicating higher probability of statistically significant difference].

Tonseth said it is necessary to use different spatial scales for analyzing spring Chinook salmon and steelhead compared to fall Chinook salmon just because of the size of the sites, populations, and carcass drift in certain reaches. Hillman said he was hopeful that there could be a general approach that would be applied for all stocks or populations. Pearsons suggested retaining the data collection approach that allows for flexibility, starting analysis at a broad spatial scale, and if differences are not observed, then moving to a smaller spatial scale.

Murdoch read from the original analytical framework (prior to updates in 2013), which states the analysis should be done at 0.01 km (10 m). Murdoch read that the original framework states that statistical analysis should be done by origin and sex, but analysis by sex would not actually be done if males are not analyzed. Murdoch said the original test was intended to be a comparison of averages of river kilometer and the data were broken out by reach for visualization. Hillman said an ANOVA (Analysis of Variance comparison test) could be used but this approach ignores useful distribution data. With ANOVA, year and origin are independent variables. Willard asked whether the original analytical framework was updated in 2013. Mackey and Tom Kahler said yes. Murdoch asked what updates have been made over time to the M&E Plan. Willard said the more recent updates included graphic and Chi-squared analysis. Mackey said one reason comparing means was not working was because the distributions were not normally distributed. Mackey said in some cases statistics are not even needed to see the differences.

Hillman suggested moving forward by deciding whether a prescriptive approach should be written into the M&E Plan, or whether the analysts should be allowed to determine the scale for each stock and location. Graf suggested starting at 500 m and adjusting to minimize noise in the data and ensure the data are not overly clumped. Pearsons said he supports stating that analyses should be carried out at "an appropriate scale," for instance, analyzing data at 500 m does not show anything for Hanford Reach Fall Chinook salmon and would not be appropriate for that stock. Pearsons said analyzing the data by the historic reaches allows for evaluation at the largest scale, and then it should be up to the analyst to decide what smaller scale is appropriate.

Mackey said presenting the data by historic reaches presents the context. Gale said the historic reaches should not be the only default analysis method because the boundaries may not be biologically relevant. Murdoch said the time scale associated with the historic reaches is much longer and has a larger dataset and therefore should be preserved. Graf suggested leaving it to each analyst to explain why a certain scale is chosen and report at the scale that is most appropriate for a given location and population.

Gale said choosing how to bin histograms is always a problem and there are not great statistical tools to make decisions on where to separate the bins. Hillman said there are some statistical packages that do this, but he does not recommend the approach.

Agreement: The HCP HCs and PRCC HSC agreed to evaluate female carcass distribution data at the historic reach scale for comparison to past results, and also allow analysts to report distributions at a scale that is appropriate for each location and stock.

Kirk Truscott said this discussion pertains to longitudinal trends [along the river channel] but there could also be an interest in analyzing the data across the channel. Hillman agreed and said that probably pertains more to redd distribution and less to female carcass distribution. Survey crews are not assigning redds to a specific origin of fish.

B. Improvement Feasibility at Eastbank Hatchery for Wenatchee Summer Chinook Salmon SOA

Catherine Willard said that in 2016 the Rocky Reach/Rock Island HCP HCs approved a statement of agreement (SOA) to include chilled, partial water reuse at Eastbank Hatchery to help with rearing fish and to meet Wenatchee River Total Maximum Daily Load (TMDL) requirements for phosphorous discharge limits, specifically from hatchery production at Dryden Acclimation Pond adjacent to the Wenatchee River. Ian Adams presented information from the SOA and process that has led to a different approach for meeting the TMDL requirements for the Dryden Acclimation Pond.

Ian Adams gave the presentation entitled, "*Chelan County PUD Dryden TMDL Compliance*" (Attachment C).

Slide 2: The 2016 SOA indicated that phosphorous discharge limits from Dryden Pond would be met by rearing Wenatchee summer Chinook salmon to a smaller size. The SOA states, "This would be accomplished by constructing a new chilled partial water reuse system at Eastbank Hatchery utilizing circular ponds as a successfully demonstrated rearing practice prior to transfer to the Dryden Acclimation Pond for final spring acclimation."

Slides 3, 4: In 2012, after receiving an addendum to the TMDL from the Washington State Department of Ecology (Ecology), Chelan PUD took five preliminary actions to attempt to address phosphorous discharge from Dryden Pond. The final SOA moved forward with investigating feasibility of chilled partial reuse system at Eastbank Hatchery in order to grow smaller fish that would release fewer pollutants.

Slide 6: Secondary actions included modifying feeding practices, rearing Wenatchee summer Chinook salmon to a smaller size with existing infrastructure, and further negotiations with Ecology, in particular, regarding the background phosphorous levels in the Wenatchee River that exceeded thresholds for the TMDL [not including discharge from Dryden Pond].

Slide 7: Feeding methods were adjusted to hand-feeding rather than broadcast feeding with a mechanized blower system to avoid over-feeding. The fish were switched to a low-phosphorous feed (lowest levels commercially available). Adams said the low-phosphorus feed is difficult to acquire. Bill Gale said they have moved away from using this feed at Leavenworth National Fish Hatchery (LNFH) because of difficulty of acquiring the feed. Adams said they worked closely with staff at Eastbank Hatchery to reduce the size of fish during early incubation prior to transfer to Dryden Pond (previous target was 10 fish per pound, now 18 fish per pound; the hatchery typically achieves 16 fish per pound). Phosphorous discharge over years from 2012 to 2019 was shown. Feeding, early growth, and stocking methods were adjusted each year. Phosphorous levels have remained below TMDL thresholds over four consecutive years.

Slides 8,9: Adams said new Ecology staff have helped Chelan PUD to clarify the terms of their TMDL and to edit the terms of the TMDL so they are more easily interpreted. Ecology also allows for the dismissal of background phosphorous content from Dryden discharge samples.

Slides 10, 11: Some additional benefits were observed by reducing flow through the Dryden Pond per guidance from WDFW fish health on industry standards for flow indices. Water quality auto samplers were installed at Dryden Pond intake and outflow. Data are sent to Ecology once monthly during “Critical Season” months (March and April) as defined by Ecology.

Kirk Truscott asked whether the existing circular reuse at Eastbank was instrumental in adjusting fish size prior to transfer. Adams said that was not the biggest effect. The bigger effect was better management of fish reared in raceways. Only about 20% of the fish are in the circular ponds.

Gale asked whether the conversation with Ecology was difficult regarding removal of background phosphorous levels from the baseline. Adams said the conversation was difficult in the past but was more productive in recent years. Gale said LNFH will have to consult with the U.S. Environmental Protection Agency for a similar Clean Water Act Section 404 permit. Gale said there is a similar problem in Icicle Creek for LNFH, but the data that are the bases for the TMDL are out of date and he is interested in determining whether Ecology will be renewing the TMDL using more recent data.

Peter Graf said one of the other problems with the criteria that were provided for Dryden Pond is that the phosphorous load is spiky and there was no temporal element to the criteria provided in 2012.

Truscott asked how reducing flows through Dryden Pond helped to meet the TMDL; one would think the contrary would be true due to more dilution by higher flows. Adams said the change in phosphorous load allocation with flow is not linear. Phosphorous load criteria values are higher per CFS at lower flows than they are with increased flow values (shown in Slide 7). Adams said the criteria are limits for total discharge per day, so lower flows reduced total daily discharge and the phosphorous with it.

Adams said in the one year that flow had been dropped in half, the fish health issues that had occurred for several years were not exhibited. Mike Tonseth said when the flows were higher, it caused fish to move to the side of the pond and resulted in higher densities around the edge of the pond. Tracy Hillman said there are terms for this: "ecological density" versus "crude density." Truscott suggested that perhaps fewer mortalities and decaying fish may have reduced phosphorous discharge too.

Gale asked if Ecology provided options for how water quality is sampled. Adams said the options were to manually take two grab samples once per week during a normal work day and composite them, or to take hourly samples over 24-hours for one day each week and composite them. Gale said that is similar to sampling at LNFH.

Hillman thanked Adams for his presentation.

Hillman concluded the discussion by stating that because Chelan PUD is meeting their TMDL, the 2016 SOA on Improvement Feasibility at Eastbank Hatchery for Wenatchee Summer Chinook salmon is not needed.

C. Establishing ranges around broodstock collection targets

Greg Mackey said in 2013 he gave a presentation showing a modeling approach for determining the number of broodstock adults that would be required to meet juvenile production targets for the upcoming year. Mackey said modeling was originally done in Excel using PopTools but became hard to manage in Excel, so he rewrote the model code in R. Mackey said he then ran a number of scenarios through the model.

Mackey gave a presentation entitled, "*Managing Risk and Expectations in Broodstock Collection*" (Attachment D).

Slides 2, 3: Mackey showed the basic broodstock calculation: multiply the number of adult females desirable by a number of factors (e.g., pre-spawn survival, fecundity) to determine number of smolts produced. One can test iterations with different numbers of females to achieve the number of smolts desired. However, each of those factors in the equation has a mean and associated variance that were calculated from annual data sets.

Slide 5: When using a random draw from the distribution of each factor, it is unlikely a given value will be the mean of the distribution. If variances are large, choosing an individual value farther away from the mean is more likely.

Slide 6: Mackey calculated the percentage for how often a parameter would fall +/- 10% outside the mean for each factor.

Slides 7,8: Histograms depict the distributions of the various factors. One approach is to choose the number of females that might work, or alternatively one can ask the model to identify a number of females. One would choose the number of model iterations that would be run to determine an ideal number of females.

Slide 9: Running model iterations allows one to test allowable critical values for the number of females necessary and estimate the probability of achieving the target number of smolts while staying below 110% of the target.

Slide 10: Effect of population size. At very low program sizes the number of females needed to create an overage can be very small (e.g., if only 13 females are required, one additional could create an overage).

Slide 11: Data inputs. A database could be maintained for factors like survival and fecundity, then R can calculate statistics from the data.

Slide 12: Data distributions for factors considered for yearling summer Chinook salmon.

Slides 13–16: Results. Figure shows number of females (x) by probability of meeting a target (y), along with probability of exceeding 100% permitted production. The ideal result would maximize probability of meeting the program target and minimize probability of creating a surplus. The curve shows optimum number of females for meeting program size without exceeding permitted program size (producing a surplus number of juveniles). One use would be to apply the model and look back at whether the calculations of factors, such as fecundity, were accurate. This information could also be given to managers to identify targets for meeting program size or used to identify a range of numbers to give managers some flexibility in number of fish collected.

Gale asked if Bacterial Kidney Disease (BKD) culling was included in the data. Mackey said it is part of the model but was not used for this simulation. Mackey said you could include the percentage collected assuming culling would occur.

Slides 17–19: Key Concepts. PUD programs do not want to routinely fall below targets and fail to meet mitigation obligations; however, going over targets poses problems like collecting too many wild adults for broodstock or needing to find a home for surplus juvenile fish.

Mackey concluded by saying he would like to start using this model in the 2020 BCPs to identify target numbers.

Willard asked whether the optimal numbers identified by the model matched the current targets in the BCPs. Mackey said some of the data for various factors he used from monitoring reports was slightly different than what was in the BCPs. Tonseth said in recent years a geometric mean has been reported rather than arithmetic mean to de-emphasize the extreme high and low values. Tonseth said sometimes different pre-spawn mortality values are reported for males and females of hatchery-origin and natural-origin fish. Mackey said this year is a good example of a case for spring and summer Chinook salmon when fish were quite a bit bigger with higher fecundities than what was assumed in the BCP. Tonseth said in some programs (e.g., steelhead), fecundity has been highly variable and problematic to predict. For instance, within one age class, fish would come back at the same length but different body condition; perhaps there is a different metric that could be collected like fish girth behind the pectoral fin to associate with fecundity that would be a more predictive metric of fecundity than length (measured as post-orbital to hypural length). Tonseth said when fecundity is that much higher, it does not take many females to create an overage of thousands of eggs. WDFW does not want overages, which are especially problematic for listed fish.

Todd Pearsons asked whether the 10% overage limit is an annual target or rolling target and whether it is captured in agreements. Tonseth said that is an annual target and is written into the permit language. The 90% minimum to meet the mitigation credit has been the PUD's obligation. Pearsons said a 5-year rolling average is used to report PNI. Is the 90% target a rolling average or an individual year? Gale said it is an individual year but is not specifically worded in other agreements like *US v. Oregon*. The conversation has always assumed that 10% below targets is always a trigger for regulatory actions. Gale said the other way this is evaluated is a total adult production (TAP) goal; no range is offered, but TAP reported on an annual basis would likely be aggregated over 5 years because of variability due to ocean conditions. Pearsons said the target number of juvenile releases is really a sensitive metric and it is hard to hit the target, so a rolling average over 5 years, for instance, may be a more appropriate way to evaluate whether targets have been met.

Truscott said there are also cases where targets are not met because of production issues that affect only 1 year. If the method Mackey proposes is used and something happened during production, then the method might be in question. Truscott acknowledged the range provided for meeting program levels offers some flexibility.

Tonseth said the approach he uses is a back-calculation from target number of smolts to the number of adult females needed for the broodstock. Mackey said conceptually it is the same math, just running the calculations in reverse compared to the method presented today. Tonseth suggested going through the conventional approach and the approach developed by Mackey, and then comparing the outputs.

Hillman said the challenge is to provide a single target to the fish culturists. Tonseth said in-season monitoring of the return will be evaluated to determine if the target should change. Steelhead are the most variable. Gale said the strength of Mackey's method is allowing managers to see what variable is driving the selection of number of females, and the factors input into the model could be targeted based on what is known about a given run, like BKD load; a value slightly higher than the mean could be selected for that factor. Pearsons asked Tonseth if the latitude should be given to the fish culturists ahead of the season or should changes be made in-season by the Committees. Tonseth said M&E specialists are sampling the fish for length and fecundity in season and can recommend adjustments in season. Tonseth said if the change was large, he would advise bringing the decision for discussion in the Committees. Mackey confirmed that the original goal was to provide a range of acceptable targets in the BCP; Tonseth said the State would hesitate to give the fish culturists that flexibility because they will choose the maximum every time. Mackey confirmed that a very small spring Chinook salmon program should not be over-collected, but for larger summer Chinook salmon programs, they could notify the Committees that extra fish are being retained. Tonseth said he would rather see fish culturists subsample some individuals to confirm assumptions about the factors that greatly affect production before collecting more fish in excess of target numbers.

Hillman asked what the next steps for this topic should be. Mackey said he would like to work with Tonseth to test the method further and prepare a white paper for use across the programs. Mackey said he would like to try it for the Douglas PUD programs. Tonseth said he would like to couple the method with a proposal for one of the programs in the 2020 BCPs.

Hillman thanked Mackey for his presentation.

D. Surplus Juvenile Production

Tracy Hillman provided background on the topic, which Douglas PUD originally distributed an email on September 20, 2019, regarding out-planting surplus juvenile steelhead to a non-anadromous lake. The surplus juveniles were offspring of hatchery-by-hatchery crosses from the Methow Safety Net (MSN) and Columbia Safety Net (CSN) programs.

Keely Murdoch reiterated concerns she had originally expressed via email that although the Yakama Nation (YN) approved the anticipated methods for distribution of surplus juveniles listed in the BCP, there was no chance to discuss this particular decision in the Committees, and a decision was made rather quickly. Murdoch said the release of surplus juvenile salmon and steelhead to non-anadromous waters should be a very last resort. Murdoch said she would have liked to find a different program to accept these fish and an adequate discussion for the potential for release of the fish to the Columbia River. Murdoch said there is an irony that the Committees are comfortable releasing an extra 500,000 to 1 million subyearling summer Chinook salmon to the Columbia River for orca but no discussion was had for releasing 50,000 juvenile steelhead. Murdoch said she was unclear why this was such a rush. There is an advantage to holding fish longer to ensure that nothing unexpected happens during rearing that reduces numbers such that program targets for release numbers are not met. Murdoch said she feels those conversations could have been had in the Committees. Hillman acknowledged that that topic was not brought to the Committees for discussion in the last meeting.

Brett Farman clarified that for NMFS the willingness and the desire to release additional juveniles are not interchangeable positions. NMFS would prefer not to reconsult on the permits that were very recently finalized if they do not need to. Farman said, for the surplus steelhead, this was a discussion of a listed stock, whereas for increasing summer Chinook salmon numbers, we are talking about a non-listed stock. Farman said he does not support releasing fish in areas where they were not intended to be either; however, he is constrained by the Biological Opinion on the hatchery programs that identifies different effects of releasing fish in anadromous waters. Murdoch agrees that she also is not necessarily interested in re-opening consultation. However, for example, when unintended mortalities occasionally happen that exceed the "take" provided in the Biological Opinion, typically a letter is written to NMFS that safeguards will be put in place and other reasons such a loss will not happen in the future and the programs move on. Murdoch asked whether the release of surplus juveniles to anadromous waters could be handled in a similar manner.

Farman said he sees this differently, that the first case describes incidents that are not predictable, and in the second case the "unforeseen overage" is not really unforeseen; 110% of program size is intended to be the upper limit to an overage, but over time it can end up becoming the target. Murdoch said she disagrees that in this case 110% of program size was used as the target. There are many factors with ranges around the normal results that make it difficult to predict exactly the number that will be produced. Murdoch said this surplus resulted from things that happened that were outside managers' control.

Mike Tonseth said this surplus resulted from protocols used for the 2018 broodstock. Tonseth reminded members that the Committees approved a BCP in 2018, which affects the 2019 broodstock, that identified a steelhead overage to be collected in the fall as backup, in addition to the target number of adults to be collected to support safety-net programs. Tonseth said it was identified for all members that fall collections of steelhead would always result in a surplus. Murdoch said if that is the case, additional broodstock should not be collected in the spring to limit surplus. Tonseth said the CCT want to prioritize the spring collection for Okanogan River releases because the

MSN and WNFH adult returns cannot be sorted out at Wells Dam, and those destined for the Okanogan River can only be collected/identified in the spring. Tonseth said the 2020 broodyear (described in 2019 BCPs) should be the last broodyear with an acknowledged surplus prior to spawning. Tonseth said those mechanisms are in place, developed by WDFW, for dealing with that overage, which is why the Hatchery Production Management Plan (Appendix G of the BCPs) was written with a very specific pathway for addressing the overages. Tonseth said the reason for backup collections in the fall was because of the uncertainty of the spring collections with the understanding that there would be surplus juveniles.

Bill Gale said it is important to note the surplus juveniles were the product of hatchery-origin adults; there are no fewer natural-origin fish on the spawning ground as a result of out-planting to non-anadromous waters. Gale said progeny from excess adult fish that would be collected at Wells Hatchery (surplused at Wells Hatchery) would not have been encouraged to move into the Methow or Okanogan rivers anyway.

Murdoch said it is not a responsible way to deal with overages every year and is glad the changes are being made in the BCP.

Kirk Truscott noted that incremental reductions have been made in the overage each year. Gale said, given low numbers being observed passing over Bonneville Dam so far this year, this could be the year that we wish we would have collected an overage. Tonseth said counts at Priest Rapids Dam (PRD) indicate they will meet their targets.

Tonseth said in the future, if these are discussions that should happen in Committees, Appendix G should be revised, which was intended to allow the process to carry forward without requiring Committee discussion or approval each time. Murdoch said she does support a change to that aspect of the protocol.

Gale asked if there are non-anadromous waters on tribal lands. Tonseth and Truscott confirmed that they did follow through with that but did not find a suitable option before releasing these surplus steelhead.

Tonseth asked Farman whether NMFS could still permit the release of surplus fish that are the result of unexpected overages from in-hatchery effects that are not under the control of the managers, i.e., is it still in the spirit of the permit to release those fish? Murdoch agreed that it is an annual target, but to be under the target in some years and over in some years represents the normal functioning of operations.

Farman said the release of surplus juveniles is problematic because it affects the estimation of “take” in terms of endangered species risk. Farman said programs could come up with a maximum release number with boundaries around that; however, a shift in that number would require re-consulting with NMFS on the number of adults taken for brood. Farman said he was initially a proponent of considering the target release number as an average, for instance over 5 years, to allow for the over- or under-production that occurs due to operations each year. However, the problem with this approach is if there are 3 to 4 years in the 110% range, the operator would be required to produce below mitigation targets to adjust the average downward; that is the origin for developing 110% as an annual limit.

Tonseth supports continuing the improvements on front-end predictions so there are fewer problems on the back-end of production.

Hillman suggested in the future we need to ensure Committee members are aware of surpluses and allow a discussion to be had in Committee meetings.

Tonseth noted that the BCP states the surplus needs to be dealt with at the earliest possible life stage to avoid impacts to densities and other production issues. The discussion needs to be timely and cannot languish for months.

Gale said that regarding Methow steelhead, it should be recognized that use of the term "collection goal" is misleading. The goal refers to the number of natural-origin females spawned; however, the program will over-collect hatchery-origin fish to meet broodstock needs, which is different from some of the other programs. Tonseth agreed that females should be the primary target in the BCPs.

Spring Chinook Surplus

Greg Mackey said the MFH has approximately 8,000 extra spring Chinook salmon eyed-eggs. Mackey said fecundity was high among the 2019 broodstock and reducing the program by 8,000 eyed-eggs will bring the program size to 110% of the target number of juveniles. Mackey said these are the progeny of hatchery-origin female eggs crossed with wild males and that the same wild males were crossed with other fish in production, so those genes would not be lost. Mackey said he inquired if WNFH would accept the surplus eggs but Chris Pasley (U.S. Fish and Wildlife Service [USFWS]) said they are already at target production numbers.

Mackey asked Truscott if they could be used for CCT's 10(j) program at Chief Joseph Hatchery (CJH) as described in step 3 of the Surplus Upper Columbia Juvenile Spring Chinook Management, Methow Sub-basin section of Appendix G of the BCPs. Truscott said he is uncertain whether their permit allows MFH fish to be used for the 10(j) program. The permit stipulates that WNFH fish will be used for the 10(j) program. Murdoch suggested moving 8,000 eyed-eggs from WNFH to the 10(j) program and moving the MFH surplus to WNFH.

Truscott said CJH could accommodate 8,000 extra eyed-eggs but they would have to be at the same developmental stage (measured in temperature units) as the eggs that are currently incubating at CJH. Mackey said one female's eggs will hatch this week and the other two batches will hatch next week. Tonseth said, from WDFW's perspective, destroying eggs is preferable. Once the eggs hatch, they cannot be destroyed and have to be released.

Gale asked how many have already been transferred to the 10(j) program. Truscott said the target of approximately 240,000 has been met, so the proposal to transfer more is problematic. Tonseth said that WNFW can destroy a requisite number of eyed-eggs to accept more from the other program. Gale said WNFW has taken on more coho salmon and is probably at maximum production for steelhead and may not have the capacity to take more eyed-eggs. Gale said he needs to talk to Pasley about whether there is capacity and whether their eggs have hatched yet.

Truscott asked Farman whether receiving eyed-eggs directly from MFH is acceptable, knowing that this is a shift in the terms of the permit. Truscott said currently there are spring Chinook salmon on station at CJH and asked if there are any restrictions to CJH taking 8,000 more than they are permitted to rear. Truscott said CJH will take the eggs if allowable by NMFS.

Farman said he would like to talk to Charlene Hurst about whether the issue of CJH receiving eyed-eggs for the 10(j) program directly from MFH is consistent with the intent of the permit. Mackey said this needs to occur within the next day, prior to fish hatching. Farman asked if there was a written proposal for these steps. Tonseth suggested referring to step number 3 of the Surplus Upper Columbia Juvenile Spring Chinook Management, Methow Sub-basin section Appendix G of the BCPs.

Farman asked what the margins of error are for the egg count. Murdoch said there are a lot of things that can happen between hatch and release. Tonseth said the number of eggs collected has been adjusted for those factors.

Gale said he will call Pasley to confirm whether WNFH can take the excess eyed-eggs. Gale said to do so would affect the PNI results of the 3-population model.

E. Broodstock Collection Protocols Assignments

Tracy Hillman projected the table of assignments for development of content for the 2020 BCPs and reviewed the tasks and timing of necessary discussions.

Bill Gale asked what the timeline is for reviewing contributions and agreeing to what will be written in the BCPs. Hillman said assignments should be completed during the November meeting. Authors will then commence drafting sections of the BCPs. Members will review draft sections during December, January, and February.

Greg Mackey agreed to prepare alternative spawning recommendations for the November meeting, including testing new methods in certain programs. Gale suggested testing the use of the alternative broodstock methods in the Methow spring Chinook salmon program first. Mike Tonseth said there may not be enough spread in ages because spring Chinook salmon tend to return largely at the same age. Tonseth suggested the Carlton program (Methow/Okanogan summer Chinook salmon raised at Carlton Acclimation Pond) for testing the methods with a multiple age-class mix. Mackey said Douglas PUD is interested in trying the method with the Wells summer Chinook salmon, also.

Kirk Truscott asked how the broodstock would be collected. Mackey said broodstock are collected in the usual way, i.e., take healthy fish and attempt to match larger males with smaller females. Mackey said the selection for larger males is not made during collection. Gale said because there is no way to test the success of the method, he suggests trying it with any stock to test the feasibility of implementation, but not necessarily to test for biological effects. Tonseth said the way the implementation would work is that the largest males would be selected when they are ripe and smaller males may be selected just because they are ripe on the given day. Mackey agreed that feasibility of the implementation should be tested.

Mackey agreed that it is probably not possible to test the biological effects and it should be implemented on faith that it is the best method for the resource. Tonseth noted that the literature suggests this could be a best management practice. Gale reminded members that the Hankin method was modeled but has not yet been implemented.[1] Todd Pearsons asked if the test is to look for an increase in age at maturity. Gale said the decision is to use best management practices.

Hillman said the most recent edition of Tom Quinn's 2018 salmon ecology book[2] focuses on four primary reasons for change in age at maturity and references the original work by Ricker, which discusses the balance between selecting for earlier maturation versus forcing fish to spend another year in the ocean and subjecting them to another year of harvest. Gale said he supports using the knowledge of what fish do in nature to improve hatchery spawning practices and that perhaps the outcomes will not be to produce all older fish but broaden the age distribution, which may also benefit the stock.

Hillman summarized the BCP discussion tasks and asked if there were other topics that should be discussed next month to avoid conflicts later.

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[1] Hankin, D. G., J. Fitzgibbons, and Y. Chen, 2009. "Unnatural Random Mating Policies Select for Younger Age at Maturity in Hatchery Chinook Salmon (Oncorhynchus Tshawytscha) Populations." *Canadian Journal of Fisheries and Aquatic Sciences* 66(9):1505–1521.

[2] Quinn, T. P., 2018. *The Behavior and Ecology of Pacific Salmon and Trout, Second Edition*. University of Washington Press, Seattle, WA and American Fisheries Society, Bethesda, Maryland.

Tonseth said parts of the BCP could be reviewed early. Tonseth suggested that appendices be distributed for various authors to work on prior to review of the complete plan in February. Suggested co-authors and notes on production status for each appendix are summarized in Table 1.

Table 1
2020 Broodstock Collection Protocols Assignments

Appendix	Title	Assigned Parties	Notes
A	2019 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2020 BY Summer Steelhead Hatchery Programs	WDFW and PUDs	
B	Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations	All	
C	Return Year Adult Management Plans	WDFW lead	Contingent on run forecast available in Jan/Feb 2020
D	Site Specific Trapping Operation Plans	PUDs and M&E staff YN to review	Identify plans and ensure they are still accurate
E	Columbia River TAC Forecast	WDFW	Forecast available in late Dec 2019/early Jan 2020
F	Annual Chelan, Douglas, and Grant County PUD M&E Implementation Plans	PUDs	Provide links
G	DRAFT Hatchery Production Management Plan	All	
H	DRAFT Preferred Alternative for 2020 BY and Beyond, Methow Sub-basin Conservation Steelhead Programs	Revisit after completion of 2019/2020 steelhead return	Pending discussion by Joint Fisheries Parties; concern about acquiring broodstock in the spring
I	Program Specific Rearing and Release Descriptions	PUDs and M&E staff	Staged release at PRH to be addressed
J	2019 BY Spring and Summer Chinook Disease Management Plans	CPUD M&E staff and WDFW veterinarian (Megan Finley)	

K	2019 YN Coho Broodstock Collection Plans	YN	
General	Species-Specific Run Forecasts	WDFW	

Tonseth will break out the appendices and send those to Larissa Rohrbach for distribution. Tonseth requested that all edits be submitted to him by the December meeting and for members to identify any additional issues that require further discussion during the December meeting. Tonseth said some topics will require waiting until completed returns are observed in October.

F. National Marine Fisheries Service Consultation Update

Brett Farman said there is no new update from last month. Representatives from the PUDs confirmed that the recently finalized permits have been signed or have been submitted within the PUDs for signature.

Tracy Hillman asked what the next steps are. Mike Tonseth said the next permit is the Wenatchee Spring Chinook permit, which is due in 2026. Truscott said it depends on the results of the next 5-year status review (due in 2021). Hillman asked members to identify when discussions should start on developing the Hatchery and Genetic Management Plans. Tonseth said recalculation will occur in 2023. Farman suggested starting discussions in 2023.

III. PRCC HSC

A. Approve the September 18, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the September 18, 2019 meeting minutes as revised.

Brett Farman said he will not be able to attend the November meeting and so would send along his updates via email, or inquire whether his alternate, Charlene Hurst, could attend.

B. Recap Wenatchee Spring Chinook Salmon Life-Cycle Model and Next Steps for White River

Tracy Hillman said the presentation by Jeff Jorgensen to the PRCC was similar to a presentation to the Regional Technical Team (RTT), with some updates and specificity for the hatchery programs. PRCC Facilitatory Denny Rohr told Hillman that the PRCC is still working to determine the next steps for the HSC.

Keely Murdoch stated that the PRCC has not yet met this month. Murdoch summarized the overall problem for the PRCC HSC, that, in her opinion, the Lake Wenatchee survival proposal that was submitted by WDFW was missing a step to collect data that could feed into the life-cycle model (LCM), and what was missing was identification of the questions the LCM would be asked to answer. Murdoch said the PRCC was stuck on whether to issue an RFP for additional data collection because members could not decide what data should be collected. Murdoch said she hopes the path forward is the PRCC can come up with a list of questions they would like the LCM to address. Jorgensen can then confirm what additional data are needed to fill these data gaps, and the PRCC could move forward with a proposal.

Todd Pearsons was thinking that Jorgensen would try to answer the questions that were prepared by the PRCC HSC, but time ran out and the majority of them were not addressed. Murdoch said she thought many of them were addressed in the presentation. Pearsons noted that there will be three talks about the topics in question at the upcoming Upper Columbia Science Conference that may inform this process: a talk by Matt Polacek (WDFW) on predator assemblage in Lake Wenatchee, one by Carlos Polivka (USFWS) on effects of non-lethal predation risk in Lake Wenatchee, and one by David Beachamp (University of Washington) on rearing and foraging behavior using stable isotope analysis in Lake Wenatchee. In addition, Dan Rawding is presenting an Upper Columbia spring Chinook salmon life-cycle survival model using passive integrated transponder (PIT) tags. Jorgenson referred to this other model during his presentation. Pearsons said it looks like there is a fair amount of work that is ongoing or has already been done in Lake Wenatchee.

Mike Tonseth said WDFW's predator assemblage analysis was done as part of the original Lake Wenatchee study proposal and is a replication of Thompson and Tufts' work done in the 1960s to confirm which predators are eating which prey.

Hillman summarized that the HSC will wait for direction from the PRCC per feedback from Rohr.

IV. Administration

A. Next Meetings

Larissa Rohrbach reminded the HCP HCs that Douglas PUD's 2018 M&E Report is currently available for a 60-day review, with comments due to Greg Mackey by November 15, 2019.

Todd Pearsons asked whether the group had decided that annual reports should be limited to a 30-day review to streamline the review periods. PUDs intended to spread the reviews over the year. Kirk Truscott said that he generally does not need the 60-day review but sometimes needs the 60-day period to find time to work on it. Bill Gale said 60 days is useful so other staff can review. Tracy Hillman reviewed protocols and confirmed that it states at least 30 days unless decided otherwise. Gale said his preference is that if 60 days can be given then to do so. Mike Tonseth said implementation plans were already shifted to accommodate contracting. Pearsons said he will be sending the PRH report soon so there will be some overlap in the review period with the Methow program report.

The next HCP-HCs and PRCC HSC meetings are November 20, 2019, December 18, 2019, and January 15, 2020, at Grant PUD in Wenatchee, Washington.

V. List of Attachments

Attachment A	List of Attendees
Attachment B	"Review of Hatchery Broodstock and Mating Practices for Conservation Programs"
Attachment C	*Chelan County PUD Dryden TMDL Compliance*
Attachment D	*Managing Risk and Expectations in Broodstock Collection*

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Ian Adams	Chelan PUD
Catherine Willard*	Chelan PUD
Kirk Truscott*‡	Colville Confederated Tribes
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Peter Graf‡	Grant PUD
Todd Pearsons‡	Grant PUD
Brett Farman*‡°	National Marine Fisheries Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Alf Haukenes	Washington Department of Fish and Wildlife
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

Review of Hatchery Broodstock and Mating Practices for Conservation Programs

Greg Mackey

Douglas PUD

October 14, 2019

Introduction

The Upper Columbia includes several conservation hatchery programs for spring Chinook and summer steelhead in the Wenatchee and Methow basins. The premise of a conservation hatchery program is to rebuild depleted stocks while conserving genetic diversity and minimizing negative ecological and genetic impacts on wild populations (Fisch et al. 2014). Inevitably, hatcheries induce artificial selection on the fish held and reared within (Christie et al, 2012; Neff et al. 2011). To counter artificial selection, conservation hatchery operations are typically designed to induce as little artificial selection as possible. The extent to which this is implemented and is successful is clearly debatable and likely varies widely across species, programs, and hatchery practices at different facilities (see Auld et al. 2019; Fraser 2008). Artificial rearing emancipates fish from natural selection while in the hatchery setting, which may reduce their fitness in the wild. While this review of mating strategies is broad in nature, the particulars focus on Methow basin spring Chinook, but the principles can be applied to other conservation hatchery programs.

Background

Selection of broodstock is the first opportunity where artificial selection may affect fish in the hatchery setting. The age of the fish, with size as a proxy, have been commonly used to choose which fish are retained and mated in the hatchery, with particular focus on incorporation rates of jacks. The age-3 proportion of returning adults for the Methow basin spring Chinook population has averaged 0.0729 from 2006 through 2018 (Figure 1). This proportion may be used to inform the rate at which age-3 males could be incorporated into broodstock (e.g., use 7% age 3 males in broodstock), while the proportion used in spawning may be further modified by an estimate of their reproductive success in the wild relative to larger males (Olson et al. 2004). For example, Berejekian et al. (2010) estimated that Chinook salmon jacks sired 20% of the offspring in a controlled study where the number of males was held constant and Schroder et al. (2012) found jacks sired 3% of the offspring in a similar study. Thus, using the 20% figure, for example, could result in a program where:

$$7\% * 20\% = 1.4\% \text{ age 3 male contribution rate in hatchery program}$$

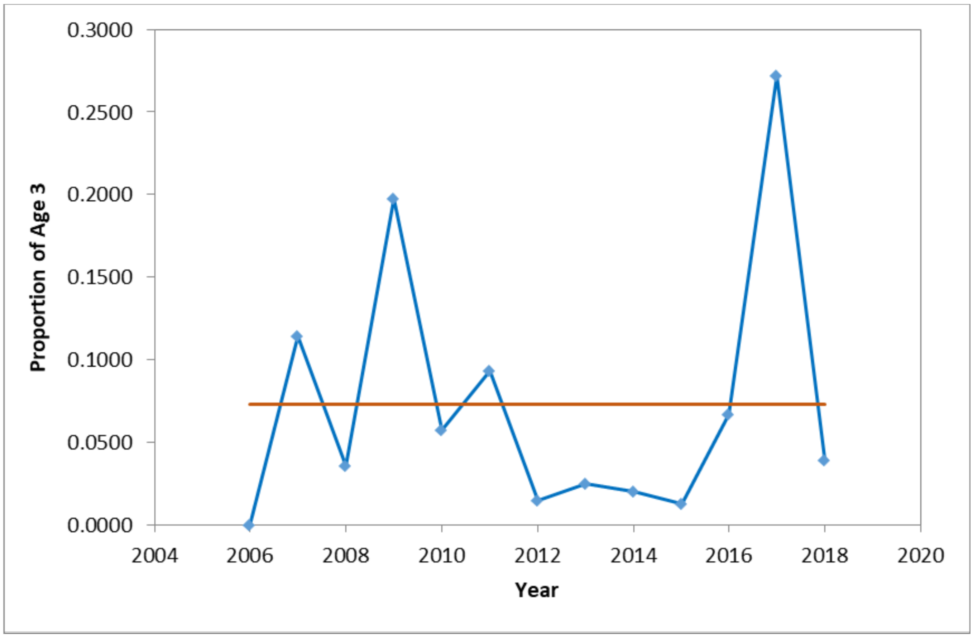

Figure 1. Proportion of Age 3 spring Chinook sampled at Wells Dam (mean = 0.0729, orange line)

Fisheries can select for younger age at maturity and such selection can be exacerbated by hatchery propagation due to increased harvest rates on populations supplemented by hatchery programs, gear directed to capture older, larger fish, and mixed stock fisheries (Quinn 2005b; Hankin et al. 2009). This phenomenon may affect Methow spring Chinook, where losses of wild Methow basin spring Chinook as estimated from PIT tags between Bonneville Dam and McNary Dam have ranged from 0.00-0.40 for 2-ocean fish and 0.00-0.29 for 3-ocean fish, while 1-ocean fish are not harvested (Figure 2).

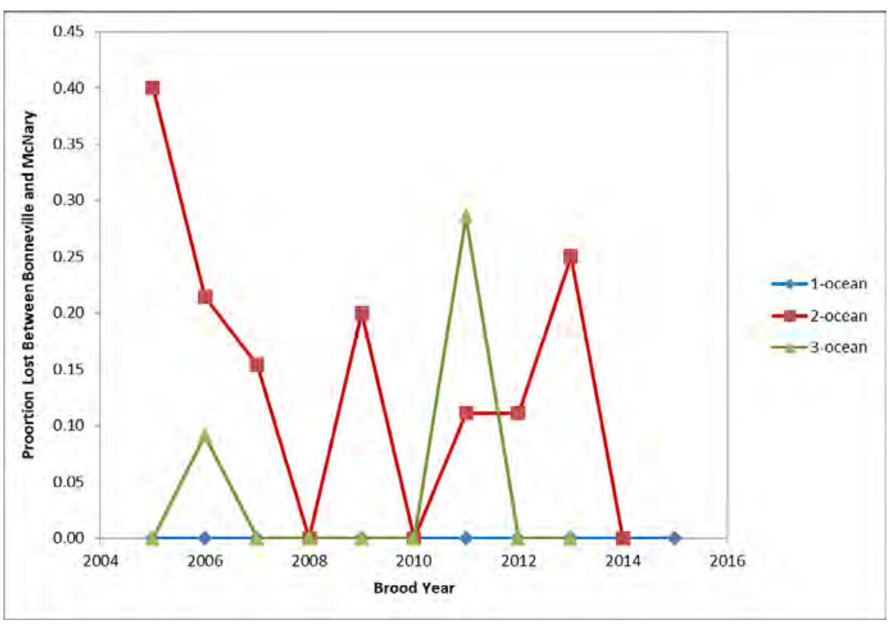

Figure 2. Losses of wild Methow basin spring Chinook between Bonneville Dam and McNary Dam by brood year

Mating systems of salmonids are extremely complex in nature, as exemplified by Seamons et al. (2004), where in a small steelhead population, matings ranged from monogamy to polygynandry networks consisting of up to 16 fish (Figure 3). Many potential parents had no offpspring detected: males = 43% and females = 23%. The point of this is that natural mating systems are complex and include multiple mating systems and extensive competition for mates and opportunity to fertilize eggs. Natural mating systems bear little resemblance to hatchery spawning protocols (Figure 4).

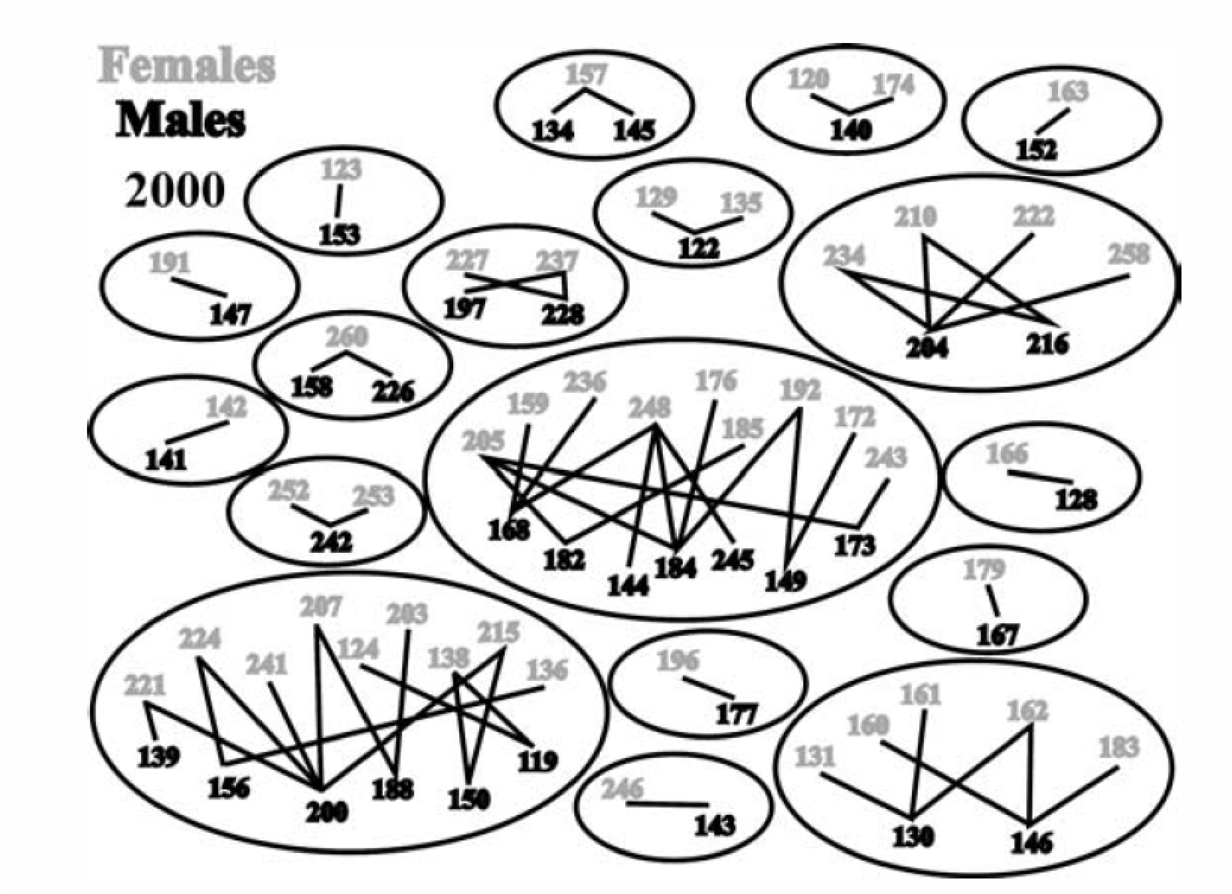

Figure 3. Inferred mating patterns of steelhead in Snow Creek from BY 2000. Each oval encompasses the individual parents (shown as identification numbers) in a mating group inferred from an extended half-sibling family of offspring. Lines connect males (solid black numbers) and females (gray numbers) with their inferred mate(s). Four types of mating were apparent: monogamy, polygyny, polyandry and polygynandry (from Seamons et al., 2004).

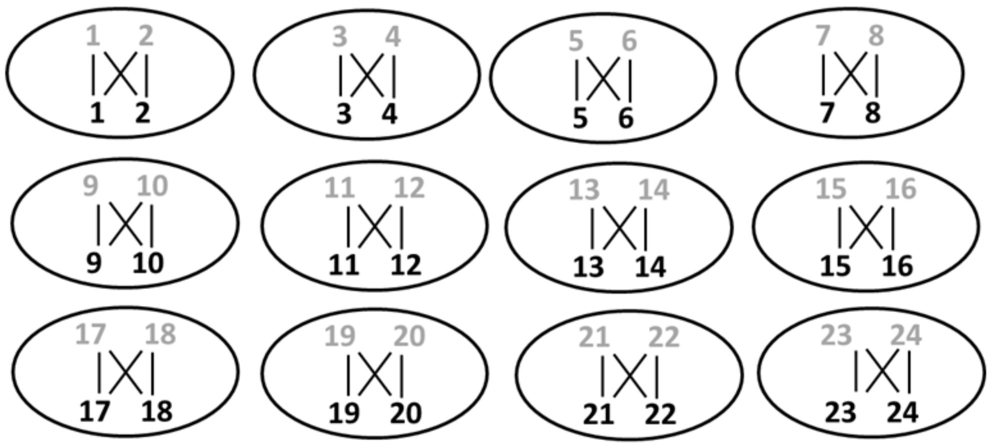

Figure 4. Typical 2x2 matrix mating pattern in a hatchery.

Population size, program size, and population history (e.g., bottlenecks) all may affect a supplemented population. However, the perception these factors may invoke does not necessarily predict the status of the population. The average homozygosity in the Methow Hatchery's Twisp Spring Chinook 2017 brood sample was lower than in any Spring/ Summer population samples in the Snake River baseline (Figure 5; Young et al., 2019). This suggests that despite obvious opportunity for genetic bottlenecks and a small hatchery program, to this point the integrated hatchery and wild populations are genetically robust compared to other similar populations. This analysis was originally performed to preliminarily explore the relatedness of parent in a group of juveniles displaying deformed caudal peduncle morphology. This result should be interpreted cautiously because it is from one sample of 50 deformed offspring from the Twisp River program. The analysis, preliminarily, did not suggest that the parentage of the deformed fish was from only a select group of parents, which might indicate a familial genetic link. Nevertheless, the homozygosity result is rather surprising.

Phenotype may provide further insight into the status of a population. The length of age 4 wild fish females appears to be constant over time, but fecundity may be declining. Wild and hatchery females at age 4 show no difference in fork length (Figure 6). Fecundity of Wells Hatchery Summer Chinook broodstock may also be declining (Figure 7). Declining fecundity in a wild population is of concern and there is little guidance as to how this may be countered, but see Hankin et al. 2009.

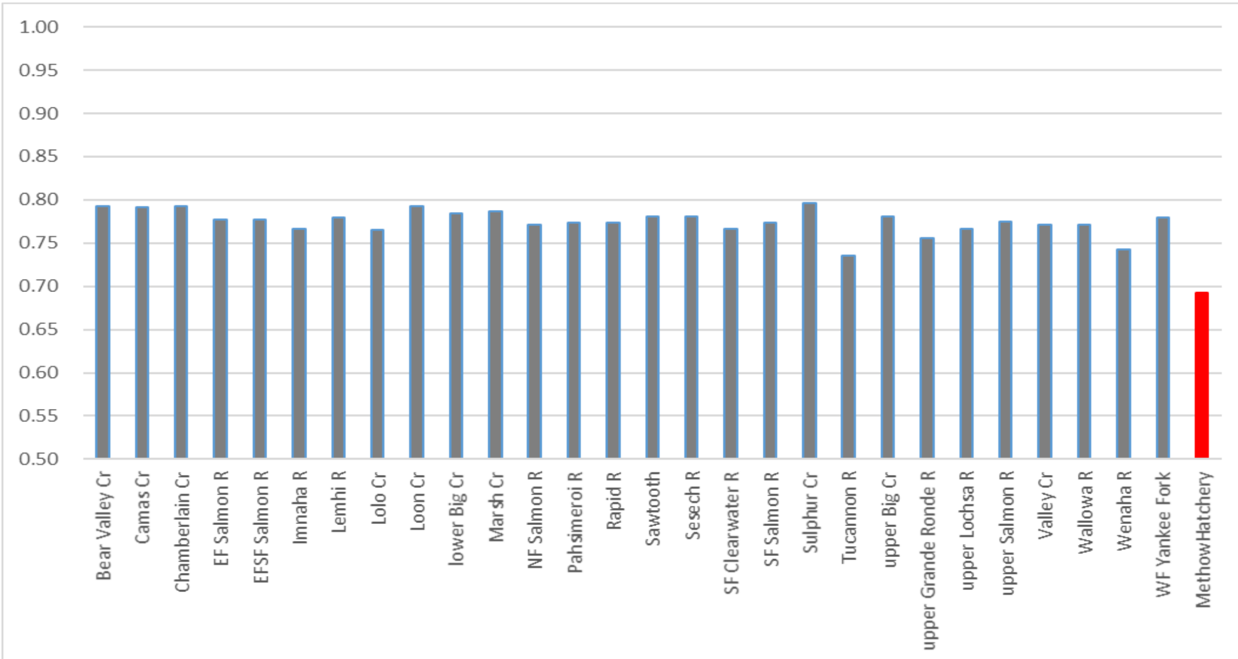

Figure 5. Average homozygosity of spring Chinook in the Snake River basin and Twisp River, Methow Basin (from Young et al., 2019).

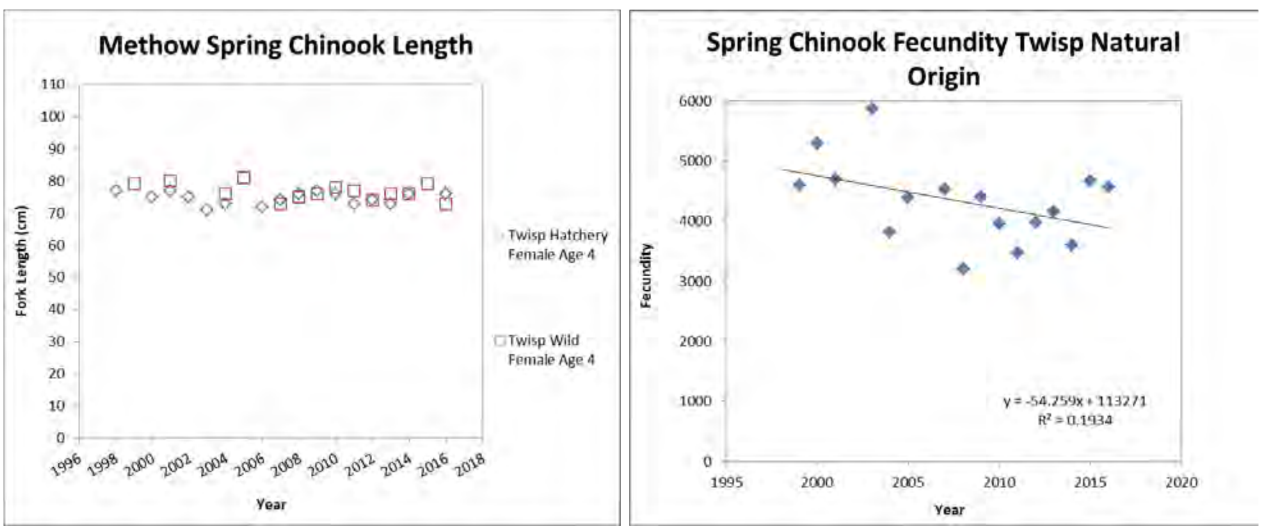

Figure 6. Mean annual fork length of hatchery and wild Twisp spring Chinook females (left) and fecundity of wild females (right).

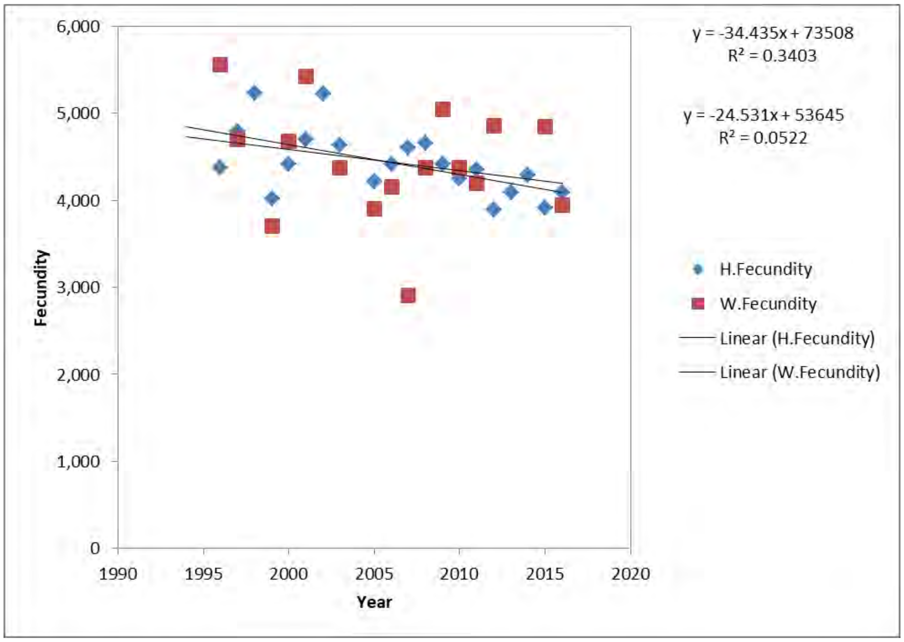

Figure 7. Mean annual fecundity of hatchery and wild female Summer Chinook at Wells Hatchery.

Strategies for Broodstock Management

Broodstock collection and spawning are the first steps in the sequence of hatchery program actions. The program specifications as to which fish to capture and retain for broodstock and how they are mated will have a profound effect on the resulting hatchery population, and this population will subsequently interact with the wild population. Therefore, it is important to operate the program in a manner to achieve the goals of the program. In general, there are two philosophies for managing broodstock and mating designs in conservation programs: 1) Attempting to minimize genetic divergence caused by the hatchery program by emulating and preserving the genetic diversity of the population (e.g., HSRG 2004; Campton 2004); and 2) Attempting to emulate the selective regime in the wild to preserve the fitness of the population and minimize effects of domestication (e.g., Hankin et al. 2009; Quinn 2005a). There are several aspects of broodstock collection, mating and spawning for which a variety of authors have recommended certain strategies:

Genetically Benign Approach:

1. Incorporation of sufficient numbers of natural-origin adults into the broodstock each year to overcome the potential effects of random genetic drift, domestication and divergent natural selection in the two environments.
2. Protocols for trapping and spawning adults such that the means and variances of phenotypic characters related to fitness (e.g., run timing) equal those of the parental natural population
3. Efforts made to minimize artificial selection and other domestication effects in the hatchery (behavioral, epigenetic, gene-environment interaction).
4. Broodstock collection

   a. Random selection of parents from the pool of available adults with respect to age, size, and other life history characteristics (Campton 2004; HSRG 2004)
      i. Jacks should be included (Campton 2004; HSRG 2004)
      ii. Cull to equalize family size to optimize effective population size (HSRG 2004)
5. Mating Scheme
   a. Spawn randomly with respect to age, size, and other life history characteristics

<u>Emulate Natural Processes Approach:</u>

1. Hankin (2009) – modeled spawning design to counter selection in the hatchery for younger age at maturity.
   a. Idea is to counter artificial selection in the hatchery for younger age at maturity (Larsen et al., 2019) and to help counter selection by fisheries for younger age at maturity.
   b. Attempts to emulate the spawning structure/mate choice that would occur in the wild to maintain fitness in the population.
   c. Note that Larsen et al. (2019) found that integrated hatchery program broodstock resulted in higher rate of early maturation (progeny of wild parent mature early compared to hatchery parents, even after one generation in the hatchery environment).
2. Quinn (2005a) – Breeding schemes where each adult is given equal opportunity to contribute to reproduction, and milt from two or more males is never mixed, does not remotely resemble natural mating systems.
   a. The key processes in hatcheries occur during broodstock collection and during mate choice and gamete collection.

<u>Other Aspects of Broodstock Management:</u>

1. Minimize kinship
      i. In captive breeding programs this is the best way to retain genetic diversity (Ivy and Lacy, 2012)
      ii. Our programs are not captive breeding programs, but these principles may still apply.
         1. Retrospective analysis of relatedness in programs is possible in some cases. This could help us identify if there are potential improvements or if the program is doing a good job of not performing matings of close relatives.
2. Mating Schemes
   a. Random Pairwise 1:1
      i. All adults have equal opportunity to reproduce
   b. Overlap Pairwise
      i. Backup male used
      ii. Sperm competition can still occur even 45 s after first fertilization.
   c. Pooled
      i. Sperm competition
      ii. Loss of control over mating scheme – not recommended by anyone.
   d. Pooled Matrix

        i. Multiple females' eggs mixed and separate into aliquots. Separate males fertilize each aliquot.
        ii. Greater potential for disease transmission
        iii. Cannot track family groups for disease management or performance analysis
    e. Nested
        i. For skewed sex ratio 1:2 or more
        ii. Recommendation is to collect more fish so the less abundant sex meets minimum broodstock needs and excess of the abundant sex are discarded.
    f. Factorial (Matrix) (Busack and Knudsen, 2007)
        i. 2x2, 3x3, 4x4 etc.
        ii. Maximizes number of family groups and genotypic diversity
        iii. Maximizes effective number of breeders in the hatchery

<u>Current Conditions – Methow Hatchery Programs:</u>

The Methow Hatchery currently follows these protocols for broodstock collection and mating:

1. Broodstock collection is (somewhat) random
    a. Brood is attempted to be collected across the entire run timing, but the realities of trapping a small population and to minimize the number of fish trapped and handled tend to front load the trapping to ensure enough brood are captured.
    b. Injured or sick fish may not be retained to improve the chances that the fish will survive to spawning in the hatchery.
    c. Jacks are not retained (except in 2019 the Broodstock Protocols included an exception to retain jacks if wild males were in short supply).
2. Mating follows a 2x2 matrix with males used as backup reciprocally.
    a. The programs are small and therefore, there are relatively few fish to spawn per week. This limits the range of possibilities for matrix spawning.
    b. Fish to be mated are chosen at random by staff, but it is likely they are not randomly chosen in terms of phenotypic traits (Mclean et al. 2005).
3. Culling
    a. Families are not culled to equalize family size.
    b. Culling may be performed to control BKD, but this has rarely been done in recent years. Instead, families are held in quarantine to see if clinical signs of disease manifest. If not, the fish are carried through to production.

<u>Possible Path Forward – Methow Hatchery Programs:</u>

The Methow Hatchery could make the following adjustments to the protocols for broodstock collection and mating:

1. Broodstock collection
    a. Brood collection to be random (to the best of our abilities).
    b. Jacks included in collection at a pre-determined rate; (e.g., up to 7%; see below).
2. Mating
    a. Continue to use factorial mating protocol with backup male

   i. Ensure enough time has passed between primary and backup fertilization to prevent sperm competition (>>45s).
   ii. Jacks to fertilize only a partial aliquot of each female mate's eggs (e.g., 7% of the females will have up to 20% of their eggs fertilized by jacks [results in about 1.4% of all eggs being fertilized by jacks]; to be determined)

b. To the extent possible, follow the protocol in Hankin et al. (2009) where larger males are preferentially mated with smaller females to select for older age at maturity to counteract effects of hatchery propagation and fisheries.

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Chelan County PUD
Dryden TMDL Compliance

Chelan County PUD

Rocky Reach and Rock Island HCPs
Hatchery Committees

October 16th, 2019

Rock Island and Rocky Reach HCP Hatchery Committees
Statement of Agreement
Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook
FINAL
(Chelan PUD, NMFS, USFWS, WDFW, YN, and CCT approved on February 17, 2016)

Statement

The Rock Island and Rocky Reach Habitat Conservation Plans' (HCP) Hatchery Committees (HC) agree that Chelan PUD will proceed with a feasibility for design of a chilled, partial water reuse aquaculture system at Eastbank Hatchery for Wenatchee summer Chinook, to enable Chelan PUD to meet phosphorus discharge limits under the Wenatchee River Total Maximum Daily Load (TMDL) for dissolved oxygen and pH.

Background

On March 7, 2012 the Washington Department of Ecology issued an *Addendum to the Wenatchee River Watershed Dissolved Oxygen and pH TMDL, WRIA 45.* This Addendum acknowledged that the Dryden Acclimation Pond was not assigned a waste load allocation when the initial TMDL was published in 2010 and sought to remedy the oversight. As such, the Dryden Acclimation Pond received a waste load allocation of 9.2 micrograms/liter of total phosphorus, during facility operation. Subsequently, in July 2012, Chelan PUD committed to evaluating multiple activities (*Chelan PUD- Dryden TMDL Compliance, July 18, 2012*) to ensure that Chelan can meet hatchery production levels at Dryden Acclimation Pond while operating in compliance with the TMDL. As a result, Chelan completed a robust feasibility analysis and concluded that the most effective and risk minimizing approach to meeting phosphorous discharge limits is to rear Wenatchee summer Chinook to a smaller size (anticipated to be 18 fpp). This would be accomplished by constructing a new chilled partial water reuse system at Eastbank Hatchery utilizing circular ponds as a successfully demonstrated rearing practice, prior to transfer to the Dryden Acclimation Pond for final spring acclimation.

Introduction

- March 7, 2012 – Ecology issues Addendum to Wenatchee River TMDL for DO and pH, allocating 9.2 micrograms/liter of waste load to the Dryden Acclimation Facility
- July 12, 2012 – Chelan proposes to evaluate five actions to determine compliance with the TMDL

Preliminary Actions

1. Measure baseline phosphorus levels in Wenatchee River and Dryden facility (Chelan PUD) before, during, and after fish on station
2. Conduct low phosphorus feed trial at Dryden (Grant PUD & Chelan PUD)
3. Benchmark Chelan Falls and Leavenworth circulars (Chelan PUD & USFWS)
4. Evaluate size of smolts released-use physiological data and PIT tag data to empirically test different smolt sizes (NOAA-Beckman and Larsen & Chelan PUD)
5. Evaluate the number of fish released and effects on phosphorus levels (Chelan PUD)

Results

- February 17, 2016 – Final SOA to conduct feasibility for a chilled partial water reuse facility with round pond technology at Eastbank Hatchery.

Secondary Actions

- Negotiation with Ecology
  - Eliminated background phosphorous loading
  - Clarified collection metrics
- Modified feeding practices
  - Hand feeding
  - Strengthened BMPs
  - Low phosphorous feed
- Rearing Wenatchee summer Chinook to a smaller size
  - 18 FPP target (16 FPP +/- actual)

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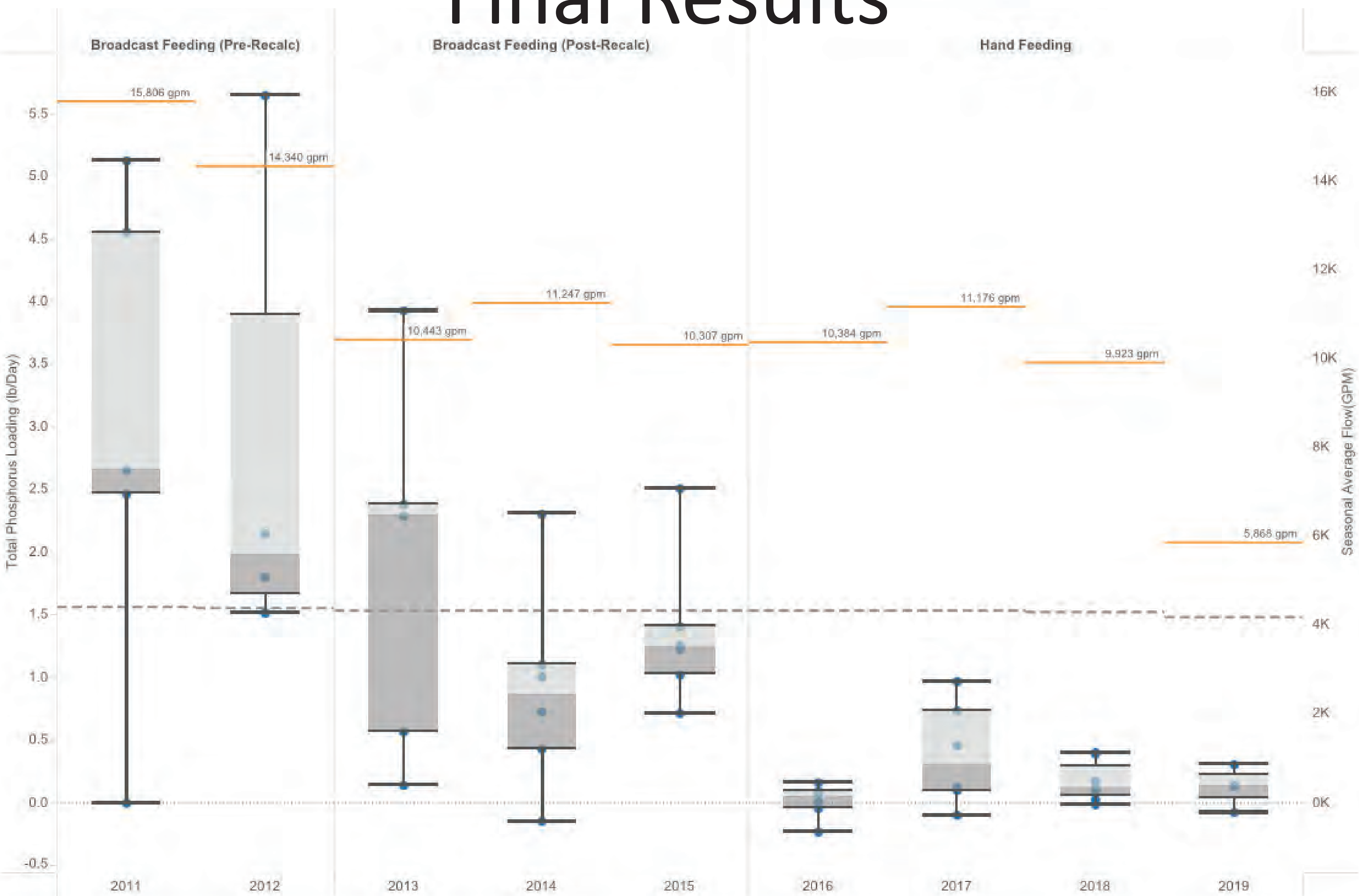
Attachment C

Final Results



Note: Dots represent the average net pond loading of each of the individual sampling events (grab, or continuous) during their respective season. Flow data represents the seasonal average. Estimated Seasonal TMDL's are presented in each year with a dashed line.

Summary

- Continued negotiation with Ecology results in
  - Ecology refines the their allocation table to remove ambiguity
  - Ecology allows the District to eliminate background phosphorous from the Dryden Pond's total phosphorus effluent results

Summary

TMDL Addendum Limits Table – March 07, 2012

Dryden Q	Conc	Load
cfs	ug/L	g/d
33	9.2	743
17	16.1	670
8	32.0	626
4	62.3	610
2	122.8	601
1	243.6	596

Facility Specific Cover Page Limits Table – November 01, 2018

Effluent Limitations

Flow, cfs [1]	Daily Maximum Net, Total Phosphorus, grams/day [2]
>17.0 to 33.0	743
>8.0 to ≤17.0	670
>4.0 to ≤8.0	626
>2.0 to ≤4.0	610
>1.0 to ≤2.0	601

[1] Flow sampling at rearing facility intake

[2] Phosphorus sampling at rearing facility effluent prior to mixing with the receiving waters

Summary

- Dryden Pond meets Ecology’s TMDL without the need for RAS development at Eastbank Hatchery
  - An additional benefit realized through operational optimization is a reduction in water consumption by adhering to accepted industry standards for Flow Indices (FI)
- The District installed automated water samplers to collect required samples weekly

Auto Samplers

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Questions?

Attachment D

Managing Risk and Expectations in Broodstock Collection

Greg Mackey
Douglas PUD

HCP Hatchery Committee

October 2019

Attachment D

Broodstock Calculation

Basic Broodstock Calculation

Number of Females Collected X Pre-Spawn Survival X BKD Culling Survival X Fecundity X Egg to Release Survival = Smolts

Number of Females Collected → Assume 1:1 Sex Ratio → + Number of Males Collected = Total Broodstock

Broodstock Calculation

Example

55 females X 0.979 pre-spawn survival X 0.814 cull survival X 3,702 fecundity X 0.837 egg to release survival = 135,000 smolts

Assume 1:1 Sex Ratio → + 55 males = 110 broodstock

Attachment D

Broodstock Calculation

Example

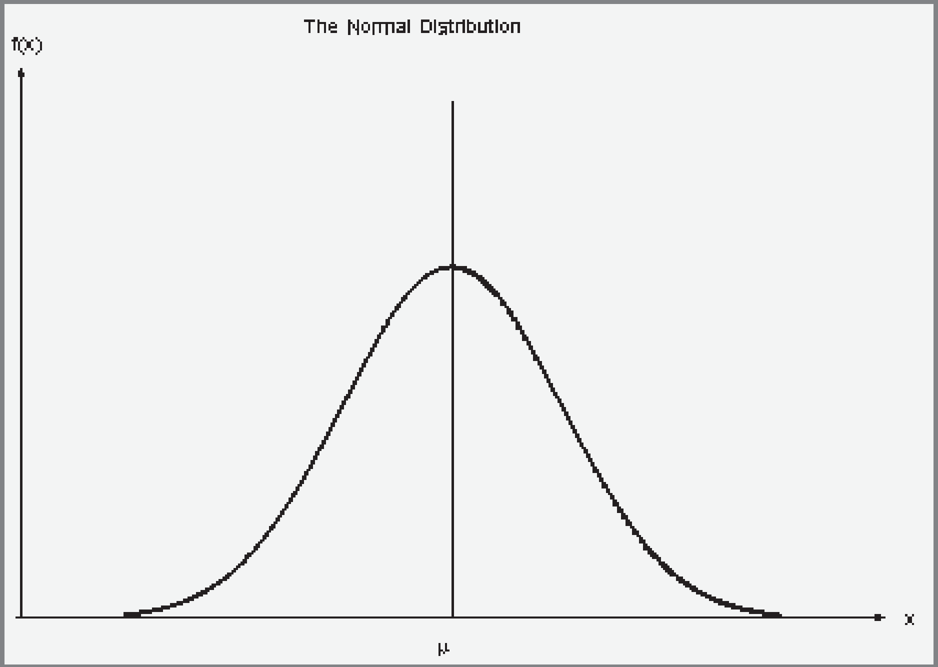
55 females X 0.979 pre-spawn survival (sd = 0.09) X 0.814 cull survival (sd = 0.133) X 3,702 fecundity (sd = 201) X 0.837 egg to release survival (sd = 0.037) = 135,000 smolts

Assume 1:1 Sex Ratio → + 55 males = 110 broodstock

Attachment D

Normal Distribution

50 % above the mean
50 % below the mean



Broodstock Calculation

How often would a parameter be outside of the +/- 10% range?

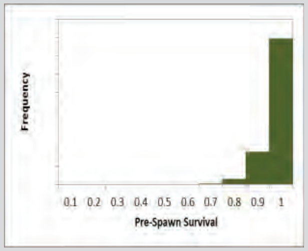
55 females	X	0.979 pre-spawn survival sd = 0.09	X	0.814 cull survival sd = 0.133	X	3,702 fecundity sd = 201	X	0.837 egg to release survival sd = 0.037	=	135,000 smolts
		16.0 %		51.5 %		6.1 %		2.5 %		

Attachment D

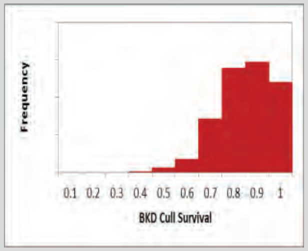
Broodstock Calculation

Example of Uncertainty

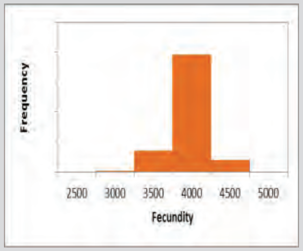
55 females X



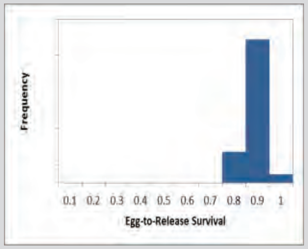
X



X



X



= 135,000 smolts +/- 95% CI

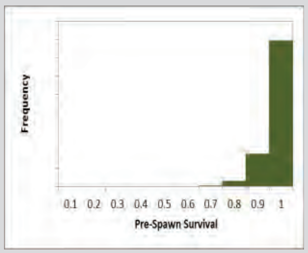
Assume 1:1 Sex Ratio

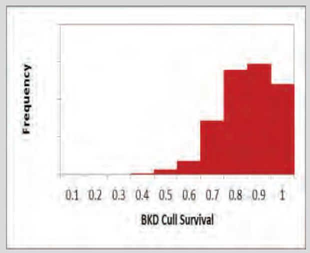
+ 55 males = 110 broodstock

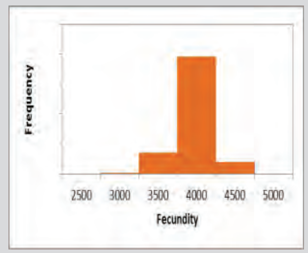
Attachment D

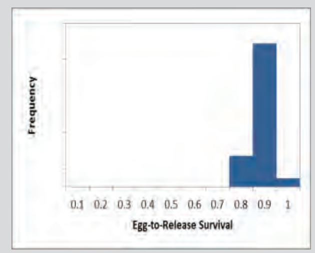
Broodstock Calculation

We can model this









Random Draw

How many females? X Pre-Spawn Survival X BKD Culling Survival X Fecundity X Egg to Release Survival = 135,000 smolts +/- 95% CI

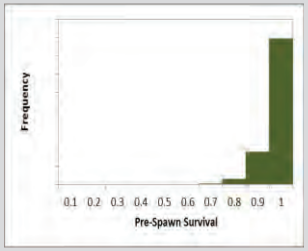
Attachment D

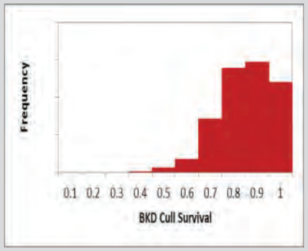
Repeat and Test Critical Values for Varying Numbers of Broodstock

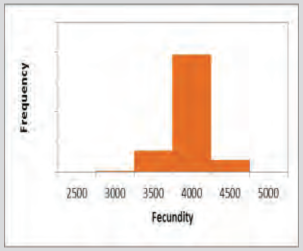
Target Production Value

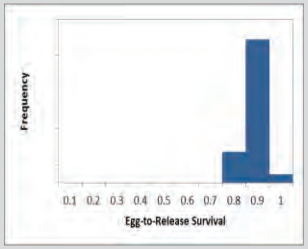
+10 % Production Value

Probability of Meeting Target and Below 110%







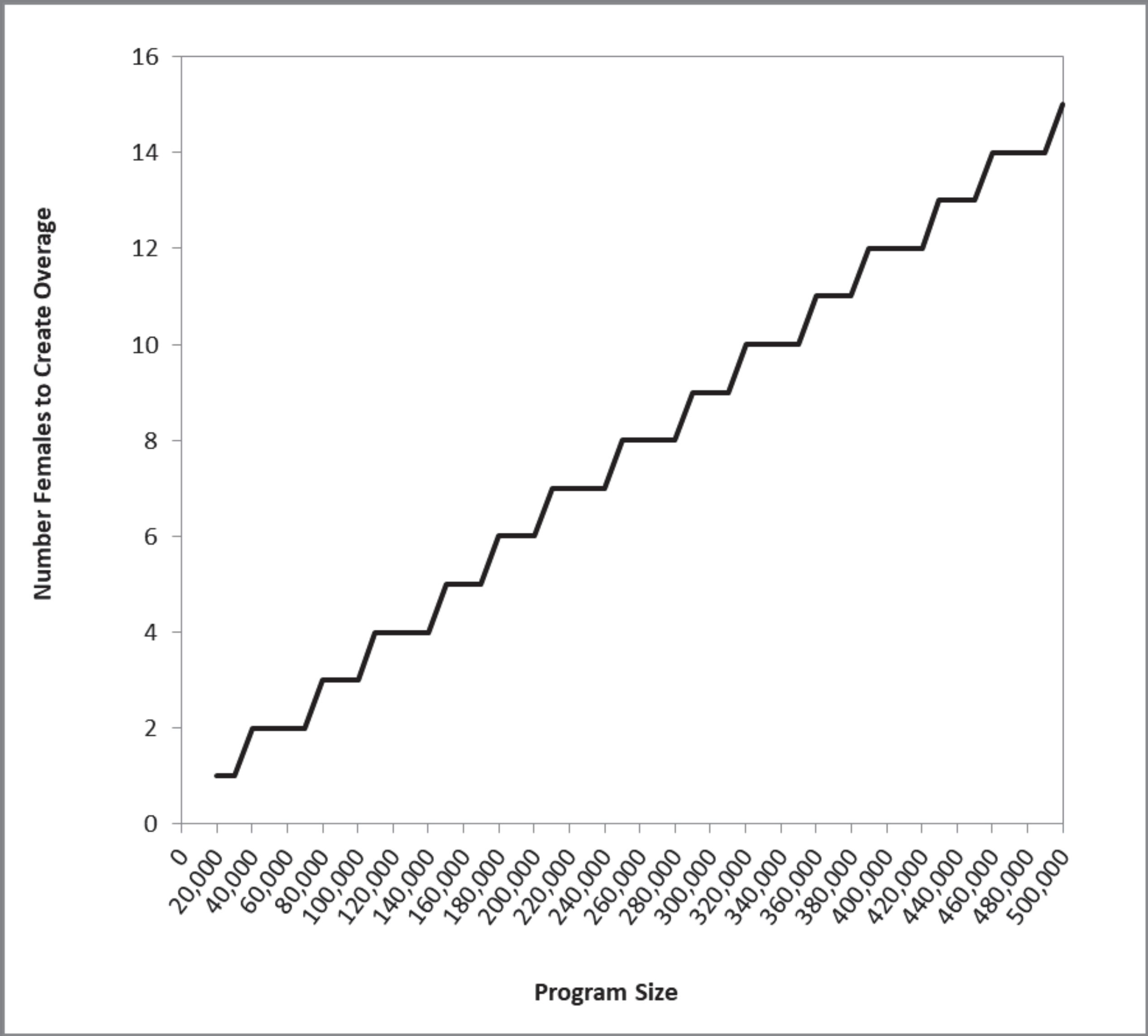


Random Draw

How many females? X Pre-Spawn Survival X BKD Culling Survival X Fecundity X Egg to Release Survival = 135,000 smolts +/- 95% CI

Attachment D

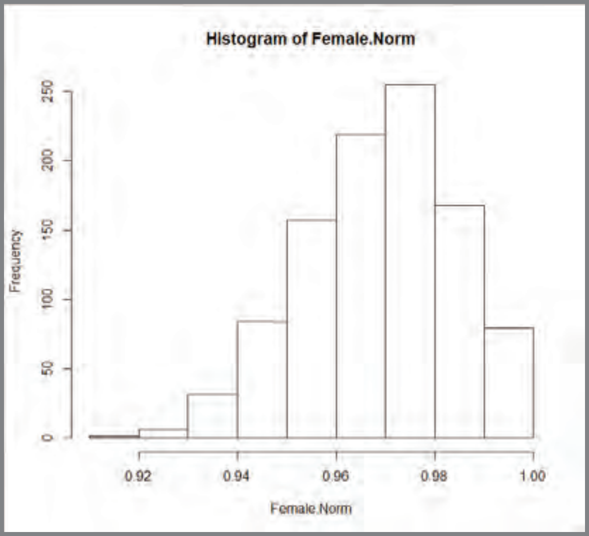
Effect of Program Size

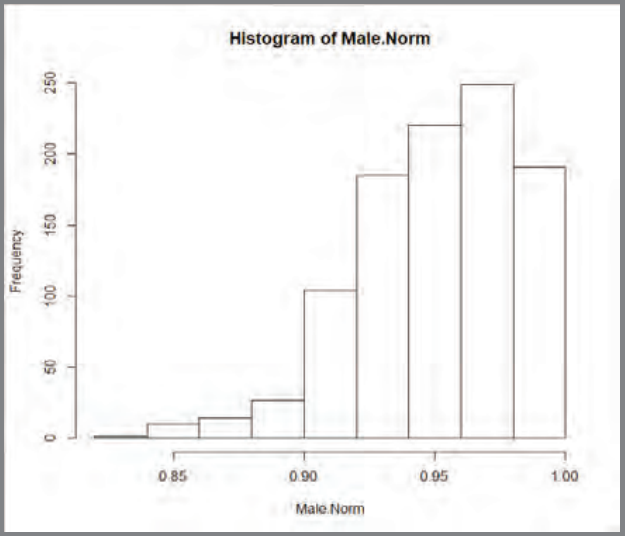


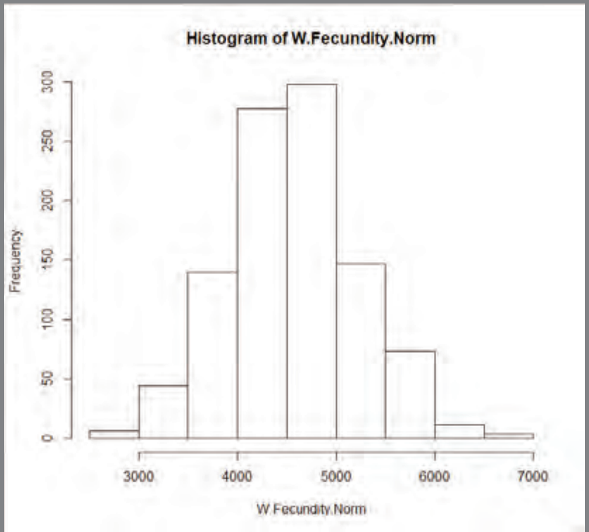
Model Data and Parameters

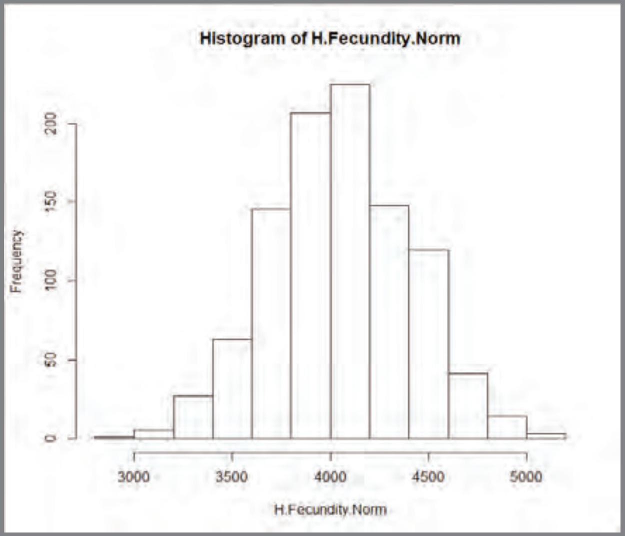
MF_Ratio : 1
H_Prop : 0.9
W_Prop : 0.1
Female.mean : 0.9701667
Female.sd : 0.01646833
Male.mean : 0.963
Male.sd : 0.03793183
W.Fecundity.mean : 4547
W.Fecundity.sd : 663.7167
H.Fecundity.mean : 4056
H.Fecundity.sd : 374.7723
EggToRelease.mean : 0.83
EggToRelease.sd : 0.1351431
Smolt_Target : 320000
Smolt_Min : 288000
Smolt_Max : 352000

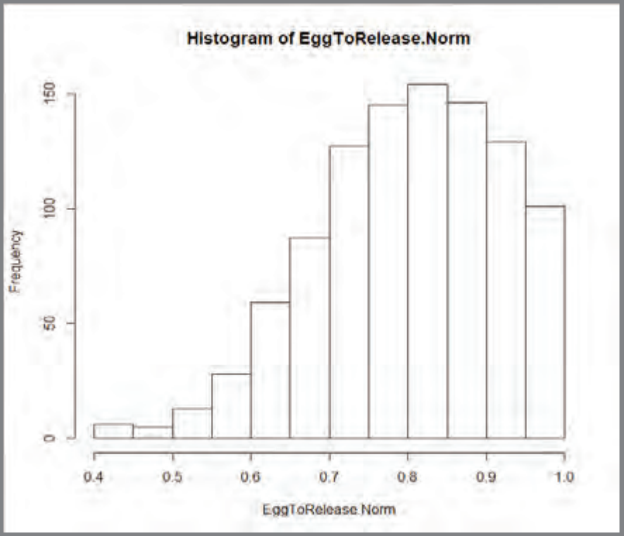
Results: Yearling Summer Chinook



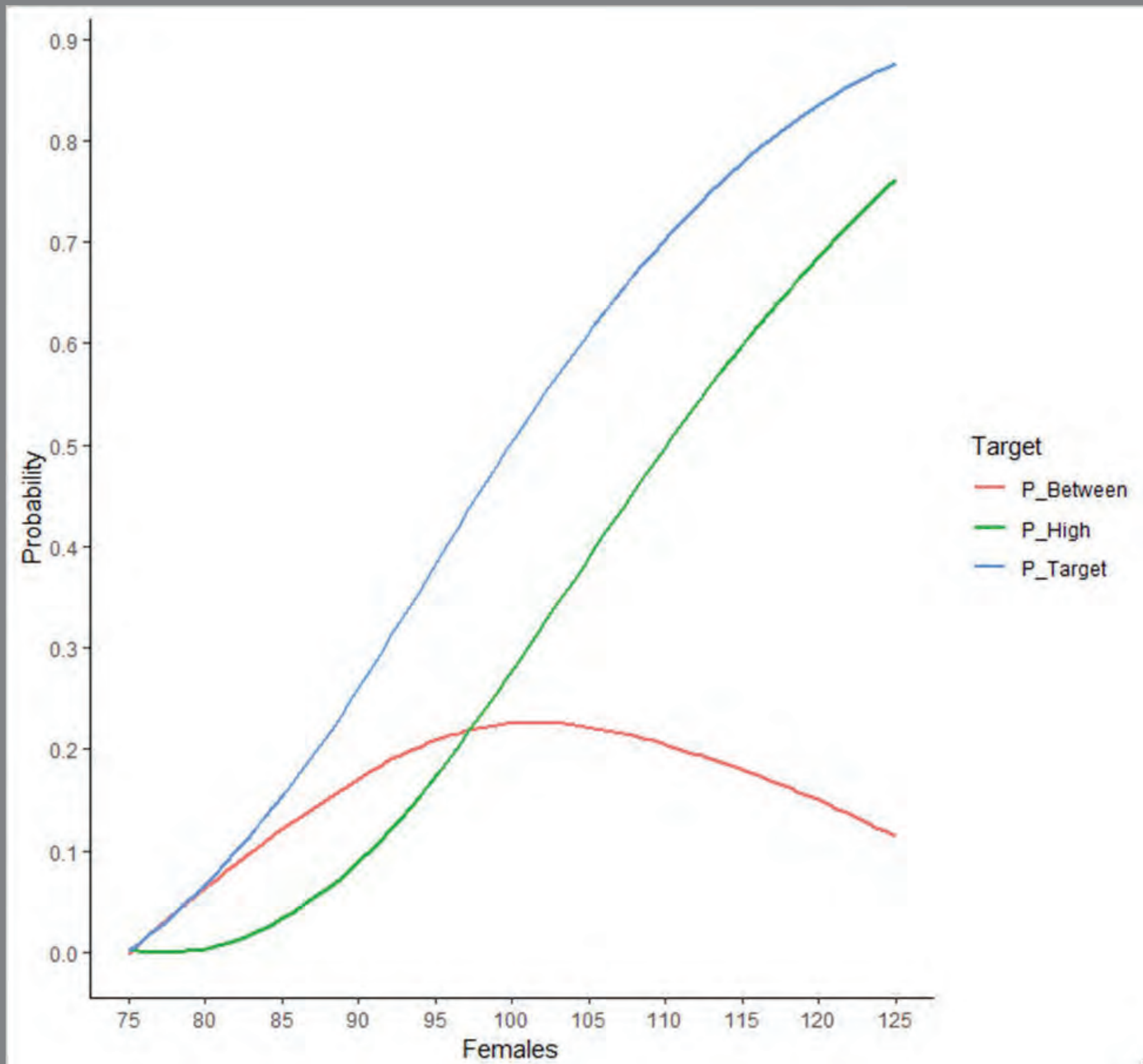








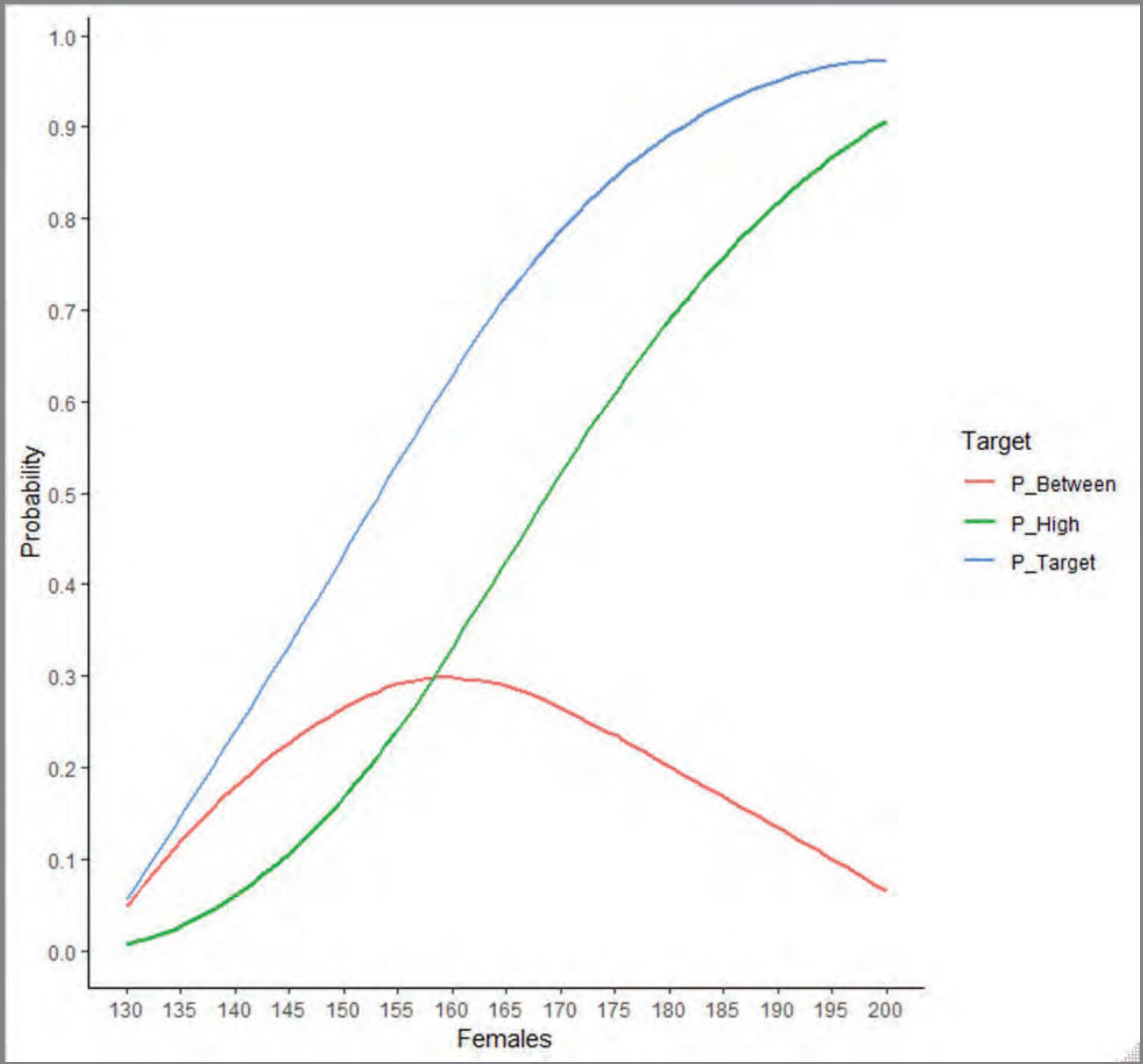
Results: Yearling Summer Chinook



Results: Yearling Summer Chinook

Females	P_Target	P_Low	P_High	P_VeryLow	P_Between	Smolts	Target
75	0.0165	0.9840	0.0005	0.8930	0.0160	239,772	320,000
77	0.0288	0.9710	0.0023	0.8440	0.0265	246,384	320,000
79	0.0482	0.9520	0.0047	0.7960	0.0435	252,043	320,000
81	0.0710	0.9290	0.0092	0.7460	0.0618	258,793	320,000
83	0.1040	0.8960	0.0166	0.6820	0.0877	265,302	320,000
85	0.1280	0.8720	0.0239	0.6610	0.1040	268,574	320,000
87	0.1960	0.8040	0.0473	0.5620	0.1490	278,709	320,000
89	0.2290	0.7710	0.0694	0.5250	0.1600	283,947	320,000
91	0.2790	0.7210	0.1010	0.4700	0.1780	290,827	320,000
93	0.3370	0.6630	0.1340	0.4200	0.2030	297,270	320,000
95	0.3860	0.6140	0.1750	0.3730	0.2100	303,856	320,000
97	0.4350	0.5650	0.2140	0.3270	0.2220	310,335	320,000
99	0.4890	0.5110	0.2620	0.2930	0.2270	316,857	320,000
101	0.5180	0.4820	0.2980	0.2640	0.2200	321,606	320,000
103	0.5750	0.4250	0.3520	0.2260	0.2230	329,429	320,000
105	0.5970	0.4030	0.3780	0.2130	0.2200	332,880	320,000
107	0.6550	0.3450	0.4300	0.1740	0.2250	341,435	320,000
109	0.6900	0.3100	0.4820	0.1510	0.2080	348,772	320,000
111	0.7250	0.2750	0.5270	0.1340	0.1980	355,044	320,000
113	0.7550	0.2450	0.5650	0.1150	0.1900	360,936	320,000
115	0.7770	0.2230	0.6020	0.0987	0.1750	367,260	320,000
117	0.8020	0.1980	0.6390	0.0894	0.1630	373,731	320,000
119	0.8240	0.1760	0.6750	0.0781	0.1490	380,107	320,000
121	0.8410	0.1590	0.7020	0.0673	0.1380	386,826	320,000
123	0.8710	0.1290	0.7420	0.0525	0.1290	393,919	320,000
125	0.8720	0.1280	0.7490	0.0543	0.1230	395,739	320,000

Results: Subyearling Summer Chinook



Results: Subyearling Summer Chinook

Females	P_Target	P_Low	P_High	P_VeryLow	P_Between	Smolts	Target
130	0.0795	0.9200	0.0105	0.6950	0.0690	411,354	484,000
132	0.0995	0.9000	0.0170	0.6450	0.0825	417,829	484,000
134	0.1270	0.8730	0.0248	0.5980	0.1020	424,016	484,000
136	0.1550	0.8450	0.0306	0.5520	0.1240	430,152	484,000
138	0.1870	0.8130	0.0420	0.5080	0.1450	436,287	484,000
140	0.2260	0.7740	0.0594	0.4510	0.1670	443,728	484,000
142	0.2620	0.7380	0.0719	0.4060	0.1910	449,956	484,000
144	0.3020	0.6980	0.0933	0.3700	0.2090	455,838	484,000
146	0.3460	0.6540	0.1150	0.3270	0.2300	462,604	484,000
148	0.3860	0.6140	0.1310	0.2890	0.2540	468,291	484,000
150	0.4250	0.5750	0.1570	0.2550	0.2680	474,588	484,000
152	0.4620	0.5380	0.1840	0.2310	0.2780	480,089	484,000
154	0.5150	0.4850	0.2230	0.1940	0.2920	487,624	484,000
156	0.5550	0.4450	0.2590	0.1700	0.2960	494,133	484,000
158	0.5930	0.4070	0.2980	0.1460	0.2950	500,579	484,000
160	0.6400	0.3600	0.3340	0.1240	0.3060	507,500	484,000
162	0.6690	0.3310	0.3670	0.1120	0.3010	512,448	484,000
164	0.6950	0.3050	0.4000	0.0913	0.2950	518,303	484,000
166	0.7350	0.2650	0.4420	0.0722	0.2920	525,131	484,000
168	0.7660	0.2340	0.4980	0.0684	0.2690	533,280	484,000
170	0.7850	0.2150	0.5210	0.0577	0.2640	537,915	484,000
172	0.8120	0.1880	0.5630	0.0503	0.2500	544,394	484,000
174	0.8340	0.1660	0.5940	0.0402	0.2400	550,286	484,000
176	0.8510	0.1490	0.6240	0.0362	0.2270	556,253	484,000
178	0.8760	0.1240	0.6630	0.0276	0.2130	563,067	484,000

Key Concepts

1. Meet Program Target
2. Under -10% Bound: Fail to meet mitigation obligations
3. Over +10% Bound: Deal with overages – mine wild fish, culling etc.

These are likely to be competing objectives

Key Concepts

1. <u>Conservation Program</u>
   a. Emphasis on not being below lower 10% bound
   b. Avoid mining wild brood
2. <u>Safety-Net Program</u>
   a. Emphasis on meeting program
   b. Avoid overages
3. <u>Harvest Program</u>
   a. Emphasis on meeting program
   b. Overages on non-listed species easier to deal with

Conclusions

- Meeting program targets carries considerable uncertainty
- Various objectives may be mutually exclusive
- Use modeling to pre-determine acceptable broodstock collection target range.
- Broodstock collection ranges tailored to each program based on ESA status, program size, population status

```
##################Monte Carlo################################################

# collect parameter grids in list for the Monte Carlo Package (see help for this package):
#param_list=list("Females"=Females, "W.Fecundity.mean"=W.Fecundity.mean, "W.Fecundity.sd"=W.Fecundity.sd, "EggToRelease.mean"=EggToRelease.mean,
"EggToRelease.sd"=EggToRelease.sd,"Smolt_Target"=Smolt_Target )

# collect parameter grids in list (for Monte Carlo Package):
param_list=list("Females"=Females, "H_Prop"=H_Prop, "W_Prop"=W_Prop, "MF_Ratio"=MF_Ratio,
        "Female.mean"=Female.mean, "Female.sd"=Female.sd, "Male.mean"=Male.mean,
        "Male.sd"=Male.sd, "H.Fecundity.mean"=H.Fecundity.mean,
        "H.Fecundity.sd"=H.Fecundity.sd, "W.Fecundity.mean"=W.Fecundity.mean,
        "W.Fecundity.sd"=W.Fecundity.sd, "EggToRelease.mean"=EggToRelease.mean,
        "EggToRelease.sd"=EggToRelease.sd,"Smolt_Target"=Smolt_Target, "Smolt_Max"=Smolt_Max,
        "Smolt_Min"=Smolt_Min)

sim=10000 #number of iterations to run in Monte Carlo
```

```
##################################################################################

broodtest<-function(Females, MF_Ratio, H_Prop, W_Prop, Female.mean, Female.sd, Male.mean, Male.sd,
            W.Fecundity.mean,W.Fecundity.sd, H.Fecundity.mean,
            H.Fecundity.sd, EggToRelease.mean, EggToRelease.sd, Smolt_Target, Smolt_Min,
            Smolt_Max)
 {

# generate Numbers of fish:
 Females
   H.Females<-round(Females*H_Prop) #Parse Females into Hatchery Females
   W.Females<-round(Females*W_Prop)   #Parse Females into Wild Females
 Male.Norm<-rtruncnorm(length(Females),a=0,b=1, Male.mean,Male.sd) #Draws male survival from normal distribution
 H.Males<-round(H.Females*MF_Ratio) #Create number of H males based on number of females, sex ratio, male survival
 W.Males<-round(W.Females*MF_Ratio) #Create number of W males based on number of females, sex ratio, male survival
 Males<-H.Males+W.Males

 H.Fecundity.Norm<-rtruncnorm(length(Females),a=0,b=Inf, H.Fecundity.mean,H.Fecundity.sd) #draw hatchery fecundity from normal distribution
 W.Fecundity.Norm<-rtruncnorm(length(Females),a=0,b=Inf, W.Fecundity.mean,W.Fecundity.sd) #draw wild fecundity from normal distribution
 EggToRelease.Norm<-rtruncnorm(length(Females),a=0,b=1, EggToRelease.mean,EggToRelease.sd) #draw egg to release survival from normal distribution

 # calculate production estimates
 H.Eggs<-H.Females*Female.mean*H.Fecundity.Norm #Hatchery eggs
 W.Eggs<-W.Females*Female.mean*W.Fecundity.Norm #Wild eggs
 Total.Eggs<-H.Eggs+W.Eggs #Hatchery+Wild eggs = Total Eggs

 # calculate test statistic:
 Production<-Total.Eggs*EggToRelease.Norm #Calculate total program production

 # get test decisions:
 Test.Target<-ifelse (Production>=Smolt_Target,1,0)#test if production >= program target
 Test.Low<-ifelse (Production<Smolt_Target,1,0) #test if production < program target
 Test.VeryLow<-ifelse (Production<Smolt_Min,1,0) #test if production < program minimum
 Test.High<-ifelse (Production>=Smolt_Max,1,0) #test if production >= program maximum
 Test.Between<-ifelse(Production>=Smolt_Target & Production<=Smolt_Max,1,0) #test if production is between program minimum and maximum

  # return result (for Monte Carlo Package):
 return(list("Females"=Females, "H.Females"=H.Females, "W.Females"=W.Females, "Males"=Males,
        "H.Males"=H.Males, "W.Males"=W.Males, "MF_Ratio"=MF_Ratio, "Production"=Production,
        "Test.Target"=Test.Target,"Test.Low"=Test.Low,"Test.High"=Test.High,
        "Test.VeryLow"=Test.VeryLow,"Test.Between"=Test.Between,
        "H.Fecundity.Norm"=H.Fecundity.Norm, "W.Fecundity.Norm"=W.Fecundity.Norm,
        "EggToRelease.Norm"=EggToRelease.Norm))
}
```

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: January 15, 2020

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the November 20, 2019 HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings

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The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees (HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held in Wenatchee, Washington, on Wednesday, November 20, 2019, from 10:00 a.m. to 3:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) to present prespawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A). *(Note: this item is ongoing)*
- Kirk Truscott will discuss with Colville Confederated Tribes (CCT) biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multipopulation model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will work with Mike Tonseth to test a modeling approach and prepare a white paper on the method for determining a range for the number of females to be collected for a given broodstock in the upcoming year (Item I-A).
- Greg Mackey will prepare a plan to test the feasibility of alternative mating strategies based on findings described in his previously distributed literature review (Item I-A).
- Mike Tonseth will confirm the completion date for an updated plan for Outplanting Surplus Methow Composite Spring Chinook salmon (Item II-A).

Wells Hatchery Committee

- Keely Murdoch will contact Melinda Goudy (YN) to determine if there is capacity to transfer surplus summer-fall Chinook salmon eggs to the Yakima Basin programs (Item III-A).

PRCC HSC

- Todd Pearsons will revise the 2020 Broodstock Collection Protocols to pilot test collecting all Priest Rapids Hatchery (PRH) Fall Chinook salmon in the Angler Broodstock Collection (ABC) fishery.

Decision Summary

- There were no decisions made in today's meeting.

Agreements

- There were no agreements made in today's meeting.

Review Items

- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on October 28, 2019, notifying them that the Draft "*Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs In 2020*" Plan was available for review with edits due by November 27, 2019.
- Larissa Rohrbach sent an email to the HCP-HCs and PRCC HSC on November 5, 2019, notifying them that the Draft 2020 Broodstock Collection Protocols appendices are available for review with edits due by Wednesday, December 4, 2019 (Item II-B).

Finalized Documents

- There were no documents finalized in today's meeting.

I. Welcome

A. Routine Safety Briefing

Grant PUD staff provided a routine safety briefing on emergency procedures for the meeting location. In case of emergency, Deanne Kunkel-Pavlik will call 911. Hillman reviewed the locations of the automated external defibrillator, the address for communicating with 911 written on the white board, and first-aid kits.

B. Review Agenda, Review Last Meeting Action Items, and Approve the October 16, 2019 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the HCP-HCs and PRCC HSC to the meeting.

Hillman informed the members that Steve Parker with the Yakima Nation (YN) will be retiring. Parker was the YN's representative to the HCP Policy Committee and frequently attended HCP meetings. The Committees agreed to send a congratulatory card.

Hillman reviewed the agenda and asked for any additions or changes to the agenda. The following two items were added to the agenda:

- Greg Mackey added an item to the Wells HC portion of the meeting to notify the Committee of summer Chinook salmon egg surpluses (Item III-A).
- Todd Pearsons added an item to the PRCC HSC portion of the meeting to provide an update on Nason Creek program spring Chinook salmon transfers and Carlton program summer Chinook salmon (Item IV-D).

The HCP-HCs and PRCC HSC members approved the revised agenda.

The HCP-HCs and PRCC HSC representatives reviewed the revised October 16, 2019 meeting minutes. The HCP-HCs and PRCC HSC members approved the meeting minutes as revised.

Action items from the HCP-HCs and PRCC HSC meeting on October 16, 2019, were reviewed, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meetings on October 16, 2019)*:

Joint HCP-HCs and PRCC HSC

- Mike Tonseth will coordinate with Andrew Murdoch (WDFW) to present prespawn mortality modeling results for spring Chinook salmon at an upcoming HCP-HC meeting (Item I-A).
  Tonseth said this item is ongoing.
- Kirk Truscott will discuss with CCT biologists whether elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs (Item I-A).
  Hillman said he talked to Truscott and this item is ongoing.
- Brett Farman will discuss with Charlene Hurst and Mike Tonseth the potential use of a multipopulation model for estimating PNI for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).
  Farman was not in attendance. Tonseth said he and Farman have located key information and are now making progress. Tonseth said this item is ongoing.

- Greg Mackey will work with Mike Tonseth to test a modeling approach and prepare a white paper on the method for determining a range for the number of females to be collected for a given broodstock in the upcoming year (Item II-C).
  Mackey said this item is ongoing.
- Brett Farman will confer with Charlene Hurst and confirm whether transfer of surplus spring Chinook salmon eyed-eggs from Methow Fish Hatchery to the Colville Confederated Tribes' 10j program is consistent with the intent of the 10j permit (Item II-D).
  Hillman confirmed that the transfer was not consistent with the 10j permit. This item is complete.
- Bill Gale will confirm whether Winthrop National Fish Hatchery (WNFH) can receive surplus spring Chinook salmon eyed-eggs from Methow Fish Hatchery (Item II-D).
  Matt Cooper confirmed that WNFH cannot receive the eggs. This item is complete.
- Mike Tonseth will prepare, and Larissa Rohrbach will distribute the appendices to the Broodstock Collection Protocols for editing by the relevant parties that were identified in the October 16, 2019 meeting (Item II-E).
  The appendices were distributed by Rohrbach on November 5, 2019, requesting that Committees members return edits to her by December 5, 2019, to be compiled in revised versions of the appendices. This item is complete.

II. Joint HCP-HCs and PRCC HSC

A. Outplanting Surplus Methow Composite Spring Chinook Salmon Adults

Mike said he spoke with Michael Humling (USFWS) and Charlie Snow (WDFW) regarding desired updates to the existing outplanting plan that was developed in 2017. Humling reviewed an analysis he had done earlier in the year to determine the potential outcomes depending on different outplanting scenarios, in terms of the effects on PNI. Many scenarios were being tested, such as outplanting only hatchery females and prioritizing MFH males for use as a safety-net brood. This would minimize the creation of HxH progeny in the wild and help insure out-year effects to PNI are reduced.

Keely Murdoch asked what will be done with the results of Humling's analysis. Tonseth said the results of the analysis will be incorporated into the outplanting plan and presented to the Committees as a revised outplanting plan for review and approval.

Murdoch asked if PNI would be calculated by reach. Tonseth said that's part of the discussion and scenarios being tested; whether to focus the outplanting on areas that would benefit most by those activities as indicated by PNI. Murdoch said the decision on where and how to outplant could depend on habitat quality. Tonseth agreed and said Charlie Snow is looking at the effects of some factors such as habitat capacity and the existing density of spawners. Murdoch said the reason for asking is that in years when there are low returns, it may be beneficial to outplant in areas that have low densities and this benefit would not be reflected by looking solely at PNI. Tonseth said his recollection was that the 2017 version of the outplanting plan was initially prepared to test the approach. This objective is still relevant to test the approach before fully implementing outplanting based on productivity metrics.

Murdoch said the conflict is that outplanting hasn't been carried out yet because of low run sizes and prioritization of broodstock for the hatchery programs, but it is in low run years when this plan may be more beneficial, and this presents conflicting fish uses. Murdoch said another conflict exists in deciding which adults should be outplanted. Tonseth said the adults chosen for outplanting are part of the scenarios that Humling is testing; for example, outplanting surplus Methow spring Chinook salmon versus WNFH spring Chinook salmon. Murdoch said the analyses presented test both sides of that issue, for instance reserving conservation program males versus outplanting. Hillman asked if the Committees need to reconsider outplanting during low return years. Tonseth said that for Methow spring Chinook salmon, at low run sizes, below 500 spawners, the permit requires management for escapement rather than PNI to allow a certain number of spawners to return to the basin.

Tonseth said they are bound by PNI requirements in the permit, but in order to test this method, they may need to work outside the PNI requirements and would need agreement from National Marine Fisheries Service (NMFS) that a given year would not be included in 5-year PNI calculations. Pearsons said in previous years Broodstock Collection Protocols (BCPs) noted that the priority was for fish to go to WNFH, because the spawning outcome at WNFH is known whereas productivity after outplanting is unknown. Pearsons asked if that logic is being challenged now with an alternative perspective. Tonseth said it's not necessarily a challenge, but a method for allowing for multiple choices during broodstock collection. For instance, Humling tested retaining only Methow Component males and using females for outplanting. This practice would reduce pNOB slightly but allows wild males to pair up with Methow Component hatchery females to spawn naturally.

Murdoch asked if the Committees will be able to review the plan in time for incorporation into the 2020 BCPs. Tonseth said the outplanting plan is not likely to be ready by December and suggested maintaining the plan as a stand-alone document until the method is proven in the future. Tonseth said their expectation is to prepare the plan in time for collection of 2020 spring Chinook salmon broodstock. Tonseth said they are restructuring the document with a suite of options to allow the Committees to decide on the optimal approach(es) depending on multiple metrics. Tonseth said he, Humling, and Snow will be discussing the analysis next week. The plan will be provided in 2020 for Committee review.

Mackey said the 2017 outplanting plan has detailed methods for meeting permit conditions using the multi-population PNI model for the Methow Basin.

Mackey said one other option is to outplant eggs. After natural spawning occurs, additional eggs can be outplanted in areas where spawning has not occurred to target areas with low densities. Mackey said it is also another way to make use of surplus eggs. Tonseth said it is challenging to measure success of egg outplanting and it is challenging to construct artificial redds. Murdoch said it may actually be more difficult to document success of outplanting adults because it is difficult to track spawning after adults have been moved into an area, but the advantage of outplanting adults is that it reduces any domestication selection on eggs in the hatchery. Tonseth said outplanting adults reduces but does not eliminate all domestication selection because the hatchery staff are selecting which fish to outplant. Mackey said it would be more difficult to know whether outplanted adults have spawned in areas with low densities. Mackey said it would be relatively easy to electroshock juveniles to confirm that the productivity was the result of outplanted eggs. Tom Kahler said a Parentage Based Tagging genetic analysis could be performed on offspring as well to confirm parentage. Tonseth said they would need to ensure NMFS agrees that outplanting of eggs was consistent with the permit, and how NMFS would view outplanting eggs in terms of calculating PNI. Graf said he researched some backpack pump units that blow the gravel clean and then inject eggs. Mackey said this pump technique is capable of rapidly outplanting hundreds of thousands of eggs.

Tonseth said he will confirm the completion date of the outplanting plan.

B. Broodstock Collection Protocols Progress Update

Hillman reviewed the 2020 BCP topics for discussion. Hillman asked whether there were questions about editing the BCP appendices (Table 1). Tonseth reminded the Committees that some appendices won't be ready for December because they depend on run forecasts. Tonseth said the Technical Advisory Committee (TAC) forecast is typically available in late December for estimating returns. Tonseth said this information will be added to the appendices as the information comes in. Larissa Rohrbach requested that edits be sent to her for compilation by December 4.

Pearsons asked if the goal was to simply update the numbers in the appendices. Tonseth said yes, and the data provided in the appendices will be used to draft the body of the BCPs. Tonseth said most of the appendices simply require review, for instance to confirm that site-specific plans are still accurate.

Tonseth noted that Appendix K on the YN coho salmon program is to be completed by the YN. Murdoch confirmed that she will strive to make Appendix K available by the end of January. Tonseth said the goal would be for it to be distributed with the February draft BCPs.

Tonseth said USFWS should be responsible for Leavenworth National Fish Hatchery (LNFH) and WNFH forecasts. Matt Cooper said those also tier from the TAC forecasts.

Table 1
2020 Broodstock Collection Protocols Assignments

Appendix	Title	Assigned Parties	Notes
A	2019 BY Biological Assumptions for Upper Columbia River Spring, Summer, and Fall Chinook salmon and 2020 BY Summer Steelhead Hatchery Programs	WDFW and PUDs	
B	Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations	All	
C	Return Year Adult Management Plans	WDFW lead	Contingent on run forecast available in Jan/Feb 2020
D	Site-Specific Trapping Operation Plans	PUDs and M&E staff YN to review	Identify plans and ensure they are still accurate
E	Columbia River TAC Forecast	WDFW	Forecast available in late Dec 2019/early Jan 2020
F	Annual Chelan, Douglas, and Grant County PUD M&E Implementation Plans	PUDs	Provide links
G	DRAFT Hatchery Production Management Plan	All	
H	DRAFT Preferred Alternative for 2020 BY and Beyond, Methow Sub-basin Conservation Steelhead Programs	Revisit after completion of 2019/2020 steelhead return	Pending discussion by Joint Fisheries Parties; concern about acquiring broodstock in the spring
I	Program Specific Rearing and Release Descriptions	PUDs and M&E staff	Staged release at Priest Rapids Hatchery to be addressed
J	2019 BY Spring and Summer Chinook Disease Management Plans	CPUD M&E staff and WDFW veterinarian (Megan Finley)	
K	2020 YN Coho Broodstock Collection Plans	YN	
General	Species-Specific Run Forecasts	WDFW, USFWS (LNFH, WNFH)	

Notes:
M&E: Monitoring and Evaluation

C. NMFS Consultation Update

Representatives of the CCT and NMFS were not in attendance. Committees members noted that the recurring agenda item for a NMFS Consultation Update is no longer necessary because all permits have been finalized.

Tonseth said a recalculation in 2021/2022 could force re-consultation. Tonseth said 2024 would be the first release year of offspring after recalculation. He added that consultation discussions should start at about the same time as recalculation discussions in 2020.

D. Annual Skaha Lake and Okanogan Lake Sockeye Reintroduction Update

Hillman introduced Ryan Benson (Okanagan Nation Alliance), who gave a presentation entitled, "*Skaha Lake Sockeye Re-introduction Program Update*" (Attachment B).

Slide 2: Benson provided an annual summary of hatchery operations. Benson said that 2015 was affected by massive fish kills in the lower Okanogan River due to warm temperatures. In 2019, mean egg take was low (1,650 average eggs per female) because many of the females collected were half-spent already. The numbers in 2019 also reflect the effects of poor returns in 2015; however, improvement from 2015 shows growth of the cohort. In 2019, all females to be used for broodstock were retained instead of returning females that were not ripe to the river. They are now held in the hatchery until becoming reproductively mature.

Each year milt from a proportion of the males is cryo-stored as a contingency in case of a population crash. Managers typically use milt from previous years to test the viability of the frozen sperm and to fertilize a small number of sample eggs; however, this was not done in 2019 due to low run sizes, but milt was archived in 2019.

Starting in 2016, the release strategy has been to match peak emergence of fry because temperatures that vary by 5 to 10 degrees year to year in spring can shift emergence timing considerably. The program releases early, mid, and late release groups in March, April, and May, respectively. No differences in survival between release groups have been detected yet, but managers are continuing to monitor. The advantage is a reduction in hatchery operational costs when fish are released early.

Pearsons asked about the fate of the males used for the milt cryopreservation program. Benson said the milt is collected from a male and that male is returned to the river. Pearsons asked if a male could be spawned in one year and milt used in later years. Benson said the males used for cryopreservation are not spawned in the year in which they were collected.

Mackey asked what the egg take goal is. Benson said it is based on the escapement estimate, a target of 30,000 adults. Hillman asked what the capacity of the hatchery is. Benson said 5 million eggs.

Slide 3: Benson said in 2019 there were a high number of 3-year-olds, mostly jacks, and some jills. To augment the collection in 2019, approximately 32 females (6.2% of total egg take) were collected from Penticton Channel. Jacks and jills were also collected from an effluent pipe from the hatchery that was protected by bars that were spaced so that only smaller adults passed though. Benson said they are improving practices in order to streamline operations for the large return expected in 2020.

Hillman asked if 3-year-olds are spawned. Benson said yes for females. This reflects natural processes as 3-year-old females are observed on the spawning ground. Pearsons asked about the origin of fish that return to the Penticton Channel and the hatchery effluent pipe. Benson said they haven't finished the analysis of otoliths but suspect they are mostly hatchery-origin fish.

Slide 4: Benson said in 2019, all fry were released in Lake Okanagan for the first time. Otolith thermal marks were used to mark three different groups for release into three different sites in the lake.

Slide 5: Benson presented estimates of survival and travel time to Bonneville Dam for BY 2017 juveniles. Travel time and survival was lower in 2019 compared to past years. Benson suspects it is related to lower flows in 2019. Survival in the lake is monitored by purse seining, which has been more successful than other methods, though it can be difficult to catch the fish if they are located near the bottom of the lake. To minimize handling during passive integrated transponder tagging, fish are tagged directly on the purse seiner during collection rather than transporting fish to a separate tagging location.

Willard asked why travel time from Skaha Lake looks faster than travel time from Osoyoos Lake, which is farther downstream. Benson said its likely because Skaha Lake sockeye are a bit larger than the wild fish from Osoyoos Lake. Willard asked about release times and detection sites. Benson said there is one detection point near the release point; however, the detection probability is better at Bonneville Dam. Benson said survival and travel time are calculated from the time they are released after tagging into the lake to redetections at downstream sites. At this time, tagging can be done within 2 to 3 days so there is less lag time between tagging and release into the lake than in the past.

Slide 6: Skaha Lake Natural Production. In 2011, high water levels allowed adult sockeye to enter Skaha Lake and spawn naturally. Fish may move upstream via the Skaha Dam fishway. Many fish pass over an outflow gate when water levels are high. There was no need to stock any fry into Skaha lake due to a naturally high escapement in 2018.

Slide 7: In-lake monitoring. Hatchery-origin fry in Skaha Lake had a lower survival rate than natural-origin fry monitored in Lake Osoyoos. Benson said the release site experiment is an attempt to improve upon survival rates. Mackey asked if fry are fed before release. Benson said yes.

Benson said there is potentially an optimum loading density for hatchery fry in Skaha Lake, indicated by suppressed growth in 2018. Various factors affect productivity in Skaha Lake, in particular discharge rate through the lake and natural pelagic fish community dynamics of sockeye, kokanee, and whitefish. Whitefish show a boom and bust pattern. Benson said there may be a need to calculate the optimum release numbers each year.

Historically, there was a concern that the Skaha Lake kokanee population could crash due to competition with mysid shrimp and reintroduced sockeye. Results show the kokanee stock has increased in recent years based on number of spawners and biomass in the lake. Skaha Lake does not appear to have a problem with competition. The main grazers of zooplankton are 2 to 3-year-old kokanee; the grazing impact of sockeye fry is minimal compared to kokanee.

Slide 8: Lab development. Lab tests include the following:

- qPCR
- Chinook salmon biosampling of carcasses
- Northern pike
- Water quality
- Macroinvertebrates

Tests that use qPCR are used to screen for disease (Infection Hematopoietic Necrosis and Bacterial Kidney Disease), environmental DNA (eDNA) for other species of concern, and for invasive species. Benson said they expect to expand lab work with recent funding from the Province of British Columbia.

Slide 9: Okanagan Basin Salmon Restoration Sub-Committee. Benson said there is a new mandate that directs reintroduction in the entire basin, including Skaha Lake. The mandate also addresses invasive species and other endangered species and uses an ecosystem approach including habitat initiatives. Benson said there is a Draft Okanagan Lake Recovery Plan and they will eventually move on to recovery planning for other lakes upstream. There was recent approval and support for release of 4.2 million fry into Okanagan Lake. One concern to address in the future is sockeye residualization and hybridization between kokanee and sockeye.

Slide 10: Okanagan Lake Program. The Department of Fisheries and Oceans, Canada, has approved a long-term hatchery outplanting program contingent on monitoring and evaluation program planning and implementation. There is a technical sub-committee overseeing the draft plans. The groups are working toward activating the fishway over Penticton Dam at the outlet to Okanagan

Lake and to tag and plant 100 adults to track their movement in Okanagan Lake. Ceremonial stocking has been done since 2016. Benson said productivity is lower in Lake Okanagan compared to Skaha per unit area; however, the potential productivity could be larger than other lakes like Skaha due to the size of Okanagan Lake.

Dave Duvall (Grant PUD) asked what the lake productivity estimates are based on. Benson said it is based mainly on the limnetic characteristics of the lake and not a formal analysis. Benson said this does not take into account spawning in natural tributaries. Restoration and passage monitoring into tributary creeks may improve natural spawning.

Benson said the Okanagan River Restoration Initiative has expanded restoration actions. The latest actions are to add spawning gravels to Penticton Channel.

Pearsons asked if fish that get to Okanagan Lake can access lakes farther upstream. Benson said he did not know but that he thinks the potential is there and it would not be a major task to expand the distribution of sockeye into those lakes. Pearsons asked whether upstream lakes are sockeye-producing lakes. Benson said he thought so; however, the accessibility to tributaries is unknown.

Slide 11: The Penticton Dam fishway at the outlet of Okanagan Lake was activated in 2019 allowing the first fish passage since 1953. Benson said in the past, fish passage was blocked at points downstream so there was no reason to open the Penticton Dam fishway. Flows and boards were adjusted in 2019 to test feasibility. No sockeye were observed in the fishway. Benson said they may have missed the migration window by the time the fishway was running and some fish that were spaghetti tagged at the fishway were observed spawning downstream. Block nets are used to capture fish at the upstream end of the fishway. Benson said they were able to identify improvements to the 1950s engineering for future funding, such as an automated gate that adjusts along with lake levels that can fluctuate up to 1 meter each year, an improved capture platform instead of the block net, and a passive integrated transponder antenna. Benson said there is community support for fish passage into Lake Okanagan. Early returns from the 600,000 fry outplanted to the lake could appear next year.

Pearsons asked what the expectation of a large run in 2020 is based on. Benson said it is based on the number of fry outplanted in 2018. The purpose of activating the fishway this year was to work out the challenges prior to next year’s run.

Pearsons congratulated Benson on achieving fish passage into Okanagan Lake. Benson said the perspective of the British Columbia Provincial government has changed completely as a result of a directive that the Province must follow to the letter The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). The relationship between Okanagan Nation Alliance and the Province has changed completely and now they share the same perspective in terms of taking an ecosystem management approach. Benson said there is also a mandate for the Province to manage for resident fish. Results show that improving conditions for anadromous fish are improving the productivity of resident fish.

Murdoch also congratulated Benson on Okanagan Nation Alliance's achievements. Murdoch asked if the increase in kokanee is a result of residualism of sockeye outplants or habitat improvements. Benson said he thinks its habitat improvements. There are two spawning modes observed in the channel. Benson said some fish are switching life histories, which is complicating analyses. Benson said his perspective is that they are different ecotypes of the same species. Benson said in the traditional ecological knowledge of Okanagan elders there is a term for hybrid in the language. Murdoch said the concept of hybrids is interesting because they are the same species but noted that managers were able to observe kokanee genetics.

Murdoch asked if historically both ecotypes were in the lakes. Benson said yes, historically they were probably both there and that kokanee ecotypes have been deviating farther from the natural anadromous stock. Benson said that hybrids don't do as well, they appear to be an intermediate form. However, if the elders were aware of them, perhaps they had a purpose as a food for other species or overall productivity of the system. Benson said monitoring will show whether the genetics of the ecotypes continue to diverge. Murdoch asked if isolation is the reason for genetic differences. Benson said historically they were probably the same form. Mackey said when kokanee and sockeye are sympatric, kokanee are much more efficient at sequestering carotenoids than sockeye, so there are some physiological and genetic differences.

Pearsons asked Benson what changed with the Provincial perspective in recent years. Benson said this is a change that has occurred across the Province due to the outcomes of a truth and reconciliation commission that was similar to the post-apartheid commission in South Africa. Benson said there was a travelling commission that listened to all parties. The federal government signed on to the commission as well as the Provincial government. Benson said the outcomes have trickled down throughout all areas of social sciences, agriculture, and natural resources like fish and forestry. Benson said the link to UNDRIP forces changes to be implemented now. Benson said existing technical groups including the Canadian Okanagan Basin Technical Working Group have been a successful model for cooperation that has been in place since the 1990s to facilitate change.

Hillman thanked Benson for his presentation.

III. Wells HC

A. Surplus Wells Fish Hatchery Summer Chinook Eggs

Greg Mackey said that there are approximately 120,000 surplus eggs from the Wells Hatchery summer Chinook salmon egg treatment study and likely more than that from the production programs due to high fecundity and survival this year. Eggs will be shocked late this week and mortalities will be picked early next week. There is a need for the eggs to be transferred or sacrificed by December 2, as they will hatch between December 8 and 9, 2019. Mackey also said there are likely to be surplus summer Chinook salmon eggs from the Wells Subyearling Program due to high fecundities in the broodstock. The surplus eggs will be incubated on a program for developing subyearling smolts.

IV. Rock Island/Rocky Reach HC

A. Surplus Chelan Falls Summer Chinook Eggs

Tonseth said WDFW is also expecting a surplus of 400,000 to 600,000 eggs in the Chelan Falls summer Chinook program. Tonseth said he is waiting to hear from Kirk Truscott on CCT's needs and that the Chelan Falls program eggs will be shocked and picked by January. Tonseth has received some requests for small numbers of eggs for salmon in the-classroom projects but no other programs need large numbers of surplus eggs.

Willard asked Tonseth to remind the committees why there was such a large surplus in the Chelan Falls program. Tonseth said for 2019 one collection site that was identified was the Wells trap where 380 adults were collected. Concurrently, Chelan PUD coordinated beach seining with CCT and installation of an instream picket weir to collect broodstock directly from the Chelan River. Tonseth said and Willard confirmed the picket weir was successful after some initial installation challenges. Tonseth said the fish from the Chelan River were collected in warm water (>70°F) so there was uncertainty around egg quality and fecundity. Given those uncertainties, WDFW decided to spawn all fish collected. Tonseth said pre-spawn survival of the river-trapped fish was better than fish trapped at Wells Dam. Tonseth said they have only met program targets in 2 of 5 recent years. Tonseth said they did not predict that the Entiat National Fish Hatchery would have similar success this year and they were able to supply eggs to the YN programs. Tonseth said unless there is a program identified for the surplus eggs, they will be destroyed. Tonseth said it is not expected to have a surplus next year as a number of uncertainties in broodstock collection for the Chelan Falls program have been addressed. Willard said in January she will present a summary of Chelan Falls broodstock collection results.

Mackey said the CCT's Chief Joseph Hatchery may be the only outlet for surplus fish at this time. Tonseth agreed and said he is waiting to hear back from Truscott. Truscott suggested that in the interim, Mackey reach out to Matt McDaniel, the manager at Chief Joseph Hatchery, to determine if there is capacity at Chief Joseph Hatchery for the surplus eggs.

Keely Murdoch said she will ask Melinda Goudy (YN) if there is capacity in the Yakima Basin programs for more eggs.

V. PRCC HSC

A. Approve the October 16, 2019 Meeting Minutes, Committee Updates, and Meeting Summary Review (Todd Pearsons)

The PRCC HSC representatives approved the October 16, 2019 meeting minutes as revised.

Hillman reviewed the agenda. He explained that the intent of the agenda item on White River spring Chinook salmon recovery was to identify questions for Craig Busack (NMFS). His responses to the questions will support decision-making on a White River spring Chinook salmon hatchery program.

B. Priest Rapids Fall Chinook Salmon Broodstock Collection

Todd Pearsons gave a briefing on the Angler Broodstock Collection (ABC) Fishery that occurred in the Hanford Reach for the collection of fall Chinook salmon broodstock. The Coastal Conservation Association (an angling advocacy group; CCA) is the group that coordinates the anglers. The derby was capped at 100 boats for logistical reasons. Slots were filled in the first week of registration.

Pearsons said this year there were three fishing sites instead of two (Vernita Bar, White Bluffs, mid-reach). In total, 1,572 fish were collected over 3 days, which was the highest number ever collected. Last year 1,342 fish were collected. In the first year, 2012, 69 fish were collected.

Pearsons said there was good survival because all transfer boats were equipped with oxygen. Pearsons said there were enough natural-origin males to allow the Priest Rapids Hatchery (PRH) to make 1:2 crosses (M:F) instead of 1:4 crosses. In the past, 1:4 crosses were done to maximize use of natural-origin males; however, 1:2 is the typical protocol.

Murdoch asked whether the timing of the Columbia River recreational fishery closures this year occurred just before the ABC fishery as it did last year. Pearsons said yes. Murdoch asked if that was part of the angling success. Pearsons said yes, that was likely part of it, but also the publicity and participation increased this year. The CCA portrayed it as the largest fishing derby of its type in the world. Murdoch asked if the fishery will be closed at the same time in the future. Tonseth said they looked through the fishery regulations and the answer is yes, the current regulatory structure in place over the past 2 years will continue to be in place over the next 2 years, creating the lag time between closure of the recreational fishery and implementation of the ABC fishery. Pearsons said the fishery remains closed in the area of the derby.

Murdoch asked if there was an entrance fee. Pearsons said yes. He said there is a benefit to the CCA in that they acquire a lot of new members through this event. Pearsons said Grant PUD provides funding for prizes. Pearsons said one thing that has changed is that there are a number of fishing guides participating. Pearsons said CCA likes it because it increases their membership, anglers like it because they can fish waters that are typically closed to them and they are contributing to the hatchery program, and guides like it because they can book trips for the derby. Experienced anglers have been instrumental in the popularity of the program and in increasing numbers of fish captured.

Pearsons said in the 2019 BCP it was agreed to collect fewer fish at the Priest Rapids Off Ladder Adult Fish Trap (OLAFT). The target number to be trapped at the OLAFT was brought down to 650 fish, which was not achieved this year, but numbers captured in the ABC fishery greatly exceeded the target of 600 fish.

Tonseth said WDFW supports moving away from collecting natural-origin fall Chinook salmon at the OLAFT. Tonseth said Paul Hoffarth (WDFW) was initially concerned that the number collected in the ABC fishery would not be adequate, but this number has been large in the past 2 years. Tonseth proposed collecting broodstock only via the ABC fishery in 2020. Hillman asked Tonseth to remind the Subcommittee why WDFW prefers to not use the OLAFT for broodstock collection. Tonseth said there is uncertainty about the origin of the fish that ascend Priest Rapids Dam (PRD), whether they are returning to the Priest Rapids pool or are part of the aggregate that spawns in the Upper Columbia Basin, and it's unknown what contribution the adults ascending PRD are making to upstream populations.

Pearsons said he was initially apprehensive of relying solely on the ABC fishery because the reason for use of the OLAFT and fishery is to select the type of fish to meet a PNI target of 0.67. Pearsons said he has become more comfortable with the idea of not using the OLAFT because PNI has been high the last few years. Pearsons suggested using the OLAFT as a back-up option for collecting fish without having to develop a new proposal if there is a decline in PNI in future years below the target of 0.67. Pearsons suggested not collecting at the OLAFT in 2020 but treating the approach as a pilot method for the next few years in case an adequate number of fish are not captured in the ABC fishery. Tonseth said that would be a reasonable approach but would require CCT approval. Tonseth said the success of the ABC fishery depends on consistency in return timing, fishery timing and run size, and at this time there is no reason to expect these factors to change.

Murdoch said she would want to verify during the pilot years that the PRH program would backfill with hatchery-origin fish if the program runs short. Pearsons said they try to collect fish at the OLAFT that are not known to be hatchery fish, but they do spawn hatchery fish as needed. Murdoch said if PRH doesn't meet production it would likely be due to a low run size, not because of failure of the ABC fishery.

Tonseth said the PNI target is compared to a 5-year mean, so one year of PNI below the target of 0.67 would be acceptable. Pearsons said yes, but if PNI is very low in one year, for instance as low as 0.2, it may not be possible to elevate the 5-year mean PNI in subsequent years.

Pearsons asked if this proposed change to broodstock collection should be written into the BCPs now or wait until Truscott is available to approve this pilot plan. Hillman and Tonseth advised Pearsons to go forward with edits to the BCP.

C. White River Spring Chinook Salmon: Recovery Questions

Hillman said the intent of the discussion on White River spring Chinook salmon recovery is to identify questions for Craig Busack (NMFS) before he retires. His responses will support decision-making on a White River spring Chinook salmon hatchery program. Spawning aggregates of the Wenatchee spring Chinook salmon population were discussed. Major spawning areas (MSAs) include the Chiwawa River, White River, Nason Creek, Little Wenatchee River, and upper Wenatchee River; minor spawning areas (mSAs) include Chumstick Creek, Peshastin Creek, Icicle Creek, and Mission Creek.

Tracy Hillman recorded questions for Craig Busack as they were posed in the meeting. Hillman presented the initial question about the necessity of the White River spawning aggregate for recovery of the Wenatchee River spring Chinook salmon population.

Murdoch asked if Busack is working closely with Northwest Fisheries Science Center (NWFSC) because at yesterday's PRCC meeting, Scott Carlon (NMFS) suggested that scientists at the NWFSC may be changing their thoughts on the importance of the White River spawning aggregate to the recovery of the Wenatchee River spring Chinook salmon population. Murdoch noted that the importance of the spawning aggregates are written into the recovery plan so that would represent a change to the recovery plan. Murdoch said in her view this would represent a major change to the recovery plan. The implication is that there is no concrete decision at this time but the topic may be under discussion. Graf agreed that the view was not specific, so a general question to be ask is what is the NWFSC's recent view on the White River spawning aggregate.

Murdoch posed questions from Tom Scribner (YN). Scribner asked if the White and Little Wenatchee spawning aggregates are limited by predation in the Lake Wenatchee, how do the federal regulatory agencies interact to resolve this issue? Is there a willingness by NMFS to rewrite the recovery plan? Tonseth agrees this is difficult because the programs are bound by the direction in the recovery plan. Tonseth asked, given the uniqueness of Lake Wenatchee and the White River and Little Wenatchee spawning aggregates, should they be considered one aggregate? Matt Cooper asked how often the recovery plan undergoes review. Murdoch said it doesn't. Tonseth said the plan was written in 2007.

Pearsons asked how different the White River spring Chinook salmon spawning aggregate needs to be from other spawning aggregates to be considered independent in terms of Viable Salmonid Population (VSP) parameters such as diversity. Pearsons asked, if that genetic diversity is lost and the aggregates are no longer different, how is diversity recovered? Tonseth suggested reframing the question to ask as how different all the spawning aggregates need to be to achieve the diversity component of recovery? Tonseth asked whether the plan should identify genetic characteristics that need to be met to identify a group as a spawning aggregate. Murdoch said there are specific goals for the abundance metric of VSP but there are not goals for the diversity metric. Murdoch said diversity at this time represents post-1940s divergence within the Wenatchee River spring Chinook salmon population and the goal would be to maintain the divergence that has occurred. Hillman said metrics for spatial structure and diversity are combined into a matrix and the results are used to determine if the population is at very low, low, moderate, or high risk of extinction. There are targets for spatial structure and diversity. For example, the recovery plan identifies how many spawning aggregates need to be populated with natural-origin fish. Hillman said the goal is to maintain natural spawners in 4 of 5 MSAs and in one mSA downstream from Tumwater Canyon. Thus, one or both of the MSAs upstream of Lake Wenatchee are needed for recovery.

Tonseth said there are surplus fish from Endangered Species Act-listed hatchery programs returning upstream of the Icicle Creek that currently cannot be used at LNFH because of NMFS' definition of what constitutes an Endangered Species Act-listed fish; that is, hatchery-reared fish included as part of the listing status. Kahler said in the Methow River, Methow Hatchery-origin fish are declared surplus to the recovery of the population, so that they can be surplussed for adult management or utilized as broodstock in other hatcheries. Tonseth said if listed hatchery fish could be delisted, they could be used at LNFH. Cooper said, hypothetically, a proposal would be for LNFH to be set up as a safety net program, similar to WNFH to maintain mitigation obligations using the Carson stock. Tonseth said possibly, but not at the expense of allowing natural-origin fish to spawn in the Icicle Creek, reclaiming the Icicle Creek spawning aggregate. Cooper said hypothetically, how would recovery of the Icicle Creek aggregate affect the White and Little Wenatchee aggregate. Tonseth said if the Icicle Creek aggregate were recovered to a level of a major spawning area, the White River and Little Wenatchee River could be considered minor aggregates. Murdoch said that scenario is highly speculative.

Pearsons asked, if money were put toward recovery of an aggregate, would the choice be to invest in the White and Little Wenatchee rivers, or in Icicle Creek. Tonseth and Pearsons agreed it would be Icicle Creek due to the quality and quantity of habitat in Icicle Creek.

Murdoch said all of the ideas discussed would require redrafting the recovery plan and asked who the authors of the recovery plan are. Hillman said it is NMFS's plan. NMFS and the State of Washington provided the Upper Columbia Salmon Recovery Board (UCSRB) with funds to help NMFS write the plan. Involving the UCSRB led to a grass-roots effort. Murdoch said reopening the plan would require reinitiating that effort.

Murdoch said if there is an opening to reconsider aggregate status in the recovery plan, the Upper Wenatchee River major spawning area should be discussed. Murdoch said the upper Wenatchee River MSA has very low productivity and the few natural-origin fish that return to the Wenatchee River do not typically spawn in the upper Wenatchee MSA. Spawners in the upper Wenatchee River MSA tend to be hatchery-origin strays. Murdoch suggested that perhaps the Upper Wenatchee MSA should not be considered a MSA. Pearsons agreed and remarked the data show that is not a self-sustaining spawning location and serves more as a sink. Tonseth agreed and commented that the data on spawning success and survival were not available when the plan was written. The plan was written based on where fish were observed spawning.

Hillman projected the recovery plan for reference. Hillman showed the recovery criteria for abundance, productivity, diversity, and spatial structure. Pearsons said he is interested in one of the criteria on genetic variation; how different do the stocks have to be (number 1c)? Hillman said the assumption was made that there was some differentiation between spawning aggregates. Specifically, the focus on the White and Little Wenatchee was because it was thought those aggregates were substantially different from others. Pearsons said this was written before more recent information was provided by geneticists (e.g., provided by the panel of genetic experts consulted in late 2018). Pearsons noted that differentiation of the White River fish was determined to have occurred over just two generations, which may not necessarily be adaptive variation, but rather the result of a founder effect. Murdoch said she was also surprised by how little genetic difference there was between populations. Graf said genetic reports have shown that diversity within the Chiwawa aggregate is greater than between aggregates.

Hillman showed the risk analysis scores for the individual spawning aggregates and the criteria for scoring abundance/productivity risk factors (Appendix B to the recovery plan). Hillman said NMFS reevaluates the status of the populations every 5 years to determine if the viable population parameters (abundance, productivity, spatial structure, and diversity) have improved.

Matt Cooper asked what the end goal is for the PRCC HSC. Is the Subcommittee's task to evaluate hatchery actions to move the needle toward recovery? How should the Subcommittee evaluate other actions that contribute to recovery? Murdoch said many of these questions came up when tasked with the question of whether to reinitiate a White River hatchery plan. Pearsons said gathering all the information possible will help the committee determine what program should occur in the White

River. Hillman said one reason to get this information from Busack is to help inform the subcommittee as to the need for a White River Hatchery program. If a program is deemed necessary, feedback from Busack will further inform what fish would be collected for broodstock, how many broodstock would need to be collected, and how many juveniles would need to be produced in the program. Pearsons said using brood from other sources counteracts the goal of recovery to protect or increase the diversity of the White River aggregate.

Murdoch said a lot of research has been done over the past 10 years and a key question is if there are criteria identified that are no longer relevant based on recent results and whether there is an opportunity to revise the criteria. Murdoch asked Hillman if a question like that would carry more weight coming from the HSC or from the UCSRB, and whether the UCSRB would engage on the issue. Hillman said it may get more traction if it is supported by the UCSRB. Hillman said bringing all parties along to create the recovery plan was very challenging; the UCSRB may not be interested in reopening the plan. Murdoch suggested finalizing some additional research such as the reproductive success study. If the science suggests some of the goals are no longer supported, the UCSRB may support reopening the recovery plan. Hillman suggested waiting for the results of the next status review (to be completed in 2020) to see if the populations have moved toward recovery. Hillman noted that in the last status review, NMFS determined that populations in the Upper Columbia were holding steady.

Pearsons suggested asking Busack these questions and the PRCC HSC can take a particular course of action depending on his responses.

Pearsons added a few more questions. Pearsons asked, if the White River genetic signature is lost (has been lost already or is lost due to hatchery actions), what is the path to recovery? Murdoch said Scribner had a similar question. Murdoch said the Relative Reproductive Success Study is showing that the hatchery fish (Chiwawa River strays) spawning in the White are equally as productive as the natural-origin fish spawning in the White River. So why is there still a distinct signature for the White River aggregate? Pearsons said the White River genetics may be diluted and whether the uniqueness of the aggregate has been maintained may come to light in the 10-year Comprehensive Report (to be completed in 2020).

Pearsons asked whether NMFS would support a composite broodstock. Murdoch added if the spawning aggregates are not genetically distinct, how would it change NMFS view on supplementation? Murdoch said the current interpretation is to wait and see if the aggregates are genetically distinct.

Pearsons asked how hatchery-origin spawners contribute to recovery if they don’t contribute appreciably to increasing the production of natural-origin offspring. Pearsons said the interpretation of VSP criteria is that hatchery fish don't count toward recovery, and in fact they can count against the status of the aggregate. Pearsons asked whether starting a hatchery program would contribute to recovery in terms of the VSP criteria or count against it? Cooper said hatchery fish may count towards diversity or other metrics. Murdoch said a hatchery could contribute by maintaining natural-origin productivity. Murdoch said hatcheries won't bring an aggregate to recovery if the limiting factors are not addressed. Hatcheries can buy time and offer an extinction risk buffer.

Hillman said responses from Busack should provide members with some of the information they need to support or reject a White River hatchery program. Answers to these questions provide Subcommittee members justification for making recommendations.

Hillman suggested if Busack cannot represent NMFS' position on these questions, the questions should be provided to someone else at NMFS. Hillman suggested allowing the PRCC HSC members an opportunity to review the list and provide edits/comments by December 5. The list can then be sent to Busack.

The draft list of questions for Busack, recorded by Hillman during the preceding discussion is as follows:

1. Is the White River spawning aggregate necessary to the Wenatchee spring Chinook salmon population in regards to meeting Viable Salmonid Population criteria?
2. What is the NOAA Science Center's most recent view on the importance of the White River spawning aggregate?
3. If survival data indicate the bottleneck for White River spring Chinook salmon is predation (e.g., bull trout) within Lake Wenatchee, how do the federal regulatory agencies interact to resolve the issue?
4. If the White River and Little Wenatchee spawning aggregates are important to recovery and both suffer from similar agents of mortality within Lake Wenatchee, how will NOAA address recovery without one or both aggregates?
    a. Can both aggregates be considered one aggregate?
    b. Is there a need to revise the existing recovery plan?
5. How important is the White River aggregate to the overall genetic diversity of Wenatchee spring Chinook salmon?
    a. How much within-population genetic variation is needed for recovery?
6. If the White River genetic signature is lost, can recovery still be achieved?
    a. If so, how do we achieve recovery without the White River genetic signature?
7. Would NOAA support a composite broodstock hatchery program for the White River?
8. If White River spring Chinook salmon are not genetically distinct from other Wenatchee spring Chinook salmon aggregates, what would be NOAA's view on White River supplementation?

9. If hatchery-origin fish do not contribute to natural-origin fish, would adding another supplementation program in the Wenatchee contribute to recovery?

D. Chinook Salmon Transfers from Eastbank Hatchery

Todd Pearsons updated the Subcommittee on transfers of spring Chinook salmon from Eastbank Hatchery to acclimation facilities.

Nason Creek spring Chinook salmon were transferred to the Nason Creek acclimation facility in the third week of October. Survival was good.

Carlton summer Chinook salmon were transferred during the second week of October. They are currently being held on groundwater because of past health concerns, and mortality rates have been very low. Pearsons said the use of groundwater seems to be helping with fish health.

VI. Administration

A. Next Meetings

The next HCP-HCs and PRCC HSC meetings are December 18, 2019, January 15, 2020, and February 19, 2020, at Grant PUD in Wenatchee, Washington.

A determination will be made in early December whether the HCP-HCs and PRCC HSC will convene in person or via conference call.

VII. List of Attachments

Attachment A List of Attendees
Attachment B Skaha Lake Sockeye Re-introduction Update

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Larissa Rohrbach	Anchor QEA, LLC
Ian Adams	Chelan PUD
Scott Hopkins	Chelan PUD
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Peter Graf‡	Grant PUD
Todd Pearsons‡	Grant PUD
David Duvall	Grant PUD
Ryan Benson	Okanagan Nation Alliance
Matt Cooper*‡	U.S. Fish and Wildlife Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
David Clark°	Washington Department of Fish and Wildlife
Keely Murdoch*‡	Yakama Nation

Notes:
* Denotes HCP-HC member or alternate
‡ Denotes PRCC HSC member or alternate
° Joined by phone

Attachment B

Skaha Lake Sockeye Re-Introduction Program Update

November 20, 2019

Wenatchee, WA

Presented to PRCC Hatchery Subcommittee

syilx Okanagan Nation Alliance

OKANAGAN NATION AQUATIC ENTERPRISES LTD.

Attachment B

Hatchery Operation

Attribute	2014 (start up)	2015	2016	2017	2018	2019
Fecundity mean	2,439	2,096	2,144	2,095	1,864	1,650
Total eggs collected	2,452,000	508,000	5,256,000	1,312,429	4,148,460	720,459
Trap & Transport eggs	N/A	N/A	800,000 (15%)	514,000 (39%)	847,060 (20%)	**100%**
Egg to fry survival	71.8%	72.0%	95.1%	93.9%	90.9%	N/A
Cryofreezing samples	40 males	33 males	23 males	35-40 males	40 males	24 males

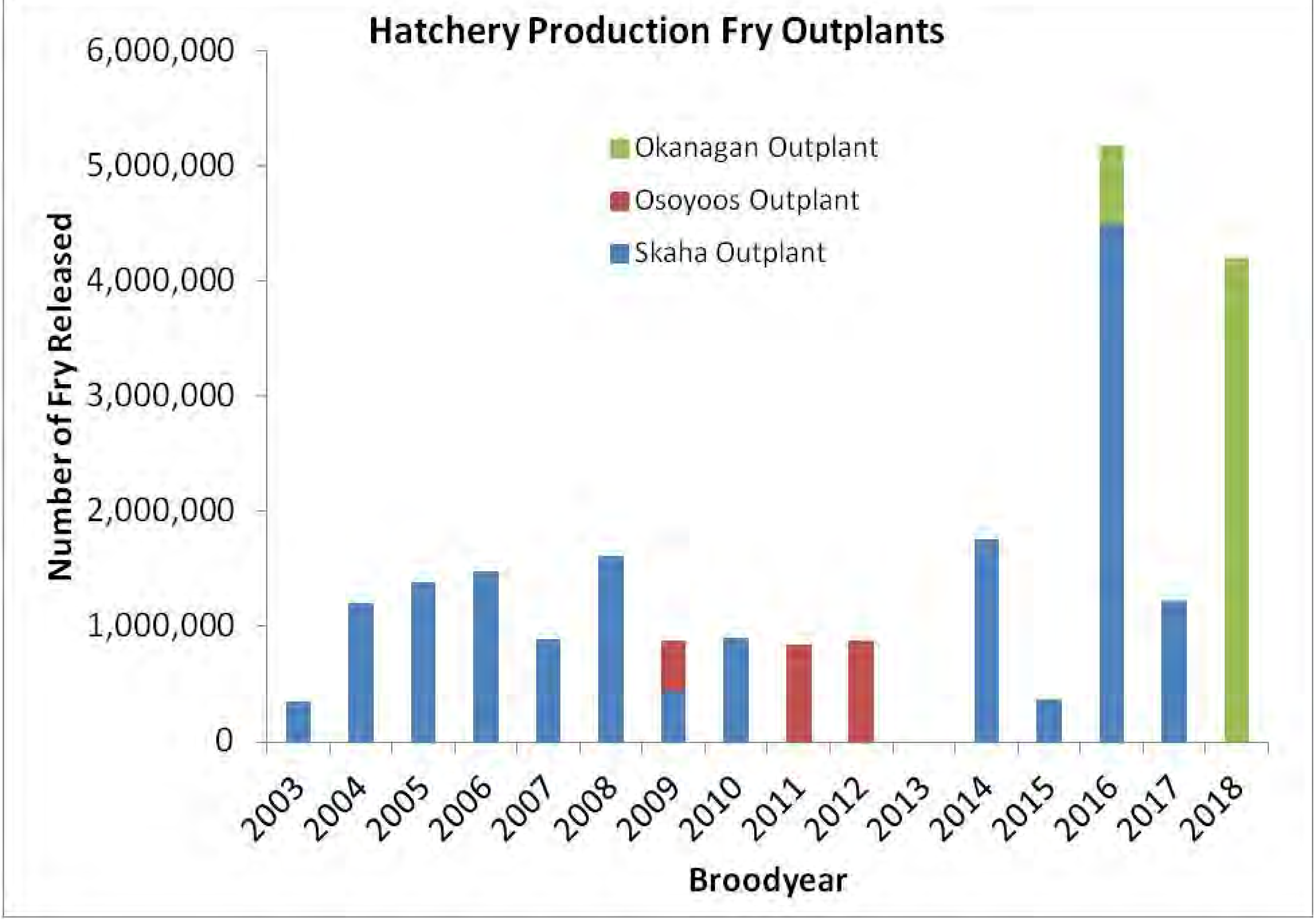
- Archiving milt for future years (contingency). Typically use 20 male samples from four years previous for fertilization; same parental stock cycle. (Not done in 2019).
- Continue experimenting with more natural release strategy (March, April, May)

Hatchery Operation – cont'd

- High number of 3-year olds – total 30 females (6.8 %)
- 32 females from Penticton Channel (6.2% of total egg take)
- Jacks and Jills were trying to enter hatchery effluent pipe

•All brood females were transported to hatchery for spawning (improved logistics)

- All males live squeezed and released in Oliver.
- Streamline for large 2020 return


Hatchery Production Fry Outplants
Number of Fry Released
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Okanagan Outplant
Osoyoos Outplant
Skaha Outplant
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Broodyear

BY 2017 (spring 2019) PIT Results

	Osoyoos	Skaha	Combined
Survival (release to Bonneville)	0.34	0.24	0.28
Travel Time (days)	30.0	27.1	29.1

- On-going improvements in methods – reduced handling to improve survival
- Total PIT tagged = 9,082;
  - Osoyoos = 4,968
  - Skaha = 4,114

Skaha Lake Natural Production

Brood Year	Escapement (est)	Egg deposition (million)	Natural Smolts
2011	9,426	10.3	309,000
2012	8,273	9.1	270,000
2013	6,840	7.5	225,000
2014	20,916	23	690,000
2015	1,632	1.8	54,000
2016	4,016	4.4	132,000
2017	5,600	6.2	185,000*
2018	23,500	25.9*	940,000*
2019*	2,240**	2.0*	60,000*

In-Lake Monitoring Summary

- BY 2004-2017 mean hatchery survival
  - Fry to pre-smolt – 40.7% (56% lower than Osoyoos natural)
  - Egg to pre-smolt – 15.2% (102% or 3X higher than natural)

- Possibly reached Skaha L. carrying capacity
  - Potential density dependence: growth suppression in 2018, no survival reduction detected.
  - May change annually depending on conditions (nutrients & production, flushing, natural SK/KO escapement, Lake Whitefish)
  - Possible optimal/maximum loading density for hatchery fry

- Various fry release scenarios based on thermal marks.
  - Range 500,000 – 4.2 million in Skaha
  - 2 – 3 million hatchery fry would achieve same level as BY 2016 (approximately 2000 SK fry/ha, including wild)

- Skaha Lake kokanee stock is better than pre-treatment
  - Escapement 770-20,000 (pre) vs. 12,000-98,000 (post)
  - 2017 in-lake biomass was highest in 12 years
  - 2-3 year old KO have the greatest impact on zooplankton

Lab development



- Molecular testing qPCR
  - Real time PCR for IHN and BKD
  - ELISA for BKD
  - eDNA for N. Pike, Chinook, mussels (invasive and endangered)
- PRV disease testing for fish farms
- Chinook biosampling initiatives
- Northern Pike aging
- Water Quality Monitoring
- Macroinvertebrates
  - CABIN and EEM method
  - Partnership with certified taxonomists

Okanagan Basin Salmon Restoration Sub-Committee

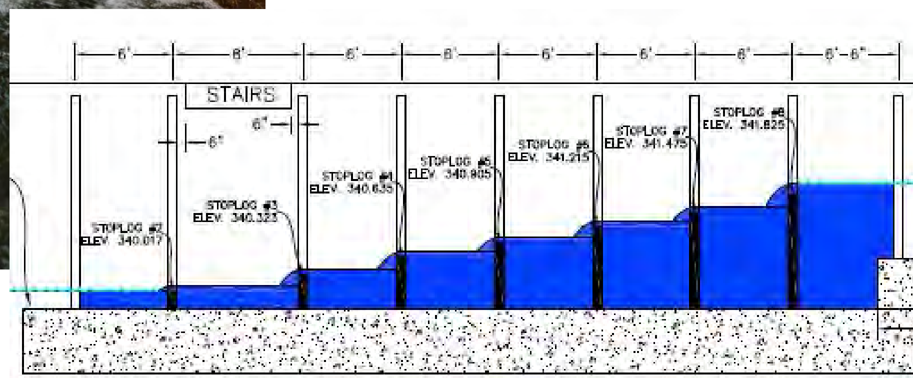
- New mandate of the Skaha Re-Introduction Sub-Committee
- Incorporates all lakes and tributaries in Okanagan Watershed
- Salmonids (Sockeye/kokanee, Chinook, Rainbow/steelhead)
- Invasives and Species at Risk
- Ecosystem approach
- Currently drafting an Okanagan Lake Monitoring and Evaluation Plan for the Basin
- 4.2 million Sockeye fry released in Okanagan Lake (ITC approval, COBTWG Letter of Support)
    - Monitor fry using Fall/ Winter ATS
    - Smolt migration in 2020
    - Returning adults
    - Residualization

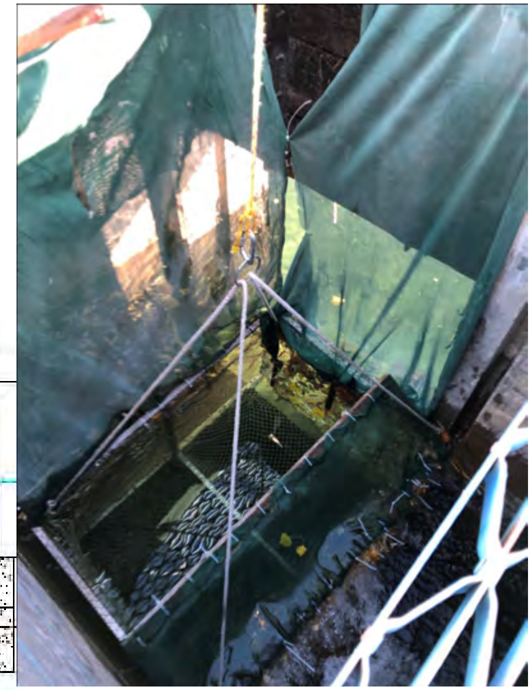
Okanagan Lake Program

- DFO has approved long-term hatchery Sockeye outplants, contingent on an M&E program
  - M&E Plan is being finalized
  - Okanagan Basin Salmon Recovery Sub-Committee
  - Working towards Salmon passage at Penticton Dam (proposed trap and tag 100 adults in October 2019)

- Hatchery stocking:
  - 2016 – 9,994
  - 2017 – 683,656
  - 2018 – 10,110
  - 2019 – 4,200,000
- Potential for high natural production; exceed Skaha and Osoyoos combined

Penticton Dam (Okanagan Lake Outlet) Passage





- First passage since 1953
- Similar to Skaha Lake Dam
- Testing hydraulics, jump efficiency, attraction flow for 2020
- No SK captured, likely missed migration window
    - 2 mid-sized Rainbow Trout in net pen

•Identify improvements for future funding (e.g. automated gates, capture platform, PIT antenna)

limləmt

Appendix C
Habitat Conservation Plan Tributary Committees 2019 Meeting Minutes

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 10 January 2019

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Catherine Willard (Chelan PUD), and Tracy Hillman (Committees Chair).

Members Absent: Kate Terrell (USFWS) and Justin Yeager (NOAA Fisheries)[1].

Others Present: Becky Gallaher (Tributary Project Coordinator), Steve Kolk (U.S. Bureau of Reclamation), Mike McAllister (Inter-Fluve), and Hans Smith, Chris Clemons, and Jason Breidert (Yakama Nation).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 10 January 2019 from 9:00 am to 12:45 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following changes:

- Added East Fork Mission Creek Restoration Project discussion.
- Added Monitoring Side Channel Design Project discussion.
- Added Icicle Boulder Field Fish Passage Project discussion.
- Added Barkley Irrigation – Under Pressure Project Time Extension.
- Deleted Burns-Garrity Seasonal Side Channel Project: The project sponsor (Cascade Columbia Fisheries Enhancement Group) did not submit the proposal.

II. Review and Approval of Meeting Minutes

Tributary Committees members present reviewed and approved the 13 December 2018 meeting notes. Tracy will secure approval from Kate and Justin, who were not present because of the federal government furlough.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

[1] Kate and Justin will provide their input and votes on decision item following the meeting.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported that Phase 1 of construction is complete. A contract has been issued for Phase 2 and the sponsor released a bid solicitation for Phase 3.
- Icicle Boulder Field Project – The sponsor (TU) reported they continue to prepare a potential bid solicitation, which they hope to release in spring 2019. They also worked with Washington Department of Fish and Wildlife (WDFW) and the City of Leavenworth to address the fish screen costs. The City agreed to remove several features that were originally added to improve future water management. These features were unnecessary for fish screen function.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (WDFW) submitted the third-year monitoring report, which was uploaded to the Extranet Site.
- Burns-Garrity Design Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a new project application that proposes to develop a seasonal side channel rather than a perennial side channel.
- Beaver Fever Project – The sponsor (TU) continues to work with the Forest Service on installation of beaver dam analogs (BDAs) in Potato and Roaring creeks.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) reported no new activity on this project. The sponsor plans to resume surveys next summer.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported they are currently reviewing the preliminary design. A regulatory site visit is planned for mid-January.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they continue to do weekly water-quality sampling. Because of snowfall, sampling has been limited to the lower site at the Chiwawa River Road Bridge.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they held a meeting on 19 December with Natural Systems Design (NSD) and members of the TC to discuss initial designs. NSD is developing preliminary designs.

IV. Project Collaboration

Steve Kolk (Bureau of Reclamation; BOR) described their (BOR) vision for habitat restoration work in the Upper Columbia (see Attachment 1). He talked about the evolution of restoration efforts in the Upper Columbia and concluded that we are now at a point where we need to implement larger, more complex and expensive projects than we have in the past (what he called “mega” projects). He added that most of the easier, smaller projects (he called these “micro” projects) have been implemented. Steve presented a flow diagram showing the framework for implementing both “micro” and “mega” projects. Under the “mega” approach, BOR will no longer sole source projects but rather allow implementers to bid on larger projects. Steve believes competition will increase the cost-effectiveness of projects.

The approach begins with BOR teaming with a funding entity (the team is referred to as the Development Team). BOR believes engaging a funding partner early in the process will have the highest likelihood of success. The Development Team will work together to identify and scope high priority projects in high priority areas. Once identified, BOR will use their resources to develop preliminary, draft, and final designs. Project sponsors are selected (e.g., through competitive bids) and they implement the projects. This scope-driven approach should reduce costs and increase certainty of success.

Steve explained that BOR brings project management and technical expertise to the process. Regarding project management, BOR will identify roles and responsibilities, provide stakeholder management, and help identify “Go” or “No Go” decision points. BOR has numerous technical partners including support from their Technical Service Center. Steve said the BOR has identified a few high-priority projects in the Upper Columbia including actions on the Upper Wenatchee, in Peshastin Creek, the Sugar Levee, and possible passage at natural barriers (e.g., upper Nason Creek and Upper Little Wenatchee River). These projects are consistent with potential projects identified earlier by the Tributary Committees. The Committees will continue to discuss teaming opportunities with BOR and identification of high-priority projects.

V. Time Extension Request

Barkley Irrigation Company – Under Pressure Project

The Rock Island Tributary Committee received a time extension request from Trout Unlimited on the Barkley Irrigation Company – Under Pressure Project. Because of the size and complexity of the project, and the time needed to complete the project, the sponsor asked to extend the completion date from 31 December 2018 to 31 December 2019. After review and discussion, members present from the Rock Island Tributary Committee approved the time extension. Tracy will secure input from Kate and Justin once the furlough ends.

VI. General Salmon Habitat Program Application

Icicle Creek Fish Passage – Wild Fish to Wilderness Project

In December, the Committees received a General Salmon Habitat Program proposal from Trout Unlimited titled: *Icicle Creek Fish Passage – Wild Fish to Wilderness Project*. The purpose of the project is to enhance fish passage at the Boulder Field (RM 5.6) on Icicle Creek and thereby provide access to more than 23 miles of high-quality habitat. This will be accomplished by creating a 160-foot fishway (14% slope, step-pool channel) along the left bank. This project is likely to have a large positive effect on steelhead abundance, productivity, and spatial structure. The total cost of the project is $2,275,000. The sponsor requested $375,000 from HCP Plan Species Account Funds. The amount requested from the Tributary Committees would be in addition to the $250,000 approved by the Rock Island Tributary Committee in 2015. In December, all members except the Colville Confederated Tribes (CCT) approved funding for the project. The CCT asked for additional time before providing their vote on the project. During the January meeting, CCT approved funding for the project provided a statement of agreement (SOA) regarding anadromous fish management in the Icicle watershed is signed by the Yakama Nation (YN), CCT, WDFW, NOAA Fisheries, and USFWS. Approval by YN was also contingent on approval of the SOA. The Rock Island Tributary Committee considers this proposal a budget amendment. Thus, the total amount approved by the Rock Island Tributary Committee for this project is $625,000. Justin and Kate provided input on this project in December.

Upper Kahler Stream and Floodplain Enhancement Project

In December, the Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Upper Kahler Stream and Floodplain Enhancement Project*. The purpose of the project is to reduce the risk of an avulsion near RM 8.6 on Nason Creek by constructing a large, buried, log jam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project will also construct three additional buried bank jams and enhance fish habitat at the downstream end of the avulsion channel. In addition to minimizing the risk of an avulsion, the proposed placement of wood and enhancement of the downstream end of the avulsion channel will improve spring Chinook and steelhead habitat. The total cost of the project is $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. In November, the Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the Committees during a future meeting explaining the design of the project.

During the January meeting, YN and their consultant, Mike McAllister (Inter-Fluve), gave a presentation on the design of the Upper Kahler Stream and Floodplain Enhancement Project (see Attachment 2). They walked through the design process and why certain elements identified by the Tributary Committees were or were not included in the final design. They stated that the current landowner has removed riparian vegetation around the avulsion channel and that is why there will be no disturbance to riparian vegetation during the filling of the avulsion channel. The Committees questioned the need for filling the avulsion channel. They recommended simply adding large wood and a few boulders that will help trap sediments and fill the avulsion channel naturally.

With regard to the large logjam at the upstream end of the avulsion channel, YN stated the structure serves two purposes; it provides fish habitat and reduces erosion of the bank where an avulsion is most likely to occur. The structure is designed to allow higher flows to spread out onto the floodplain. Thus, it still provides floodplain connectivity, but without the concern of an imminent avulsion. The other large-wood structures are designed to provide fish habitat (i.e., pools and cover, both of which are limiting in this reach of Nason Creek).

Following the presentation, the YN recused themselves and the Committees discussed the project. The Committees struggled with filling the avulsion channel with large sediments. They believe adding wood and a few boulders in the avulsion channel will help trap smaller sediments and fill the channel naturally. They elected to table a decision on this project until Justin and Kate have an opportunity to provide feedback on the project. Once the furlough ends, Tracy will schedule a conference call to discuss this project with all members.

Stormy Project Area "A" Stream and Floodplain Enhancement Project

In December, the Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Stormy Project Area "A" Stream and Floodplain Enhancement Project*. The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat. This will be accomplished by constructing ten mainstem log structures and two perennial side channels. One side channel will be 200 feet long; the other will be 2,500 feet long. Large wood will also be placed throughout the side channels. The total cost of the project is $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. In December, the Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the Committees during a future meeting explaining the design of the project.

During the January meeting, YN and their consultant, Mike McAllister, gave a presentation on the design of the Upper Kahler Stream and Floodplain Enhancement Project (see Attachment 3). They explained that the existing side channel that the Committees wanted reconnected is too high on the floodplain to connect with the river and has zero gradient. They would also need to mitigate for the existing network of wetlands that currently exist in the side channel. The side channel proposed by YN was designed to avoid destroying existing wetlands but nevertheless provide wetland connections at higher flows. YN showed a similar side channel project along the Chewuch River in the Methow River basin. They indicated that the side channel is used for spawning and rearing by spring Chinook salmon, coho salmon, and steelhead. YN also explained that the large wood structures proposed along the margins of the main channel are designed to provide fish habitat (pools and cover) and are not designed to stabilize banks.

The Committees asked about the possibility of elevating the bed of the main channel. This would allow floodplain reconnection without extensive floodplain excavation. YN indicated they examined the possibility of elevating the bed but found it would have unacceptable consequences to an upstream landowner, who opposed the action. Thus, they are limited to restoring the floodplain without elevating the main channel.

Following the presentation, YN recused themselves and the Committees discussed the project. The Committees appreciated the discussion on the project and they better understand the reasons for the constructed side channels and the placement of proposed large wood structures in the mainstem Entiat River. Given the presentation and discussions, members of the Committees present elected to fund the project for $1,140,968.15. They directed Tracy to secure justification from YN for the cost of excavation and mobilization. Together, these items cost nearly $600,000, which seems excessive given the spoils from excavation will be placed onsite. They also directed Tracy to secure feedback from Kate and Justin, who were not present because of the government furlough. If Justin approves the project, the Rock Island or Rocky Reach Plan Species Account will support the project.

Johnson Creek US Highway 97 Habitat Restoration Project

The Committees received a General Salmon Habitat Program proposal from Trout Unlimited titled: *Johnson Creek US Highway 97 Habitat Restoration Project*. The purpose of the project is to remove a fish passage barrier on Johnson Creek, a tributary to the Okanogan River. The project will replace the existing culvert, which is located just upstream from the town of Riverside, with a precast concrete structure that will allow passage for all life stages of Chinook salmon and steelhead at all flows. The project will allow fish access to nine miles of high-quality spawning and rearing habitat in Johnson Creek. The total cost of the project is $1,562,455.00. The sponsor requested $267,547.00 from HCP Plan Species Account Funds. Tributary Committees members present elected to fund the project. Note that Chris Fisher (CCT) recused himself from voting on this project. The Committees directed Tracy to secure feedback from Kate and Justin on this project. If approved by Justin, the Wells Plan Species Account will support the project.

VII. Review of Tributary Committees' Policies and Procedures

Policies and Procedures for Funding Projects

The Committees reviewed their Policies and Procedures document and made a minor edit to clarify language in Sections 2.0 (Funding Programs). They made no other edits or changes to the document.

Tributary Committee Operating Procedures

The Committees reviewed their operating procedures and made a formatting change to the Introduction. They made no other edits or changes to the document.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from December and January:

   Rock Island Plan Species Account:

   - $35.00 to Clifton Larson Allen for Rock Island financial administration in December 2018.
   - $1,451.29 to Chelan PUD for Rock Island project coordination and administration during the fourth quarter of 2018.
   - $13,922.09 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project.
   - $70.66 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project.
   - $2,194.59 to Trout Unlimited for the Beaver Fever – Restoring Ecosystem Function Project.

Rocky Reach Plan Species Account:

- $35.00 to Clifton Larson Allen for Rocky Reach financial administration in December 2018.
- $878.92 to Chelan PUD for Rocky Reach project coordination and administration during the fourth quarter of 2018.
- $7,492.31 to Cascade Columbia Fisheries Enhancement Group for the Burns-Garrity Restoration Design Project.

Wells Plan Species Account:

- $427.38 to Chelan PUD for Wells project coordination and administration during the fourth quarter of 2018.

2. Catherine Willard and Tracy Hillman reported they participated on a conference call with CCNRD and their consultant to discuss designs for the Monitor Side Channel Project. Because few Rock Island Tributary Committee members participated on the call, Tracy asked the Committee if CCNRD can present the preliminary designs to the Committee during the March meeting. Members present apologized for not participating on the call and agreed to invite CCNRD to the March meeting to discuss the Monitor Side Channel designs.
3. Tracy Hillman stated that he received an email from CCNRD asking if the Committees would be interested in seeing a proposal that restores 2.8 miles of East Fork Mission Creek, which has been affected by the presence of a retired Forest Service road within the floodplain. The road is contributing large amounts of fine sediment to the channel, causing channel incision, and creating a possible fish passage barrier. The goal of the proposed project is to remove the road prism and add wood to help reconnect the floodplain. Committees members present indicated they would like to review a proposal on the proposed project.

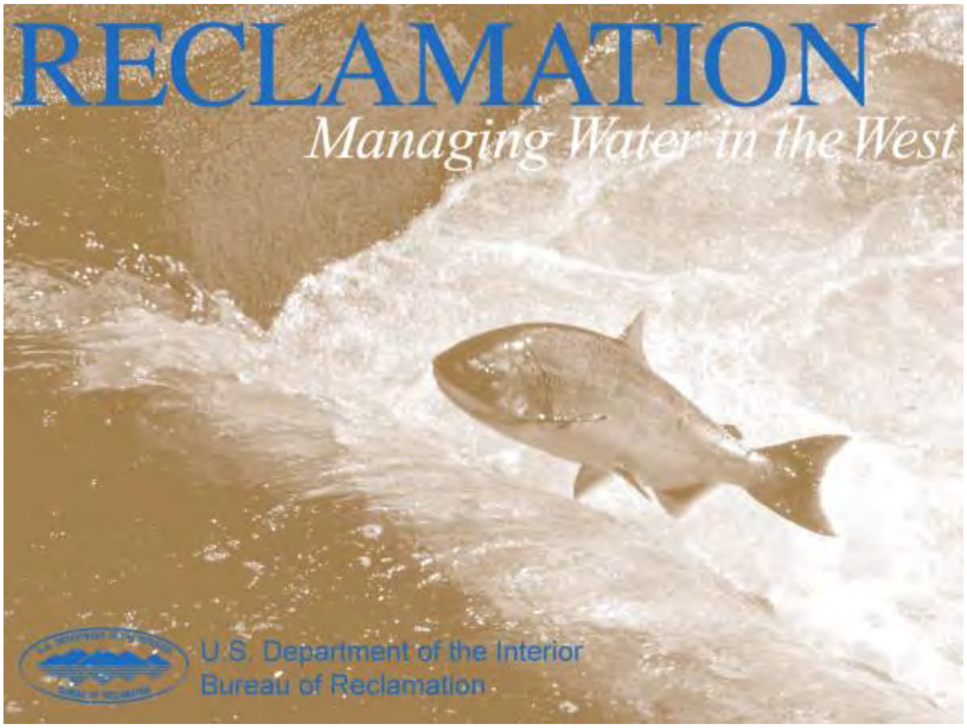
IX. Next Steps

The next scheduled meeting of the Tributary Committees will be on Thursday, 14 March 2019 at Grant PUD in Wenatchee.

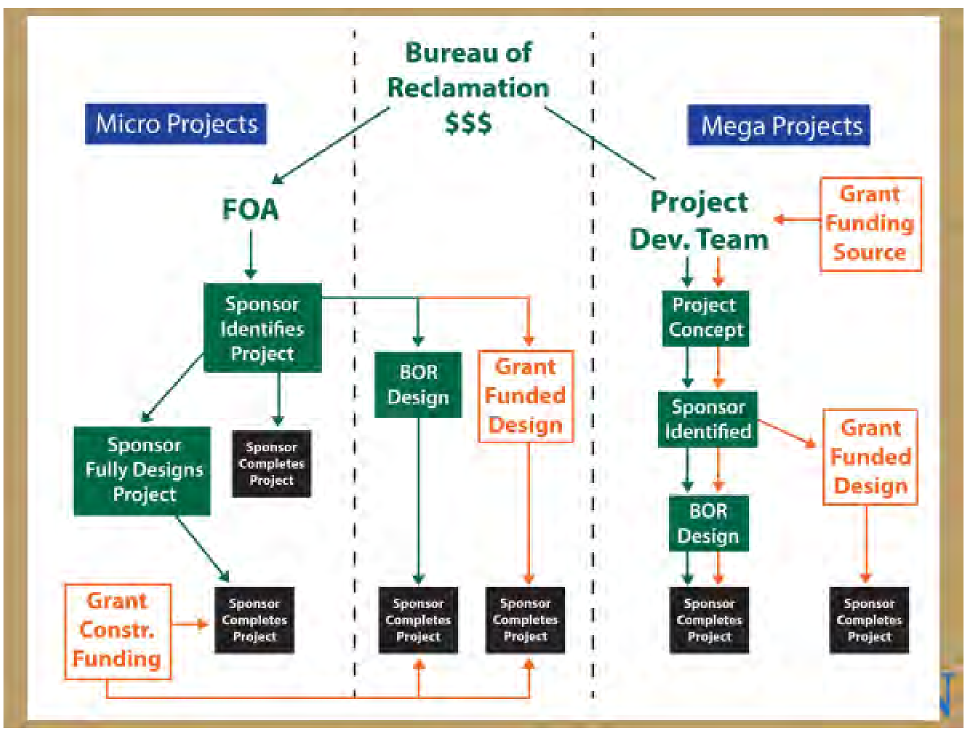
Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

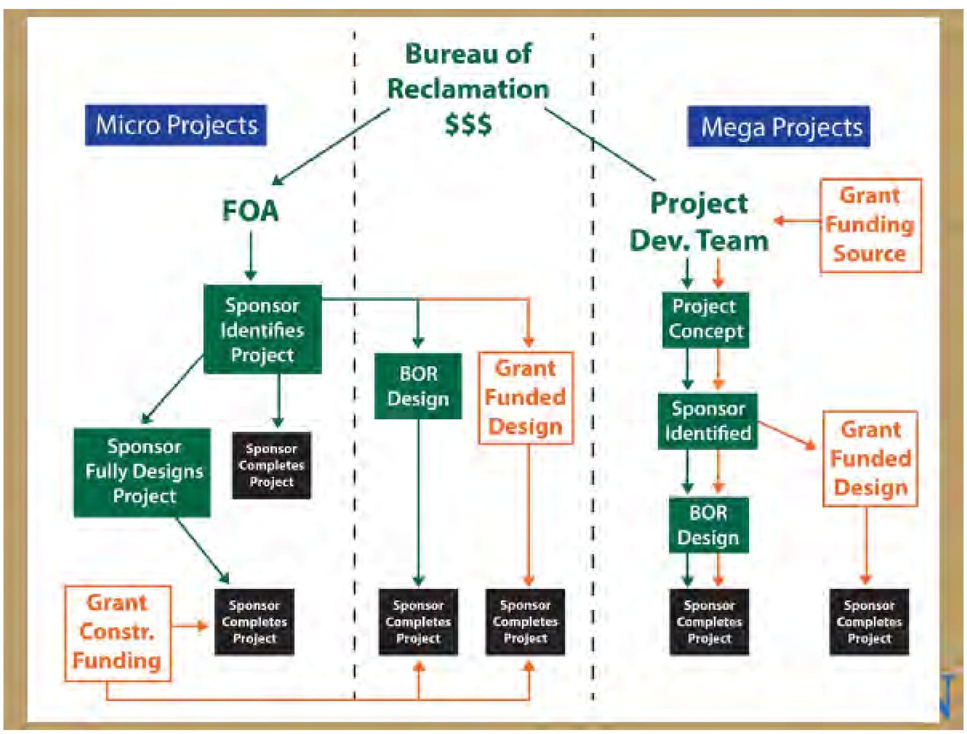
Presentation by Steve Kolk (BOR) on Partnering with HCP TCs on Targeted Projects




Reclamation Habitat Program Direction
• Regional Emphasis
• "Mega" Projects
–Finite
• "Micro" Projects
–Infinite?
RECLAMATION


Bureau of Reclamation $$$
Micro Projects
Mega Projects
FOA
Sponsor Identifies Project
Sponsor Fully Designs Project
Sponsor Completes Project
Grant Constr. Funding
Sponsor Completes Project
BOR Design
Grant Funded Design
Sponsor Completes Project
Sponsor Completes Project
Project Dev. Team
Grant Funding Source
Project Concept
Sponsor Identified
Grant Funded Design
BOR Design
Sponsor Completes Project
Sponsor Completes Project


Process Improvements
• Scope Driven
• Reduce Costs
–Time
–$$
• Provide Certainty
RECLAMATION


Bureau of Reclamation $$$
Micro Projects
Mega Projects
FOA
Project Dev. Team
Grant Funding Source
Sponsor Identifies Project
BOR Design
Grant Funded Design
Project Concept
Sponsor Identified
Grant Funded Design
Sponsor Fully Designs Project
Sponsor Completes Project
BOR Design
Grant Constr. Funding
Sponsor Completes Project
Sponsor Completes Project
Sponsor Completes Project
Sponsor Completes Project
Sponsor Completes Project

Tools and Resources

- Project Management
  - Roles and Responsibilities
  - Stakeholder Management
  - Go/No-Go Decision Points
- Technical Expertise
  - TSC
  - RO
  - IDIQ
  - WDFW
  - USFWS
  - Sponsors

RECLAMATION

Projects

- Current
  - Sugar Levee
  - Upper Wenatchee
- Pending
  - Peshastin Creek
  - Methow
- Future
  - Natural Barriers
  - Columbia Confluence
  - Additional Upper Wenatchee

RECLAMATION

Attachment 2

Presentation by Mike McAllister (Inter-Fluve) on the Upper Kahler Stream and Floodplain Enhancement Project

Issues Raised by the Committees

Avulsion - why filling the avulsion channel is necessary

- The Committees understand your efforts to minimize risk of avulsion. An avulsion at this site would reduce the amount of available habitat by disconnecting the existing meander.
- However, they do not support filling the avulsion channel with large sediments.
- Rather, they believe the risk of an avulsion could be reduced by placement of wood structures within the main channel that encourage deposition at the potential site of avulsion.
- The proper placement of these structures would also divert high-energy flow away from the left bank and thereby reduce the risk of an avulsion.

Large Wood Structures - why buried bank jams are the preferred solutions in this site

- Finally, to reduce enhancement costs, they recommend the use of pilings and racked wood to improve fish habitat in the reach. These structures would replace the proposed buried bank jams at an expected reduced cost.

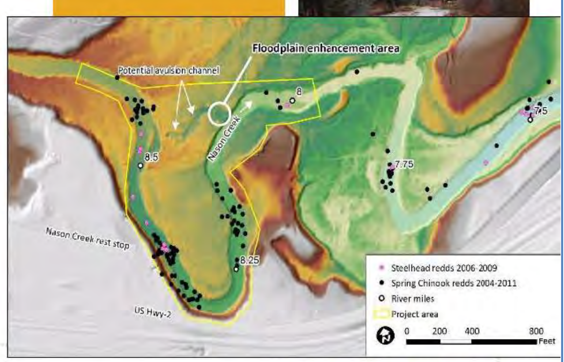
HONOR. PROTECT. RESTORE.

Project Goals

- Improve juvenile steelhead and spring Chinook rearing habitat
- Preserve existing habitat
- Increase instream complexity and alcove habitat

Objectives

- Install large wood to enhance physical habitat (e.g. increased hydraulic complexity, scour pools, gravel retention/sorting and cover)
- Preserve existing riparian vegetation and enhance riparian vegetation where practical.
- Increase high flow refuge and improve floodplain connectivity in a safe and practical manner.
- Reduce headcut risk.



HONOR. PROTECT. RESTORE. 3

Existing Condition

Natural Conditions in reach?

- Wood deficit
- Homes, roads, bridges, highway, railroad, power lines, riprap

Natural Conditions at site?

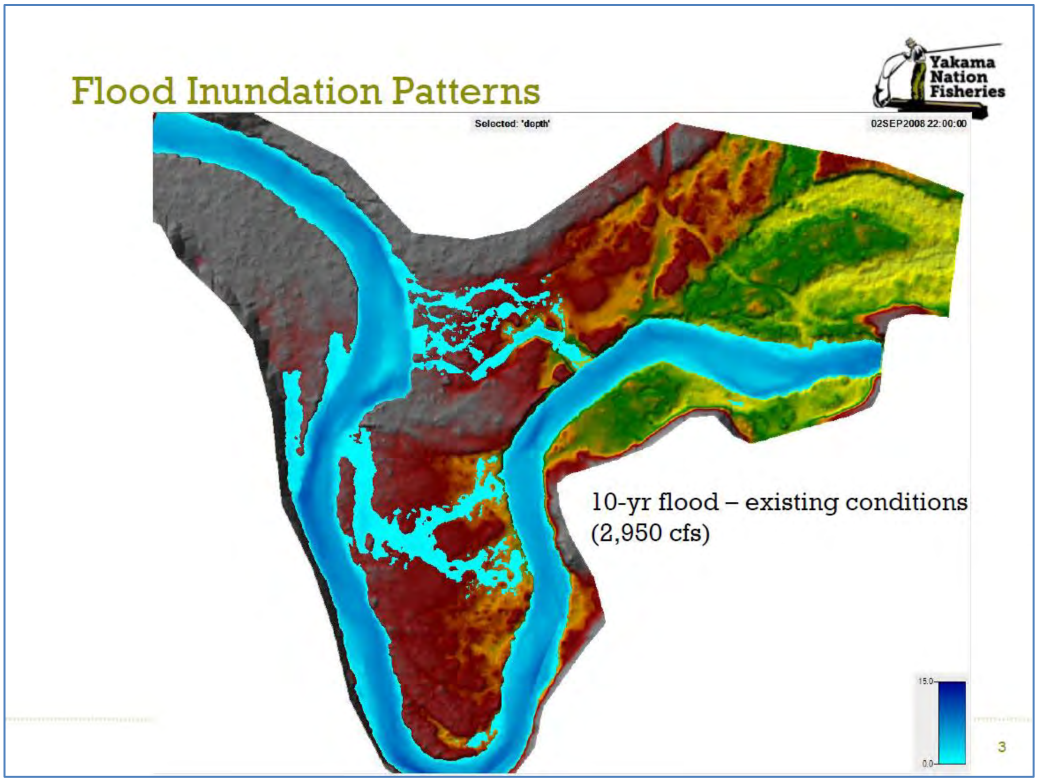
- Landowner has removed understory riparian shrubs. Ground is smooth (Low roughness). Overbank flow is swift.
- Lack of dense root structures to bind soils. Easily eroded.

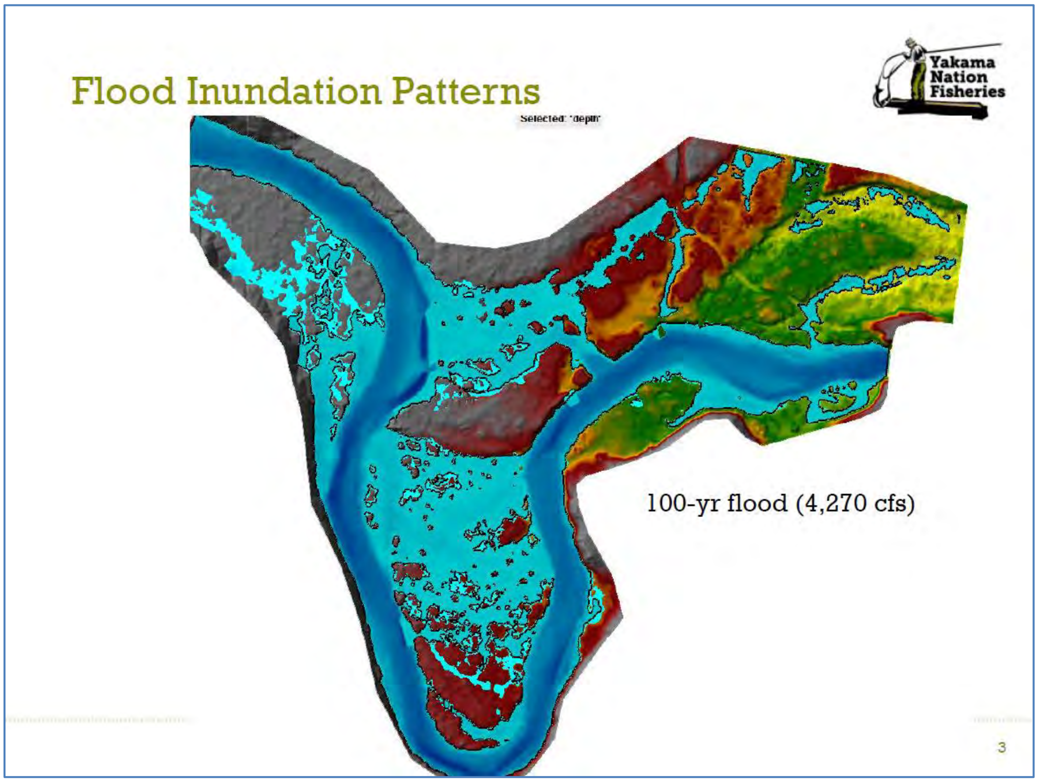
HONOR. PROTECT. RESTORE. 3

Aerial View of Existing Conditions

Yakama Nation Fisheries

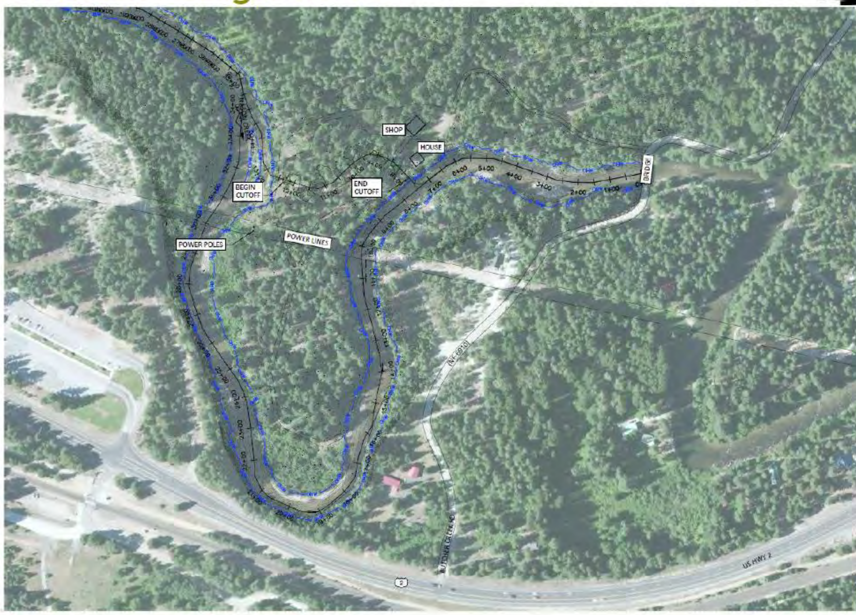
HONOR. PROTECT. RESTORE. 3


Flood Inundation Patterns
Yakama Nation Fisheries
Selected: 'depth'
02SEP2008 22:00:00
10-yr flood – existing conditions (2,950 cfs)
15.0
0.0
3


Flood Inundation Patterns
Yakama Nation Fisheries
Selected: 'depth'
100-yr flood (4,270 cfs)
3

Channel Alignments

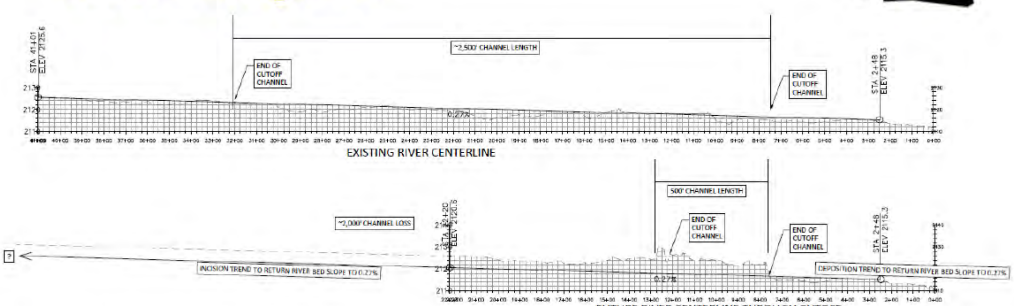
Yakama Nation Fisheries



HONOR. PROTECT. RESTORE. 3

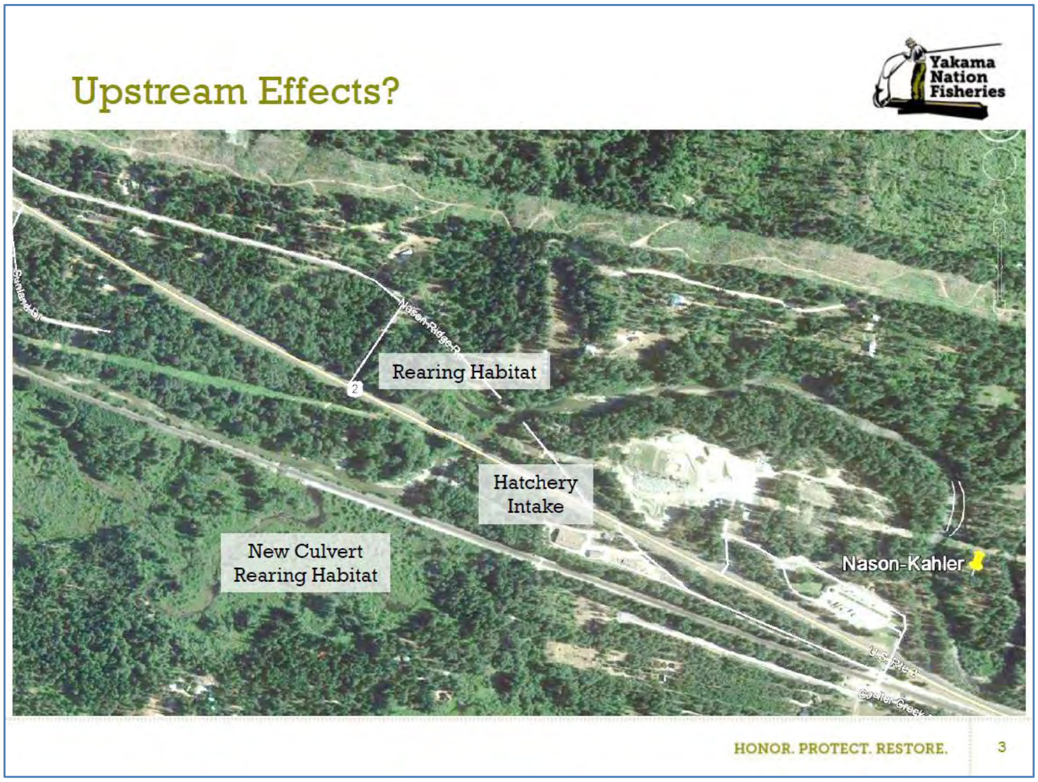
Vertical Response

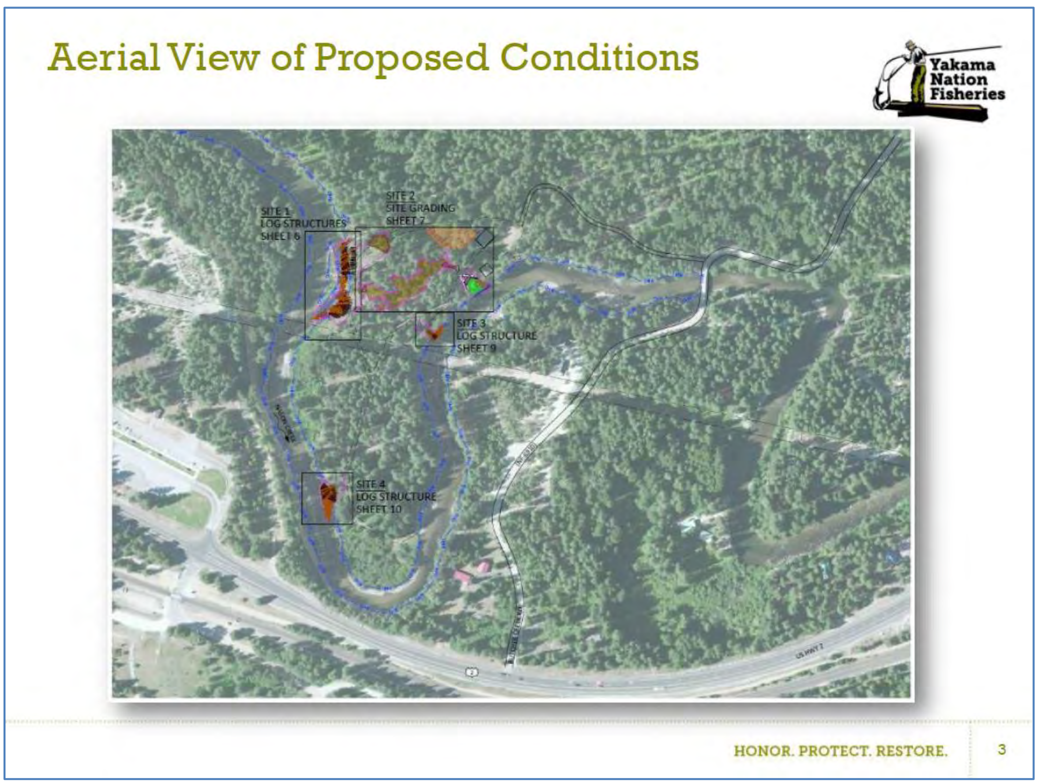
Yakama Nation Fisheries



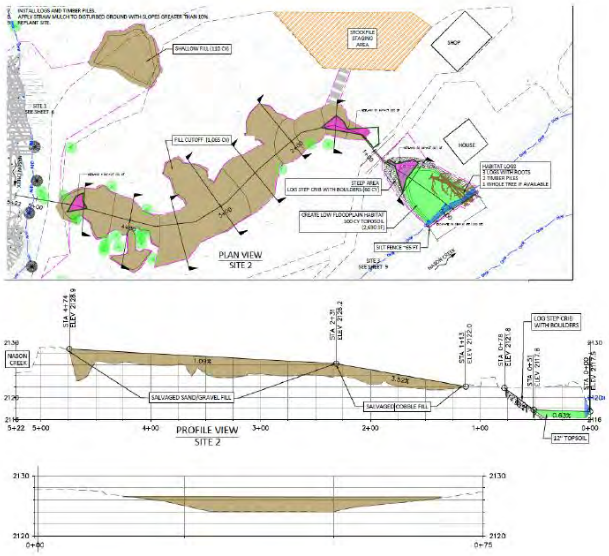
- 0.27% equilibrium slope
- Cutoff reduces channel length ~2,000 ft
- Up to 8 ft incision possible though cutoff.
- Residual headward erosion of channel, up to 5ft deep, could progress upstream to unknown distance.
- Deposition of mobilized floodplain and channel material will occur downstream (flood rise, property protection responses)

HONOR. PROTECT. RESTORE. 3


Upstream Effects?
Yakama Nation Fisheries
Rearing Habitat
Hatchery Intake
New Culvert Rearing Habitat
Nason-Kahler
HONOR. PROTECT. RESTORE.
3

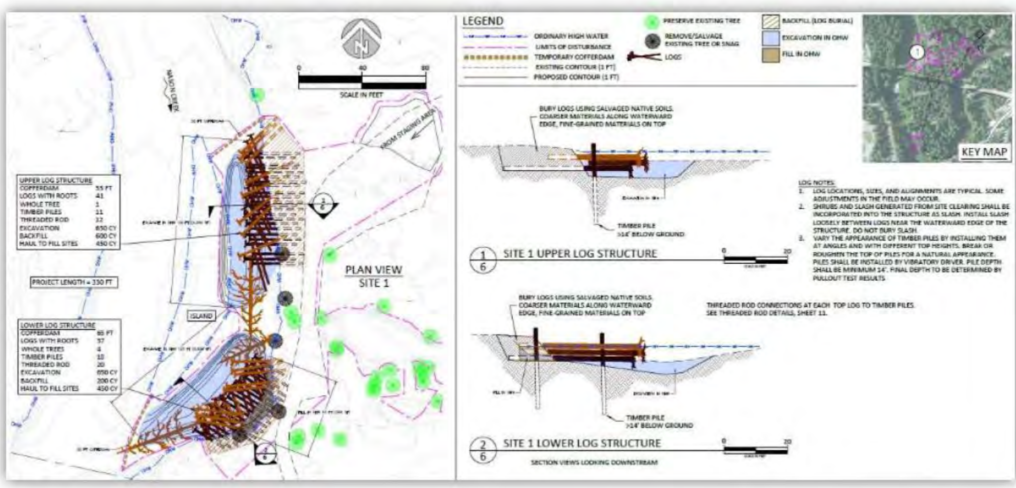

Aerial View of Proposed Conditions
Yakama Nation Fisheries
SITE 1 LOG STRUCTURES SHEET 6
SITE 2 SITE GRADING SHEET 7
SITE 3 LOG STRUCTURE SHEET 9
SITE 4 LOG STRUCTURE SHEET 10
HONOR. PROTECT. RESTORE.
3

Construction Concepts

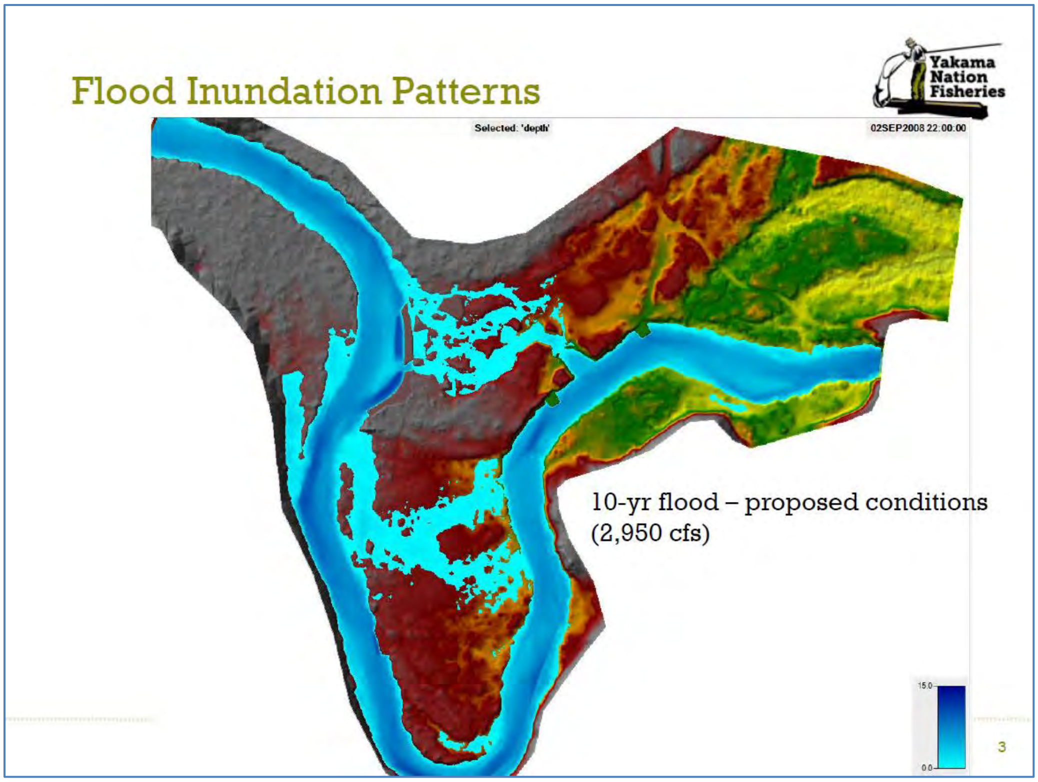


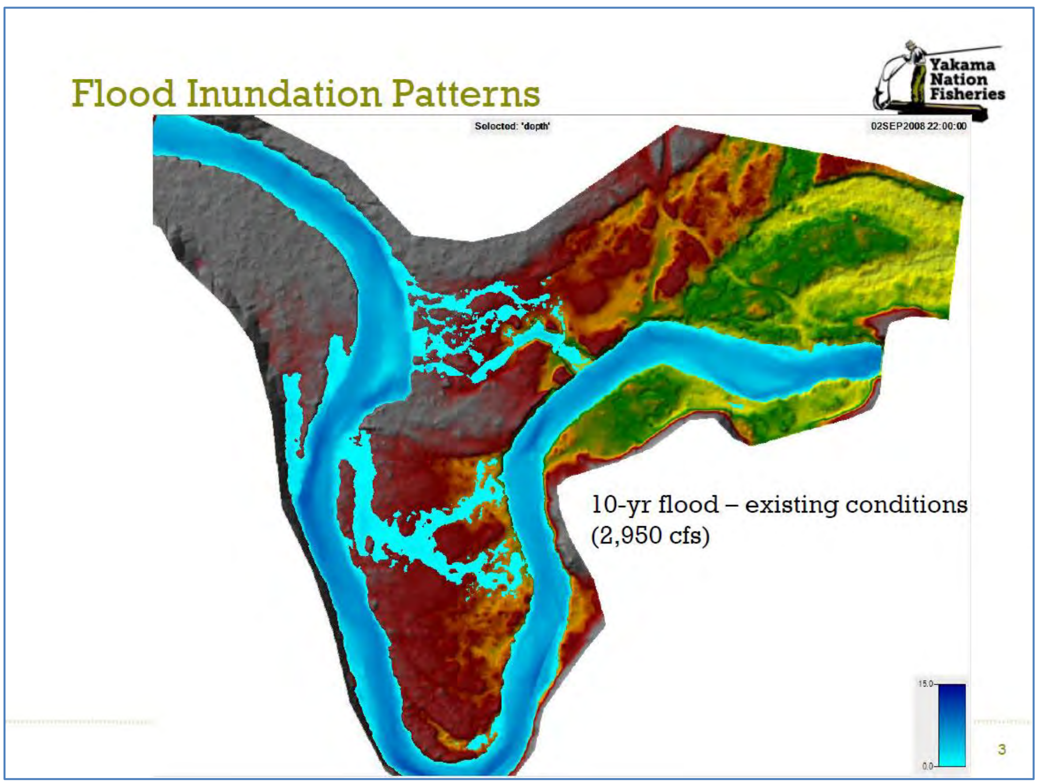
HONOR. PROTECT. RESTORE. 3

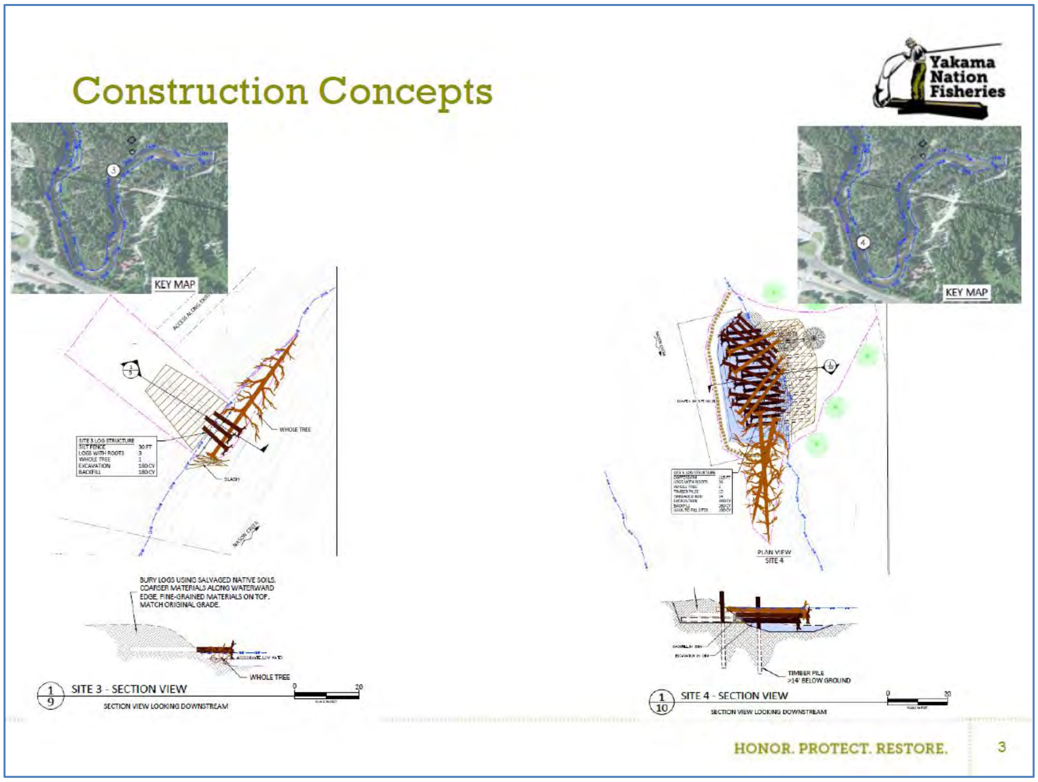
Construction Concepts



HONOR. PROTECT. RESTORE. 3


Flood Inundation Patterns
Yakama Nation Fisheries
Selected: 'depth'
02SEP2008 22:00:00
10-yr flood – proposed conditions
(2,950 cfs)
15.0
0.0
3


Flood Inundation Patterns
Yakama Nation Fisheries
Selected: 'depth'
02SEP2008 22:00:00
10-yr flood – existing conditions
(2,950 cfs)
15.0
0.0
3


Construction Concepts
Yakama Nation Fisheries
KEY MAP
WHOLE TREE
EXCAVATION 180 CY
BACKFILL 180 CY
SLASH
BURY LOGS USING SALVAGED NATIVE SOILS. COARSER MATERIALS ALONG WATERWARD EDGE, FINE-GRAINED MATERIALS ON TOP. MATCH ORIGINAL GRADE.
WHOLE TREE
1/9 SITE 3 - SECTION VIEW
SECTION VIEW LOOKING DOWNSTREAM
0 20
KEY MAP
PLAN VIEW SITE 4
TIMBER PILE >14' BELOW GROUND
1/10 SITE 4 - SECTION VIEW
SECTION VIEW LOOKING DOWNSTREAM
HONOR. PROTECT. RESTORE.
3

Attachment 3

Presentation by Mike McAllister (Inter-Fluve) on the Stormy Project Area "A" Stream and Floodplain Enhancement Project

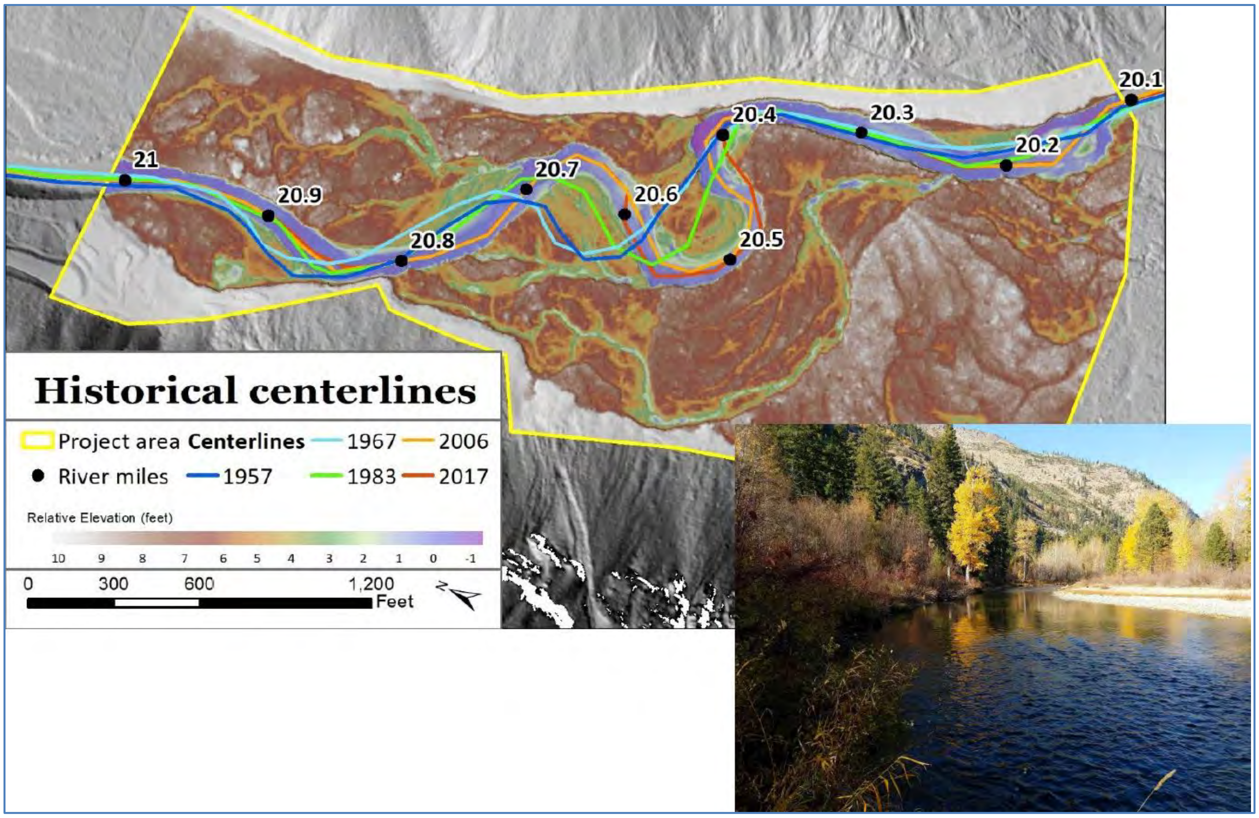
Issues Raised by the Committees

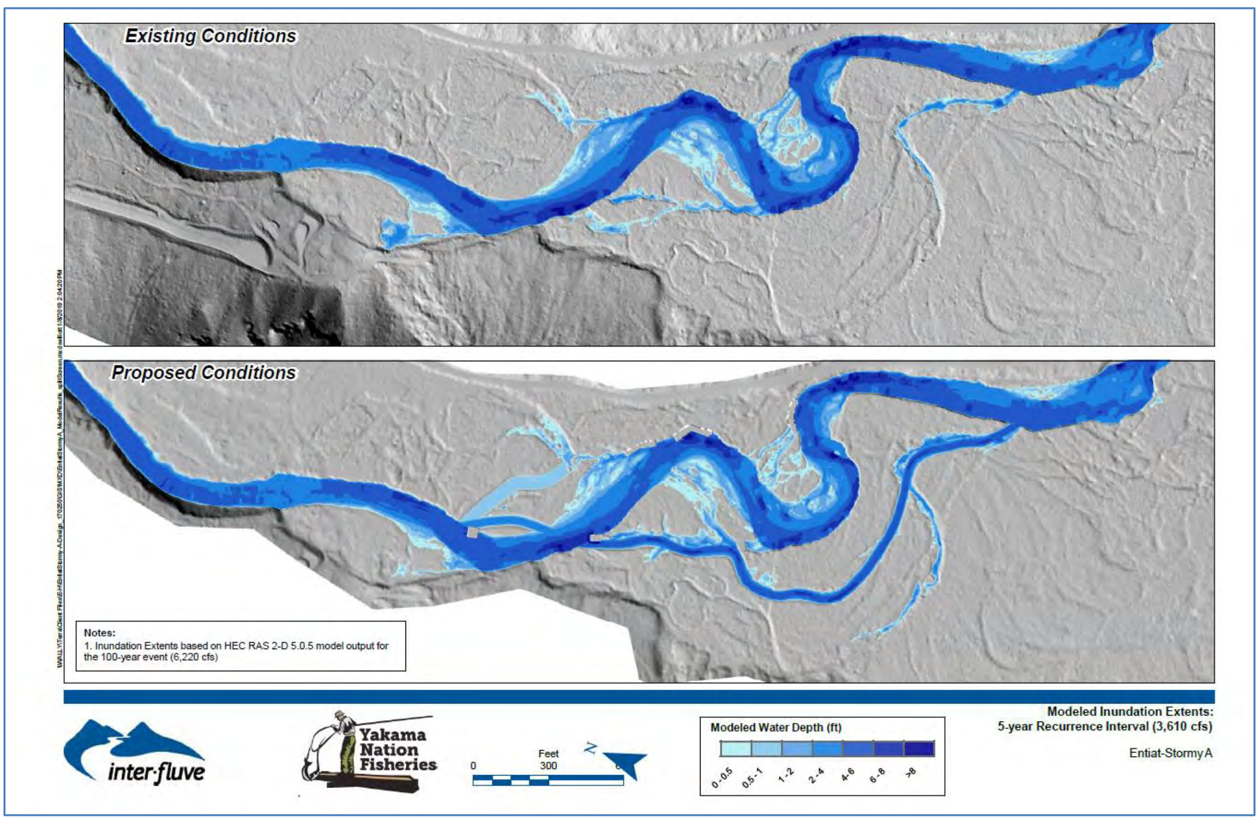
Large Wood Structures

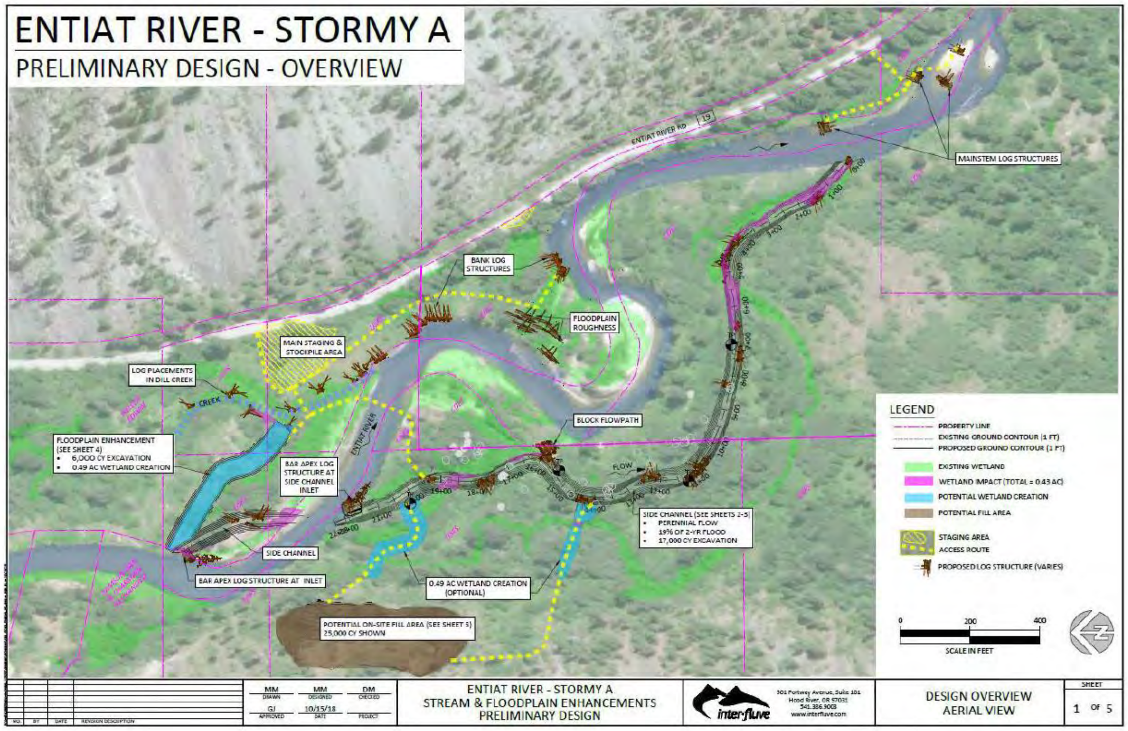
- On several occasions in the past the Committees reviewed similar designs prepared by the Bureau of Reclamation (BOR) for the Entiat River.
- During the reviews, the Committees consistently said they supported removing levees and enhancing the Cottonwood Flats site. they do not support the proposed large wood projects, many of which appeared to be designed to stabilize banks (recall that the Independent Scientific Advisory Board also questioned these large wood projects).
- There are several large wood elements in the Stormy Project Area "A" proposal that are similar to elements in the BOR designs. As with the BOR designs, the Committees do not support these structures identified in the Stormy Project Area "A" proposal.

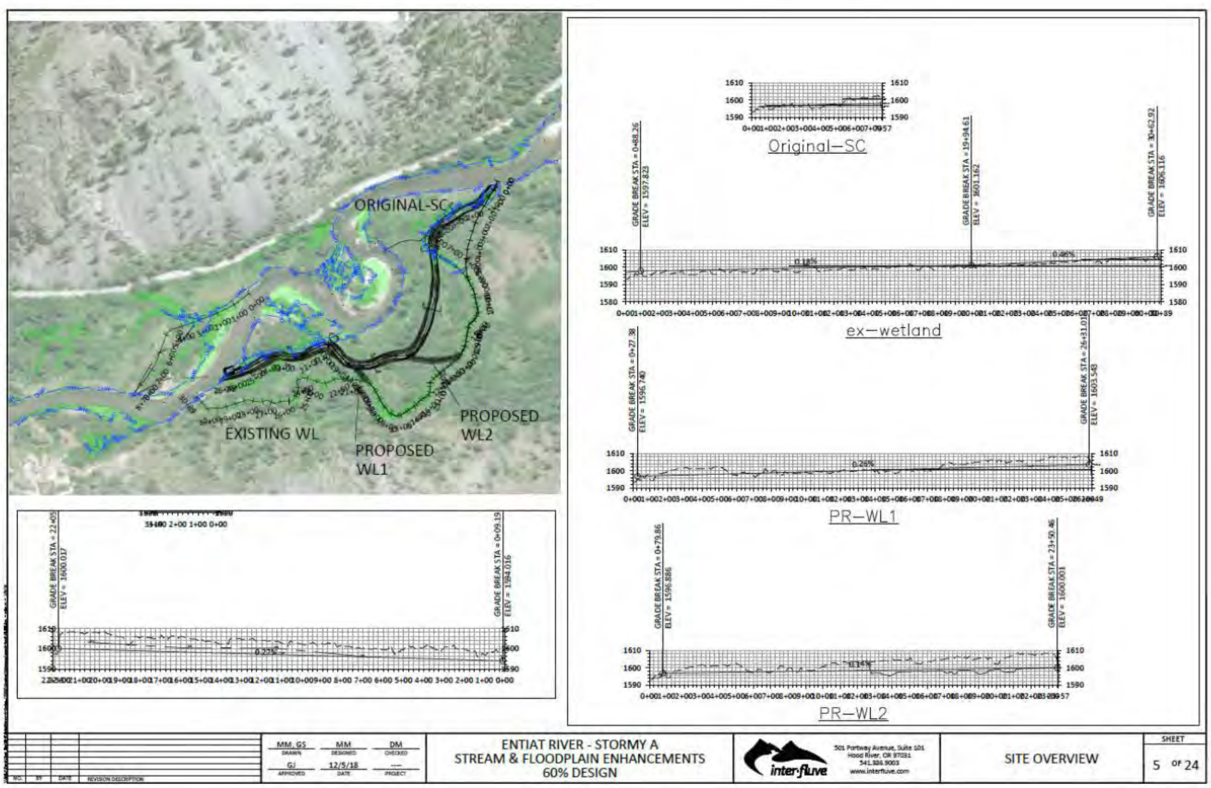
Side Channel

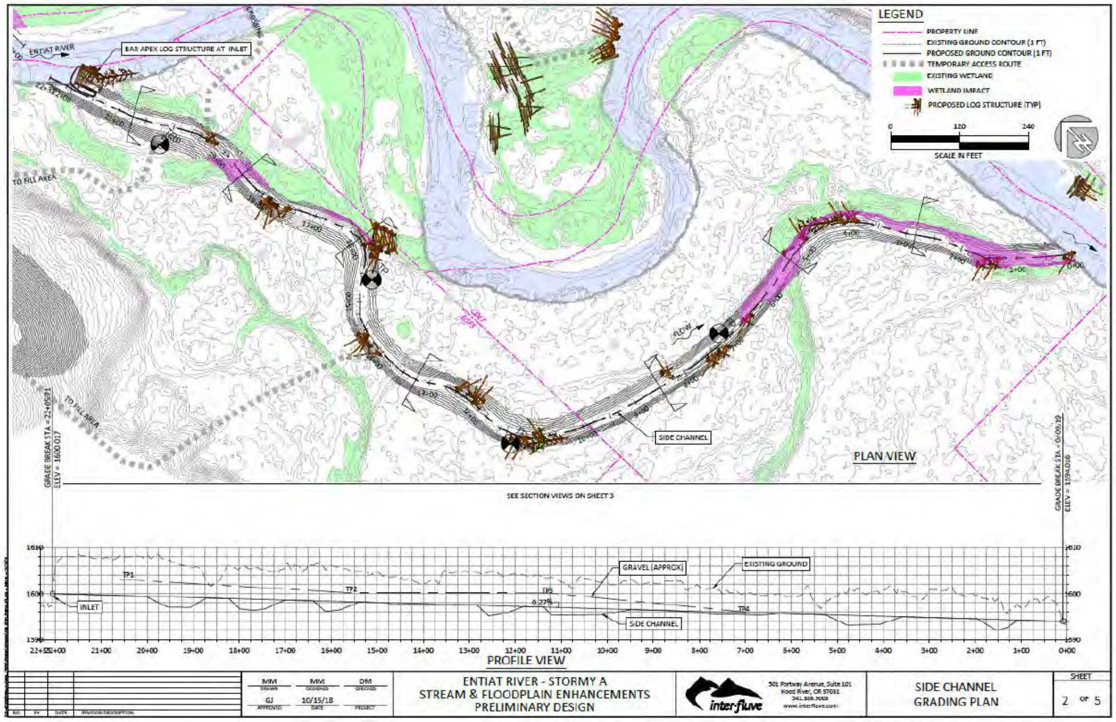
- That said, the Committees do support the activation of the longer side channel (not the excavated channel) on river right. The Committees believe that activating the longer side channel will provide greater biological benefit than the excavated channel.
- The feasibility and cost effectiveness of activating the longer side channel is unclear given the need for wetland mitigation; however, the Committees recommend that this action be explored.

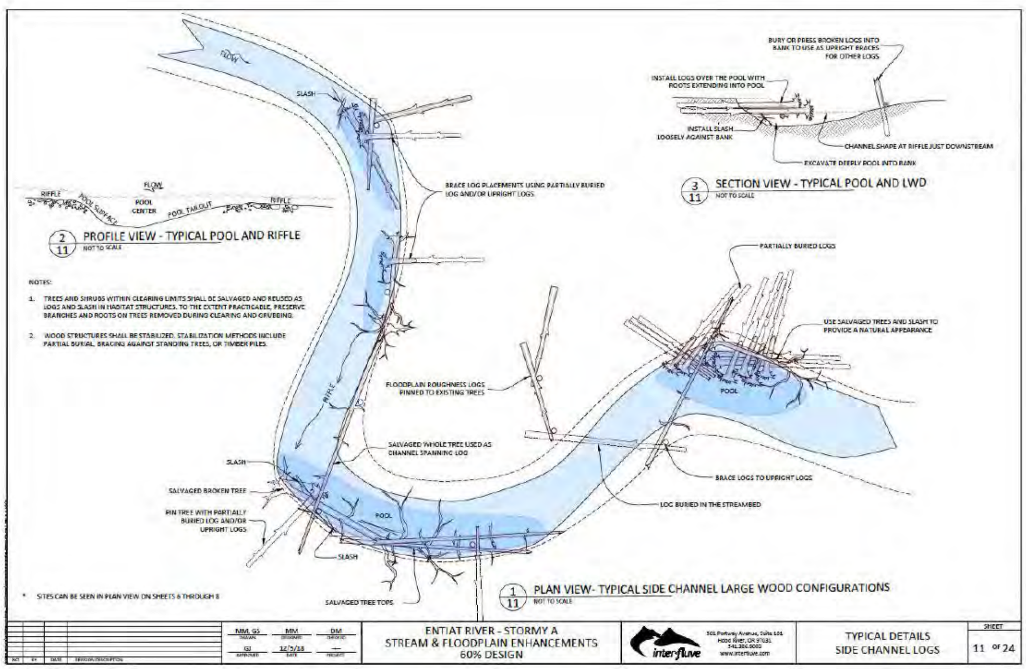

21
20.9
20.8
20.7
20.6
20.5
20.4
20.3
20.2
20.1
Historical centerlines
Project area Centerlines 1967 2006
River miles 1957 1983 2017
Relative Elevation (feet)
10 9 8 7 6 5 4 3 2 1 0 -1
0 300 600 1,200 Feet

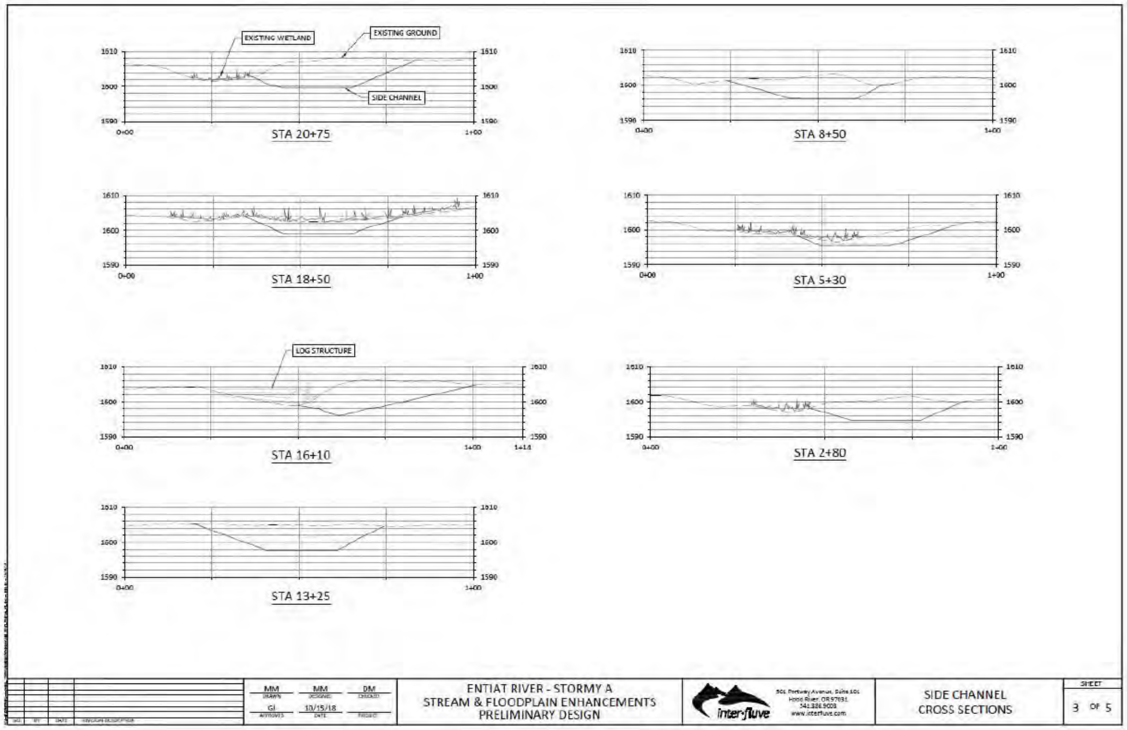

Existing Conditions
Proposed Conditions
Notes:
1. Inundation Extents based on HEC RAS 2-D 5.0.5 model output for the 100-year event (6,220 cfs)
inter-fluve
Yakama Nation Fisheries
Feet
0 300
Modeled Water Depth (ft)
0-0.5 0.5-1 1-2 2-4 4-6 6-8 >8
Modeled Inundation Extents:
5-year Recurrence Interval (3,610 cfs)
Entiat-Stormy A


ENTIAT RIVER - STORMY A
PRELIMINARY DESIGN - OVERVIEW
MAINSTEM LOG STRUCTURES
BANK LOG STRUCTURES
FLOODPLAIN ROUGHNESS
MAIN STAGING & STOCKPILE AREA
LOG PLACEMENTS IN DILL CREEK
FLOODPLAIN ENHANCEMENT (SEE SHEET 4)
6,000 CY EXCAVATION
0.49 AC WETLAND CREATION
BAR APEX LOG STRUCTURE AT SIDE CHANNEL INLET
BLOCK FLOWPATH
SIDE CHANNEL
BAR APEX LOG STRUCTURE AT INLET
0.49 AC WETLAND CREATION (OPTIONAL)
SIDE CHANNEL (SEE SHEETS 2-5)
PERENNIAL FLOW
19% OF 2-YR FLOOD
17,000 CY EXCAVATION
POTENTIAL ON-SITE FILL AREA (SEE SHEET 5) 25,000 CY SHOWN
LEGEND
PROPERTY LINE
EXISTING GROUND CONTOUR (1 FT)
PROPOSED GROUND CONTOUR (1 FT)
EXISTING WETLAND
WETLAND IMPACT (TOTAL = 0.43 AC)
POTENTIAL WETLAND CREATION
POTENTIAL FILL AREA
STAGING AREA
ACCESS ROUTE
PROPOSED LOG STRUCTURE (VARIES)
SCALE IN FEET
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
PRELIMINARY DESIGN
DESIGN OVERVIEW
AERIAL VIEW
1 OF 5


ORIGINAL-SC
EXISTING WL
PROPOSED WL1
PROPOSED WL2
Original—SC
ex—wetland
PR—WL1
PR—WL2
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
60% DESIGN
SITE OVERVIEW
5 OF 24


LEGEND
PROPERTY LINE
EXISTING GROUND CONTOUR (1 FT)
PROPOSED GROUND CONTOUR (1 FT)
TEMPORARY ACCESS ROUTE
EXISTING WETLAND
WETLAND IMPACT
PROPOSED LOG STRUCTURE (TYP)
SCALE IN FEET
ENTIAT RIVER
BAR APEX LOG STRUCTURE AT INLET
TO FILL AREA
SIDE CHANNEL
PLAN VIEW
SEE SECTION VIEWS ON SHEET 3
GRAVEL (APPROX)
EXISTING GROUND
INLET
SIDE CHANNEL
PROFILE VIEW
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
PRELIMINARY DESIGN
interfluve
SIDE CHANNEL
GRADING PLAN
SHEET
2 OF 5


BURY OR PRESS BROKEN LOGS INTO BANK TO USE AS UPRIGHT BRACES FOR OTHER LOGS
INSTALL LOGS OVER THE POOL WITH ROOTS EXTENDING INTO POOL
INSTALL SLASH LOOSELY AGAINST BANK
CHANNEL SHAPE AT RIFFLE JUST DOWNSTREAM
EXCAVATE DEEPLY POOL INTO BANK
SECTION VIEW - TYPICAL POOL AND LWD
NOT TO SCALE
FLOW
RIFFLE
POOL SURFACE
POOL CENTER
POOL TAILOUT
RIFFLE
PROFILE VIEW - TYPICAL POOL AND RIFFLE
NOT TO SCALE
NOTES:
1. TREES AND SHRUBS WITHIN CLEARING LIMITS SHALL BE SALVAGED AND REUSED AS LOGS AND SLASH IN HABITAT STRUCTURES. TO THE EXTENT PRACTICABLE, PRESERVE BRANCHES AND ROOTS ON TREES REMOVED DURING CLEARING AND GRUBBING.
2. WOOD STRUCTURES SHALL BE STABILIZED. STABILIZATION METHODS INCLUDE PARTIAL BURIAL, BRACING AGAINST STANDING TREES, OR TIMBER PILES.
SLASH
PARTIALLY BURIED LOGS
USE SALVAGED TREES AND SLASH TO PROVIDE A NATURAL APPEARANCE
POOL
LOG BURIED IN THE STREAMBED
PIN TREE WITH PARTIALLY BURIED LOG AND/OR UPRIGHT LOGS
SLASH
SALVAGED TREE TOPS
* SITES CAN BE SEEN IN PLAN VIEW ON SHEETS 6 THROUGH 8
PLAN VIEW- TYPICAL SIDE CHANNEL LARGE WOOD CONFIGURATIONS
NOT TO SCALE
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
60% DESIGN
interfluve
TYPICAL DETAILS
SIDE CHANNEL LOGS
SHEET
11 OF 24


EXISTING WETLAND
EXISTING GROUND
SIDE CHANNEL
STA 20+75
STA 8+50
STA 18+50
STA 5+30
LOG STRUCTURE
STA 16+10
STA 2+80
STA 13+25
MM
DRAWN
MM
DESIGNED
DM
CHECKED
GI
APPROVED
10/15/18
DATE
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
PRELIMINARY DESIGN
inter-fluve
www.interfluve.com
SIDE CHANNEL
CROSS SECTIONS
SHEET
3 OF 5

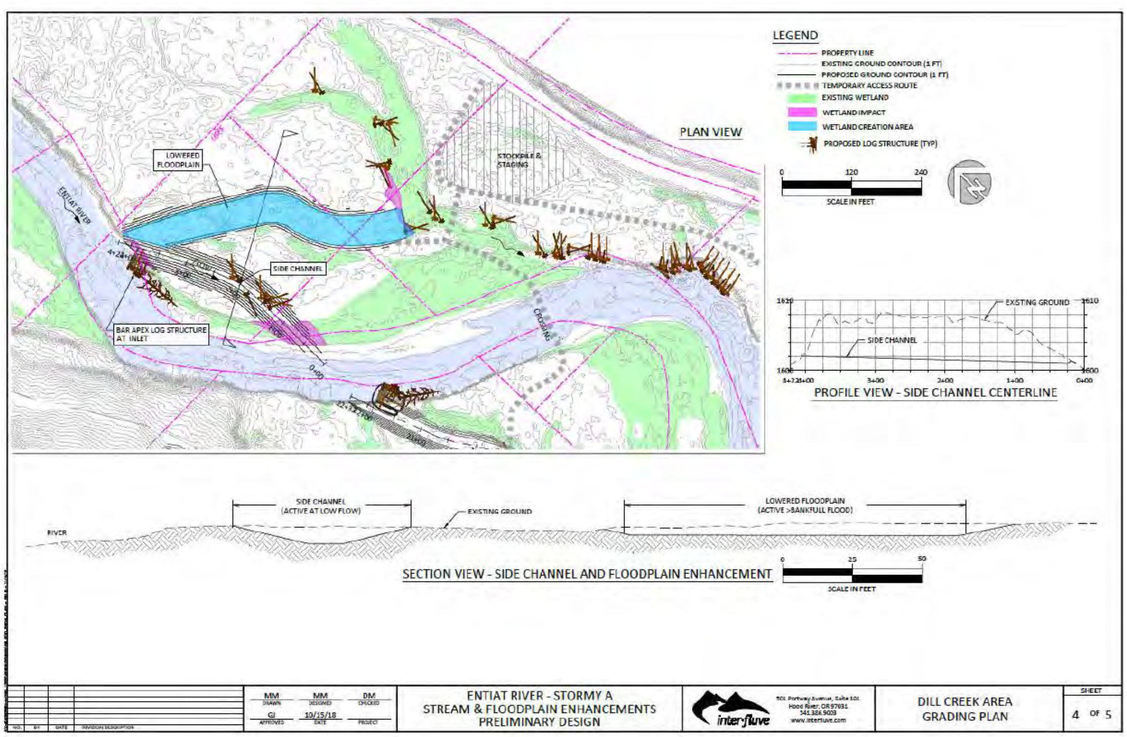

Google Earth

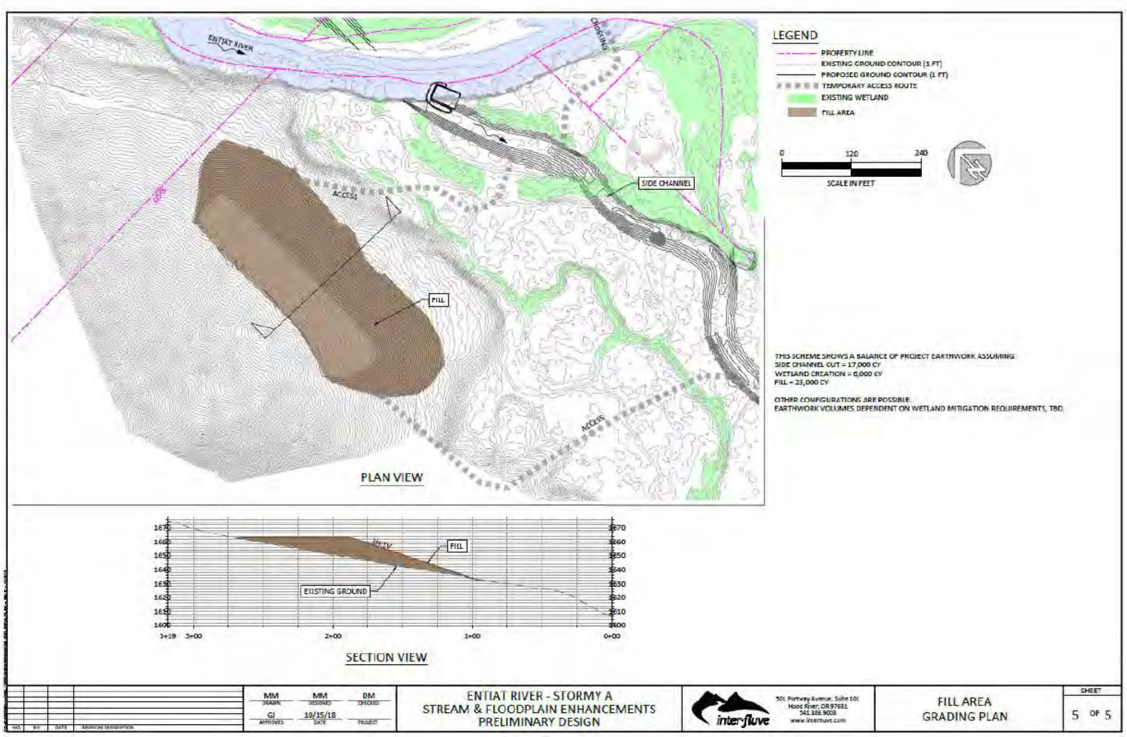

457 ft
Google Earth

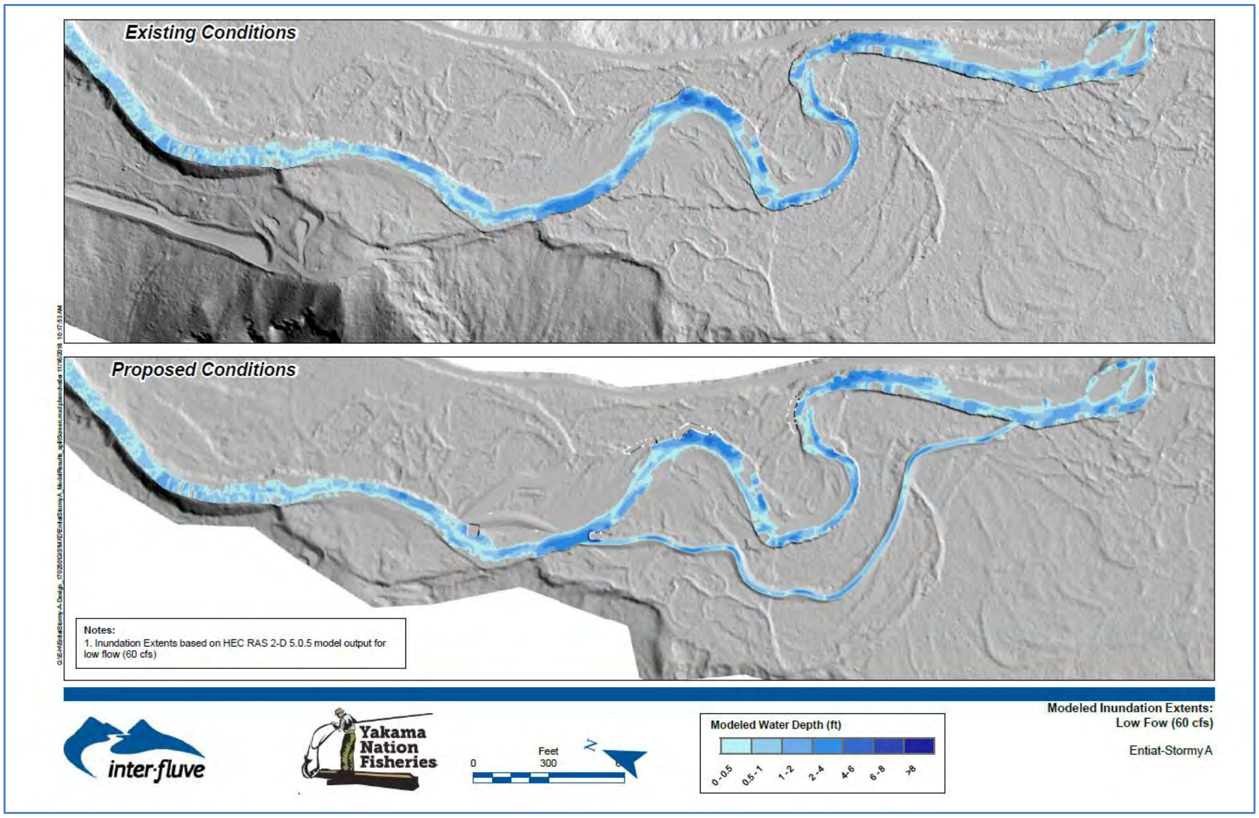

Google Earth

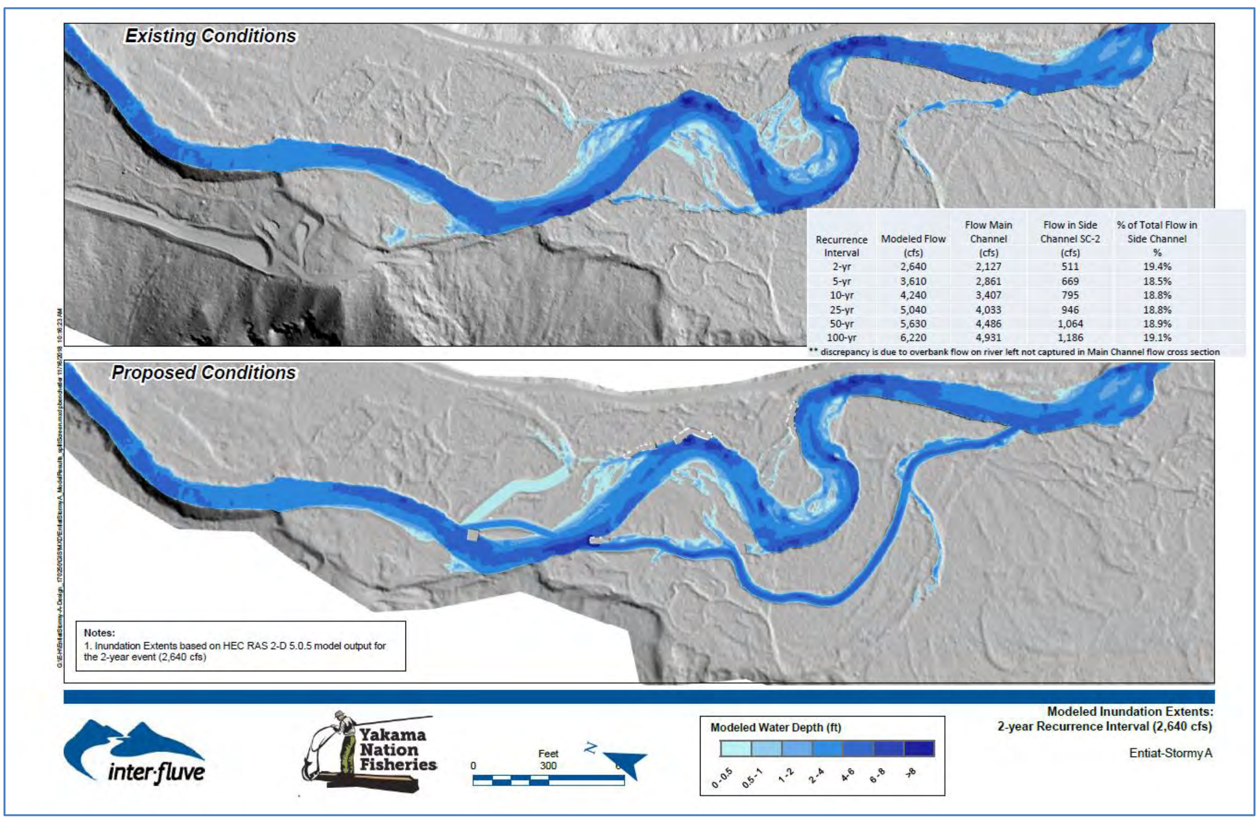

ADJACENT WETLAND
BECOMES FLOODPLAIN


ADJACENT WETLAND
BECOMES FLOODPLAIN


LEGEND
PROPERTY LINE
EXISTING GROUND CONTOUR (1 FT)
PROPOSED GROUND CONTOUR (1 FT)
TEMPORARY ACCESS ROUTE
EXISTING WETLAND
WETLAND IMPACT
WETLAND CREATION AREA
PROPOSED LOG STRUCTURE (TYP)
PLAN VIEW
0 120 240
SCALE IN FEET
LOWERED FLOODPLAIN
STOCKPILE & STAGING
SIDE CHANNEL
BAR APEX LOG STRUCTURE AT INLET
ENTIAT RIVER
EXISTING GROUND
SIDE CHANNEL
PROFILE VIEW - SIDE CHANNEL CENTERLINE
SIDE CHANNEL (ACTIVE AT LOW FLOW)
EXISTING GROUND
LOWERED FLOODPLAIN (ACTIVE >BANKFULL FLOOD)
RIVER
SECTION VIEW - SIDE CHANNEL AND FLOODPLAIN ENHANCEMENT
SCALE IN FEET
MM
MM
DM
GJ
10/15/18
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
PRELIMINARY DESIGN
inter-fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com
DILL CREEK AREA
GRADING PLAN
SHEET
4 OF 5

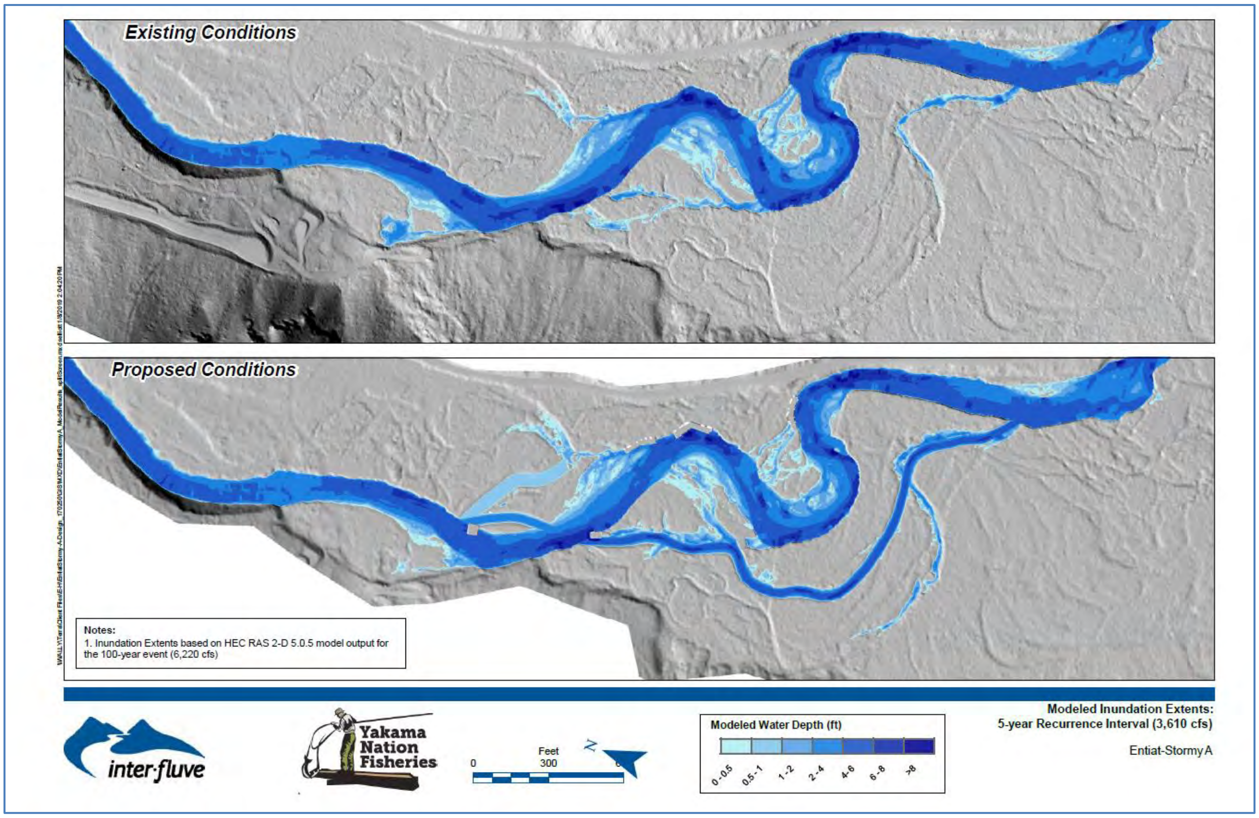

ENTIAT RIVER
SIDE CHANNEL
ACCESS
FILL
PLAN VIEW
LEGEND
PROPERTY LINE
EXISTING GROUND CONTOUR (1 FT)
PROPOSED GROUND CONTOUR (1 FT)
TEMPORARY ACCESS ROUTE
EXISTING WETLAND
FILL AREA
0 120 240
SCALE IN FEET
THIS SCHEME SHOWS A BALANCE OF PROJECT EARTHWORK ASSUMING
SIDE CHANNEL CUT = 17,000 CY
WETLAND CREATION = 6,000 CY
FILL = 23,000 CY
OTHER CONFIGURATIONS ARE POSSIBLE.
EARTHWORK VOLUMES DEPENDENT ON WETLAND MITIGATION REQUIREMENTS, TBD.
EXISTING GROUND
SECTION VIEW
MM DRAWN
MM DESIGNED
DM CHECKED
GJ APPROVED
10/15/18 DATE
PROJECT
ENTIAT RIVER - STORMY A
STREAM & FLOODPLAIN ENHANCEMENTS
PRELIMINARY DESIGN
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com
FILL AREA
GRADING PLAN
SHEET
5 OF 5

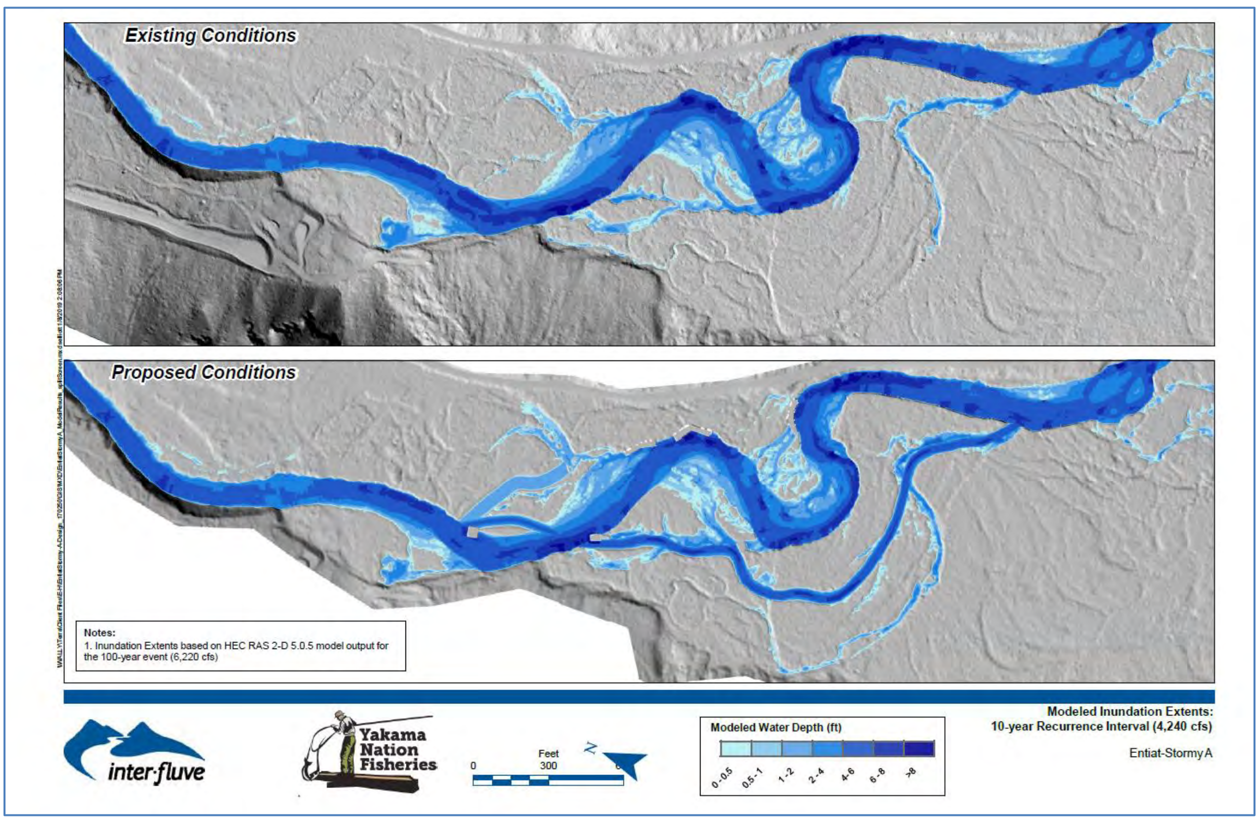




Recurrence Interval	Modeled Flow (cfs)	Flow Main Channel (cfs)	Flow in Side Channel SC-2 (cfs)	% of Total Flow in Side Channel %
2-yr	2,640	2,127	511	19.4%
5-yr	3,610	2,861	669	18.5%
10-yr	4,240	3,407	795	18.8%
25-yr	5,040	4,033	946	18.8%
50-yr	5,630	4,486	1,064	18.9%
100-yr	6,220	4,931	1,186	19.1%

** discrepancy is due to overbank flow on river left not captured in Main Channel flow cross section


Existing Conditions
Proposed Conditions
Notes:
1. Inundation Extents based on HEC RAS 2-D 5.0.5 model output for the 100-year event (6,220 cfs)
inter-fluve
Yakama Nation Fisheries
Feet
0
300
Modeled Water Depth (ft)
0-0.5
0.5-1
1-2
2-4
4-6
6-8
>8
Modeled Inundation Extents:
5-year Recurrence Interval (3,610 cfs)
Entiat-Stormy A


Existing Conditions
Proposed Conditions
Notes:
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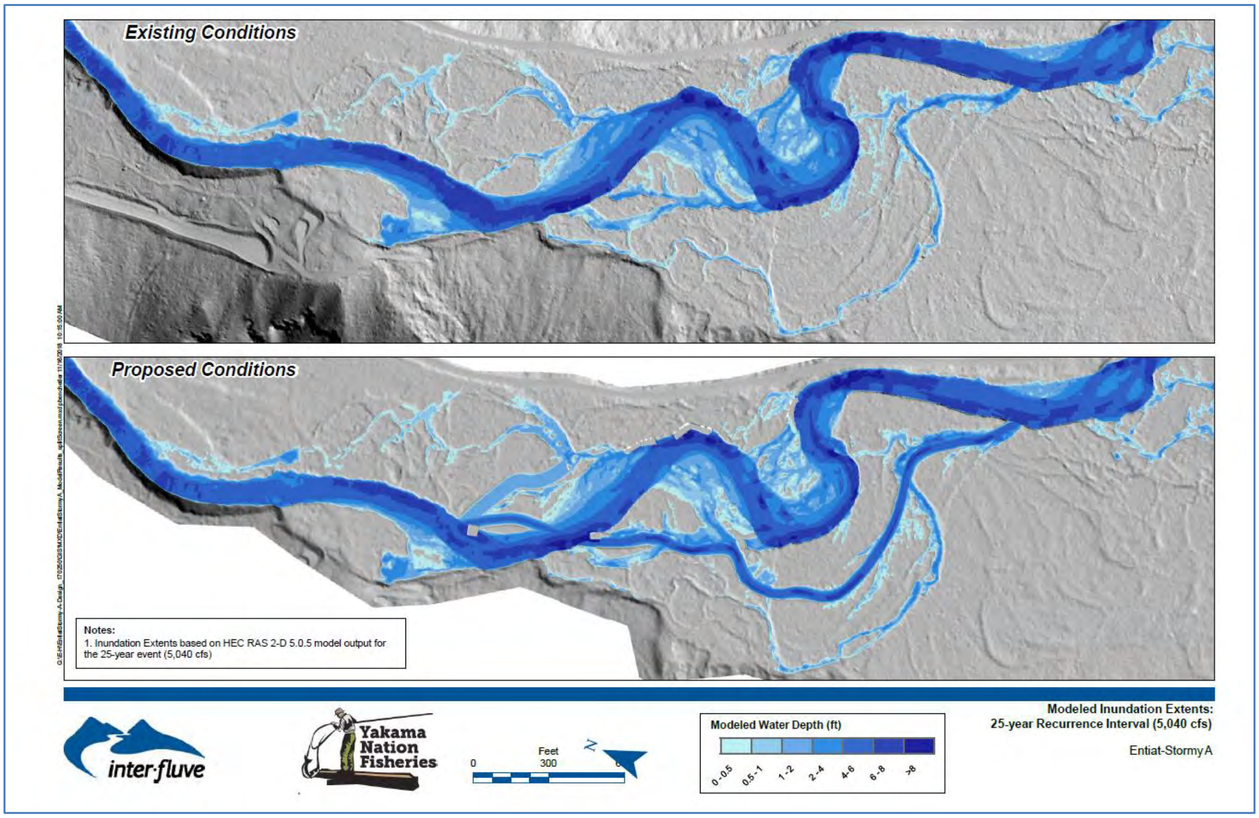
inter-fluve
Yakama Nation Fisheries
Feet
0
300
Modeled Water Depth (ft)
0-0.5
0.5-1
1-2
2-4
4-6
6-8
>8
Modeled Inundation Extents:
10-year Recurrence Interval (4,240 cfs)
Entiat-Stormy A


Existing Conditions
Proposed Conditions
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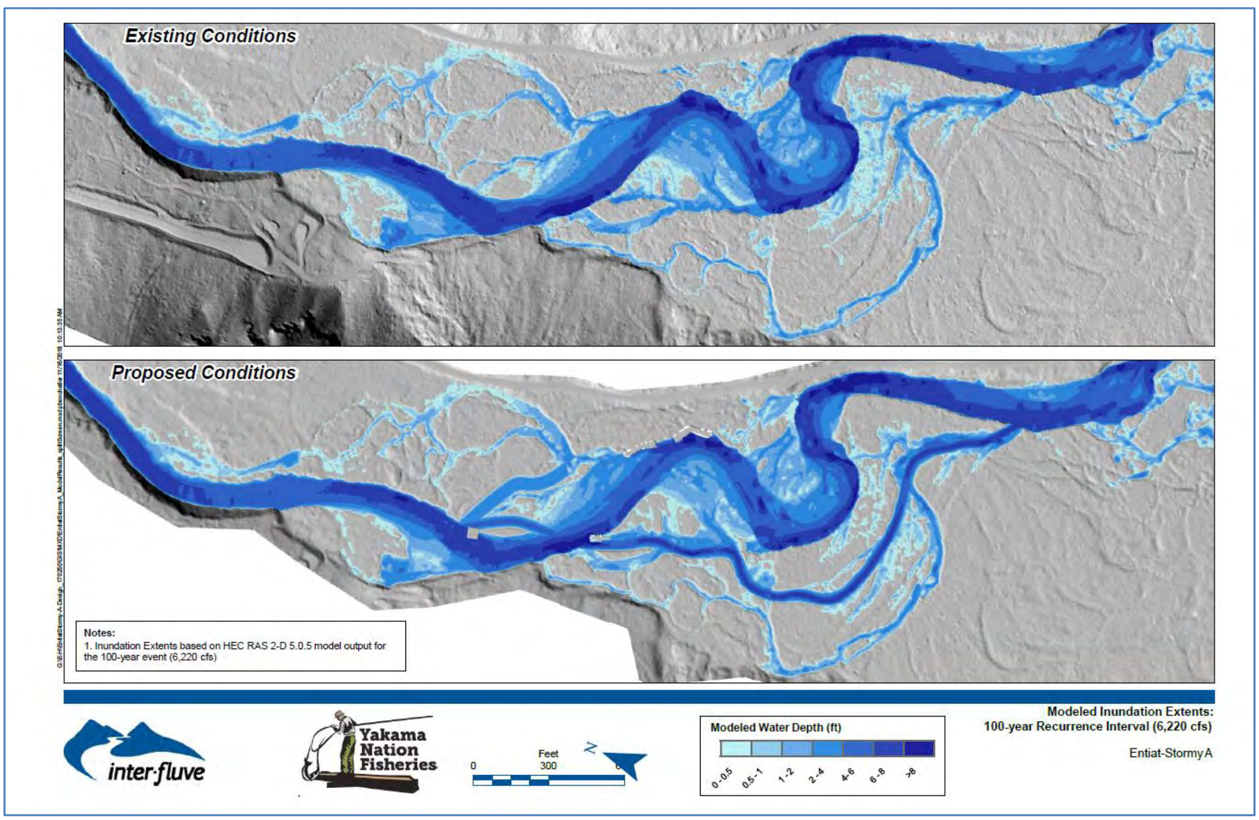
Yakama Nation Fisheries
inter-fluve
Feet
0
300
Modeled Water Depth (ft)
0-0.5
0.5-1
1-2
2-4
4-6
6-8
>8
Modeled Inundation Extents:
25-year Recurrence Interval (5,040 cfs)
Entiat-Stormy A


Existing Conditions
Proposed Conditions
Notes:
1. Inundation Extents based on HEC RAS 2-D 5.0.5 model output for the 100-year event (6,220 cfs)
Yakama Nation Fisheries
inter-fluve
Feet
0
300
Modeled Water Depth (ft)
0-0.5
0.5-1
1-2
2-4
4-6
6-8
>8
Modeled Inundation Extents:
100-year Recurrence Interval (6,220 cfs)
Entiat-Stormy A

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 14 March 2019

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator); Mike McAllister (Inter-Fluve); Hans Smith, Chris Clemons, and Jason Breidert (Yakama Nation); Erin McKay (Chelan County Natural Resources Department); Mike Kane (Kane Natural Resources); and John Soden and Nic Truscott (Natural Systems Design).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 14 March 2019 from 8:30 am to 1:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following changes:

- Added review of the East Fork Mission Creek Floodplain Restoration Project Proposal.
- Added review of the 2019 Eightmile Creek Fisheries Assessment Project Proposal.
- Added Icicle Screening Projects Update.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 10 January 2019 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) did not provide an update for this month.
- Icicle Boulder Field Project – The sponsor (TU) did not provide an update for this month.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (WDFW) will provide the next annual report on 31 December 2019.
- Burns-Garrity Design Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) reported they are not working on designs at this time.

- Beaver Fever Project – The sponsor (TU) did not provide an update for this month.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) did not provide an update for this month.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported they have begun the permitting process.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported that they conducted no field work in February. The sponsor submitted the 2018 annual report, which was uploaded to the Extranet site.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they hired Natural Systems Design (NSD) and they are currently working on hydraulic modeling. They will present those results to the Committee today.
- Peshastin Creek Environmental Site Assessment Project – The sponsor (CCNRD) reported they met with the landowners and are in the process of obtaining written landowner agreements.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported they are coordinating with Cascadia Conservation District on landowner outreach in the Entiat River basin.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported they have started the cultural resources process and have drafted landowner agreements.

IV. General Salmon Habitat Program Applications

Upper Kahler Stream and Floodplain Enhancement Project

In December, the Committees received a General Salmon Habitat Program proposal from the Yakama Nation (YN) titled: *Upper Kahler Stream and Floodplain Enhancement Project*. The purpose of the project is to reduce the risk of an avulsion near RM 8.6 on Nason Creek by constructing a large, buried, log jam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project will also construct three additional buried bank jams and enhance fish habitat at the downstream end of the avulsion channel. In addition to minimizing the risk of an avulsion, the proposed placement of wood and enhancement of the downstream end of the avulsion channel will improve spring Chinook and steelhead habitat. The total cost of the project was $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. In November, the Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the Committees during a future meeting explaining the design of the project.

In January, YN and their consultant, Mike McAllister (Inter-Fluve), gave a presentation on the design of the Upper Kahler Stream and Floodplain Enhancement Project. They walked through the design process and why certain elements identified by the Tributary Committees were or were not included in the final design. At that time, the Committees questioned the need for filling the avulsion channel and recommended simply adding large wood and a few boulders that will help trap sediments and fill the avulsion channel naturally.

On 26 February, YN submitted a response to the Committees concern about filling the avulsion channel with sediments. The YN response identified three alternatives (not including the original proposed action) that include the use of wood: wood only alternative at a cost of $234,600, wood and fill alternative at a cost of $211,550, and a new fill alternative at a cost of $194,800. YN noted these alternatives may provide as much certainty in preventing an avulsion as the YN preferred action. The response noted that all alternatives must prevent a drop into the avulsion channel and interrupt headward erosion and growth of the avulsion channel. The response also pointed out that the landowner has expressed opposition to using large wood on his property where it is visible from his house.

During the meeting, YN and their consultant (Mike McAllister) described the three alternatives and their associated costs. Members of the committees appreciated the identification of alternatives but continued to struggle with filling the avulsion channel. They asked if the landowner would be willing to sign an agreement stating that the landowner cannot alter or affect the project for at least 20 years. YN did not know if the landowner would agree to those terms. Following discussion, Brandon recused himself from the meeting and members voted on the project. Given that members are opposed to floodplain fill and were concerned the landowner would not sign an agreement forbidding the landowner from altering the site for at least 20 years, the Rock Island Tributary Committee agreed to fund the large wood structures within Nason Creek (i.e., upper log structure site 1, lower log structure site 1, log structure site 3, and log structure site 4). They will not fund any actions to fill the avulsion channel. They asked YN to provide a detailed budget for the construction of the large wood structures within Nason Creek.

Stormy Project Area "A" Stream and Floodplain Enhancement Project

In December, the Committees received a General Salmon Habitat Program proposal from YN titled: *Stormy Project Area "A" Stream and Floodplain Enhancement Project*. The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat. This will be accomplished by constructing ten mainstem log structures and two perennial side channels. One side channel will be 200 feet long; the other will be 2,500 feet long. Large wood will also be placed throughout the side channels. The total cost of the project was $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. In December, the Tributary Committees elected to not fund this project as currently designed but invited the project sponsor to give a presentation to the Committees during a future meeting explaining the design of the project.

During the January meeting, YN and their consultant, Mike McAllister, gave a presentation on the design of the Stormy Project Area A Project. They explained that the existing side channel the Committees wanted reconnected is too high on the floodplain to connect with the river and has zero gradient. They would also need to mitigate for the existing network of wetlands that currently exist in the side channel. The side channel proposed by YN was designed to avoid destroying existing wetlands but nevertheless provide wetland connections at higher flows. YN also explained that the large wood structures proposed along the margins of the main channel are designed to provide fish habitat (pools and cover) and are not designed to stabilize banks. At that time, members present supported the project but needed feedback from their federal colleagues (Kate and Justin), who were furloughed.

Following the furlough, members discussed the project with Kate and Justin. Based on that discussion, members agreed to support the proposed actions on river right (i.e., excavation of the 2,500-ft perennial side channel) and the 200-ft side channel on river left, including the apex jams used to control flows into the side channels. Because of the overall cost of the proposed project, they did not support the installation of the other mainstem log structures. In addition, they believed some of the mainstem log structures will have limited biological benefit because they do not interact with the water at lower flows and therefore will not provide important habitat for summer and winter parr. They recommended that YN seek a cost share for the implementation of the mainstem log structures.

In February, YN submitted a revised proposal to the Committees that included an updated itemized budget for the construction of the perennial side channels and apex jams associated with the side channels. The total cost of the project was $1,564,211.15. The sponsor requested $823,161.15 from HCP Plan Species Account Funds. ***The Rocky Reach Tributary Committee approved $823,161.15 for the project.***

V. Small Project Applications

East Fork Mission Creek Floodplain Restoration Project

The Committees received a Small Project proposal from Chelan County Natural Resource Department (CCNRD) titled: *East Fork Mission Creek Floodplain Restoration Project*. The purpose of this project is to develop permit-ready designs that will result in improved base flows in the Mission Creek watershed by reconnecting floodplain in a severely incised system and improve habitat for steelhead. This will be accomplished by removing an eroding road prism located within the floodplain, adding in-stream wood, and addressing potential passage barriers. The project is located along a 2.8 mile stretch of East Fork Mission Creek in the upper Mission Creek watershed. The total cost of the project is $96,169. The sponsor requested $74,669 from HCP Plan Species Account Funds.

After careful review, the Committees were unable to make a funding decision due to uncertainty about the status of the road closure and they need more information. The proposal states, "Rd 7100 is permanently closed to motorized vehicles and was formally abandoned in 2013…" During the meeting, however, the project sponsor indicated the statement in the proposal was incorrect. Therefore, the Committees asked CCNRD to provide clarification on the closure of the road. Before the Committees can make a funding decision on this project, they need to know if the Forest Service has permanently closed the road.

2019 Eightmile Creek Fisheries Assessment Project

The Committees received a Small Project proposal from Washington Department of Fish and Wildlife (WDFW) titled: *2019 Eightmile Creek Fisheries Assessment Project*. The purpose of this project is to assess the status of fish within Eightmile Creek, a tributary to the Chewuch River in the Methow River basin. These data will be used to determine a strategy for removing brook trout and restoring native salmonid production to 21 km of stream. Currently, a fish passage barrier near the mouth of Eightmile Creek precludes steelhead (and bull trout) from migrating into the stream. Because YN is looking to remove the barrier, managers want information on species composition, fish abundance, stream flows, and temperatures within Eightmile Creek. In addition, they propose to collect tissue samples from bull trout and *O. mykiss* collected within Eightmile Creek to determine their genetic composition. These data are needed to determine a strategy for removing brook trout, if necessary. The total cost of the project is $67,200. The sponsor requested the full amount from HCP Plan Species Account Funds.

After careful review, the Committees were unable to make a funding decision. They identified the following concerns with the project:

- There is no management plan that clearly identifies decision rules for determining which strategy would be selected for removing brook trout. That is, after assessments are complete, how will managers use the data to determine whether to use electrofishing, piscicides, or other brook trout removal techniques, or to decide that no brook trout removal is necessary?
- Rather than use snorkeling to conduct assessments, the sponsor should consider using electrofishing. Complete census surveys with electrofishing gear can be used to provide data on species richness and abundance and can be used to remove brook trout during the surveys. Thus, the sponsor would complete both objectives during the surveys; assessments (including collection of tissue samples for genetics analysis) and brook trout removal. Additional electrofishing surveys may be needed to reduce brook trout numbers to a level that supports successful steelhead colonization (see Thompson and Rahel 1996; Buktenica et al. 2013)[1].

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[1] Thompson, P. D. and F. J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain Streams. North American Journal of Fisheries Management 16:332-339.
Buktenica, M. W., D. K. Hering, S. F. Girdner, B. D. Mahoney, and B. D. Rosenlund. 2013. Eradication of nonnative brook trout with electrofishing and antimycin-A and the response of a remnant bull trout population. North American Journal of Fisheries Management 33:117-129.

- The sponsor needs to indicate whether labor rates and other budget items include overhead.
- Finally, Plan Species Account Funds are not to be used to purchase equipment (e.g., snorkel equipment and water temperature loggers). This is because the Committees do not want to own and store equipment purchased with Plan Species Account Funds. However, funds can be used to rent equipment.

If the sponsor can address these concerns, the Committees will review a revised proposal.

VI. Update by CCNRD on the Monitor Side Channel Restoration Design Project

CCNRD (Erin McKay) and their consultants (Mike Kane with Kane Natural Resources and John Soden and Nic Truscott with Natural Systems Design) provided an update on the Monitor Side Channel Restoration Design Project. As background, they described the goals and objectives of the project and identified design challenges and constraints. Some of the challenges associated with this project include recreational issues, PUD powerlines, lots of infrastructure (homes), and identifying actions that will not affect the opening to the side channel. They also provided results from their hydraulic modeling work, which included RiverFlow 2D and topobathymetric LiDAR analysis and model calibration. They showed how velocities and depths change within the side channel under different flow scenarios. They also described sediment dynamics within the channel under different flows.

They presented conceptual designs that include boulder clusters, bank ELJs, weir logs, and willow trenches. They identified conceptual design alternatives noting they are considering a light touch in the upper reach of the side channel, a more aggressive approach in the middle reach, and a moderate tough in the lower reach. In the upper reach, where the channel is more confined and higher gradient, they are looking mostly at placement of boulder clusters and perhaps a few bank ELJs anchored with boulders. Within the middle reach, which is less confined, wide, and lower gradient, they are proposing bank and log weirs to create a narrower, meandering channel. In the lower reach, they propose to use weir logs and a few bank logs. The goal in the lower reach is to avoid actions that will encourage deposition at the outlet of the side channel.

Members provided feedback on the proposed alternatives. In general, they support the boulder clusters in the upper reach and recommended additional bank structures in the middle reach. They also supported more log weirs in the middle and lower reaches. Finally, they would like the project designed so it will be no more than $200,000 to construct. CCNRD and their consultants will continue working on the designs and will provide additional updates to the Committees in the near future.

VII. Review of Draft SOA

On 25 February, YN submitted a draft Statement of Agreement (SOA) to the Committees for review (see Attachment 1). Brandon Rogers said the purpose of the draft SOA is to provide a basis for decision making in the HCPs Tributary Committees. He indicated the SOA is draft and asked members to review and discuss it, edit it as necessary, and vote on it during the April meeting. Justin Yeager asked what precipitated the need for an SOA on decision making. Brandon responded the “NO” vote on the Scaffold Camp Acquisition #2 Project and the fact that the Committees have no clearly defined criteria for evaluating project proposals. Chris Fisher stated CCT cannot support the draft SOA nor will they support an SOA that will take away their right to prevent the YN from owning land in the Upper Columbia River basin. Jeremy Cram noted the language in the draft SOA is too strong and would force the Committees to vote “YES” on any project that has biological benefit. He said it appears to take way the Committees ability to require cost shares, to save money for future projects, and to reject projects based on a sponsor’s ability to implement the project. He added it places too much emphasis on cost-benefit relationships. Others agreed and said it takes away rights to reject projects based on criteria that may not be included in the draft SOA.

Tom Kahler reminded members that funding decisions require unanimous approval of the Committees (as described in HCPs), affording each member discretionary rights when reviewing and voting on project proposals. Tom provided examples within other HCP committees where parties have exercised this right and stated that Douglas PUD could not approve any agreement that would limit those discretionary rights. Furthermore, editing the draft SOA to preserve the discretionary voting rights of signatory parties would result in a very complicated document that would no longer fulfill the intent of YN in preparing the SOA. Catherine Willard pointed members to Section 9.4 of the Rock Island HCP, which states voting members "shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled."

Kate Terrell and Justin asked why an SOA is necessary. The Committees have made funding decisions and justified those decisions for several years. Brandon responded that without some side boards, the Committees can make decisions based on anything they want, and these decisions may have nothing to do with what is best for the resource. Catherine again reminded members of the language in the HCPs. Chris commented that except for the Scaffold Camp Acquisition Project (and a YN protection project that was submitted through the PRCC Habitat Subcommittee), he has always voted based on what he believes is best for the resource. He said he can do nothing about Tribal politics and the issues between CCT and YN cannot be resolved within the HCP Committees.

Kate asked, given that CCT cannot support an SOA that takes away their right to prevent the YN from owning land within the Methow River basin, what is YN trying to accomplish with the draft SOA? Brandon stated that the SOA is less about the issues between the tribes and more about how the Tributary Committees make funding decisions. To that end, YN wants clear, transparent criteria that focus funding decisions on what is best for the resource. Kate asked what if the SOA is not approved. Brandon said YN will consider disputing the decision and they are also evaluating other options.

Tracy Hillman reminded the Committees that they directed him to identify possible criteria for evaluating project proposals (see Attachment 2). He reviewed those criteria with the Committees and asked if these provide the clarity and transparency the Committees desire. He added that these could be appended to an SOA or added to the Committees' Policies and Procedures for Funding Projects document (Section 5). Tracy also noted that YN is not the only party who has requested evaluation criteria. Others have as well, and Tracy said the criteria will help him prepare responses to project sponsors. Members liked the idea of having transparent criteria and Kate noted that she used the criteria when evaluating the Eightmile Creek Fisheries Assessment Project. She said the criteria were very useful and were consistent with how she has evaluated projects in the past.

Members discussed the idea of updating Section 5 in the Policies and Procedures for Funding Projects. Some members believe this would eliminate the need for an SOA. Kate and Jeremy noted this would allow the Committees to review and update evaluation criteria annually or more frequently if necessary. Brandon said he will discuss this internally, but still wants the Committees to review and edit (if necessary) the draft SOA. He said the YN will ask for a vote on the draft SOA (or edited version) during the April meeting.

Members will review and edit, if necessary, the draft SOA and be prepared to discuss it and vote on it during the April meeting. In addition, Tracy will recast the evaluation criteria, so they fit within the Policies and Procedures for Funding Projects document.

VIII. Review of Draft Wells HCP Tributary Committee Action Plan

On 17 January, Douglas PUD provided the Wells Committees with the Draft Wells HCP Tributary Committee Action Plan for 2019 for a 30-day review. Members reviewed the plan and CCT provided minor edits, which were incorporated into the plan. No other edits or comments were provided.

IX. Review of Draft Rock Island and Rocky Reach HCP Tributary Committees Action Plans

On 11 February, Chelan PUD provided the Rocky Reach and Rock Island Committees with the Draft Rocky Reach and Rock Island HCP Tributary Committees Action Plans for 2019 for a 30-day review. Members reviewed the plans and had no comments or edits.

X. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from February and March:

   Rock Island Plan Species Account:

   - $77.00 to Clifton Larson Allen for Rock Island financial administration in January 2019.
   - $35.00 to Clifton Larson Allen for Rock Island financial administration in February 2019.
   - $6,019.24 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project (for work in January).
   - $5,992.22 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project (for work in February).
   - $170.55 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project (for work in November and December 2018).
   - $583.14 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project (for work in January and February).
   - $985.20 to Chelan County Treasurer for the Monitor Side Channel Design Project (for work in December 2018).
   - $76.67 to Chelan County Treasurer for the Monitor Side Channel Design Project (for work in January).
   - $1,171.74 to Chelan County Treasurer for the Monitor Side Channel Design Project (for work in February).

   Rocky Reach Plan Species Account:

   - $77.00 to Clifton Larson Allen for Rocky Reach financial administration in January 2019.
   - $35.00 to Clifton Larson Allen for Rocky Reach financial administration in February 2019.
   - $142.73 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Environmental Site Assessment Project (for work in January).
   - $556.50 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Environmental Site Assessment Project (for work in February).
   - $44.89 to Cascade Columbia Fisheries Enhancement Group for the Burns-Garrity Restoration Design Project (for work in January).

- $406.60 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project (for work in January).

2. Becky Gallaher reported that the PUDs deposited funds into each of the Plan Species Accounts at the end of January 2019. Chelan PUD deposited $784,331 into the Rock Island Plan Species Account and $371,474 into the Rocky Reach Account. Douglas PUD deposited $284,793.79 into the Wells Account. As of March 2019, the unallocated balances within each account were $6,910,306 in the Rock Island Account, $3,215,267 in the Rocky Reach Account, and $1,813,698 in the Wells Account. Thus, among the three accounts, there is about $11,939,271 available.
3. Tracy Hillman shared the Salmon Recovery Funding Board (SRFB) Funding Schedule with the Committees (see Attachment 3). He said draft proposals are due on 12 April. Project tours are scheduled tentatively for 9 May (Okanogan and Methow), 13 May (Wenatchee), and 14 May (Entiat). Sponsors will give presentations on 12-13 June. The Committees will evaluate the draft proposals on 13 June and decide which projects should be submitted as final proposals. Final proposals are due on 28 June. The Committees will evaluate final proposals and make funding decisions on 11 July.
4. Tracy Hillman stated that John Ferguson (Chair of the HCP Coordinating Committees) sent letters to the Confederated Tribes of the Umatilla Indian Reservation and American Rivers inquiring about their interest in participating in a meeting with members of the HCP Coordination, Hatchery, and Tributary Committees. These parties were involved in negotiating the HCPs but elected not to sign the HCPs. This is an opportunity for the Committees to provide the two parties with a progress report on implementation, as well as give them an opportunity to ask questions of the Committees members. The two entities are to provide a formal response to the invitation by 15 April 2019.
5. Jeremy Cram gave a brief update on the Icicle Screening Projects (see Attachment 4). He indicated the cost of the City of Leavenworth screen has increased significantly, primarily because of the need to redesign the structure to address concerns with frazil ice, debris, and sweeping flows. Jeremy said unforeseen expenses included discovery that power did not run past the water treatment facility, the waterline between the intake and treatment plant runs parallel to flow within the bounds of ordinary high water (the proposed design relocates that portion of the line outside of the ordinary high water and keeps horizontal bends and removal of riparian trees to a minimum but requires substantial excavation), the pipe runs through an existing settling basin that is housed in a structurally failing concrete building, and material costs have gone up dramatically since the initial budget was developed. The redesigned City of Leavenworth screen will cost about $941,500. The ask from the Tributary Committees could be about $801,500, which is about 2.3 times greater than the ask last year. Members said they would consider supporting the project for $352,545, which was equivalent to 75% of the original ask. Recall the Committees required the City of Leavenworth to contribute 25% of the total cost. Jeremy will share this information with Jennifer Novak and Jeff Dengel.
6. The Committees were unable to discuss coordination with the Bureau of Reclamation and the targeted projects. They will discuss these items during the April meeting.

XI. Next Steps

The next scheduled meeting of the Tributary Committees will be on Thursday, 11 April 2019 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Draft SOA from the Yakama Nation

Rocky Reach, Rock Island, and Wells HCP Tributary Committees
DRAFT Statement of Agreement

Basis for Decision Making in HCP Tributary Committees
February 25, 2019

Statement

The Rocky Reach, Rock Island, and Wells Habitat Conservation Plans (HCP) Tributary Committees (TCs) agree that mitigation funding decisions will be based exclusively on the merit of proposed projects (biological benefit, technical merit, feasibility, durability, and cost effectiveness) having a direct nexus to plan species, plan species habitat, or plan species management. Signatories agree not to base funding decisions on criteria other than project merit.

Background

The Wells, Rocky Reach, and Rock Island HCP Tributary Committees' Policies and Procedures for Funding Projects (January 10, 2019) describes the eligibility and review criteria for evaluating project funding decisions. Section 5 of that document specifies that project funding decisions are made on the basis of biological benefit, technical merit, feasibility, durability, and cost effectiveness. However, Section 5 does not explicitly disallow criteria unrelated to resource benefits to be introduced into decision-making. The purpose of this SOA is to clarify that the Tributary Committees intend that all funding or other decisions regarding how PUD mitigation is implemented will have a direct nexus to the expected benefits to a plan species or plan species habitat. Decision making by a signatory for reasons unrelated to mitigation benefits are not within the spirit or intent of the HCPs and will impede the operation of the Committees. Any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from 'voting'.

Attachment 2
Draft Project Evaluation Criteria

HCP Tributary Committees Project Evaluation Rubric

I. General Criteria

Target Species

Does the proposed project address HCP Plan Species (spring Chinook, summer/fall Chinook, coho, sockeye, and/or steelhead)?

Target Area

Is the proposed project located within the geographic scope of the HCPs (projects must be in the Columbia River watershed from Rock Island Dam tailrace to Chief Joseph Dam tailrace)?

II. Restoration Projects

Biological Benefit

Does the proposed project reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Does the proposed project address limiting life stages of Plan Species within the watershed or AU?

Is the proposed project sited within an important spawning/rearing area, or provides access to habitat that would function as important spawning/rearing habitat for Plan Species?

Does the proposed project increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Does the proposed project promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

How long will it take for the proposed project to achieve its intended response?

How long will the proposed project and its benefits persist?

Will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the proposed project from being implemented?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

III. Protection Projects

Biological Benefit

Is the proposed project sited within an important spawning/rearing area for Plan Species?

To what extent does the proposed project protect high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?

What would be the anticipated loss in freshwater survival, capacity, spatial structure, and/or diversity of Plan Species at the project or reach scale if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of Plan Species at the project/reach scale)?

Technical Merit

How imminent is the threat of habitat degradation to the proposed land if the project is not implemented?

Will the landowner allow public access?

Durability

Does the proposed project protect watershed processes or important high-quality habitat in perpetuity?

Are there any conditions regarding the protection of the property that could limit the existing high-quality habitat?

Will the proposed project help ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (e.g., based on cost per linear foot of streambank or cost per acre of riparian/floodplain habitat protected)?

Does the proposed project need a cost share? If so, how much?

IV. Design Projects

Biological Benefit

Will the proposed design lead to development of projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?
Will the proposed design lead to development of projects that address limiting life stages of Plan Species within the watershed or AU?
Is the proposed design sited within an important spawning/rearing area, or will provide access to habitat that would function as important spawning/rearing habitat for Plan Species?
If the design is implemented, will it increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?
Is the proposed project appropriately scaled and scoped?
Is the proposed project sequenced properly?

Durability

Will the proposed design lead to development of projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?
If the design is implemented, how long will it take for the proposed project to achieve its intended response?
If the design is implemented, how long will the proposed project and its benefits persist?
If the design is implemented, will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?
Are there permitting or regulatory constraints that will prevent the design from being implemented?
Are there funding constraints that will prevent the design from being implemented?
Does the project sponsor have the experience, resources, and infrastructure to complete the designs?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?
Does the proposed project need a cost share? If so, how much?

V. Assessment Projects

Biological Benefit

Will the proposed assessment lead to projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?
Will the proposed assessment lead to projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed assessment sited within an important spawning/rearing area, or in an area that could function as important spawning/rearing habitat for Plan Species?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?
Is the proposed project appropriately scaled and scoped?

Durability

Will the proposed assessment lead to projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?
Will the proposed assessment lead to projects that ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?
Are there permitting or regulatory constraints that will prevent the assessment from being implemented?
Are there funding constraints that will prevent the assessment from being implemented?
Does the project sponsor have the experience, resources, and infrastructure to complete the assessment?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?
Does the proposed project need a cost share? If so, how much?

Attachment 3
Draft SRFB Funding Schedule

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
MARCH				
March 13	Meeting: SRFB/TRIB Kick-Off Meeting	LE, RTT, TRIB, Sponsors, RCO	CFNCW	LE/RCO
March 29	**Deadline:** One paragraph project abstracts/JotForm submitted to Lead Entity	Sponsors	Email	LE
APRIL				
April 12	**Deadline:** Draft proposals due	Sponsors, LE, RCO, SRP, RTT, CAC, TRIB	PRISM	LE
MAY				
May 8 & 9	Tours: SRFB/TRIB Project Tours Wenatchee (WED) Entiat (THUR)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
May	Deadline: Monitoring Letter of Intent	Sponsors, UCSRB Staff	GSRO	UCSRB
May 13& 14	Tours: SRFB/TRIB Project Tours Okanogan (Mon) Methow (TUE)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
JUNE				
June 12 & 13	Sponsor Presentations	RTT, TRIB, SRP	TBD	LE
June TBD	Action: SRP provides comments	SRP	Email via LE	RCO/SRP

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
June 13	Action: TRIB reviews draft proposals	TRIB	TRIB	TRIB Chair
June 17	Action: TRIB provide comments	TRIB	Emails	TRIB Chair
June 28	**DEADLINE:** Final proposals due for Regional scoring and ranking	Sponsors, LE, RTT, CAC, TRIB	PRISM	LE
JULY				
July 15	Action: RTT technical scoring	RTT, CAC, LE, BOR	RTT Meeting	RTT
July 11	Action: TRIB reviews final proposals	TRIB	TRIB Meeting	TRIB Chair
July 19	Action: TRIB Decisions	TRIB	Email/Letter	TRIB Chair
July 23/25	Presentations to Citizens: Okanogan/Chelan CAC's	Sponsors, CAC's, RTT, LE	Twisp River Bank/Wenatchee Reclamation Office	LE
July 31	CAC Project Rankings Chelan/Okanogan CAC's	CAC's, LE	Chelan Fire Hall	LE
AUGUST				
August 8	Deadline: Sponsors PRISM upload	Sponsors, LE	PRISM	LE
August 15	Deadline: Submit Regional List	LE	PRISM	LE/RCO
SEPTEMBER				
Sept 6	Deadline: Regional Submittal	LE	Email	LE
Sept 10	Monitoring Review Panel Provides Comments	Monitoring Review Panel	Email via UCSRB	UCSRB

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
Sept 21	Deadline: Response to comments from Monitoring Review Panel	Sponsors, UCSRB	Email via UCSRB	UCSRB
Sept 26	Action: SRP provides comments	SRP	Email via LE	SRP
OCTOBER				
Oct 10	Deadline: Response to comments from project sponsors to SRP	Sponsors, LE	Email via LE	LE
Oct 22-24	Presentations: Sponsors present projects to SRP (*only projects identified*)	Select Sponsors, LE	Olympia, Washington or via phone	RCO
NOVEMBER				
Oct 30	Action: SRP finalizes comments	SRP	Email via LE	SRP
Nov 6	Deadline: Submit Final Regional List	LE/UCSRB	PRISM	LE/UCSRB
Nov 14	Final report by SRP to SRFB	RCO		RCO
DECEMBER				
Dec 12-13	Action: SRFB Decisions	SRFB	Olympia, WA	RCO

Acronyms
CAC- Citizen's Advisory Committee
LE- Lead Entity Coordinator/Program
RCO- Recreation and Conservation Office
RTT- Upper Columbia Regional Technical Team
SRP- State Review Panel
SRFB- Salmon Recovery Funding Board
TRIB- Tributary Committees
UC- Upper Columbia Region
UCSRB- Upper Columbia Salmon Recovery Board

Timeline Legend	
Meetings	Blue
Deadlines	Red
Actions	Black

Attachment 4
Update on Icicle Screening Projects

IPID and City of Leavenworth Fish Screen Projects Updated Cost Estimates

To: PRCC and Tributary Committees

From: Jennifer Novak, Project Manager;
Shawn Stanley, Project Engineer;
Jeff Dengel, Icicle Working Group Liaison

Date: March 14, 2019
Re: Updated Cost Estimates for IPID and City of Leavenworth Fish Screen Projects

Concept level designs were developed and presented to the Icicle Working Group (IWG) in December 2015. In January 2016, we were given 10 calendar days to develop a design and construction estimate and proposal for Bonneville Power Administration (BPA) distributed targeted solicitation funds for the City and IPID fish screens. The original construction estimate for the City design was $410k, with an additional $25k for permitting, and $41k for construction oversight, totaling $476k. That concept was for an airburst cleaned plate screen at the point of diversion using the existing infrastructure and the disturbed footprint would be minimal. The design concept and estimate were completed prior to having a robust topographic survey, hydraulic modeling, or any input from the City.

A design contract was executed in August 2017 with BPA. Minimal work was performed on the design through the end of the year due to competing demands for staff time. The funding request submitted January 2018 utilized the previously developed scoping estimate for an airburst system. WDFW began meeting with the City of Leavenworth staff and contractors for the boulder field project monthly to develop the City's screen design from Jan 2018 – Jan 2019. Due to concerns with frazil ice, debris, and sweeping flows, it became apparent that using the existing pod infrastructure would have ongoing operational challenges. The resulting design is 700 feet downstream of the original location in a different style building over a vault 15 feet deep in the ground to tie into the City's existing water conveyance pipe. A drastically different product than originally envisioned but much better functionally overall.

Benefits of relocating the screen include:

1. Improved operational function. The screen will not need to be pulled when frazil ice is present and there will be increased sweep past the screen compared to the original design, both benefitting fish.
2. Elimination of in-water construction work minimizes impacts on water resources during the construction process, reduces complexity of work, and minimizes opportunities for fouling.
3. Enhanced access for construction and maintenance equipment with the expectation of reducing construction complexity, duration, risk, and cost.
4. Increased level of safety for maintenance personnel.
5. Reduced operational and maintenance expenses and level of effort.

When this design change was made, cost trade off assumptions were made. Anticipated reductions in cost were:

1. Elimination of a generator and compressor setup from the design.
2. Improved access for equipment eliminates vertical work with a crane and expedites prosecution of work.
3. The building housing the compressor and generator was planned to be concrete block construction to attenuate equipment noise. This would be replaced by a cheaper pre-engineered metal building since the new hydraulically operated screen would not produce the equivalent noise.
4. Elimination of in-water work removes dewatering requirement.

Those savings were assumed to be equivalent to:

1. Excavation and installation of 200 feet of pipe and
2. Excavation and construction of a vault for the screen.

Unforeseen expenses added to the budget include:

1. Discovery that power did not run past the water treatment facility. It was assumed that power extended past the City's treatment plant (last location of aerial lines) buried adjacent to the road servicing residences and buildings past the plant. Power service ends at the plant. Power had to be ran for 1,600 feet instead of being able to tie into roadside power 60 feet away from the proposed building as originally expected.
2. The waterline between the intake and treatment plant runs parallel to flow within the bounds of ordinary high water (OHW). The proposed design relocates that portion of the line outside of OHW and keeps horizontal bends and removal of riparian trees to a minimum but requires substantial excavation.
3. The above mentioned pipe runs through an existing settling basin that is housed in a structurally failing concrete building. The concrete structure is also within OHW and, for the foreseeable future, will continue to harden the bank, disintegrate into the channel, and pose a liability risk for the City. The estimated cost to remove the building and regrade the bank is $70k.
4. Materials costs have gone up dramatically since the initial budget was developed Jan 2016. Steel is up 100%, concrete has been up as much as 100%, and fuel is up 100%. There is an abundance of work available for contractors to bid on at the present time. 2012-2016 saw considerably more competition on bids and lower prices than we have in 2017-2018. Bid prices have come in 20-30% higher than they did above previous work and costs. Estimated increase in job cost, $80-130k.

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 11 April 2019

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator), Scott Hopkins (Chelan PUD Rock Island and Rocky Reach TCs Alternate), and Steve Kolk (Bureau of Reclamation; for Sugar Levee Coordination Agenda Item).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 11 April 2019 from 8:30 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following changes:

- Review the revised budget for the Upper Kahler Stream and Floodplain Enhancement Project.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 14 March 2019 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) started work on the MVID inlet modifications and reported that pipe has been delivered to the Phase 1 staging area. Completion of Phase 1 piping is scheduled for early June.
- Icicle Boulder Field Project – The sponsor (TU) reported they continue to work through the permitting process. Ecology is cautious because there is a lot of public focus on Icicle Creek. The sponsor met with Ecology to discuss the HEC-RAS (Hydrologic Engineering Center's River Analysis System) model output and focused on model runs that were requested by Ecology. Ecology would like to better understand slope stability at the conclusion of the project and the extent to which project impacts stay within the project area. Ecology also expressed a need to understand project impacts that extend beyond the project area.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (WDFW) will provide the next annual report on 31 December 2019.

- Burns-Garrity Design Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will provide a final report soon.
- Beaver Fever Project – The sponsor (TU) continues to reach out to landowners in the Roaring Creek watershed.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) did not provide an update this month.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) did not provide an update this month.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they are coordinating with Ecology to amend the water quality permit to allow an adjustment to the treatment period and allow for minimal phosphorous exceedances in the Chiwawa.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they and Natural Systems Design completed a site visit to evaluate access, locate potential structures, and gather additional data such as pebble counts.
- Peshastin Creek Environmental Site Assessment Project – The sponsor (CCNRD) did not provide an update this month.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported there was no new activity this month.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) did not provide an update this month.
- Johnson Creek Habitat Restoration Project – The sponsor (TU) did not provide an update this month.
- Cottonwood Flats Floodplain Restoration Project – The sponsor (CCNRD) did not provide an update this month.

IV. Small Project Applications

East Fork Mission Creek Floodplain Restoration Project

In March, the Committees received a Small Project proposal from Chelan County Natural Resource Department titled: *East Fork Mission Creek Floodplain Restoration Project*. The purpose of this project is to develop permit-ready designs that will result in improved base flows in the Mission Creek watershed by reconnecting floodplain in a severely incised system and improve habitat for steelhead. This will be accomplished by removing an eroding road prism located within the floodplain, adding in-stream wood, and addressing potential passage barriers. The project is located along a 2.8 mile stretch of East Fork Mission Creek in the upper Mission Creek watershed. The total cost of the project is $96,169. The sponsor requested $74,669 from HCP Plan Species Account Funds.

During the March meeting, the Committees were unable to make a funding decision. This is because they needed more information about the status of the road. The proposal stated, "Rd 7100 is permanently closed to motorized vehicles and was formally abandoned in 2013…" During the March meeting, however, the project sponsor indicated the statement in the proposal was incorrect. Therefore, the Committees asked CCNRD to provide clarification on the closure of the road.

On 27 March, CCNRD reported that the Forest Service Road is not officially and permanently closed. Based on this information, the Committees elected to not fund the project. They indicated they would reconsider the proposal if the road is officially and permanently closed, and the trail has been rerouted and constructed out of East Fork Mission Creek and the riparian area.

V. General Salmon Habitat Program Applications

Upper Kahler Stream and Floodplain Enhancement Project

During the March meeting, the Rock Island Tributary Committee agreed to fund the large wood structures within Nason Creek (i.e., upper log structure site 1, lower log structure site 1, log structure site 3, and log structure site 4). They indicated they would not fund any actions associated with filling the avulsion channel. They asked the Yakama Nation to provide a detailed budget for the construction of the four large wood structures within Nason Creek.

On 1 April, the Yakama Nation provided a revised budget for the construction of the four wood structures within Nason Creek (see Attachment 1). After review of the revised budget, the Rock Island Tributary Committee approved the budget for $149,000.

Evaluating Environmental Impacts of Tumwater Dam

The Committees received a General Salmon Habitat Program proposal from Cascade Columbia Fisheries Enhancement Group titled: *Evaluating Environmental Impacts of Tumwater Dam*. The purpose of the project is to evaluate how Tumwater Dam affects water quality and habitat forming processes. Specifically, the project will (1) quantify the difference between existing and historic habitat conditions within the vicinity of the dam and Lake Jolanda, (2) evaluate how water quality (temperature, dissolved oxygen, etc.) in Lake Jolanda may affect fish migration and behavior, (3) quantify and classify sediments stored behind Tumwater Dam, (4) test sediment behind Tumwater Dam for toxins or heavy metals, and (5) evaluate hydraulics and slope stability of Highway 2 and Lake Jolanda shorelines within a dam removal scenario. The total cost of the project is $279,600. The sponsor requested $139,800 from HCP Plan Species Account Funds. After careful review, the Committees elected to not fund the assessment.

Although the Committees see some value in better understanding entrance efficiency, thermal regimes, and sediments, the Committees believe the cost of the proposed work is too expensive and noted that results from the work will not be compelling enough to lead to dam removal in the near future. Indeed, much of this work would need to be repeated in the future should dam removal ever be considered. Furthermore, the effects of Tumwater Dam on fish have not been identified as important data gaps by the Regional Technical Team, nor is Tumwater Canyon (middle Wenatchee) a priority area for restoration. As noted in the Tributary Committees Funding Policies and Procedures document, an assessment is fundable if the results of the assessment directly and clearly lead to identification, siting, or design of a habitat protection or restoration project or fill a data gap that is identified as a priority in the Upper Columbia Biological Strategy.

VI. Coordination with Bureau of Reclamation on the Sugar Levee Project

Steve Kolk with BOR met with the Committees to discuss a cooperative relationship between the Bureau of Reclamation and the Tributary Committees on the Sugar Levee Project. The purpose of the project is to evaluate removal or breaching of the Sugar Levee, which is located near RM 42.2 in the Middle Reach of the Methow River just upstream from the Town of Twisp. This project will reconnect side channels and more than 17 acres of floodplain habitat. This project was identified as a possible targeted project by the Tributary Committees.

Steve said their Technical Services Center in Denver, CO, is currently using a 2D model to evaluate existing conditions. He said before they begin evaluating possible enhancement alternatives, they need a funding partner. He asked the Tributary Committees if they would be willing to "sign on" with project development. If so, he wants the Tributary Committees engaged in meetings and project development discussions. He also said early involvement in the process will allow all parties to work collaboratively and develop a project with high biological benefit. Although this project is not schedule driven, Steve said they would like to start developing and reviewing alternative designs this summer. BOR is currently in the process of hiring a group to work on designs.

Following Steve's visit with the Tributary Committees, members discussed the risks and benefits of teaming with BOR on this project. Because the relationship allows any party to exit the process at any time, the Committees agreed to work with BOR on developing the Sugar Levee Enhancement Project. Members discussed who from the Committees would participate in the meetings and on conference calls. Kate Terrell, Jeremy Cram, Chris Fisher, and Brandon Rogers agreed to participate in the meetings as time allows. In order to keep all members informed, Tracy Hillman recommended that email communications on the project be shared with everyone on the Committees. In addition, members participating in the process will provide monthly updates to all members on the Committees.

VII. Review of the Yakama Nation Draft SOA

On 25 February, the Yakama Nation submitted a draft Statement of Agreement (SOA) to the Committees for review (see Attachment 2). During the March meeting of the Tributary Committees, Brandon Rogers said the purpose of the draft SOA is to provide a basis for decision making in the HCPs Tributary Committees. He indicated the SOA is draft and asked members to review and discuss it, edit it as necessary, and vote on it during the April meeting. Although members discussed the need (or no need) for an SOA during the March meeting, the Yakama Nation asked members to edit the draft SOA if necessary and be prepared to vote on it during the April meeting.

Tracy Hillman reported that he received no edits to the draft SOA. Therefore, he asked each member to vote on the draft SOA as written and provide their reasons for their yes or no vote. Members voted as follows:

- YN voted yes because there are no written rules for what criteria can and cannot be used to evaluate proposed projects. For example, a member can vote no on a proposed project based on criteria that have nothing to do with the project.
- NMFS voted no because they see no need for an SOA, and it does not address the issue between the tribes (between YN and CCT).
- CCT voted no because they cannot support an SOA that removes their right to prevent the Yakama Nation from owning property in the Upper Columbia.
- USFWS voted no because they see no need for an SOA. They believe the evaluation criteria developed for the Policies and Procedures document provide a sufficient foundation for evaluating project proposals.
- WDFW voted no because the SOA is too restrictive and other factors need to be evaluated in making funding decisions (e.g., competency of the project sponsor to implement the project, cost shares, etc.).
- CPUD voted no because they see no need for the SOA. They support the proposed evaluation criteria in the Policies and Procedures document.
- DPUD voted no because they see no need for the SOA and believe the evaluation criteria being developed are sufficient for evaluating proposed projects. In addition, they do not want members to lose their discretionary voting rights.

Tracy summarized the votes and reasons for the votes and asked the Yakama Nation if they intend to dispute the decision by the Tributary Committees. Brandon said they will discuss this internally and decide what they intend to do. Several members indicated that their organization's vote today will not change in the Coordinating Committee or Policy Committee. Thus, this issue is unlikely to be resolved in any of the HCP Committees. Tracy asked Brandon to let him (Tracy) know if the Yakama Nation needs guidance on initiating the dispute resolution process should they choose to dispute the Tributary Committees decision.

Chris Fisher reminded the group that except for the Scaffold Camp Acquisition #2 Project, the Committees have always made funding decisions based on the cost and biological merits of the proposed project. He said Tracy requires us to provide justification for our decisions. This gives Tracy and Becky the information they need to respond to project sponsor when sponsors question our funding decisions. Chris stated the issue with the Scaffold Project was a policy-level decision for which he had no control. He said policy-level intervention is not likely to change anytime soon.

Tracy thanked everyone for their candid and open discussion on the draft SOA.

VIII. Review of Section 5 of the Policies and Procedures Document

Tracy Hillman said the Committees directed him to add the review criteria discussed during the March meeting to Section 5 of the Committees' Policies and Procedures for Funding Projects. On 21 March 2019, Tracy submitted a draft of Section 5 to the Committees for review. Tracy said he received edits only from Brandon Rogers, which he shared with the Tributary Committees. Brandon's edits included the need for determining if the proposed project was sited within a priority area for restoration or protection. Although members agreed to include the edits, they indicated the need to identify priority areas in the Okanagan subbasin in Canada. The Upper Columbia Regional Technical Team has identified priority areas for restoration and protection only within the U.S. portion of the Upper Columbia. Chris Fisher said he will work with the Okanagan Nation Alliance to identifying priority areas for restoration and protection in Canada.

Following discussion, the Tributary Committees unanimously approved the updated Section 5 of the Policies and Procedures for Funding Projects document (see Attachment 3). They directed Tracy to finalize the Policies and Procedures document. Tracy reminded the Committees they can review and update the evaluation criteria anytime they see necessary.

IX. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from March and April:

   Rock Island Plan Species Account:

   - $112.50 to Clifton Larson Allen for Rock Island financial administration in March 2019.
   - $884.80 to Chelan PUD for Rock Island project coordination and administration during the first quarter of 2019.
   - $247.28 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project.
   - $5,978.75 to Chelan County Treasurer for the Monitor Side Channel Design Project.

   Rocky Reach Plan Species Account:

   - $112.50 to Clifton Larson Allen for Rocky Reach financial administration in March 2019.
   - $863.50 to Chelan PUD for Rocky Reach project coordination and administration during the first quarter of 2019.
   - $183.92 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project.

   Wells Plan Species Account:

- $435.11 to Chelan PUD for Wells project coordination and administration during the first quarter of 2019.

2. Tracy Hillman shared the Salmon Recovery Funding Board (SRFB) Schedule with the Committees (see Attachment 4). He said draft proposals are due on 12 April. Project tours are scheduled tentatively for 9 May (Okanogan and Methow), 13 May (Wenatchee), and 14 May (Entiat). Sponsors will give presentations on 12-13 June. The Committees will evaluate the draft proposals on 8 May and decide which projects should be submitted as final proposals. Final proposals are due on 28 June. The Committees will evaluate final proposals and make funding decisions on 11 July.
3. Time permitting, the Tributary Committees will discuss targeted projects during the May meeting.

X. Next Steps

The next scheduled meeting of the Tributary Committees will be on Wednesday, 8 May 2019 at Grant PUD in Wenatchee. The Committees will visit proposed project sites on 9, 13, and 14 May.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Revised Budget on the Upper Kahler Project

3/29/2019 Cost Proposal to the Rock Island Tributary Committee
Nason Creek - Kahler

Item #	Description	Quantity	Units	Price	Extended Price
001	TESC, SPCC	1	LS	$ 5,000	$ 5,000
002	Mobilization	1	LS	$ 16,000	$ 16,000
003	Road Maintenance	1	LS	$ 5,000	$ 5,000
004	Site Prep, Salvage Trees and Shrubs	1	AC	$ 8,000	$ 8,000
005	Upper Log Structure Site 1	1	LS	$ 30,000	$ 30,000
006	Lower Log Structure Site 1	1	LS	$ 30,000	$ 30,000
007	Log Structure Site 4	1	LS	$ 30,000	$ 30,000
008	Log Structure Site 3	1	LS	$ 25,000	$ 25,000
	Project Total				**$ 149,000.00**

Attachment 2
Draft SOA from the Yakama Nation

Rocky Reach, Rock Island, and Wells HCP Tributary Committees
DRAFT Statement of Agreement

Basis for Decision Making in HCP Tributary Committees
February 25, 2019

Statement

The Rocky Reach, Rock Island, and Wells Habitat Conservation Plans (HCP) Tributary Committees (TCs) agree that mitigation funding decisions will be based exclusively on the merit of proposed projects (biological benefit, technical merit, feasibility, durability, and cost effectiveness) having a direct nexus to plan species, plan species habitat, or plan species management. Signatories agree not to base funding decisions on criteria other than project merit.

Background

The Wells, Rocky Reach, and Rock Island HCP Tributary Committees' Policies and Procedures for Funding Projects (January 10, 2019) describes the eligibility and review criteria for evaluating project funding decisions. Section 5 of that document specifies that project funding decisions are made on the basis of biological benefit, technical merit, feasibility, durability, and cost effectiveness. However, Section 5 does not explicitly disallow criteria unrelated to resource benefits to be introduced into decision-making. The purpose of this SOA is to clarify that the Tributary Committees intend that all funding or other decisions regarding how PUD mitigation is implemented will have a direct nexus to the expected benefits to a plan species or plan species habitat. Decision making by a signatory for reasons unrelated to mitigation benefits are not within the spirit or intent of the HCPs and will impede the operation of the Committees. Any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from 'voting'.

Attachment 3
Proposed Section 5 for the Policies and Procedures Document

5 Review Procedures

The Committees will make funding decisions based on eligibility criteria (see Section 4), fund availability, and if necessary, the recommendations from technical advisors. During review of project proposals, the Committees will act in good faith and within the spirit of the collaborative nature of the HCPs to make project funding decisions and having a direct nexus to plan species, plan species habitat, or plan species management. Furthermore, consistent with Section 9 of the HCPs, voting members shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled. Importantly, as agreed to during HCP negotiations, funding decisions require unanimous approval of the Committees (as described in HCPs Section 7), affording each member discretionary rights when reviewing and voting on project proposals.

Project proposals will be evaluated based on general and specific criteria. Below we identify the general criteria, which are from the HCPs, and specific criteria, which are based on biological and technical merit, feasibility, durability, and cost-effectiveness. The Committees may also solicit reviews of project proposals from technical experts outside the Committees.

5.1 General Criteria

Project proposals will first be evaluated based on the following general criteria.

Target Species

Does the proposed project address HCP Plan Species (spring Chinook, summer/fall Chinook, coho, sockeye, and/or steelhead)?

Target Area

Is the proposed project located within the geographic scope of the HCPs (projects must be in the Columbia River watershed from Rock Island Dam tailrace to Chief Joseph Dam tailrace)?

5.2 Specific Criteria

Project proposals that address target species within the target area will be evaluated based on biological and technical merit, feasibility, durability, and cost-effectiveness. Separate criteria were established for restoration, protection, design, and assessment projects.

5.2.1 RESTORATION PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration?[1]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Does the proposed project reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Does the proposed project address limiting life stages of Plan Species within the watershed or AU?

Is the proposed project sited within an important spawning/rearing area, or provides access to habitat that would function as important spawning/rearing habitat for Plan Species?

Does the proposed project increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Does the proposed project promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

How long will it take for the proposed project to achieve its intended response?

How long will the proposed project and its benefits persist?

Will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the proposed project from being implemented?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

[1] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

5.2.2 PROTECTION PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for protection? [2]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

To what extent does the proposed project protect high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?

What would be the anticipated loss in freshwater survival, capacity, spatial structure, and/or diversity of Plan Species at the project or reach scale if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of Plan Species at the project/reach scale)?

Technical Merit

How imminent is the threat of habitat degradation to the proposed land if the project is not implemented?

Will the landowner allow public access?

Will the landowner allow restoration actions?

Durability[3]

Does the proposed project protect watershed processes or important high-quality habitat in perpetuity?

Are there any conditions regarding the protection of the property that could limit the existing high-quality habitat?

Will the proposed project help ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there funding constraints that will prevent the project from being implemented?

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[2] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

[3] In Section 7 under Ownership of Assets, the HCPs state that "[a]ll real property purchased shall include permanent deed restrictions to assure protection and conservation of habitat."

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

5.2.3 DESIGN PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration? [4]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Will the proposed design lead to development of projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed design lead to development of projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed design sited within an important spawning/rearing area, or will provide access to habitat that would function as important spawning/rearing habitat for Plan Species?

If the design is implemented, will it increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Will the proposed design lead to development of projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

If the design is implemented, how long will it take for the proposed project to achieve its intended response?

If the design is implemented, how long will the proposed project and its benefits persist?

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[4] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

If the design is implemented, will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the design from being implemented?

Are there funding constraints that will prevent the design from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the designs?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

5.2.4 ASSESSMENT PROJECTS

Biological Benefit

Is the proposed assessment located within a priority assessment unit or area? [5]

Is the proposed assessment sited within an important spawning/rearing area for Plan Species?

Will the proposed assessment lead to projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed assessment lead to projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed assessment sited within an important spawning/rearing area, or in an area that could function as important spawning/rearing habitat for Plan Species?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Durability

Will the proposed assessment lead to projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

[5] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Will the proposed assessment lead to projects that ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the assessment from being implemented?

Are there funding constraints that will prevent the assessment from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the assessment?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

All decisions on funding will be held in a closed executive session. The Committees reserve the right to hold closed sessions on other issues, when necessary. Project proposal presentations may be open to the public. All other meetings will be open by invitation only. The Committees may use the Mid-Columbia Forum[6] to inform stakeholders of the status of the Plan Species Account(s). Decisions by the Committees are final and not subject to review by any entity.

The Committees may sponsor workshops for all stakeholders to present the annual Plan activities and project selection policies and procedures. Successful project applicants may be asked to present the status of their projects during these workshops.

[6] The Mid-Columbia Forum is a meeting of the HCP Coordinating, Hatchery, and Tributary Committees with stakeholders, including the Confederated Tribes of the Umatilla Indian Reservation and American Rivers, who were involved in negotiating the HCPs but elected to not sign the HCPs. The purpose of the meeting is to provide stakeholders with a progress report on implementation, as well as give them an opportunity to ask questions of the Committee members.

Attachment 4
Draft SRFB Funding Schedule

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	**ACTIVITY/MILESTONE**	**PARTICIPANTS**	**LOCATION**	**FACILITATOR/ COORDINATOR**
MARCH				
March 13	Meeting: SRFB/TRIB Kick-Off Meeting	LE, RTT, TRIB, Sponsors, RCO	CFNCW	LE/RCO
March 29	**Deadline:** One paragraph project abstracts/JotForm submitted to Lead Entity	Sponsors	Email	LE
APRIL				
April 12	**Deadline:** Draft proposals due	Sponsors, LE, RCO, SRP, RTT, CAC, TRIB	PRISM	LE
MAY				
May 8 & 9	Tours: SRFB/TRIB Project Tours Wenatchee (WED) Entiat (THUR)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
May	Deadline: Monitoring Letter of Intent	Sponsors, UCSRB Staff	GSRO	UCSRB
May 13& 14	Tours: SRFB/TRIB Project Tours Okanogan (Mon) Methow (TUE)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
JUNE				
June 12 & 13	Sponsor Presentations	RTT, TRIB, SRP	TBD	LE

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	**ACTIVITY/MILESTONE**	**PARTICIPANTS**	**LOCATION**	**FACILITATOR/ COORDINATOR**
June TBD	Action: SRP provides comments	SRP	Email via LE	RCO/SRP
June 13	Action: TRIB reviews draft proposals	TRIB	TRIB	TRIB Chair
June 17	Action: TRIB provide comments	TRIB	Emails	TRIB Chair
June 28	**DEADLINE:** Final proposals due for Regional scoring and ranking	Sponsors, LE, RTT, CAC, TRIB	PRISM	LE
JULY				
July 15	Action: RTT technical scoring	RTT, CAC, LE, BOR	RTT Meeting	RTT
July 11	Action: TRIB reviews final proposals	TRIB	TRIB Meeting	TRIB Chair
July 19	Action: TRIB Decisions	TRIB	Email/Letter	TRIB Chair
July 23/25	Presentations to Citizens: Okanogan/Chelan CAC's	Sponsors, CAC's, RTT, LE	Twisp River Bank/Wenatchee Reclamation Office	LE
July 31	CAC Project Rankings Chelan/Okanogan CAC's	CAC's, LE	Chelan Fire Hall	LE
AUGUST				
August 8	Deadline: Sponsors PRISM upload	Sponsors, LE	PRISM	LE
August 15	Deadline: Submit Regional List	LE	PRISM	LE/RCO
SEPTEMBER				
Sept 6	Deadline: Regional Submittal	LE	Email	LE

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
Sept 10	Monitoring Review Panel Provides Comments	Monitoring Review Panel	Email via UCSRB	UCSRB
Sept 21	Deadline: Response to comments from Monitoring Review Panel	Sponsors, UCSRB	Email via UCSRB	UCSRB
Sept 26	Action: SRP provides comments	SRP	Email via LE	SRP
OCTOBER				
Oct 10	Deadline: Response to comments from project sponsors to SRP	Sponsors, LE	Email via LE	LE
Oct 22-24	Presentations: Sponsors present projects to SRP (*only projects identified*)	Select Sponsors, LE	Olympia, Washington or via phone	RCO
NOVEMBER				
Oct 30	Action: SRP finalizes comments	SRP	Email via LE	SRP
Nov 6	Deadline: Submit Final Regional List	LE/UCSRB	PRISM	LE/UCSRB
Nov 14	Final report by SRP to SRFB	RCO		RCO
DECEMBER				
Dec 12-13	Action: SRFB Decisions	SRFB	Olympia, WA	RCO

Acronyms
CAC- Citizen's Advisory Committee
LE- Lead Entity Coordinator/Program
RCO- Recreation and Conservation Office
RTT- Upper Columbia Regional Technical Team
SRP- State Review Panel
SRFB- Salmon Recovery Funding Board
TRIB- Tributary Committees
UC- Upper Columbia Region
UCSRB- Upper Columbia Salmon Recovery Board

Timeline Legend	
Meetings	Blue
Deadlines	Red
Actions	Black

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 8 May 2019

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Wednesday, 8 May 2019 from 9:00 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 11 April 2019 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported they continue to make progress on the MVID inlet and Phase 1 piping. Phase 1 piping should be completed by early June.
- Icicle Boulder Field Project – The sponsor (TU) reported they continue to work through the permitting process. Department of Ecology has requested the sponsor develop a boulder breaking plan and a Temporary Erosion and Sediment Control Plan. They will also be developing a Stormwater Pollution Prevention Plan as part of the NPDES permit. Public comment period closed on the SEPA and county shorelines. There were no notable comments.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (WDFW) will provide the next annual report on 31 December 2019.
- Burns-Garrity Design Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) provided a final report, which was uploaded to the Extranet site.
- Beaver Fever Project – The sponsor (TU) indicated they have been coordinating with USFS on BDA installations in Potato and Roaring creeks. The sponsor is also working with USFS on the permitting pathway.

- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) did not provide an update this month.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported NRCS has completed the hydraulic review and the sponsor can now order the box culvert. They are currently evaluating whether to construct this year or next. Before bidding the project, the sponsor needs a construction estimate and final designs and construction documents from WDFW engineering.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported no new activity this month.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they and Natural Systems Design refined restoration plans and produce a preliminary site map and construction cost estimates. These were included in the draft SRFB/TC application.
- Peshastin Creek Environmental Site Assessment Project – The sponsor (CCNRD) reported that Phase 1 fieldwork will be completed on 10 May 2019.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported there was no new activity this month.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported they are working on SEPA and JARPA.
- Johnson Creek Habitat Restoration Project – The sponsor (TU) did not provide an update this month.
- Cottonwood Flats Floodplain Restoration Project – The sponsor (CCNRD) reported that construction will begin fall 2020.

IV. General Salmon Habitat Program Draft Applications

The Committees received 18 General Salmon Habitat Program draft proposals. The Committees reviewed each draft proposal and selected those they believe warranted a final proposal.[1] Projects the Committees dismissed were either inconsistent with the intent of the Tributary Fund, did not have strong technical merit, or had low benefits per cost (not cost effective). The Committees assigned draft proposals to one of two categories: Fundable (would like to see a final application) and Not Fundable (would not like to see a final application). It is important to note that these are ratings of draft proposals and do not reflect ratings of final proposals. The Committees directed Tracy Hillman to notify sponsors with appropriate projects to submit a final proposal, with a discussion of the questions/comments identified for each draft proposal listed below. Tracy will also notify sponsors with projects that have no chance or a low likelihood of receiving funding from the Tributary Committees.

Nason and Kahler Creek Confluence Acquisition Project (Fundable)

The Committees recommend that the project sponsor (Chelan Douglas Land Trust) submit a full proposal. The Committees had no comments on this project.

Restore Lower Chiwaukum Creek – Phase 1 (Fundable)

The Committees recommend that the project sponsor (Cascade Columbia Fisheries Enhancement Group) address the following comments/suggestions as they develop the full proposal:

[1] The Committees held a conference call on Tuesday, 21 May 2019 to discuss observations from the site visits and reassess their designation of proposed projects as fundable (would like to see a final application) or not fundable (do not want to see a final application).

- Identify any constraints the Forest Service may have on this project before identifying enhancement alternatives.
- Evaluation of alternatives needs to consider post-fire effects (e.g., changes in hydrology, debris flows, temperature effects, etc.).
- The evaluation of alternatives needs to consider the removal of camping sites located within the riparian area.

Monitor Side Channel Construction Project (Fundable)

The Committees recommend that the project sponsor (Chelan County Natural Resources Department) submit a full proposal. The Committees had no comments on this project.

Upper Wenatchee Side Channel RM 38.9-40.2 Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- The Yakama Nation will be implementing enhancement actions at this site. Thus, there is no need for another project at this site.

Peshastin RM 4.3 Side Channel Project (Fundable)

The Committees recommend that the project sponsor (Chelan County Natural Resources Department) address the following comments/suggestions as they develop the full proposal:

- Need to update the project schedule within the application.
- Include a signed landowner willingness form with the final application.
- Use the segments of Peshastin Creek upstream and just downstream from the proposed project site as a reference for designing the floodplain and side channel reconnections.

Icicle and Peshastin Irrigation Districts Full Season Pumping Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe there are too many unknowns regarding the implementation of this project. Some of those include:
    - The precise location of the proposed micro-hydropower facility is unclear.
    - It is unknown how power generated at the micro-hydropower facility will enter the power grid and what infrastructure is required to make that happen.
    - There are uncertainties regarding Snow Creek water rights.
    - It is unclear if there is or has been coordination with the Leavenworth Fish Hatchery.
    - O&M costs are mostly unknown and there is no cost estimate for the construction of a micro-hydropower facility.
    - There are no results from the original pump-station design.

The Committees are interested in better understanding this project and would like to schedule a meeting with Tony Jantzer to discuss the project in more detail.

Nason Ridge Acquisition Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- The Committees are not interested in funding an acquisition that includes mostly uplands. However, the Committees would review a proposal seeking funds to acquire the floodplain and riparian habitat along Nason Creek if the floodplain can be separated from the uplands.

Wenatchee EDT Model Development Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees understand that the Upper Columbia Regional Technical Team is developing a prioritization tool for the Wenatchee sub-basin. They also understand that this tool, which is intended to update the Upper Columbia Biological Strategy, has not been fully developed and tested at this time. If it is determined that the prioritization tool works, there may be no need for a second prioritization tool.
- Given that EDT has produced some questionable results in the Methow sub-basin, the Committees want to see how well the model performs in the Methow once additional habitat data are collected to help populate the model, before proceeding with EDT implementation in the Wenatchee.

Eagle Creek Fish Passage Barrier Removal – RM 0.3 Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- Although the barrier prioritization tool identified the lower Eagle Creek culvert as a priority barrier, the tool also evaluates clusters of barriers within a stream or small watershed. In this case, it is not appropriate to evaluate the lower barrier (which is a partial barrier) in isolation from the other roughly 20 barriers in Eagle Creek. When evaluating the cluster of barriers within the stream, it does not appear the biological benefit justifies the cost of replacing all barriers at the per-barrier cost in the proposal. That is, barrier replacement in Eagle Creek does not appear to be cost effective.
- Eagle Creek is not considered a high priority area for restoration.

Lower Wenatchee Instream Flow Enhancement Phase II Project (Fundable)

The Committees recommend that the project sponsor (Trout Unlimited) address the following comments/suggestions as they develop the full proposal:

- Identify the level of certainty that the sponsor will receive the $2M cost share.
- Provide specific information on the quality of water discharged back into the Wenatchee River. If available, provide the concentrations of pollutants and the temperature of the return water.
- Indicate the average amount of irrigation water returned to the Wenatchee River under current conditions. Also, indicate the amount of flow within the Wenatchee River at the times when water is diverted.

<u>Burns-Garrity Side Channel Project (Not Fundable)</u>

The Committees recommend that this project, sponsored by Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe the groundwater yield is too low to support Plan Species.
- The Committees would like to better understand the evolution of the main channel given the recent avulsion. They are not convinced the side channel will function appropriately for Plan Species over the long term given the dynamic nature of the main channel at this location.

<u>Restoration Strategy for the Upper Methow Project (Not Fundable)</u>

The Committees recommend that this project, sponsored by Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe the Upper Methow Reach Assessment provides adequate information to guide enhancement projects in this reach of the upper Methow River. They see no need for additional assessments in this reach.
- A better approach is to submit an application for design work, which includes enough budget to assess alternatives.

<u>Okanogan Basin Barrier Assessment Project (Not Fundable)</u>

The Committees recommend that this project, sponsored by Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe barriers within the anadromous zone within the Okanogan sub-basin are mostly known and have been or are being addressed.
- The Committees also understand that barriers upstream from natural barriers are clustered and the biological benefit gained from addressing clusters of barriers outside the anadromous zone will not justify the cost.

<u>Fuller Side Channel Well Conversion Project (Not Fundable)</u>

The Committees recommend that this project, sponsored by the Methow Salmon Recovery Foundation, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- This project will have little to no biological benefit.
- The Committees also believe this project is too expensive. The total cost of the project should be under $100,000.

<u>Upper Burns and Angle Point Areas Habitat Enhancement Project (Fundable)</u>

The Committees recommend that the project sponsor (Yakama Nation) address the following comments/suggestions as they develop the full proposal:

- Provide maps, pictures, preliminary design drawings, and modeling results supporting design in the final proposal.
- Indicate whether the landowner supports this project.
- Consider a seasonal side channel. Not all side channels need to be perennial and this may be a good location for a seasonal channel.
- Consider adjustments to the opening of the side channel and let the river carve the side channel.
- The application refers to enhancement work that began in 2017 adjacent to the proposed project

area. If available, provide any data or information on the use of these enhancement structures by Plan Species (i.e., Chinook, steelhead, and/or coho).

- Consider a construction method that minimizes disturbance of existing riparian vegetation, such as excavating a trench to design elevation and allowing the river to contour the channel banks, rather than grading side slopes to form a trapezoidal channel. If the design team determines that such an approach is not acceptable, please provide and justify the rationale for that decision.

Nason Confluence Habitat Enhancement Project (Not Fundable)

The Committees recommend that this project, sponsored by the Yakama Nation, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- Because of the sediment dynamics and high sediment load within Nason Creek, the Committees believe maintaining a side channel at the mouth of Nason Creek will be difficult. Thus, they question the longevity of the project.
- The Committees are concerned regarding the amount of established riparian vegetation that would be removed or destroyed during project implementation.
- The application would benefit from having maps, pictures, and preliminary design drawings.

Golden Doe Large Wood Project (Fundable)

The Committees recommend that the project sponsor (Yakama Nation) address the following comments/suggestions as they develop the full proposal:

- Provide maps, pictures, and preliminary design drawings in the final proposal.
- Because this is a dynamic area, consider using large-wood apex jams at the upstream end of the project area (to direct flows into specific channels) and drive pilings downstream from the apex jams to catch wood to improve peripheral and transitional habitat.
- The Committees are concerned that the side channel will not be maintained because of the sediment dynamics at this site. The sponsor needs to describe how the side channel will be maintained over time.
- Indicate if the proposed project intends to use groundwater to maintain flows in the side channel. If so, will intercepting groundwater affect riparian vegetation along the channel?

Napeequa Side Channel Connection Project

Although it was not clear in the application if the project sponsor (Cascade Columbia Fisheries Enhancement Group) was seeking funding from the Habitat Conservation Plans Tributary Committees, the Committees nevertheless reviewed the application. The purpose of the project is to remove a culvert and associated fill to restore hydraulic connectivity to a side channel along the lower Napeequa River, a tributary to the White River. This action will improve juvenile steelhead and spring Chinook survival and productivity by providing access to an important spring-fed side channel. The total cost of the project is $58,290.00. After careful review of the proposal, the ***Rocky Reach Tributary Committee elected to contribute $49,399.00 to the project*** (the project has a cost share of $8,891.00). The Committee recommended the sponsor consider a less expensive pedestrian bridge over the Napeequa River.

V. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from April and May:

   Rock Island Plan Species Account:

- $865.51 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project.
- $461.69 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project.
- $8,996.08 to Chelan County Treasurer for the Monitor Side Channel Design Project.

Rocky Reach Plan Species Account:

- $141.07 to Cascade Columbia Fisheries Enhancement Group for the Burns-Garrity Restoration Design Project.
- $690.90 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project.

2. Tracy Hillman shared the Salmon Recovery Funding Board (SRFB) Schedule with the Committees (see Attachment 1). He said project tours are scheduled for 9 May (Methow), 13 May (Wenatchee), and 14 May (Entiat). Sponsors will give presentations on 12-13 June. Final proposals are due on 28 June. The Committees will evaluate final proposals and make funding decisions on 16 July.
3. Tracy Hillman reported that he informed Steve Kolk (Bureau of Reclamation; BOR) that the Tributary Committees are interested in partnering with BOR on the Sugar Levee Project. BOR will coordinate with the Committees on future meetings and field trips. BOR should have 2D model results available for Committees' review by the end of April.

VI. Next Steps

The next scheduled meeting of the Tributary Committees will be on Tuesday, 16 July at Grant PUD in Wenatchee. The Committees will visit proposed project sites on 9, 13, and 14 May and attend presentations on 12-13 June.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Draft SRFB Funding Schedule

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
MARCH				
March 13	Meeting: SRFB/TRIB Kick-Off Meeting	LE, RTT, TRIB, Sponsors, RCO	CFNCW	LE/RCO
March 29	**Deadline:** One paragraph project abstracts/JotForm submitted to Lead Entity	Sponsors	Email	LE
APRIL				
April 12	**Deadline:** Draft proposals due	Sponsors, LE, RCO, SRP, RTT, CAC, TRIB	PRISM	LE
MAY				
May 8 & 9	Tours: SRFB/TRIB Project Tours Wenatchee (WED) Entiat (THUR)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
May	Deadline: Monitoring Letter of Intent	Sponsors, UCSRB Staff	GSRO	UCSRB
May 13& 14	Tours: SRFB/TRIB Project Tours Okanogan (Mon) Methow (TUE)	Sponsors, LE, RTT, TRIB, SRFB SRP, CAC	TBD	LE
JUNE				
June 12 & 13	Sponsor Presentations	RTT, TRIB, SRP	TBD	LE
June TBD	Action: SRP provides comments	SRP	Email via LE	RCO/SRP

Upper Columbia SRFB/TRIB DRAFT 2019 Funding Schedule				
DATE	**ACTIVITY/MILESTONE**	**PARTICIPANTS**	**LOCATION**	**FACILITATOR/ COORDINATOR**
June 13	Action: TRIB reviews draft proposals	TRIB	TRIB	TRIB Chair
June 17	Action: TRIB provide comments	TRIB	Emails	TRIB Chair
June 28	**DEADLINE:** Final proposals due for Regional scoring and ranking	Sponsors, LE, RTT, CAC, TRIB	PRISM	LE
JULY				
July 15	Action: RTT technical scoring	RTT, CAC, LE, BOR	RTT Meeting	RTT
July 11	Action: TRIB reviews final proposals	TRIB	TRIB Meeting	TRIB Chair
July 19	Action: TRIB Decisions	TRIB	Email/Letter	TRIB Chair
July 23/25	Presentations to Citizens: Okanogan/Chelan CAC's	Sponsors, CAC's, RTT, LE	Twisp River Bank/Wenatchee Reclamation Office	LE
July 31	CAC Project Rankings Chelan/Okanogan CAC's	CAC's, LE	Chelan Fire Hall	LE
AUGUST				
August 8	Deadline: Sponsors PRISM upload	Sponsors, LE	PRISM	LE
August 15	Deadline: Submit Regional List	LE	PRISM	LE/RCO
SEPTEMBER				
Sept 6	Deadline: Regional Submittal	LE	Email	LE
Sept 10	Monitoring Review Panel Provides Comments	Monitoring Review Panel	Email via UCSRB	UCSRB

UPPER COLUMBIA SRFB/TRIB DRAFT 2019 FUNDING SCHEDULE				
DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
Sept 21	Deadline: Response to comments from Monitoring Review Panel	Sponsors, UCSRB	Email via UCSRB	UCSRB
Sept 26	Action: SRP provides comments	SRP	Email via LE	SRP
OCTOBER				
Oct 10	Deadline: Response to comments from project sponsors to SRP	Sponsors, LE	Email via LE	LE
Oct 22-24	Presentations: Sponsors present projects to SRP (*only projects identified*)	Select Sponsors, LE	Olympia, Washington or via phone	RCO
NOVEMBER				
Oct 30	Action: SRP finalizes comments	SRP	Email via LE	SRP
Nov 6	Deadline: Submit Final Regional List	LE/UCSRB	PRISM	LE/UCSRB
Nov 14	Final report by SRP to SRFB	RCO		RCO
DECEMBER				
Dec 12-13	Action: SRFB Decisions	SRFB	Olympia, WA	RCO

Acronyms
CAC- Citizen's Advisory Committee
LE- Lead Entity Coordinator/Program
RCO- Recreation and Conservation Office
RTT- Upper Columbia Regional Technical Team
SRP- State Review Panel
SRFB- Salmon Recovery Funding Board
TRIB- Tributary Committees
UC- Upper Columbia Region
UCSRB- Upper Columbia Salmon Recovery Board

Timeline Legend	
Meetings	Blue
Deadlines	Red
Actions	Black

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 16 July 2019

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Wednesday, 16 July 2019 from 9:00 am to 12:40 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 8 May 2019 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported they completed Phase 1 piping on 10 June. This allowed Barkley/MVID to start running irrigation to their shareholders. The easements with the DOT/FAA and adjacent property owners along the Barkley and MVID pipe aliment continue to move slowly.
- Icicle Boulder Field Project – The sponsor (TU) reported they are waiting on federal permits and are planning on a late summer/early fall bid walk. They also continue to work closely with WDFW and are also working through the funding process for the City of Leavenworth fish screen.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (Washington Department of Fish and Wildlife; WDFW) will provide the next annual report on 31 December 2019.
- Beaver Fever Project – The sponsor (TU) reported they continue to wait on the USFS internal processes for moving forward with Roaring Creek and Potato Creek BDA installation in 2019 or 2020.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) did not provide an update this month.

- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported that because of a delay in final design development, it will be too late to have the concrete box culvert manufactured this year. Therefore, they requested a time extension to 15 December 2020 (see discussion below).
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they are preparing for the field season.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they conducted a site tour with WDFW and WDOT to secure early feedback on project plan and preliminary designs.
- Peshastin Creek Environmental Site Assessment Project – The sponsor (CCNRD) reported that their consultant is working on the draft report.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported they are preparing for the field season.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported permits have been secured with WDFW and Okanogan County. They expect permits from the Corps of Engineers and Ecology soon. They currently have a landowner agreement with one of the three landowners. Construction is scheduled to start 12 July.
- Johnson Creek Habitat Restoration Project – The sponsor (TU) did not provide an update this month.
- Cottonwood Flats Floodplain Restoration Project – The sponsor (CCNRD) reported construction will occur during fall 2020.
- Upper Kahler Stream and Floodplain Project – The Tributary Committee/Sponsor Agreement has been executed.
- Stormy Area "A: Stream and Floodplain Enhancement Project – The Tributary Committee/Sponsor Agreement has been executed.
- Napeequa Side Channel Connection Project – The Tributary Committee/Sponsor Agreement is ready for signature.

IV. Budget Amendment Request

Lower Derby Creek Fish Passage Project

In June, the Rock Island Tributary Committee received a budget amendment request from Cascade Columbia Fisheries Enhancement Group on the Lower Derby Creek Fish Passage Project. Because of unforeseen changes in the project, the sponsor requested an additional $32,196 from the Committee. The Committee originally approved $65,000 for the project. With the budget amendment, the total request from the Rock Island Tributary Committee will be $97,196. In June, the Rock Island Tributary Committee approved the budget amendment.

V. Time Extension Request

Lower Derby Creek Fish Passage Project

In July, the Rock Island Tributary Committee received a time extension request from Cascade Columbia Fisheries Enhancement Group on the Lower Derby Creek Fish Passage Project. Because of a delay in completing final designs, the sponsor requested a time extension from 1 December 2019 to 1 December 2020. After careful consideration, the Rock Island Tributary Committee approved the time extension.

VI. General Salmon Habitat Program Draft Applications

The Committees received 12 General Salmon Habitat Program proposals that were cost shares with the Salmon Recovery Funding Board (SRFB). In addition, they received an application from WDFW that was not a cost share with the SRFB.

Before reviewing the proposals and consistent with the Committees' Operating Procedures, members of the Committees identified potential conflicts of interest. Brandon Rogers recused himself from discussing and voting on the two Yakama Nation proposals.

Becky Gallaher provided the Committees with the unallocated balances within each Plan Species Account. The Wells Account has $1,813,698, the Rocky Reach Account has $2,270,634, and the Rock Island Account has $6,389,534. In sum, among the three accounts, there is $10,473,866 available to fund projects.

Nason and Kahler Creek Confluence Acquisition Project

Chelan-Douglas Land Trust is the sponsor of the Nason and Kahler Creek Confluence Acquisition Project. The purpose of this project is to purchase and protect 80 acres of riparian/floodplain habitat along lower Kahler Creek, a tributary to Nason Creek. The total cost of the acquisition was $369,150. The sponsor requested $231,500 from HCP Plan Species Account Funds. Although the Committees found the project worthy of funding, they withdrew the application because the Priest Rapids Coordinating Committee Habitat Subcommittee elected to fund this project.

Restore Lower Chiwaukum Creek – Phase I Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Restore Lower Chiwaukum Creek – Phase I Project. The purpose of the project is to evaluate the geomorphology and fish habitat within the lower one mile of Chiwaukum Creek, and create effective enhancement designs. Chiwaukum Creek is a tributary to the Wenatchee River. The total cost of the project was $116,256. The sponsor requested $55,098 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $55,098 to the project***. As part of funding for this project, the Committee requires that they review and approve restoration scenarios and designs.

Monitor Side Channel Construction Project

Chelan County Natural Resources Department is the sponsor of the Monitor Side Channel Construction Project. The purpose of the project is to construct large wood structures and boulder clusters within the Monitor Side Channel and enhance riparian habitat along the side channel, which is located within the lower Wenatchee River. The total cost of the project was $296,530. The sponsor requested $148,265 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $148,265 to the project***.

Peshastin RM 4.3 Side Channel Project

Chelan County Natural Resources Department is the sponsor of the Peshastin RM 4.3 Side Channel Project. The purpose of the project is to design a 1,200-foot long side channel along Peshastin Creek, a tributary to the Wenatchee River. The total cost of the project was $99,010. The sponsor requested $19,802 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $19,802 to the project***.

IPID Full Season Pumping Project

Chelan County Natural Resources Department is the sponsor of the IPID Full Season Pumping Project. The purpose of the project is to design a full-season, pressurized, pumpback system for the Icicle and Peshastin Irrigation Districts. This system will allow for the decommissioning of the Peshastin Irrigation

Diversion. The total cost of the project was $135,000. The sponsor requested $67,500 from HCP Plan Species Account Funds. The Committees declined the opportunity to fund this project.

The Committees understand there is about $120,000 remaining in the Peshastin Irrigation District Pump Exchange Preliminary Design Project. Because of landowner issues associated with that project, and the clear overlap in project scope with the proposed project, the Committees recommend that the sponsor work with the Salmon Recovery Funding Board on changing the scope of the Peshastin Irrigation District Pump Exchange Preliminary Design Project and amend its budget to include the proposed work. The Committees would review a revised proposal if the resulting budget amendment is inadequate to complete the Peshastin Irrigation District Full-Season Pumpback Project.

Nason Ridge Acquisition Project

Chelan County Natural Resources Department is the sponsor of the Nason Ridge Acquisition Project. The purpose of the project is to protect 3,714 acres of riparian, floodplain, and upland habitat within the Nason Creek watershed. In sum, the acquisition will protect 506 acres of riparian and floodplain habitat along lower Nason Creek. The acquisition will also allow upland restoration actions that will reduce fine sediment recruitment to Nason Creek. The total cost of the project was $5,500,000. The sponsor requested $500,000 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $500,000 to the project***. This funding is contingent on the Committee’s review and approval of the draft management plan. At a minimum, it is important to the Committee that the road density be reduced to at least 2 miles per square mile. This will directly benefit Plan Species within the project area.

Wenatchee EDT Model Development Project

Chelan County Natural Resources Department is the sponsor of the Wenatchee EDT Model Development Project. The purpose of the project is to build a model-based synthesis platform for monitoring data to support habitat status and trends reporting and restoration planning. The tool will help identify and prioritize enhancement actions, develop conceptual designs, and evaluate biological benefits and feasibility. The total cost of the project was $318,000. The sponsor requested $48,000 from HCP Plan Species Account Funds. The Committees declined the opportunity to fund this project.

The Committees understand that the Upper Columbia Regional Technical Team is developing a prioritization tool for the Wenatchee sub-basin. The Committees also understand that this tool, which is intended to update the Upper Columbia Biological Strategy, has not been fully developed and tested at this time. If it is determined the prioritization tool works, there may be no need for a second prioritization tool, such as EDT. In addition, given that EDT has produced some questionable results in the Methow sub-basin, the Committees want to see how well the model performs in the Methow once additional habitat data are collected to help populate the model, before proceeding with EDT implementation in the Wenatchee sub-basin. This was the expressed opinion of the Committees regarding the 2018 application, and given the remaining uncertainty around the suitability of the Methow EDT, the Committees’ decision is unchanged.

Lower Wenatchee Instream Flow Enhancement Phase II Project

Trout Unlimited is the sponsor of the Lower Wenatchee Instream Flow Enhancement Phase II Project. The purpose of the project is to conserve up to 15 cfs of water in the lower Wenatchee River by developing a pressurized irrigation system. The system will also eliminate the return of warm irrigation water that is contaminated with agricultural chemicals. The total cost of the project was $2,500,000. The sponsor requested $250,000 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $250,000 to the project***.

Upper Burns and Angle Point Areas Habitat Enhancement Project

The Yakama Nation is the sponsor of the Upper Burns and Angle Point Areas Habitat Enhancement Project. The purpose of the project is to reconnect relic side channels and install large wood structures within the mainstem Entiat River. The total cost of the project was $1,070,500. The sponsor requested $189,000 from HCP Plan Species Account Funds. The ***Rock Island Tributary Committee elected to contribute $189,000 to the project***.

Golden Doe Large Wood Project

The Yakama Nation is the sponsor of the Golden Doe Large Wood Project. The purpose of the project is to recreate large, bar-apex wood structures in a wide anabranching segment of the Methow River between Twisp and Carlton. The total cost of the project was $1,004,590. The sponsor requested $200,270 from HCP Plan Species Account Funds. The Committees declined the opportunity to fund this project.

The Committees believe the proposed enhancement site is located in a very dynamic reach, which means there is considerable uncertainty as to how the river will respond to the proposed structures and whether the structures will provide habitat for HCP Plan Species for a long enough period of time to warrant the substantial investment. Given these uncertainties, the Committees believe a lighter, less expensive approach, which includes the use of a few apex jams and pilings, would be best suited for this site.

Upper Methow Restoration Assessment and Design Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Upper Methow Restoration Assessment and Design Project. The purpose of the project is to develop restoration designs and a protection strategy for the Upper Methow River. The sponsor will compile available data, identify and fill data gaps, initiate stakeholder outreach, and develop enhancement concepts and a protection strategy. The total cost of the project was $80,200. The sponsor requested $35,500 from HCP Plan Species Account Funds. The Committees declined the opportunity to fund this project because they are not interested in funding additional assessment work. However, they would review applications for preliminary and final enhancement designs.

Okanogan Basin Barrier Assessment Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Okanogan Basin Barrier Assessment Project. The purpose of the project is to conduct a comprehensive fish passage barrier assessment throughout the Okanogan River sub-basin, including areas upstream from anadromy. The total cost of the project was $193,826. The sponsor requested $22,000 from HCP Plan Species Account Funds. The Committees declined the opportunity to fund this project because they believe barriers within the anadromous zone are already known. In addition, they see relatively little value in assessing barriers outside the anadromous zone because there is a low likelihood those barriers will be addressed anytime soon. Finally, barriers above the anadromous zone are also outside the zone for Plan Species, and thus ineligible for Tributary Committees funding.

2019 Eightmile Creek Fisheries Assessment Project

Washington Department of Fish and Wildlife is the sponsor of the 2019 Eightmile Creek Fisheries Assessment Project. This project did not have a SRFB cost share. The purpose of the project is to identify fish abundance, stream flows, and water temperatures to guide permitting and selecting a brook trout removal strategy for Eightmile Creek, a tributary to the Chewuch River. The total cost of the project was $130,183. The sponsor requested $125,183 from HCP Plan Species Account Funds. The Committees were unable to make a funding decision at this time. This is primarily because the fish passage barrier is scheduled to be removed in 2020 and therefore there is no need for an assessment or development of a brook trout management plan. The Committees believe the sponsor should focus on removing as many brook trout as they can before passage is provided. As such, the Committees recommended the following:

- Propose a multiple-pass electrofishing effort to remove as many brook trout as possible before they spawn this fall. An additional removal effort could also occur next summer before barrier removal. Under this approach, there is no need for block nets because the entire length of stream is fished on more than one occasion within a short period of time (see Thompson and Rahel (1996) and Buktenica et al. (2013), which were provided to the sponsor earlier).
- Remove genetic sampling as there is no need for it given that passage will be provided and, because a rotenone treatment is not necessary (given electrofishing removal efforts), there is also no need to identify or quantify bull trout losses that would occur with piscicide application. The Committees appreciate the desire to better understand the genetics of bull trout and brook trout; however, neither are Plan Species, and as a result, Plan Species Account Funds cannot be used to fund this effort.
- Please remove any costs associated with renting electrofishing gear. The Committees understand that WDFW has electrofishing gear available for the work and the Colville Confederated Tribes (CCT) have indicated they are willing to let the sponsor use their electrofishing gear if necessary.
- The Committees recommend that you discuss this project with both Jeremy Cram (WDFW) and Chris Fisher (CCT). Chris Fisher indicated that he may be able to provide technicians and gear if necessary.

Summary of Review of 2019 General Salmon Habitat Program Projects

Project Name	Sponsor[1]	Total Cost	Request from T.C.	T.C. Contribution[2]
Nason and Kahler Creek Confluence Acquisition	CDLT	$369,150	$184,575	$0
Restore Lower Chiwaukum Creek – Phase 1	CCFEG	$116,256	$55,098	RI: $55,098
Monitor Side Channel Construction	CCNRD	$296,530	$148,265	RI: $148,265
Peshastin RM 4.3 Side Channel	CCNRD	$99,010	$19,802	RI: $19,802
IPID Full Season Pumping Project	CCNRD	$135,000	$67,500	$0
Nason Ridge Acquisition	CCNRD	$5,500,000	$500,000	RI: $500,000
Wenatchee EDT Model Development	CCNRD	$318,000	$48,000	$0
Lower Wenatchee Instream Flow Enhancement	TU	$2,500,000	$250,000	RI: $250,000
Upper Burns & Angle Point Areas Enhancement	YN	$1,070,500	$189,000	RI: $189,000
Golden Doe Large Wood Project	YN	$1,004,590	$200,270	$0
Upper Methow Restoration Assessment and Design	CCFEG	$80,200	$35,500	$0
Okanogan Basin Barrier Assessment	CCFEG	$193,826	$22,000	$0
2019 Eightmile Creek Fisheries Assessment	WDFW	$130,183	$125,183	No decision
Total:		**$11,813,245**	**$1,845,193**	**$1,162,165**

[1] CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resources Department, CDLT = Chelan-Douglas Land Trust, TU = Trout Unlimited, WDFW = Washington Department of Fish and Wildlife, and YN = Yakama Nation.

[2] RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

VII. HCP Policy Committees Guidance

Tracy Hillman shared with the HCP Tributary Committees the guidance that was provided by the HCP Policy Committees. Specific to the HCP Tributary Committees:

- The Tribal Councils of the Yakama Nation and Colville Confederated Tribes will meet to discuss a third-party owner (e.g., WDFW) for the Scaffold Camp #2 Acquisition Project in the Twisp River watershed. Brandon Rogers reported that the Yakama Nation already purchased the property. Therefore, there is no need for the Policy Committees to address the Scaffold Camp #2 Acquisition Project.
- The Tribal Councils will also provide guidance on landownership. PUD staff and other signatories will likely be asked to describe the meaning and intent of the HCPs to the Councils.
- The Tributary Committees will evaluate all project applications based on biological and technical merits, feasibility, durability, and cost-effectiveness. All policy-level issues will be evaluated by the HCP Policy Committees. In addition, technical members can abstain from voting on a decision item that has policy-level implications.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from May, June, and July:

   Rock Island Plan Species Account:

   - $127.50 to Clifton Larson Allen for Rock Island financial administration in April and May 2019.
   - $75.00 to Clifton Larson Allen for Rock Island financial administration in June 2019.
   - $602.48 to Chelan PUD for Rock Island project coordination and administration during the second quarter of 2019.
   - $259.61 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project for work in May.
   - $1,509.66 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project for work in June.
   - $395.16 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project for work in May.
   - $680.03 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project for work in June.
   - $1,195.56 to Chelan County Treasurer for the Monitor Side Channel Design Project for work in May.
   - $3,701.08 to Chelan County Treasurer for the Monitor Side Channel Design Project for work in June.
   - $808.13 to Trout Unlimited for the Beaver Fever: Restoring Ecosystem Function Project.
   - $15,492.41 to Trout Unlimited for the MVID Instream Flow Improvement Project.

   Rocky Reach Plan Species Account:

- $127.50 to Clifton Larson Allen for Rocky Reach financial administration in April and May 2019.
- $75.00 to Clifton Larson Allen for Rocky Reach financial administration in June 2019.
- $571.23 to Chelan PUD for Rocky Reach project coordination and administration during the second quarter of 2019.
- $200.20 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Site Assessment Project for work in May.
- $2,577.50 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Site Assessment Project for work in June.
- $1,220.68 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project for work in May.
- $1,380.50 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project for work in June.

Wells Species Account:

- $319.06 to Chelan PUD for Wells project coordination and administration during the second quarter of 2019.

2. Tracy Hillman reported that he received a request from the Upper Columbia Salmon Recovery Board asking if the Tributary Committees would be interested in helping sponsor the 2020 Science Conference, which will be on 23-24 January 2020 in Wenatchee. The Wells, Rocky Reach, and Rock Island Tributary Committees each agreed to donate $1,000.00 to the Conference. Funding will come from administrative expenses (not to exceed $80,000 per year per account) under the Plan Species Accounts. This level of sponsorship identifies each of the Committees as a "Gold Sponsor."
3. Tracy Hillman reminded the Committees that there will be a Peshastin Pumpback Project meeting on 23 July from 10:00 am to noon at the IPID office at 5594 Wescott Dr. in Cashmere. Members are encouraged to attend this meeting.

IX. Next Steps

The next scheduled meeting of the Tributary Committees will be on Thursday, 8 August at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 8 August 2019

Members Present: Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Jeremy Cram (WDFW)

Others Present: Becky Gallaher (Tributary Project Coordinator), Allison Lutes (Chelan County Natural Resources Department), Nic Truscott (Natural Systems Design), Kari Alex (Okanagan Nation Alliance), Dave Duvall (Grant PUD), and Steve Kolk (Bureau of Reclamation).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Wednesday, 8 August 2019 from 9:00 am to 12:45 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the removal of the Napeequa Side Channel budget amendment. The project sponsor (Cascade Columbia Fisheries Enhancement Group) pulled the budget amendment request.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 16 July 2019 meeting notes with edits.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported the bid package for Phase II piping is in review and should be out for solicitation the third week of August. Work has begun on the Boesel well. The plan is to have all five wells drilled by the end of the month.
- Icicle Boulder Field Project – The sponsor (TU) reported they are working on the bid package for solicitation in mid-August. They continue to work through the permitting process.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (Washington Department of Fish and Wildlife; WDFW) will provide the next annual report on 31 December 2019.

- Beaver Fever Project – The sponsor (TU) reported that the Forest Service is still evaluating proposed projects. The sponsor is hopeful they will receive approval soon.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) did not provide an update this month.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) held a design team meeting to discuss what work still needs to be completed before going to bid in 2020.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they are preparing for the field season.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported that their consultant (Natural Systems Design) continues to work on finalizing designs.
- Peshastin Creek Environmental Site Assessment Project – The sponsor (CCNRD) reported that their consultant completed the Phase 1 Environmental Assessment. The report was submitted to the Tributary Committee for review.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported they are preparing for the field season.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that construction was completed on the alcove and crossing at the Coon property. Site planning was completed for riparian restoration. They also completed initial planning for inclusion of several BDA structures to improve alcove complexity.
- Johnson Creek Habitat Restoration Project – The sponsor (TU) did not provide an update this month. This work will occur in 2020.
- Cottonwood Flats Floodplain Restoration Project – The sponsor (CCNRD) reported construction will occur during fall 2020.
- Upper Kahler Stream and Floodplain Project – The sponsor (Yakama Nation; YN) reported that the project is complete. A final report will be available soon.
- Stormy Area "A: Stream and Floodplain Enhancement Project – The sponsor (YN) reported the project will be completed next week. A final report will be available soon.
- Napeequa Side Channel Connection Project – The sponsor (CCFEG) reported they are beginning the permitting process.

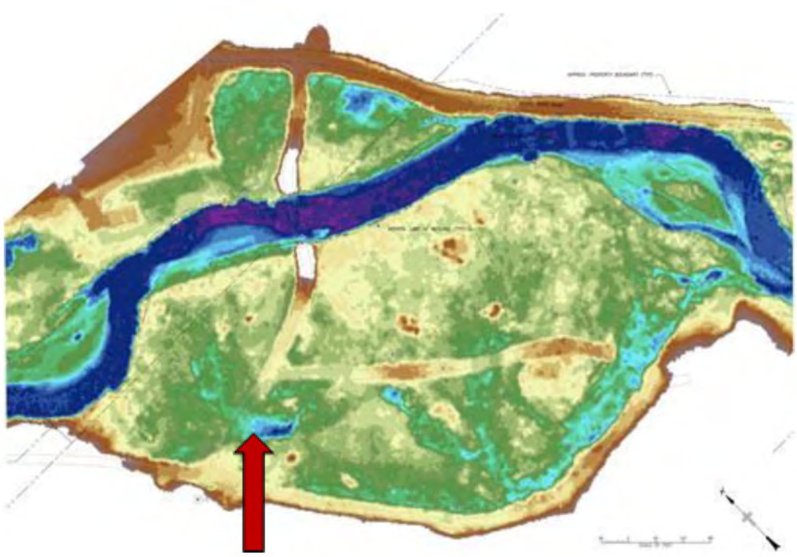
IV. Cottonwood Flats Connection Project Update

Allison Lutes (Chelan County Natural Resources Department) and Nic Truscott (Natural Systems Design) gave a presentation on the status of the Cottonwood Flats Floodplain Connection project (see Attachment 1). They began by providing an overview of the limiting factors and priority actions for the Stillwater Reach within the Entiat River (the proposed project is within the Stillwater Reach). They also provided some historical context on the Cottonwood Flats site and reminded the Committee the purpose and objectives of the proposed reconnection project. Originally, the project was to reconnect the floodplain at 500 cfs, construct a 1,200-foot long side channel, place wood in the side channel to increase structure and roughness, and remove fill and a bridge abutment. The total cost of the project was $600,598. Last year, the Rocky Reach Tributary Committee agreed to contribute $90,090 to the project. Although the SRFB agreed to fund the project, they reduced their contribution by 10% ($51,050). Thus, there is a shortfall in funding for the project. In addition, the landowner (Chelan-Douglas Land Trust) asked the sponsor to consider a design that allows reconnection at lower flows and creates a perennial alcove at the downstream end of the site.

Allison and Nic described the various design considerations including connectivity at 120 cfs, 240 cfs, and 500 cfs; inlet armoring considerations; and a perennial downstream alcove. They shared results from hydraulic modeling and described potential biological benefits from activating the floodplain at different flows. They also described inlet armoring at different flows including the cost and risks associated with armoring at different flows. Finally, they talked about the potential issues with providing a perennial downstream alcove. Because the water table is linked directly with flows in the mainstem Entiat River, it may be difficult to maintain groundwater within the perennial connection. Furthermore, an additional $40,000 will be needed to create a perennial downstream connection.

Allison and Nic then provided the Committee with three alternatives and costs. The first alternative would reconnect the floodplain at 500 cfs and provide a perennial alcove. Under this alternative, the floodplain would be activated for 84 days and no inlet hardening would be needed. This alternative would require an addition $51,000. The second alternative would reconnect the floodplain at 240 cfs and provide a perennial alcove. Under this alternative, the floodplain would be activated for 125 days and wood and/or FESL would be needed to protect the inlet. This alternative would require an additional $170,000. The final alternative would reconnect the floodplain at 120 cfs and provide a perennial alcove. Under this alternative, the floodplain would be activated for 236 days and rock and/or wood would be needed to protect the inlet. This alternative would require an additional $965,000. Allison noted that the landowner's preference is Alternative 2.

Following the presentation, the Rocky Reach Tributary Committee discussed the merits of each alternative and settled on some elements of Alternative 2. That is, they agreed with the 240-cfs connection, and wood and FESL inlet protection, but did not support a perennial alcove or the construction of a channel throughout the floodplain. Instead, they would like to see a feeder channel constructed from the inlet extending to about the first, large depression located near the old roadbed (see figure below). They believe flows exiting the feeder channel will carve out a channel or channels downgradient from the feeder channel. The Committees asked that the sponsor discuss this with their engineers and the landowner to see if this is reasonable and appropriate. If it is reasonable, the sponsor will need to provide a revised budget for the project. If it is not reasonable, the sponsor will need to explain why it is not reasonable and submit a revised budget reflecting a longer side channel (similar to the original design). The Committee will then reevaluate the need for a longer excavated side channel.



Arrow shows the location where the feeder channel would end.

V. Okanagan River Restoration Monitoring Presentation

Kari Alex with the Okanagan Nation Alliance (ONA) gave a presentation summarizing 20 years of the Okanagan River Restoration Initiative (ORRI) (see Attachment 2). Kari discussed the history of development within the Okanagan River valley and described how land uses and development disconnected the floodplain from the river. The river was dammed and channelized resulting in significant loss of habitat and connectivity. In total, 84% of the river was channelized resulting in a 50% reduction in river length, 90% of the riparian vegetation was lost, and most of the instream diversity and floodplain connectivity was lost. As a result, most native fish species declined in abundance and distribution, and exotic species expanded their distribution and increased in abundance. She said the goal of ORRI is to use an ecosystem-based approach to increase floodplain capacity, reconnect the floodplain, improve water quality, and create instream complexity. The program is managed adaptively and relies on collaboration.

Kari described the work conducted near Oliver. Here, enhancement included a large floodplain reconnection project, channel re-meandering, vertical drop structure (VDS) modification, construction of side channels and an amphibian pond, and restoration of a cottonwood meadow. Kari showed photos of these projects before and after enhancement and shared monitoring results, which included channel morphology responses, hydraulic responses, changes in fish habitat, changes in fish abundance and distribution, riparian vegetation responses, and wildlife responses. Importantly, rainbow trout and Chinook salmon returned to the enhanced reach, coverage of macrophytes decreased and Eurasian watermilfoil disappeared from the reach, and macroinvertebrate diversity and richness increased. This reach is now a preferred area for spawning, and egg incubation survival has increased significantly within the reach. Kari noted that although spawning gravels move within the reach, the quantity and quality of the gravels have not changed. In addition, large wood is recruiting to the reach, and side channels are improving overall water quality within the reach. Indeed, the side channels are providing thermal refugia for rainbow trout. She did note that the boulder clusters placed within the reach were not successful as they were eventually buried in the streambed.

Next, Kari talked about the enhancement work near Penticton. In this channelized reach, they added four large spawning beds and placed boulder clusters between spawning beds. The spawning beds were designed to improve spawning habitat for sockeye, kokanee, steelhead, and rainbow trout. They monitored channel morphology, fish habitat, hydraulic responses, and fish responses. They found that the spawning beds are used extensively. In fact, the kokanee bed has been saturated with kokanee since the beds were constructed. In addition, they found that egg incubation survival is similar to undisturbed areas, spawning beds are stable over time, macroinvertebrate diversity increased, habitat diversity increased, Eurasian watermilfoil decreased, and steelhead/rainbow use the boulder clusters. She noted that spawning habitat is still limiting within the Okanagan River.

Lastly, Kari discussed future projects, which include off-channel habitat enhancement, VDS removal, and creation of pool-riffle complexes within the Okanagan River. She also summarized the amount of habitat restored or enhanced within the Okanagan River valley and shared with the Committees information on an upcoming workshop titled, “15 years of Restoring Salmon Habitat.” The workshop will be held in Penticton on 1-2 October 2019.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from July and August:

   Rock Island Plan Species Account:

- $175.00 to Clifton Larson Allen for Rock Island financial administration in July 2019.
- $1,000.00 to the Upper Columbia Salmon Recovery Board for the 2020 Science Conference.
- $920.33 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project for work in July.
- $775.15 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project for work in July.
- $2,214.20 to Chelan County Treasurer for the Monitor Side Channel Design Project for work in July.

Rocky Reach Plan Species Account:

- $175.00 to Clifton Larson Allen for Rocky Reach financial administration in July 2019.
- $1,000.00 to the Upper Columbia Salmon Recovery Board for the 2020 Science Conference.
- $158.42 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Site Assessment Project for work in July.
- $712.30 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project for work in July.
- $1,152.16 to Cascade Columbia Fisheries Enhancement Group for the Napeequa Side Channel Project for work in July.

Wells Species Account:

- $1,000.00 to the Upper Columbia Salmon Recovery Board for the 2020 Science Conference.

2. Several members attended the Peshastin Pumpback Project meeting on 23 July from 10:00 am to noon at the IPID office in Cashmere. They reported that there are major uncertainties associated with O&M and the micro-hydropower facility. They also noted that the sponsor (CCNRD) is unwilling to move forward with the Committees' recommendation to work with the Salmon Recovery Funding Board on changing the scope of the Peshastin Irrigation District Pump Exchange Preliminary Design Project and amend its budget to include the proposed work. Members said they will continue to attend future meetings on the Peshastin Pumpack Project.
3. Members reviewed the Phase 1 Environmental Assessment report on the Peshastin Creek RM 8.8 Project. In sum, the report recommends the following: For the southern (WSDOT site) and northern (BRG quarry) parcels, there are no recognized environmental concerns. For the central portion of the site (Dietrich parcel), there may be some environmental concerns; however, it is anticipated that they can be mitigated during site clean-up. Based on what was observed on site, a Phase II Environmental Assessment is not recommended at this time. The Rocky Reach Tributary Committee directed Tracy Hillman to ask Jennifer Hadersberger (CCDNR) to attend the September meeting to discuss the Phase 1 findings and next steps. Tracy will invite Jennifer to the next meeting. This topic should be discussed jointly with the Tributary Committees and PRCC Habitat Subcommittee. Therefore, Tracy will also coordinate this agenda item with Denny Rohr, Chair of the PRCC Habitat Subcommittee.

4. Steve Kolk (Bureau of Reclamation; BOR) attended the end of the meeting to provide an update on the Sugar Levee Project. He said there has been little progress on the project; however, they (BOR) selected a contractor to help with project design. BOR selected Inter-Fluve, Inc. Steve indicated that there will be a kick-off meeting in September. He also reported that BOR will conduct a value planning study on the IPID Pumpback Project. In addition, they are working with the Yakama Nation on an upper Wenatchee project and assisting with BDA projects.
5. Justin Yeager reported that the Eightmile Creek Fisheries Assessment Project is unlikely to occur this year. According to Justin, WDFW will not have time to set up a contract and hire staff to do the work this year. In addition, it does not appear WDFW will be able to reduce their overhead to 15%.

VII. Next Steps

The next scheduled meeting of the Tributary Committees will be on Thursday, 12 September at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Presentation by Allison Lutes and Nic Truscott on Cottonwood Flats Project

Stillwater Reach –

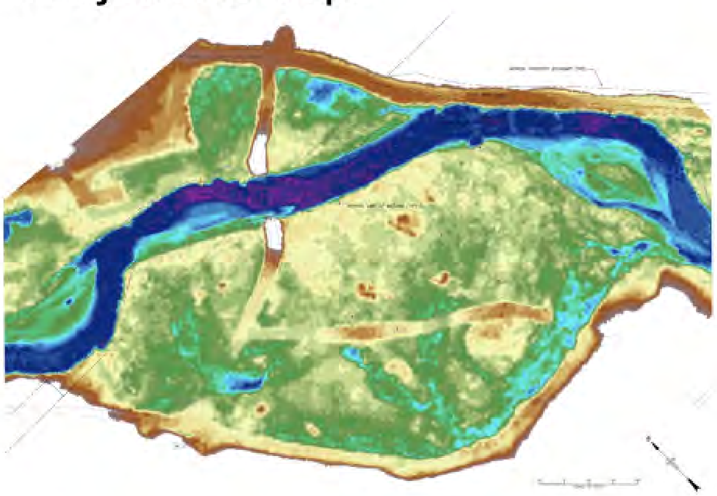
#1 Priority Reach for Restoration Actions in the Entiat River

Ecological Concerns:

#2 Peripheral/Transitional Habitat and

#3 Channel Structure and Form (in stream structural complexity) Priority Restoration Actions

Project Re-cap:

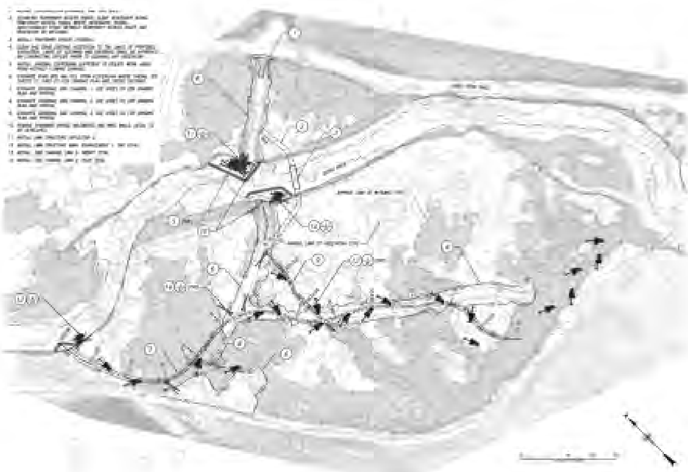


Historical fill violation (1997) on site ~ 5000 c.y. impacting est. 6 acres of wetland

Bridge deck and superstructure were removed in 2017; left bank abutment remains

CCNRD wrote grant for 2018 SRFB round for final design, permitting and construction

Project Re-Cap: 2018 SRFB/TribComm



1. Create a **floodplain side channel (1200' and 6 acres)** for high flow refugia for juvenile spring Chinook and steelhead fry.
   - **500 CFS seasonal connection**
2. Enhance connection between a **downstream alcove area** and the main-stem Entiat river (foraging habitat for spring Chinook and steelhead summer parr)
3. Strategically place main channel **large wood structures and side-channel roughness**
4. Remove 5000~ c.y. of floodplain fill to restore wetland habitat
5. Remove left bank bridge abutment and complete bank restoration

Project Re-Cap & Considerations

2018 SRFB Proposal Budget:

Cottonwood Flats Cost Estimate

Task	SRFB Request	Trib Com	Total
Final Engineering Design	$81,200		$81,200
Engineering Bid Assistance	$2,200		$2,200
Construction (see attached detail)	$348,408	$90,090	$438,498
Engineer Construction Observation	$19,200		$19,200
Cultural Resources	$4,500		$4,500
Permitting*	$9,000		$9,000
Project Management**	$24,000		$24,000
Construction Management and Environmental Compliance	$12,000		$12,000
Landowner time to review designs	$5,000		$5,000
Grant Administration, billings, progress reports	$5,000		$5,000
Total	$510,508	$90,090	$600,598

- Project funded, **budget cut $51,050** (10% by Citizens Committee)
- 2018 SRFB Engineers Estimate did not include earthwork details for downstream alcove. Will present on those details today.

Design Considerations for Discussion:

1. **Design Flows for side-channel (120 CFS vs. 240 CFS vs. 500 CFS)**
   1. Existing conditions
   2. Duration of connection and corresponding biological benefit
   3. **Inlet armoring considerations** for different side channel connections: cost vs benefit vs risk

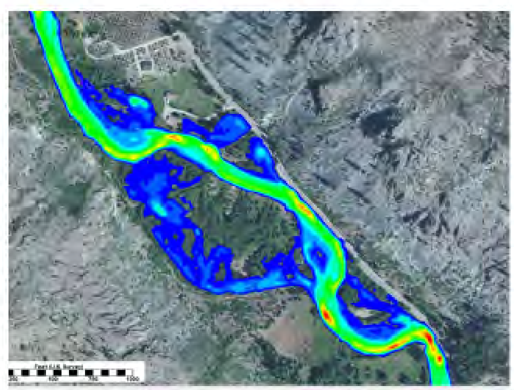
2. **Perennial downstream alcove**

- Groundwater infiltration galleries – possible or not?
- Will the outlet stay open?
- Revised excavation estimate details

6

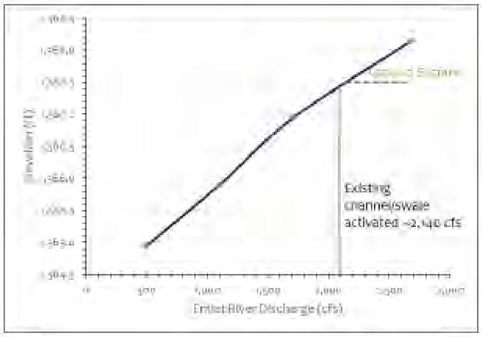
Design Flows for side-channel: Existing Conditions Modeling

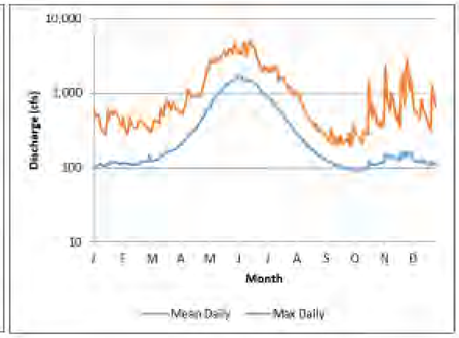
500 cfs



2680 cfs 2 year event

Design Flows for side-channel: Existing Conditions Modeling

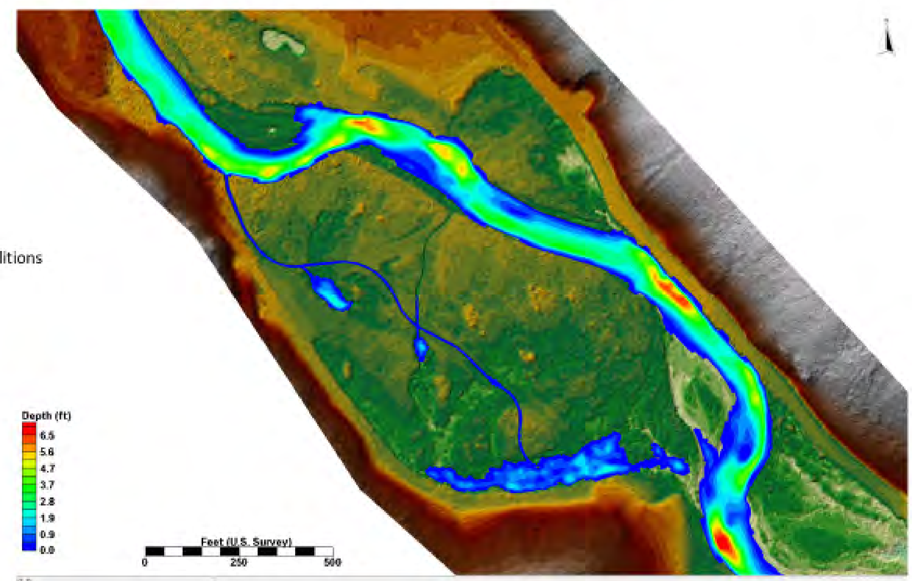




- Over the available period of record (22,550 days ~62 years) there were 400 days where average daily flow exceeded activation threshold… **side channel is active about 1.8% of the time under existing conditions**

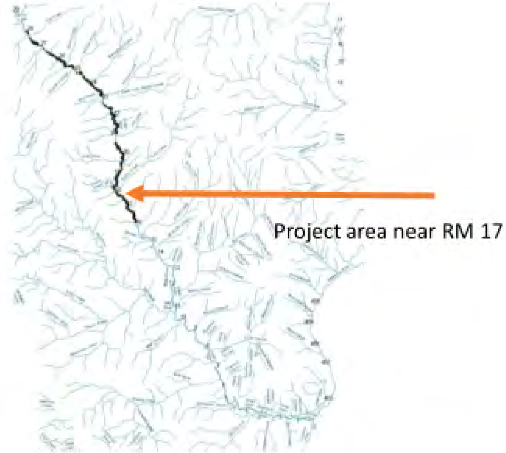
Design Flows for side-channel: Proposed Conditions Modeling: 500 CFS

Figure 1. Proposed conditions modeling at 500 cfs



Design Flows for side-channel: Biological Benefit

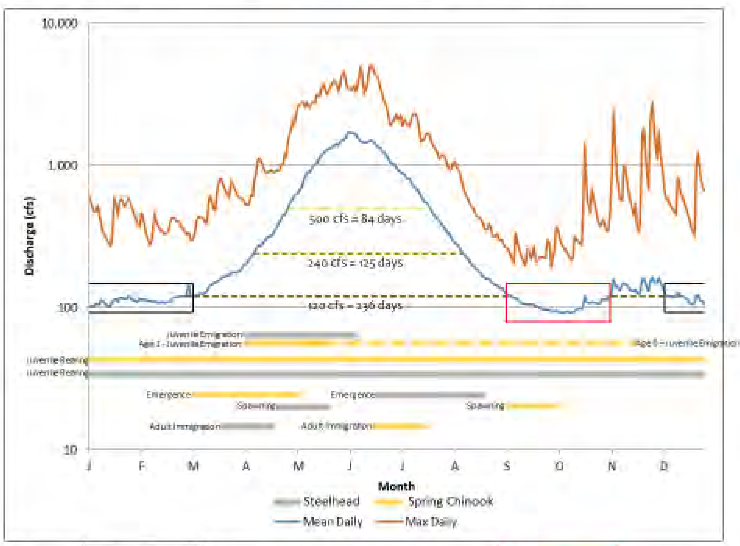
Spring Chinook (pink) and steelhead (yellow) locations in the Entiat River near the project site.



Note that the project area is near the downstream limits of spring Chinook spawning in the Entiat River.

Design Flows for side-channel: Biological Benefit

High Flow Refugia



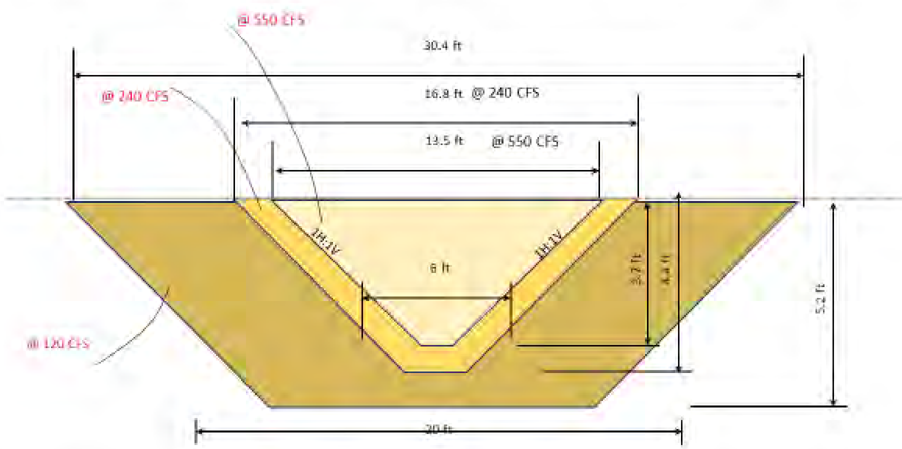
"Winter Flows"
Mean: 125
Median: 118
Min: 101

"Summer Flows"
Mean: 105
Median: 105
Min: 92

Design Considerations for Discussion:

1. **Design Flows for side-channel**
   1. Existing conditions
   2. Duration of connection = biological benefit under different flow scenarios (120 CFS vs 240 CFS vs 500 CFS)
   3. **Inlet armoring considerations** for different side channel connections: Cost vs benefit vs risk
      - 120 cfs
      - 240 cfs
      - 500 cfs
2. **Perennial downstream alcove**
   - Groundwater infiltration galleries – possible or not?
   - Will the outlet stay open?

Inlet Size and Armoring @ Different Side Channel Design Flows

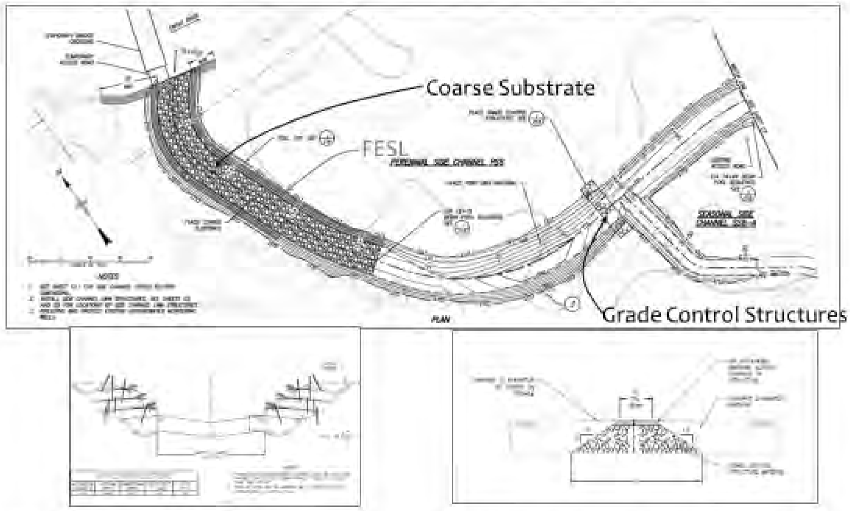


550 CFS Channel Area = 13.5' w X 3.7' d = 36.5 ft^2

240 CFS Channel Area = 16.8' w X ~4.4' d = 54.5 ft^2

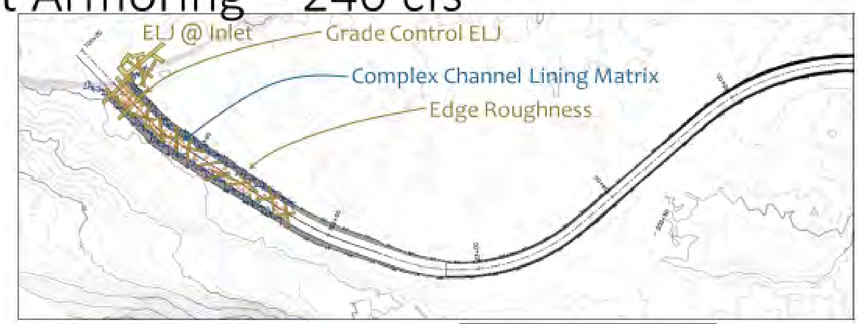
120 CFS Channel Area = 30.4' w X 5.2' d = 144 ft^2

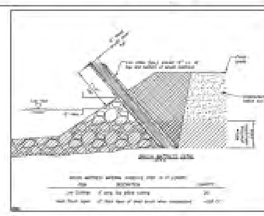
Inlet Armoring – 120 cfs



@ 120 CFS Design Flow the inlet will need more aggressive armoring due to risk in channel avulsion and shear stress risks

Inlet Armoring – 240 cfs





Inlet Hardening, Costs, Risk under Different Side Channel Design Flows

Design Alternative	Activation Flow (cfs)	Days with Surface Water Flow	Channel Excavation (CY)	Inlet Hardening	Construction Cost[1]	Design Certainty	Erosion Risk
120 cfs connection, **rock** inlet	120	236	8,600	Rock	~$1M	High	Moderately Low
120 cfs connection, **wood** inlet	120	236	8,600	Wood	~$925K	Moderately High	Moderate
240 cfs connection, **wood** inlet	240	125	1,500[2]	Wood	~$550K	Moderate	Moderate
500 cfs connection, **no hardening**	500	84	950	None	~$450K	Moderate	Moderate

[1] Construction costs were estimated using similar unit costs of $25/CY for channel excavation incl. haul; Construction Grant Total ~$440K
[2] Approximate excavation volume

Design Considerations for Discussion:

1. **Design Flows for side-channel**
   1. Existing conditions
   2. Duration of connection = biological benefit under different flow scenarios (120 CFS vs 240 CFS vs 500 CFS)
2. **Inlet armoring considerations** for different side channel connections: cost vs benefit vs risk
   - 120 cfs
   - 240 cfs
   - 500 cfs
3. **Perennial downstream alcove**

- Groundwater infiltration galleries – possible or not?
- Will the outlet stay open? What size channel/alcove is appropriate?

Perennial Downstream Alcove: Existing conditions

Alcove habitat

Perennial Downstream Alcove

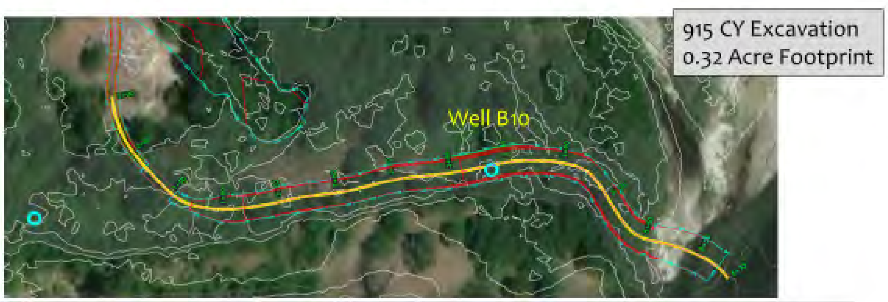
- Is a perennial downstream alcove a possibility?
  - Let's look at GW data from well b10

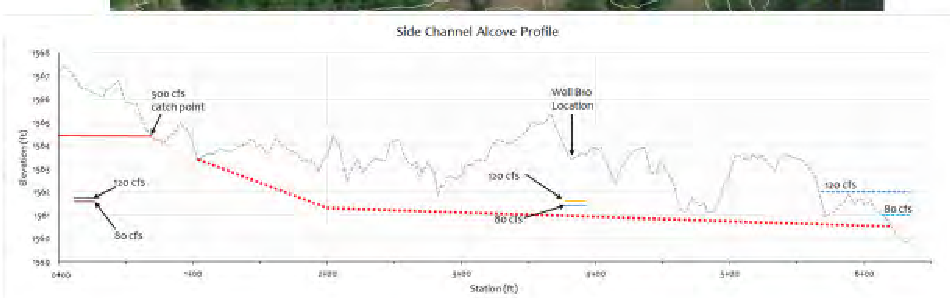
19

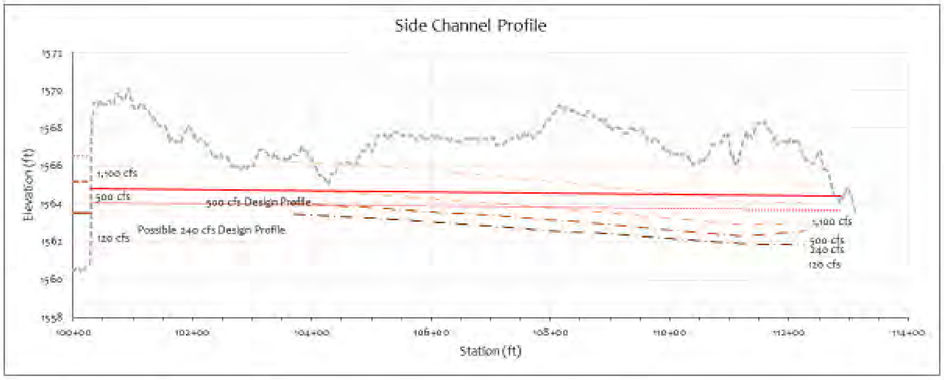
Perennial Downstream Alcove

- Similar to other wells at the site, GWSEs at B10 closely mimic flow fluctuations in Entiat River
  - Fluctuations in Entiat flow (even small) are mimicked in GWSE
  - Doesn't appear that outside sources heavily influence groundwater

Downstream Alcove: groundwater infiltration galleries?







- Side channel profile @ different design flow criteria up to beginning of downstream alcove

Groundwater Data - Takeaways

- GWSEs at all wells closely mimic flow fluctuations in Entiat River
  - Fluctuations in Entiat flow (even small) are mimicked in GWSE
  - Doesn't appear that outside sources heavily influence groundwater as fluctuations in flow and GWSE are visible across range of all flows
- Hydraulic gradient is generally from upstream to downstream with small variations laterally across floodplain
  - GWSEs generally vary approximately 1.6-1.7 ft from the furthest upstream well to the furthest downstream well
  - GWSEs may drop by 1.8-2.0 ft over the entire length of the side channel
- Need to rely upon excavation to have surface water in the side channel

Downstream Alcove – Costs & Uncertainties

- Additional Cost
  - Excavation – 915 CY @ $30/CY
  - Excavation cost likely a bit higher due to wet conditions
  - Site Isolation & Dewatering
  - Additional Access Road/Maintenance
  - Extra Mobilization Cost (Typically 10%)
  - Additional Sales Tax
  - **Estimated Cost Increase ~ $40K**

24

Design Alternatives and Costs:

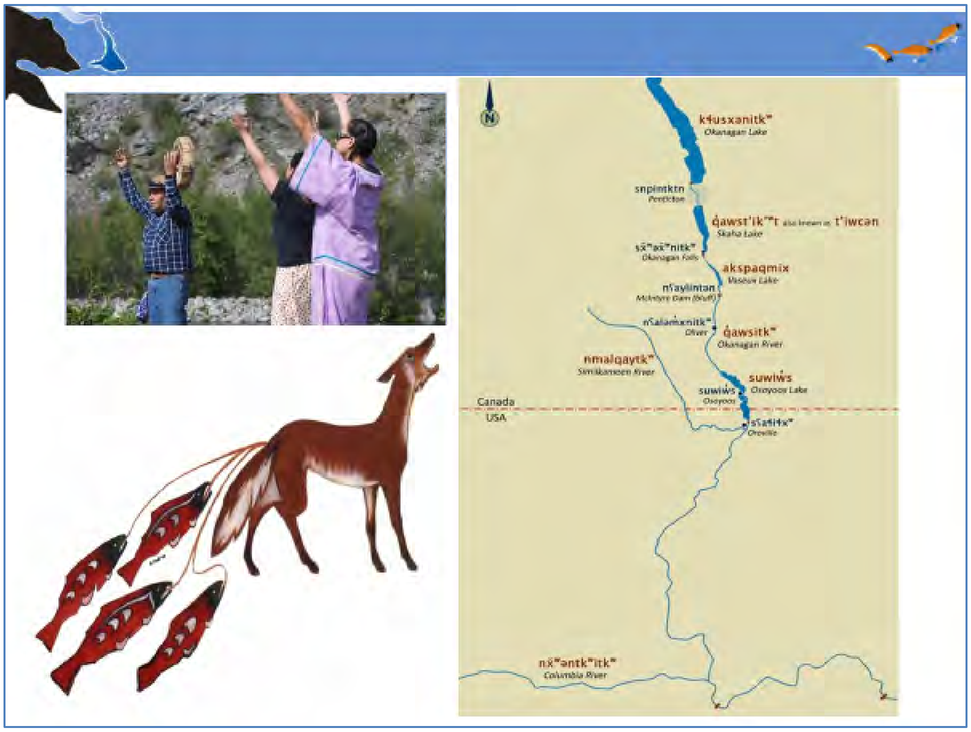
	Alternative 1	**Alternative 2**	**Alternative 3**
Design Flow	500 CFS with perennial alcove	240 CFS with perennial alcove	120 CFS with perennial alcove
Days of connection	84 days of activation	125 days	236 days
Inlet Protection	No hardening	Wood/FESL	Rock option or Wood option
Additional Modeling/Engineering Costs	Modelling completed;60% grading designs/cross-sections and profiles; final designs funded	Modeling not completed; all new grading designs, sheets, cross-sections, and profiles	Modeling completed; all new grading designs, sheets, cross-sections, and profiles
Additional Cost	$51k - 10% cut from citizens committee **= $51k total**	$51k cut from citizens + additional 120k for engineering and construction **= $170k total**	$51k cut from citizens + additional 495k for engineering and construction **= $965k total**

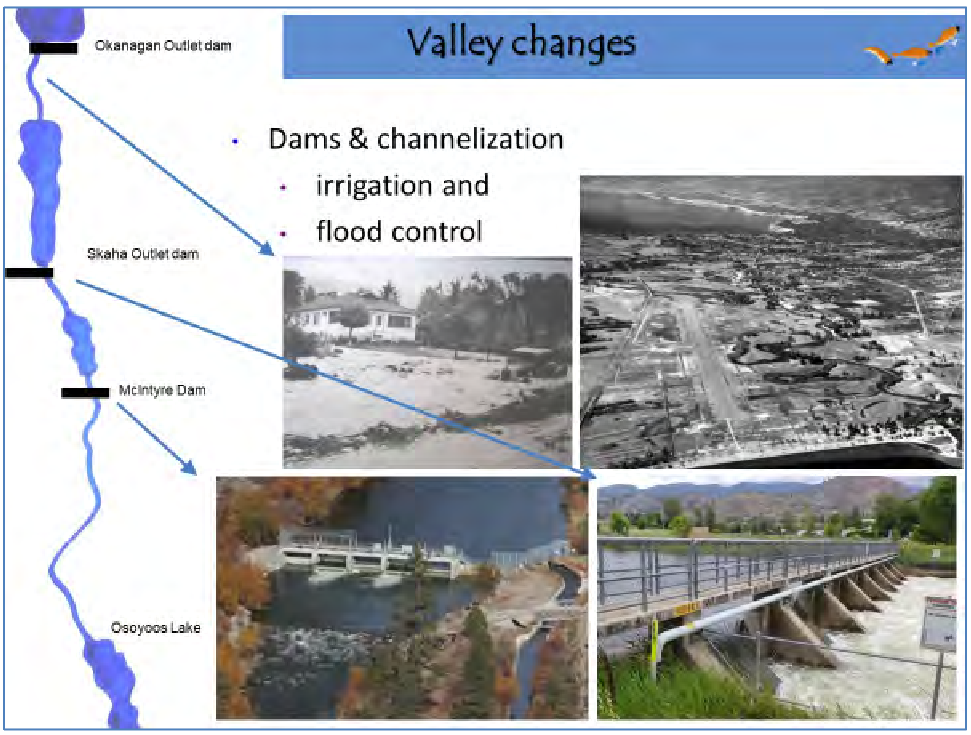
Project Timeline

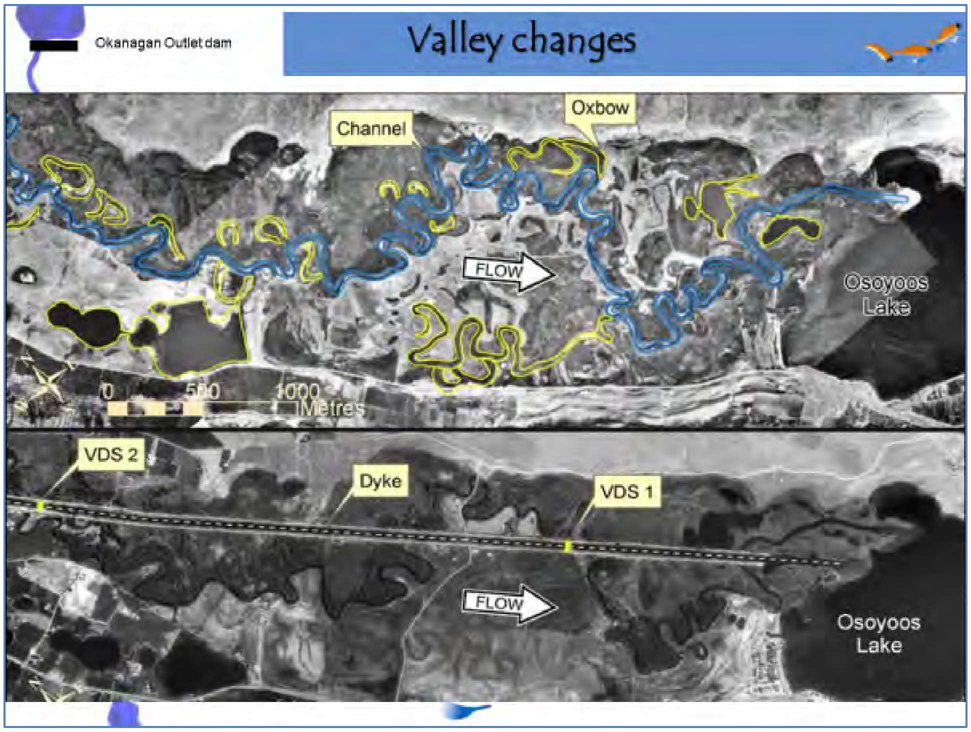
Task	Timeline
Contracting with RCO	Jan. 31, 2019
Hire Engineering Design Contractor	Feb. 2019
River left bio-engineering design	Fall 2019
River left voluntary bank restoration	Fall 2019
River right 80% design	Fall 2019
Secure permits for river right floodplain restoration	Spring 2020
Final design	Spring 2020
Bid to hire restoration contractor	June 1, 2020
Floodplain restoration river right	Oct 31, 2020

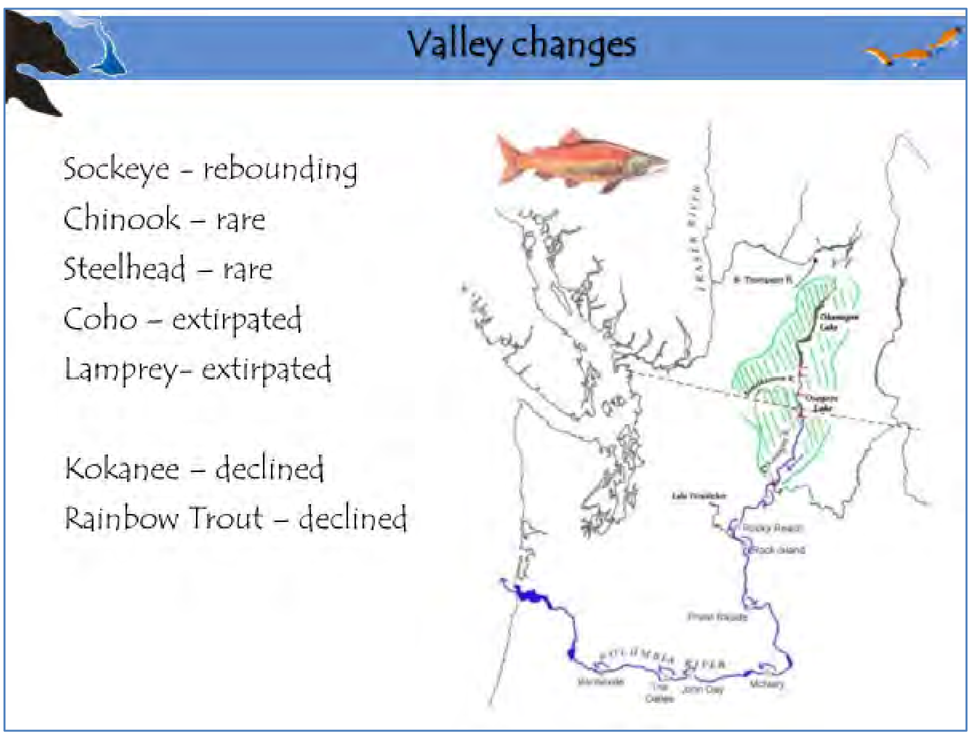
Attachment 2

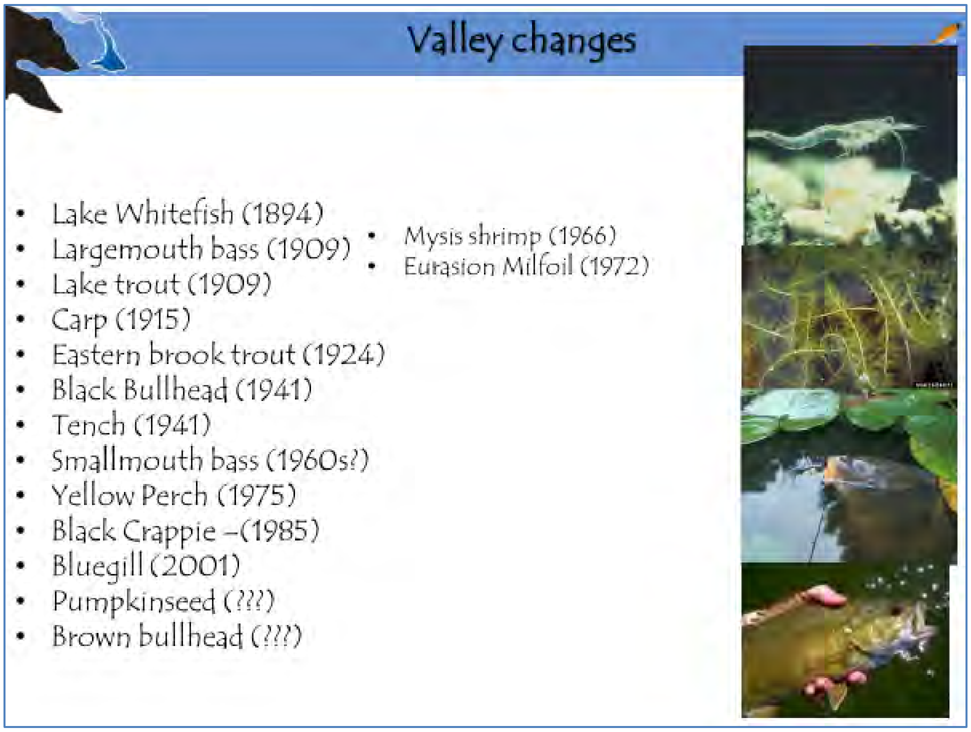
Presentation by Kari Alex on Okanagan River Restoration Monitoring


k'usxanitk
Okanagan Lake
snpintktn
Penticton
Skaha Lake
Okanagan Falls
akspaqmix
Vaseux Lake
McIntyre Dam (Bluff)
Oliver
qawsitk
Okanagan River
nmalqaytk
Similkameen River
suwiws
Osoyoos Lake
Osoyoos
Canada
USA
Oroville
Columbia River


Valley changes
Dams & channelization
irrigation and
flood control
Okanagan Outlet dam
Skaha Outlet dam
McIntyre Dam
Osoyoos Lake


Okanagan Outlet dam
Valley changes
Channel
Oxbow
FLOW
Osoyoos Lake
0 500 1000 Metres
VDS 2
Dyke
VDS 1
FLOW
Osoyoos Lake


Valley changes
Sockeye – rebounding
Chinook – rare
Steelhead – rare
Coho – extirpated
Lamprey- extirpated
Kokanee – declined
Rainbow Trout – declined

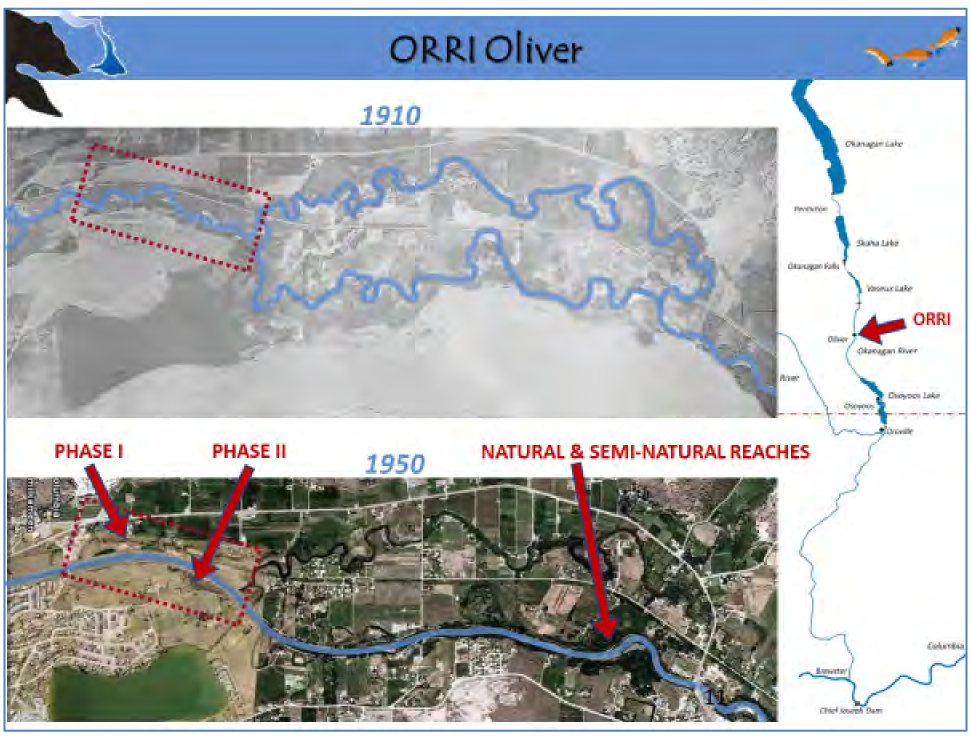

Valley changes
• Lake Whitefish (1894)
• Largemouth bass (1909)
• Lake trout (1909)
• Carp (1915)
• Eastern brook trout (1924)
• Black Bullhead (1941)
• Tench (1941)
• Smallmouth bass (1960s?)
• Yellow Perch (1975)
• Black Crappie –(1985)
• Bluegill (2001)
• Pumpkinseed (???)
• Brown bullhead (???)
• Mysis shrimp (1966)
• Eurasion Milfoil (1972)


q̓awsitkʷ (OKANAGAN RIVER) - CANADA
•1 of BC most endangered River
HABITAT LOSS
• 84% River = channelized
• 50% River length = lost
• 90% Riparian vegetation = lost
• Instream diversity = lost
• Connection floodplain = lost
• Native species = declined
• Exotic species = allowed to colonized
NATURAL: 3 km
SEMI-NATURAL: 2 km
CHANNELIZED: 30 km


Okanagan River Restoration Initiative
THE OKANAGAN RIVER
Increase flood capacity
Reconnect its floodplain
Stabilize the stream channel
Improve water quality
Create in-stream complexity
Ecosystem based
Adaptively managed
Collaborative approach

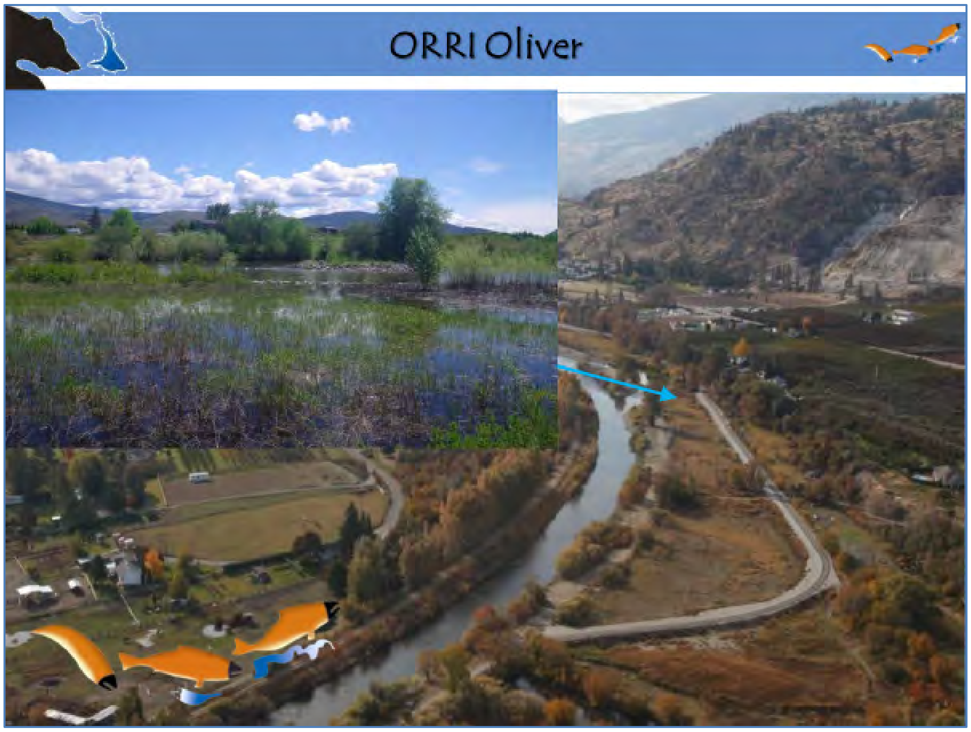

Okanagan River Restoration Initiative
Direction & guidance from Steering Committee
Okanagan Nation Alliance
British Columbia
Forests, Lands and Natural Resource Operations
Fisheries and Oceans Canada
Pêches et Océans Canada
The Nature Trust
CWS
Contribution of several Canadian & American funding agencies
Grant County PUBLIC UTILITY DISTRICT
P.U.D.
CHELAN COUNTY POWER
DOUGLAS COUNTY P.U.D.
HABITAT CONSERVATION TRUST FOUNDATION
TD Friends of the Environment Foundation
Canada
TLC
NARAMATA BENCH WINERIES ASSOCIATION
1% FOR THE PLANET
Okanagan Basin WATER BOARD
HNZ TOPFLIGHT
PACIFIC SALMON FOUNDATION
J. Kevin Dunn Photography


Okanagan River Restoration Initiative (ORRI)
ORRI Oliver
floodplain reconnection 2008
re-meander 2009
VDS13 modifications 2013
side channel 2013
Amphibian pond habitat 2014
Cottonwood meadow 2018
ORRI Penticton
spawning beds 1 & 2 – 2014
Spawning bed 3 - 2015
Spawning bed 4 - 2018
Canada
USA

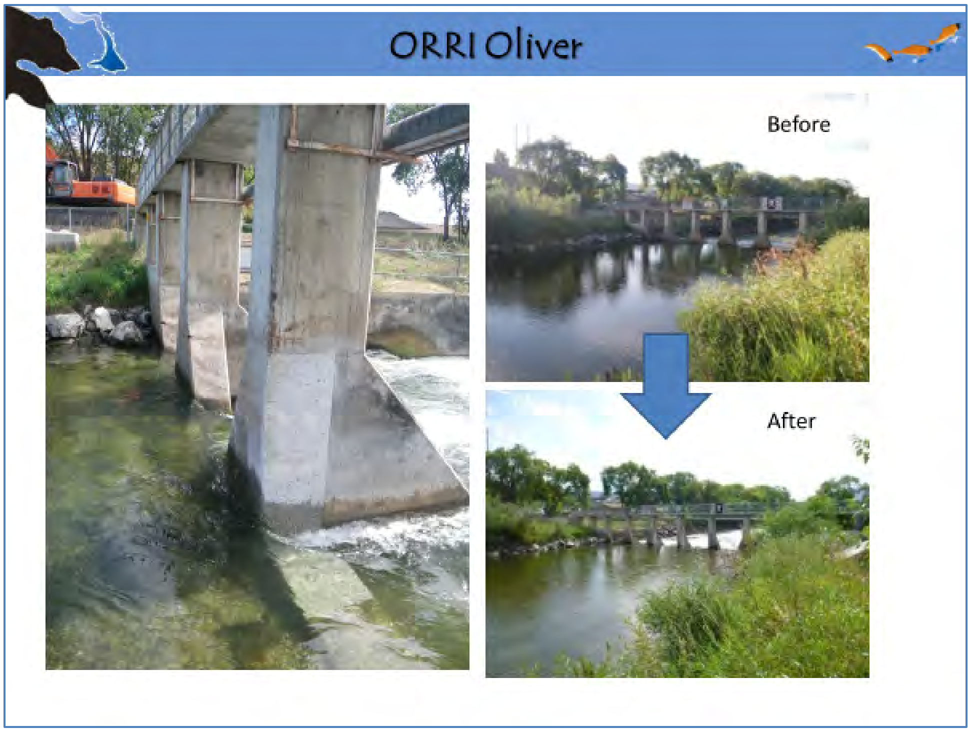

ORRI Oliver
1910
PHASE I
PHASE II
1950
NATURAL & SEMI-NATURAL REACHES
Okanagan Lake
Skaha Lake
Vaseux Lake
ORRI
Oliver
Okanagan River
Osoyoos Lake
Columbia
Chief Joseph Dam
11


ORRI Oliver
2006
2009


ORRI Oliver
2018
2009


ORRI Oliver


ORRI Oliver
2013 construction
RIFFLE
NEW DIKES
SIDE CHANNEL
EXIT


ORRI Oliver
Before
After


ORRI Oliver
Created Amphibian
Ponds (2014)

ORRI Oliver

GOALS 2018:

- Create a Cottonwood meadow.
- inundated at spring flows
- drain completely for no stranding of indigenous fish

ORRI monitoring

ORRI Oliver

- floodplain reconnection 2008
- re-meander 2009
- VDS13 modifications 2013
- side channel 2013
- Amphibian pond habitat 2014
- Cottonwood meadow 2018

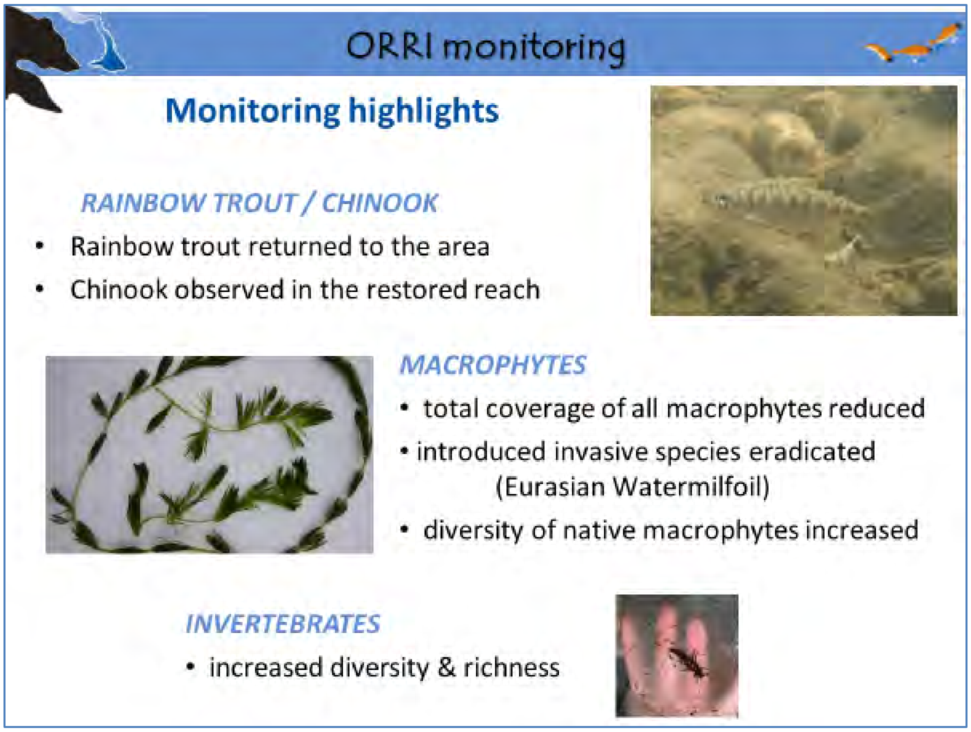
ORRI Penticton

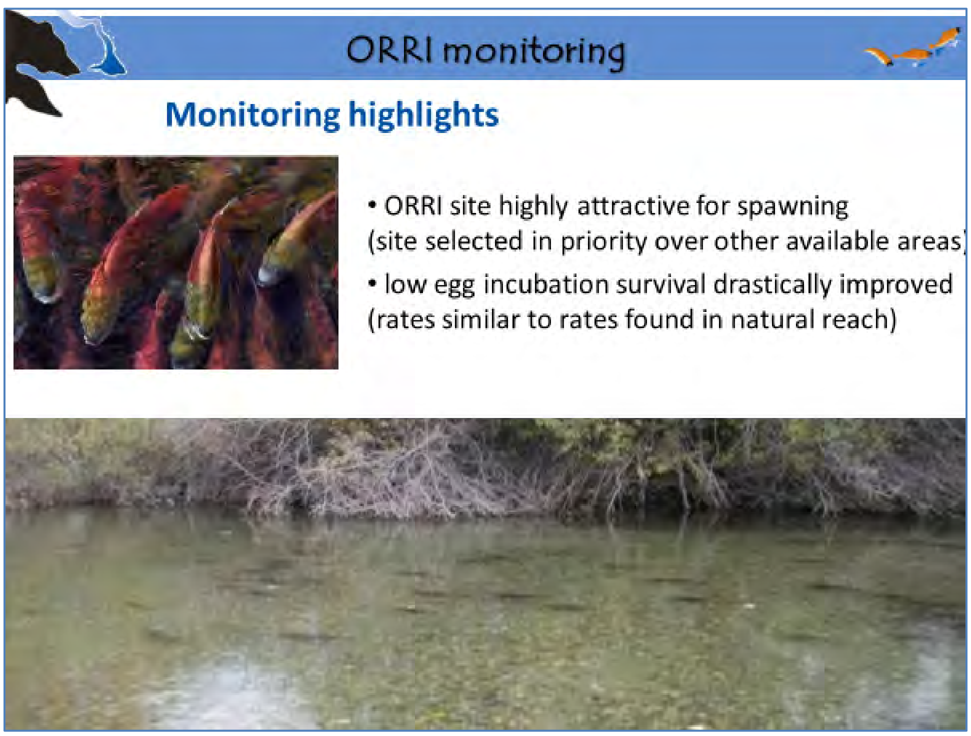
- spawning beds 1 & 2 – 2014
- Spawning bed 3 - 2015
- Spawning bed 4 - 2018

Monitoring 2008- 2018

- Channel morphology
- Hydraulic response
- Fish habitat & fish response
- Riparian response
- Wildlife response

Monitoring 2014- 2018


ORRI monitoring
Monitoring highlights
RAINBOW TROUT / CHINOOK
• Rainbow trout returned to the area
• Chinook observed in the restored reach
MACROPHYTES
• total coverage of all macrophytes reduced
• introduced invasive species eradicated (Eurasian Watermilfoil)
• diversity of native macrophytes increased
INVERTEBRATES
• increased diversity & richness


ORRI monitoring
Monitoring highlights
• ORRI site highly attractive for spawning
(site selected in priority over other available areas)
• low egg incubation survival drastically improved
(rates similar to rates found in natural reach)

ORRI monitoring

HABITAT FEATURES

- LWD increased overtime (natural transport)
- boulders are loss overtime (embedded in gravel); no trout observed

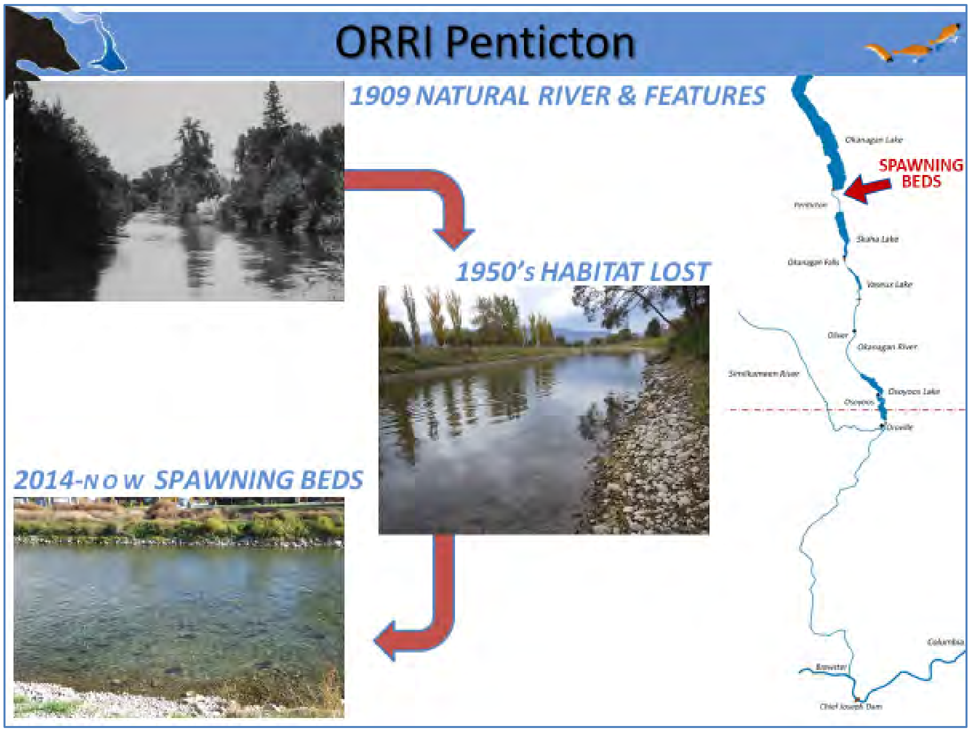
HABITAT REFUGE

Phase II side channel acted as a water quality refuge during a high turbidity event

ORRI monitoring

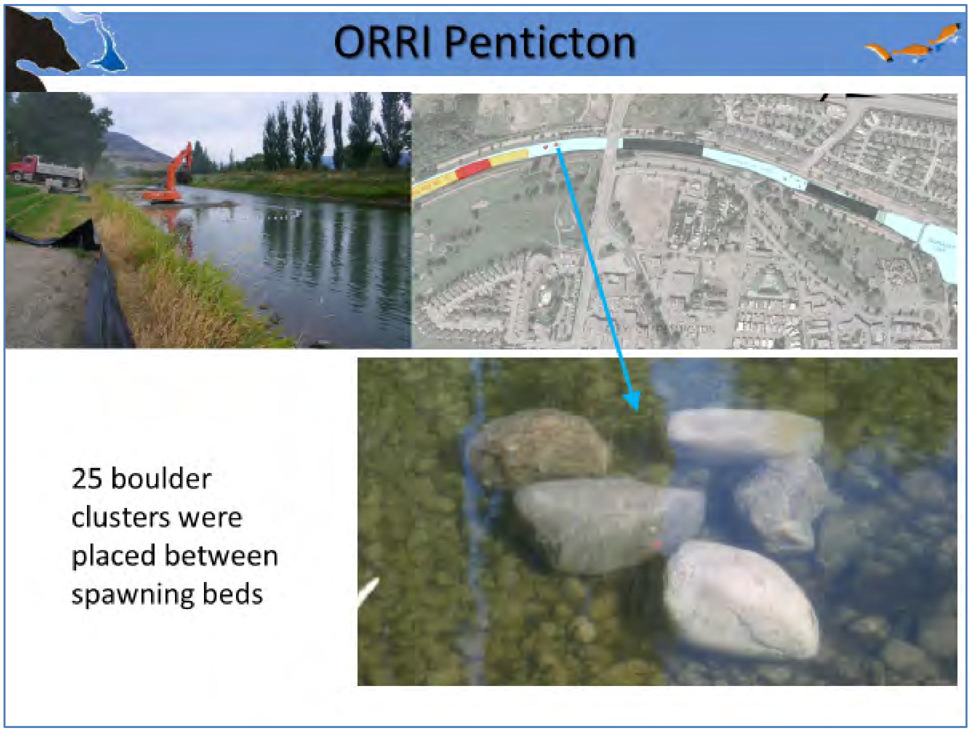
ORRI Oliver - what we learned and have used

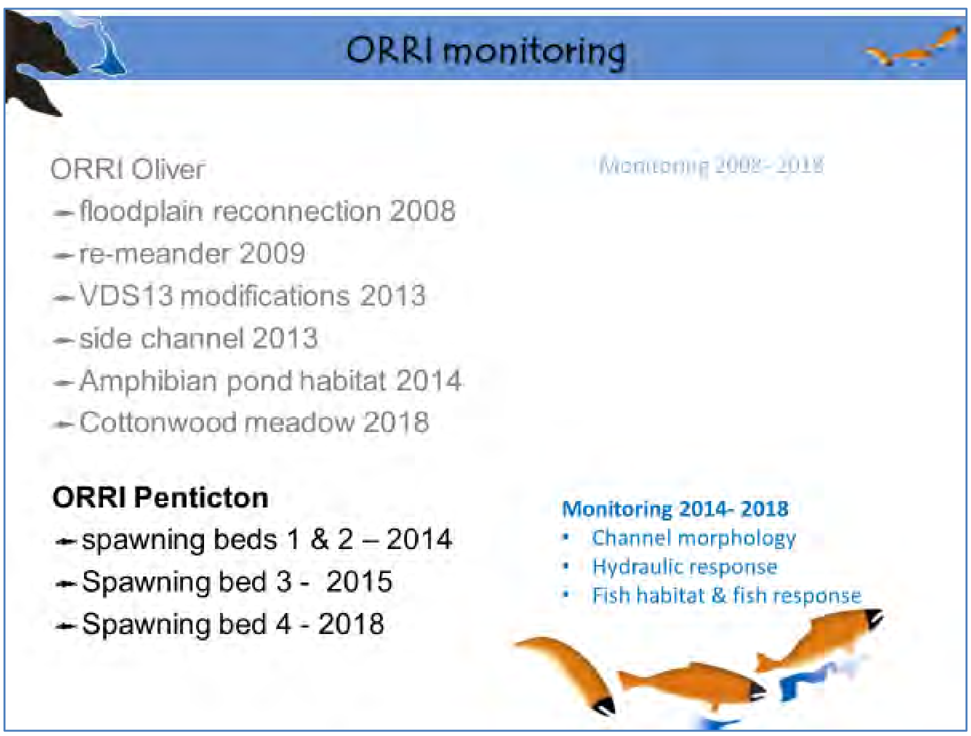
- The Froude numbers Sockeye spawners selected was built into Penticton spawning beds successfully.
- Spawning gravels moved but the total area for spawning remains the same and the spawning gravels are retained.
- We continue to learn about the redd areas needed for Sockeye pairs.
- Learned from side channel that the summer flows are too warm but that spring flow of the side channel is utilized by O.mykiss. We would like to test for use by Chinook.
- The boulder clusters we placed all dug themselves into the bed. The design was fixed for boulder clusters in the Penticton channel.
- Tested hydraulic features that can be created to eradicate milfoil.
- Used all the flow and floodplain inundation data to build the cottonwood meadow.



ORRI Penticton

Spawning Bed	Year built	Targeted species	Design gravel size	Bed length	Created area
Bed No.1	2014	Chinook	50-100 mm (D_{50}= 75 mm)	20 m (built)	480 m^2
		Sockeye & Steelhead	25-75 mm (D_{50}= 50 mm)	153 m (built)	3,400 m^2
Bed No.2	2014	Sockeye & Steelhead	25-75 mm (D_{50}= 50 mm)	163 m (built)	3,600 m^2
Bed No.3	2015	Sockeye & Steelhead	19-75 mm (D_{75}= 50 mm)	200 m (built 3A & 3C)	4,040 m^2
		Kokanee & Rainbow	19-50 mm (D_{50}= 25 mm)	70 m (built 3B)	1,460 m^2
Existing Kokanee Bed	1986; enhanced in 2018	Kokanee & Rainbow	6-38 mm (1985 design) 13-50 mm (enhancements)	160 m	4,320 m^2
Bed No.4	2018	Sockeye & Steelhead	25-75 mm (D_{50}= 50 mm)	350 m	6,250 m^2
		Kokanee & Rainbow	25-50 mm (D_{50}= 35 mm)	310 m	5,520 m^2


ORRI Penticton
25 boulder clusters were placed between spawning beds


ORRI monitoring
ORRI Oliver
- floodplain reconnection 2008
- re-meander 2009
- VDS13 modifications 2013
- side channel 2013
- Amphibian pond habitat 2014
- Cottonwood meadow 2018
Monitoring 2008 - 2018
ORRI Penticton
- spawning beds 1 & 2 – 2014
- Spawning bed 3 - 2015
- Spawning bed 4 - 2018
Monitoring 2014- 2018
• Channel morphology
• Hydraulic response
• Fish habitat & fish response

ORRI monitoring

Monitoring highlights

- Kokanee utilized Bed No.3 close to maximal capacity every year.
- Spawning habitat is still limited.
- Egg incubation survival rates similar to rates found in Natural & Semi Natural sections.
- Beds stable overtime (high freshet flows)
- Benthic invertebrate diversity has increased.

ORRI monitoring

Monitoring highlights

- Habitat diversity increased. Glides decreased (replaced by riffles and pools).
- Invasive Eurasian watermilfoil drastically decreased with construction at beds.
- *O. mykiss* observed using the boulders in 2014, 2015 and 2017

ORRI monitoring

ORRI Penticton- what we learned and have used

- The Froude numbers Sockeye spawners select is 0.31 ± 0.1. We continue to refine selection by spawners over a range of flows (6cms – 12 cms) and a range of population sizes for both SK and KO.
- We continue to learn about the redd areas needed for Sockeye pairs and how this interacts with Kokanee spawners (hybridization issues).
- Spawning gravels do not move in this reach and the flushing rates of fine sediments needs to continue to be monitored.
- Use of boulder clusters needs to be assessed.
- Continue testing hydraulic features that can be created to eradicate milfoil.
- Bed 4 is new and needs to be monitored for use and stability.

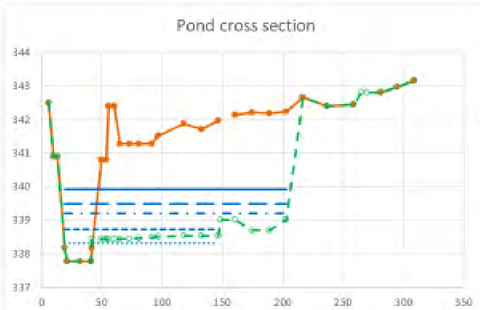
Future projects

- k'əmcənitkʷ
  - off-channel habitat
- VDS removal
  - Bed re-profile with pools & riffles

k'əmcənitkʷ

GOALS:

- restore floodplain habitats,
- create Chinook rearing pond,
- restore fish-free floodplain, and
- riparian habitat for aquatic wildlife.



VDS removal & bed re-profile

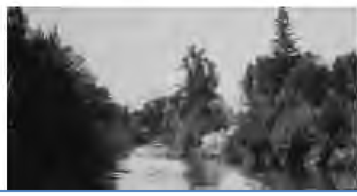
During channelization of this entire river reach reduced fish habitat features & river diversity. Four vertical drop structures (VDS 14 to 17) were added to stabilize the river bed under the increased slope of the channel straightening.

Project goal

- Create pool-riffle complexes
- Without impacting flood flows
- Maintain bed stability
- Salmonid spawning conditions are created at riffle structures.

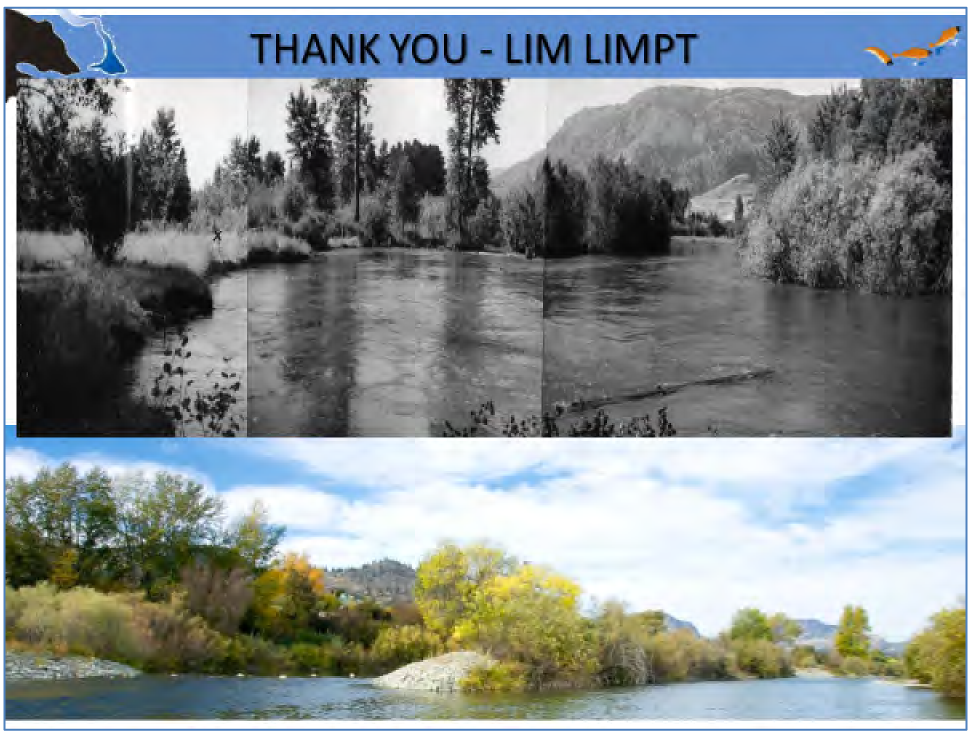
ORRI

Habitat created via ORRI		Length /areas
2008	setback dyke	1,200m
	floodplain reconnected	15,000m²
2009	Re-meander	500m
	pool-riffle habitat added	11,175m²
	spawning areas	9,100m²
2013	VDS13 modifications – spawning area	4,575m²
2013	side channel	5,239m²
2014	wetland features - salamander pond	200m²
	wetland features - spadefoot pond	60m²
	floodplain - boulder, Woody features	400m²
2014	Penticton channel spawning bed 1& 2	Sockeye 7,074m² Chinook 430m²
2015	Penticton Channel spawning bed 3	Sockeye 7,154m² Kokanee 1,477m²
2018	Pentiction Channel spawning bed 4	Sockeye 6,250m² Kokanee 5,520m²



Campbell Biology text book


Save the Date: October 1st & 2nd, 2019
WORKSHOP: 15 YEARS OF RESTORING SALMON HABITAT
The Okanagan Nation Alliance in collaboration with many project partners have been successfully restoring spawning and rearing habitat for salmon in the Okanagan Basin for over 15 years. Traditional Ecological Knowledge, best management practices, measured stream geometry and natural habitat features have guided these restoration works. This workshop will teach the math behind the stream analysis and hydraulics that directed the restoration designs and describe the planning, construction, monitoring methods and results.
Workshop outline:
• Teach the calculations behind stream analysis, river hydraulics and pool-riffle design.
• Field visits to several habitat restoration projects.
• Show the process of implementing a river restoration project from beginning-to-end (planning, designs, construction, and adaptive management).
• Explain the projects monitoring methods and results.
• Discussion and poster sessions: hydraulic modelling, fish habitat diversity, spawning beds, riffles, fish passage at barriers, floodplain reconnection, wetland restoration.
Course targeted to but not limited to:
• Those designing or reviewing river instream works, particularly for salmon habitat.
• Environmental scientists and project managers (Biologists, Engineers, Geomorphologists, Hydrologists and Fisheries Technicians).
Presenters:
• Kari Alex, Camille Rivard-Sirois & Zoe Eyjolfson. Okanagan Nation Alliance Fisheries Department
• Robert Newbury. Newbury Hydraulics
Course details:
• Date: October 1st & 2nd, 2019
• Location: En'owkin Centre, Penticton, BC, Canada
• Registration fees: $750/person
For more information or early seat reservation, please contact:
Zoe Eyjolfson, Okanagan Nation Alliance
250-707-0095 ext. 119
Okanagan Nation Alliance


THANK YOU - LIM LIMPT

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 12 September 2019

Members Present:	Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries)[1], and Tracy Hillman (Committees Chair).
Members Absent:	Brandon Rogers (Yakama Nation)[2]
Others Present:	Becky Gallaher (Tributary Project Coordinator), Allison Lutes (Chelan County Natural Resources Department), John Soden (Natural Systems Design), and David Morgan (Chelan-Douglas Land Trust).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 12 September 2019 from 10:00 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the addition of a three-year review of the HCP Tributary Committees Chair.

II. Review and Approval of Meeting Minutes

Tributary Committees members reviewed and approved the 8 August 2019 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported the bids for Phase II piping are due on 27 September with construction set to start in early October. The project should be completed by 31 March 2020. Construction on the Barkley pump station is scheduled to start at the end of September with a completion date of 31 March 2020. The sponsor indicated that they completed three of the five satellite wells in August. The others should be completed in September. They will then conduct pump tests.
- Icicle Boulder Field Project – The sponsor (TU) reported they made significant progress on permits and have received the 404 and 401 permits. The Army Corps of Engineers, NMFS, and USFWS have also made their determinations. The Hydraulic Project Approval (HPA) permit has been submitted for review. The sponsor hopes to have the bid documents completed this month,

[1] Justin called into the meeting.
[2] Brandon provided his votes and input on decision items following the meeting.

which will allow a bid walk during low flow conditions. Kate Terrell reported that the statement of agreement (SOA) regarding anadromous fish management in the Icicle Creek watershed was signed by the YN, CCT, WDFW, NOAA Fisheries, and USFWS. Jeremy Cram indicated that there remain a few obstacles that need to be addressed before the project can be implemented.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – This project is complete. The sponsor (Washington Department of Fish and Wildlife; WDFW) will provide the next annual report on 31 December 2019.
- Beaver Fever Project – The sponsor (TU) reported they conducted site visits within several Wenatchee tributaries where they conducted both pre- and post-project data collection. Site recon was also conducted in the Entiat in preparation for work with the Forest Service during the next field season.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) did not provide an update this month.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported that WDFW is working with the Army Corps of Engineers to finalize permits.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they are preparing for the field season.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported that the preliminary design is complete. They are also working with the landowners to secure access for construction.
- Peshastin Creek Environmental Site Assessment Project – This project is complete. The sponsor (CCNRD) will discuss results and next steps with the Committees in October.
- Entiat Fish Passage and Barrier Assessment Project – The sponsor (CCFEG) reported field work will be completed by the end of September with draft results available in October.
- Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported they initiated the permitting process for the beaver dam analog (BDA) structures.
- Johnson Creek Habitat Restoration Project – The sponsor (TU) did not provide an update this month. This work will occur in 2020.
- Cottonwood Flats Floodplain Restoration Project – The sponsor (CCNRD) reported construction will occur during fall 2020.
- Upper Kahler Stream and Floodplain Project – The sponsor (Yakama Nation; YN) reported construction is complete. As-builts will be completed by the end of September and site planting is scheduled for the end of October.
- Stormy Area “A: Stream and Floodplain Enhancement Project – The sponsor (YN) reported construction is complete. As-builts will be completed by the end of October.
- Napeequa Side Channel Connection Project – The sponsor (CCFEG) reported they began cultural resources evaluations. A site visit with permitting agencies is planned for late October.

IV. Cottonwood Flats Connection Project Update

Allison Lutes (Chelan County Natural Resources Department) and John Soden (Natural Systems Design) gave a presentation on the Cottonwood Flats Floodplain Connection project (see Attachment 1). This presentation is a follow up visit with the Committees based on feedback the Committees provided to the sponsor regarding reconnecting the Cottonwood Flats floodplain with the Entiat River. In August, the Committees supported the 240-cfs connection, and wood and FESL inlet protection, but did not support a perennial alcove or the construction of a channel throughout the floodplain. Instead, they recommended the development of a pilot channel extending from the inlet to about the first large depression located near the old roadbed. The Committees believe flows exiting the pilot channel will carve out a channel or channels downgradient from the pilot channel. In August, the Committees asked the sponsor to discuss the Committees' recommendation with the sponsor's engineers and the landowner (CDLT) to see if the Committees' recommendation is reasonable and appropriate. The presentation today is a result of discussions the sponsor had with their engineers and the landowner.

Allison and John began by briefly describing the recommendations provided by the Tributary Committees in August. They also reviewed the goals of the project, which are to create a floodplain side channel, activate the floodplain at certain flows, remove the fill/gravel road prism, remove concrete bridge abutments, strategically place large wood structures, and balance construction impacts with costs with overall project benefits. John then described the analyses they conducted to evaluate the "Light Touch," "Light Touch +," and "Full Channel" approaches. The Light Touch approach was the approach recommended by the Committees in August. The Light Touch "+" approach is the Light Touch with the addition of extending the pilot channel farther into the floodplain. The Full Channel approach is similar to the original proposed approach and includes extending the side channel farther down the floodplain. Analyses of the three approaches included modeling composite water surface and groundwater surface elevation maps at different stream flows.

Based on their analyses, they identified some potential concerns with the Light Touch approach, including ponding upstream of existing high points on the floodplain, flow-through connection is unlikely to occur until >1,100 cfs, uncertainty regarding formation of a preferential flow path, and the approach does not appear to achieve project objectives. In contrast, the Light Touch "+" approach will extend the pilot channel past the initial low spot and create a connection to low-lying floodplain channels. Under this approach, ponding will likely occur in upstream alcoves, flow-through connection should occur at 1,100 cfs, and preferential flow paths will form for a portion of the channel but there is uncertainty if the flow paths will form in the downstream portion of the floodplain. Unlike the Light Touch approaches, the Full Channel approach will create ponding only at the downstream alcove, flow-through connection occurs at 500-800 cfs, preferential flow paths will exist immediately, and groundwater will be expressed in the downstream end of the channel at flows >500 cfs. This approach maximizes achievement of project objectives given design guidance. John showed the following table that compares the three approaches.

Objective	Light Touch	Light Touch "+"	Full Channel
Flow-through Connection	Flow-through connection will not occur until ~1,100 – 1,500 cfs (> Q1) Ponding likely to occur upstream of existing depression	Flow-through connection occurs ~1,100 cfs Very low velocities Ponding likely to occur in alcove for lower flows >800 cfs	Flow-through connection occurs ~500-800 cfs Ponding likely to occur in downstream alcove for lower flows >500 cfs
Design Certainty	Preferential flow paths may or may not form	Preferential flow paths created for portion of channel Downstream portion may or may not form	Preferential flow paths created from Day 1

Objective	Light Touch	Light Touch "+"	Full Channel
Meets Project Objectives	Overall – does not achieve project objectives	Partially meets project objectives	Overall – maximizes achievement of project objectives given past/present design guidance

Committee members questioned the uncertainty associated with establishment of flow-through paths. They agreed that ponding will occur; however, as water continues to flow into the side channel, the water will eventually overtop the high points on the floodplain and then cut a flow path or flow paths through the floodplain. Tom Kahler suggested that if the high points are a concern, then simply knock down those high points to help flow paths develop (referred to as the "Kahler Knock-Down" approach). This does not mean constructing channels. Rather, it is a cost-effective, low-disturbance approach to guiding development of flow paths. Members agreed with this approach. John Soden and Dave Morgan also found value in this approach.

Tracy reminded the Committees that ponding can create entrapments for ESA-listed fish. This is less of a concern if the entrapments are connected with groundwater. He said there are a number of studies, including studies in the Methow, that demonstrate salmonids grow and survive well in entrapments connected with groundwater. The concern here is the upstream entrapments will not be connected with groundwater during most of the year. Thus, there is a real concern that stranding will occur, resulting in the potential loss of ESA-listed fish. Jeremy agreed and said monitoring will be needed to document potential stranding. If stranding is likely to occur, we need to be ready to salvage fish from entrapments that are likely to dewater. Members discussed the need to monitor the project and if necessary, salvage fish from entrapments. They suggested the use of drones to monitor physical changes and mark-recapture studies to evaluate fish response. Tracy said there may be cost-sharing opportunities with the Salmon Recovery Funding Board, who will be calling for proposals to evaluate floodplain reconnection projects with remote sensing.

Dave Morgan noted that his preference is to have a perennial side channel, because monitoring data from the Entiat River suggest that parr habitat, especially winter parr habitat, appears to be limiting in the Entiat. A perennial side channel would provide habitat for the limiting life stage. However, Dave said he also supports the Committees recommendation, because there is no infrastructure to protect and therefore it provides a unique opportunity to evaluate a light touch approach. John Soden agreed and said the Committees can monitor the reconnection project and, if necessary, implement actions to help with channel evolution and to reduce stranding. Given that development of flow paths could take several years (depending on high-flow events), Allison asked how long the Committees are willing to risk the possible standing of ESA-listed species. Members said they would be willing to wait about five years before implementing actions to help with channel evolution. Jeremy said the risk could be reduced if monitoring and salvage work are conducted annually.

Following the presentation, and after Allison, John, and Dave left the meeting, the Committees discussed the project further and agreed to support the Light Touch with the Kahler Knock-Down approach. Jeremy said he can support a short-season, light-touch approach with sufficient adaptive management and fish stranding monitoring, but he did not think the value of the project is maximized if the side channel is only activated for roughly three months during the highest flow conditions. He is also concerned with the high risk of stranding given the disconnection between surface water and groundwater. He added that raising the stage of the mainstem or using an ELJ or constructed riffle to divert flows into the side channel should be considered and has been considered in the past, but the reasons for moving away from these options are unclear. More information on engineering feasibility, avulsion risk, and landowner concerns is needed and perhaps the only thing that should be done on this site is fill removal.

Because Brandon was unable to attend the meeting, Tracy spoke with Brandon following the meeting. After briefing Brandon on the presentation and the Committees' recommendation, Brandon reluctantly supported the recommendation. Brandon and Jeremy share some of the same concerns. Like Jeremy, Brandon is concerned with stranding. Brandon believes stranding can be avoided with the implementation of the Full Channel approach. In addition, Brandon is concerned with the side channel not being connected with groundwater and with the lack of large wood within the side channel or whatever channel forms. Large wood would provide some stability and a long-term (~20 years) source of cover for juvenile fish. Finally, because of the low gradient floodplain, Brandon is concerned with sediment deposition.

The Committees directed Tracy to inform the project sponsor that the Committees support the Light Touch with the Kahler Knock-Down approach. That is, the preferred approach is to construct a pilot channel as identified under the "Light-Touch" approach and to "knocking down" high spots to aid channel formation down-gradient from the pilot channel. Given the absence of any infrastructure that needs protecting, this approach should reduce costs and allow the water to do most of the work. Importantly, this approach should protect most of the existing riparian vegetation on the floodplain.

V. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from August and September:

   Rock Island Plan Species Account:

   - $50.00 to Clifton Larson Allen for Rock Island financial administration in August 2019.
   - $161.41 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project for work in August.
   - $1,152.80 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project for work in August.
   - $14,419.65 to Chelan County Treasurer for the Monitor Side Channel Design Project for work in August.

   Rocky Reach Plan Species Account:

   - $50.00 to Clifton Larson Allen for Rocky Reach financial administration in August 2019.
   - $55.21 to Chelan County Treasurer for the Peshastin Creek RM 8.8 Channel Reconnection – Site Assessment Project for work in August.
   - $6,190.11 to Cascade Columbia Fisheries Enhancement Group for the Entiat Basin Fish Passage and Screening Assessment Project for work in August.
   - $1,033.58 to Cascade Columbia Fisheries Enhancement Group for the Napeequa Side Channel Project for work in August.

2. Chris Fisher reported that Okanagan Nation Alliance will be working on providing fish passage at Penticton Dam this fall. They will begin fishway construction in October. They intend to collect adult sockeye salmon within the Okanogan River (Penticton Channel) and tag them with PIT tags and spaghetti tags. They will then track them as the fish migrate upstream from the dam.

3. Tom Kahler reported that the Tributary Committees conducted an evaluation of the HCP Tributary Committees' Chair (Tracy Hillman). Tom said the PUD representatives polled all the members by email offering opportunity to reply directly or request a conference call or meeting to discuss the Chair's performance. All members replied via email that they were pleased with the Chair's performance and wanted Douglas PUD and Chelan PUD to retain Tracy's services for another three-year term. Tracy agreed to serve as the Chair for the Wells, Rocky Reach, and Rock Island Tributary Committees for another three years.
4. Tracy Hillman reminded members that Jennifer Hadersberger (CCNRD) will attend the October meeting to discuss Phase 1 Environmental Assessment results and next steps on the Peshastin Creek RM 8.8 Project. This topic will be discussed jointly with the PRCC Habitat Subcommittee. Therefore, Tracy will also coordinate this agenda item with Denny Rohr, Chair of the PRCC Habitat Subcommittee.

VI. Next Steps

The next scheduled meeting of the Tributary Committees will be on Thursday, 10 October at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Presentation by Allison Lutes and John Soden on Cottonwood Flats Project

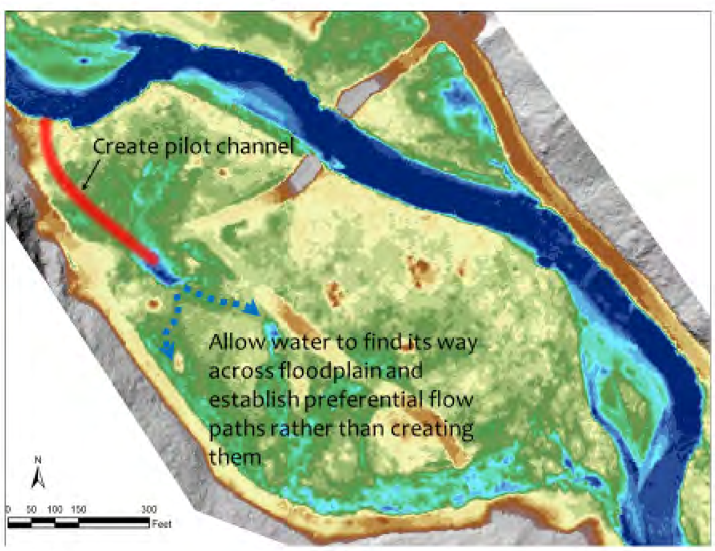
Design Take-Aways August 2019 Meeting:

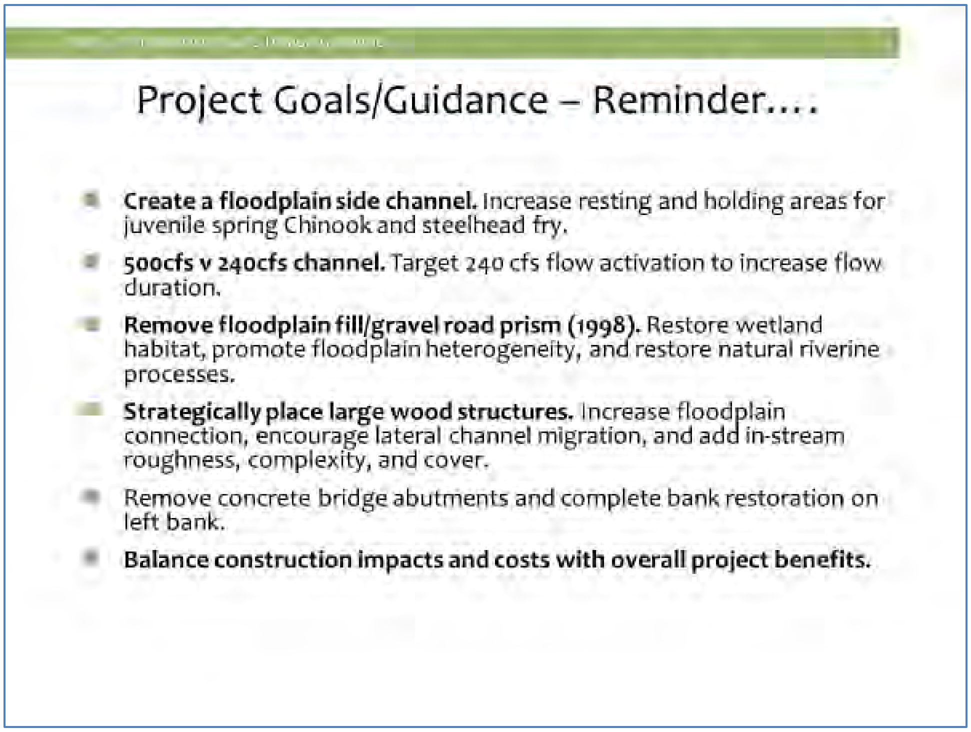
1. Design Flows for side-channel and armoring considerations:
   - 120 CFS with rock inlet armor
     - High risk of channel avulsion; not worth risk and additional cost for aggressive rock armoring (~1million construction)
   - **240 CFS wood inlet (preferred)**
     - Wood inlet armoring; moderate cost increase ($100k additional); with additional 40 days of flow activation and increased biological benefit; preferred by landowner
   - 500 CFS no armor
     - No armoring needed; 84 days of activation; original design flow; reduced excavation required

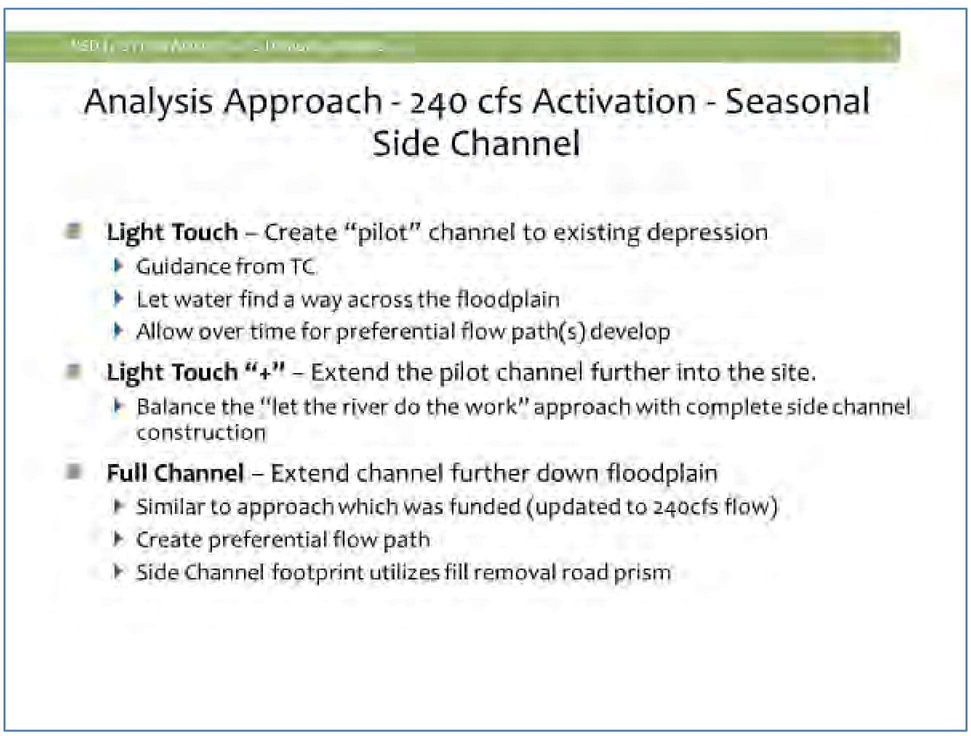
2. Perennial downstream alcove **(not preferred)**
   - Natural deposition area; uncertainty whether outlet will remain open
   - Concerns regarding excavating existing intact wetland/beaver dam habitat
   - Will need to rely on excavation to have surface water in downstream alcove;
   - Concerns regarding over excavation draining the wetland

NSD | COTTONWOOD FLATS DESIGN GUIDANCE

Light Touch – Design Guidance



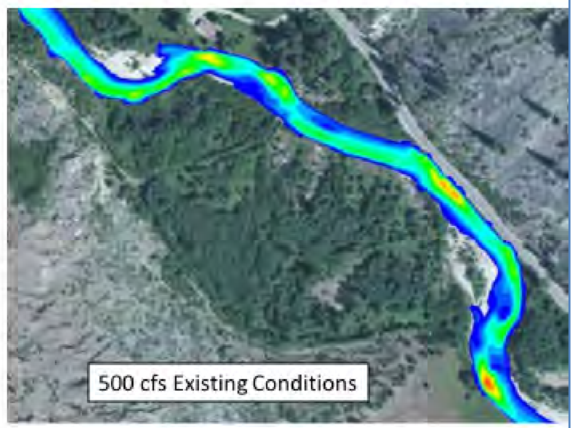

Project Goals/Guidance – Reminder….
Create a floodplain side channel. Increase resting and holding areas for juvenile spring Chinook and steelhead fry.
500cfs v 240cfs channel. Target 240 cfs flow activation to increase flow duration.
Remove floodplain fill/gravel road prism (1998). Restore wetland habitat, promote floodplain heterogeneity, and restore natural riverine processes.
Strategically place large wood structures. Increase floodplain connection, encourage lateral channel migration, and add in-stream roughness, complexity, and cover.
Remove concrete bridge abutments and complete bank restoration on left bank.
Balance construction impacts and costs with overall project benefits.


Analysis Approach - 240 cfs Activation - Seasonal Side Channel
Light Touch – Create "pilot" channel to existing depression
Guidance from TC
Let water find a way across the floodplain
Allow over time for preferential flow path(s) develop
Light Touch "+" – Extend the pilot channel further into the site.
Balance the "let the river do the work" approach with complete side channel construction
Full Channel – Extend channel further down floodplain
Similar to approach which was funded (updated to 240cfs flow)
Create preferential flow path
Side Channel footprint utilizes fill removal road prism

NSD | COTTONWOOD FLATS DESIGN GUIDANCE

Analysis Approach

- Create composite WSE/GWSE "surface"
  - Develop stage-discharge relationship for several points within the project reach using hydraulic model output and groundwater data.
  - Create composite surface for a given flow
    - Repeat over range of flows of interest
  - **Not perfect**, but illustrates some issues worth discussing
    - Static condition – doesn't reflect true "proposed" conditions



NSD | COTTONWOOD FLATS DESIGN GUIDANCE

Analysis Approach

- Create composite WSE/GWSE "surface"
  - Develop stage-discharge relationship for several points within the project reach using hydraulic model output and groundwater data.
  - Create composite surface for a given flow
    - Repeat over range of flows of interest
  - **Not perfect**, but illustrates some issues worth discussing
    - Static condition – doesn't reflect true "proposed" conditions

NSD | COTTONWOOD FLATS DESIGN GUIDANCE

Analysis Approach

- Create composite WSE/GWSE "surface"
  - Develop stage-discharge relationship for several points within the project reach using hydraulic model output and groundwater data.
  - Create composite surface for a given flow
    - Repeat over range of flows of interest
  - **Not perfect**, but illustrates some issues worth discussing
    - Static condition – doesn't reflect true "proposed" conditions

NSD | COTTONWOOD FLATS DESIGN GUIDANCE

Analysis Approach

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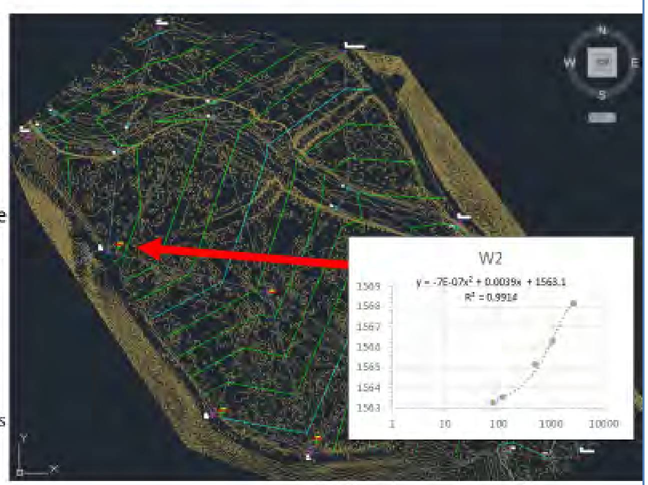
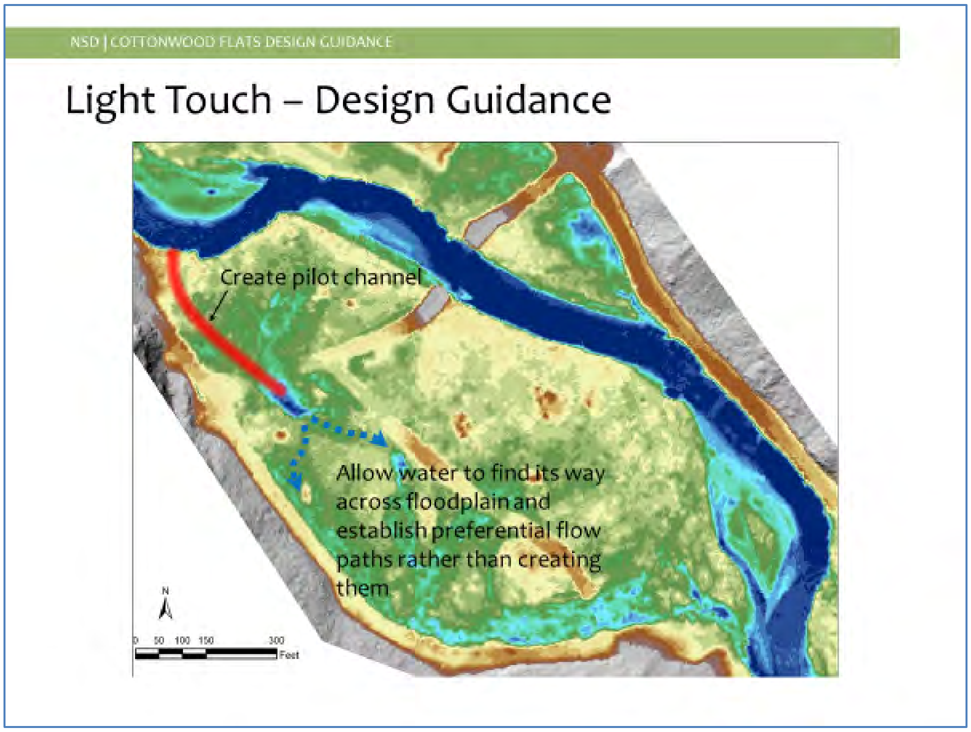
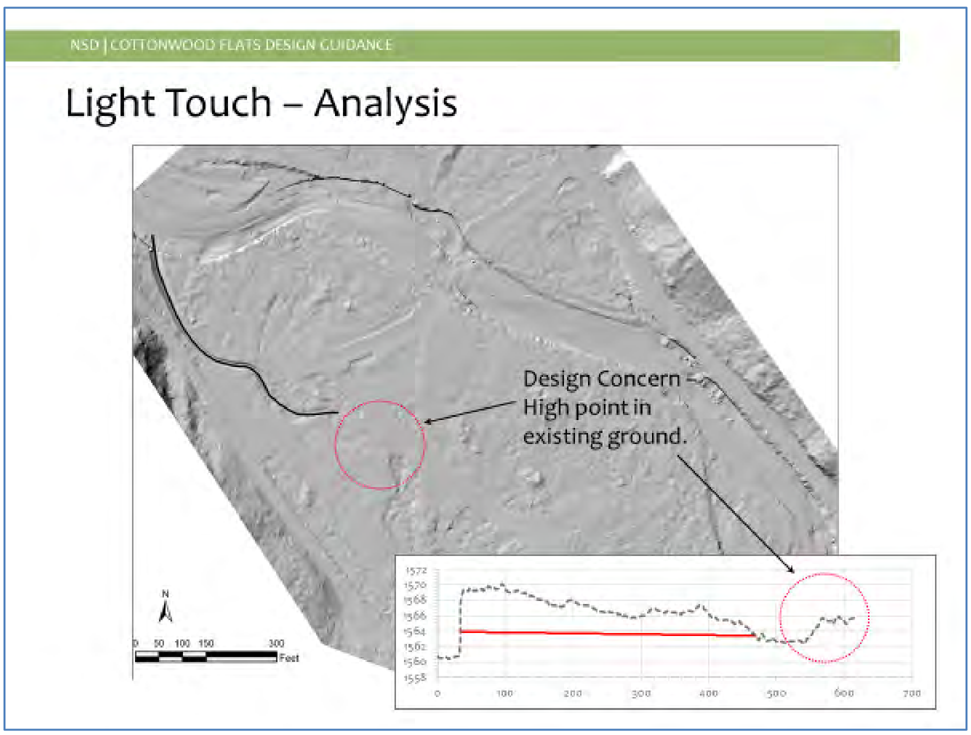
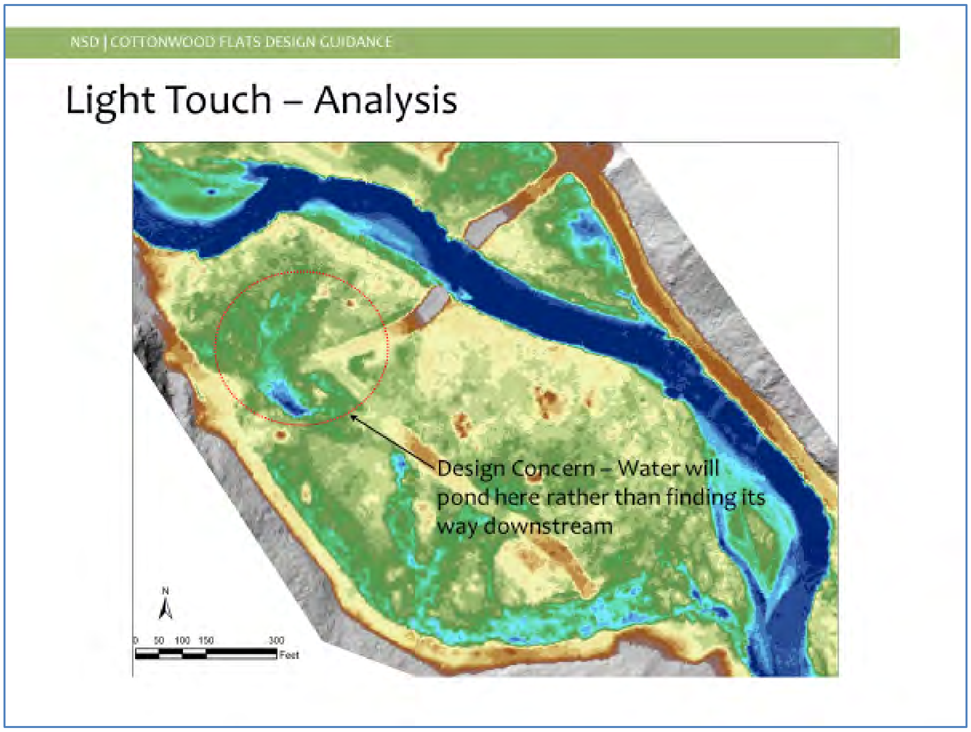
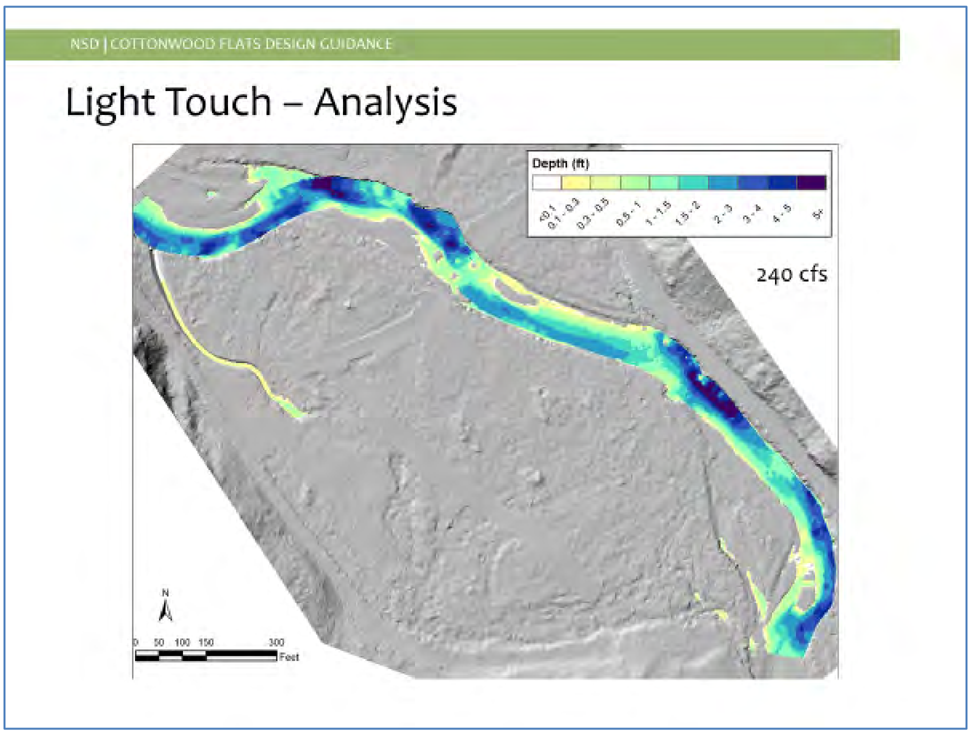
  - Develop stage-discharge relationship for several points within the project reach using hydraulic model output and groundwater data.
  - Create composite surface for a given flow
    - Repeat over range of flows of interest
  - **Not perfect**, but illustrates some issues worth discussing
    - Static condition – doesn't reflect true "proposed" conditions

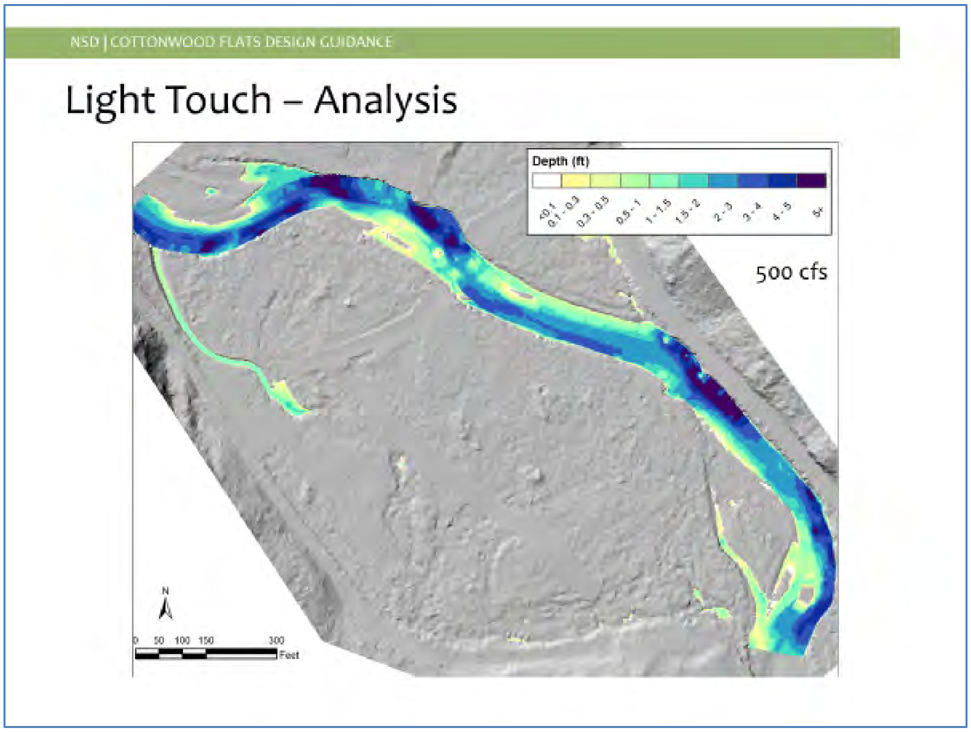


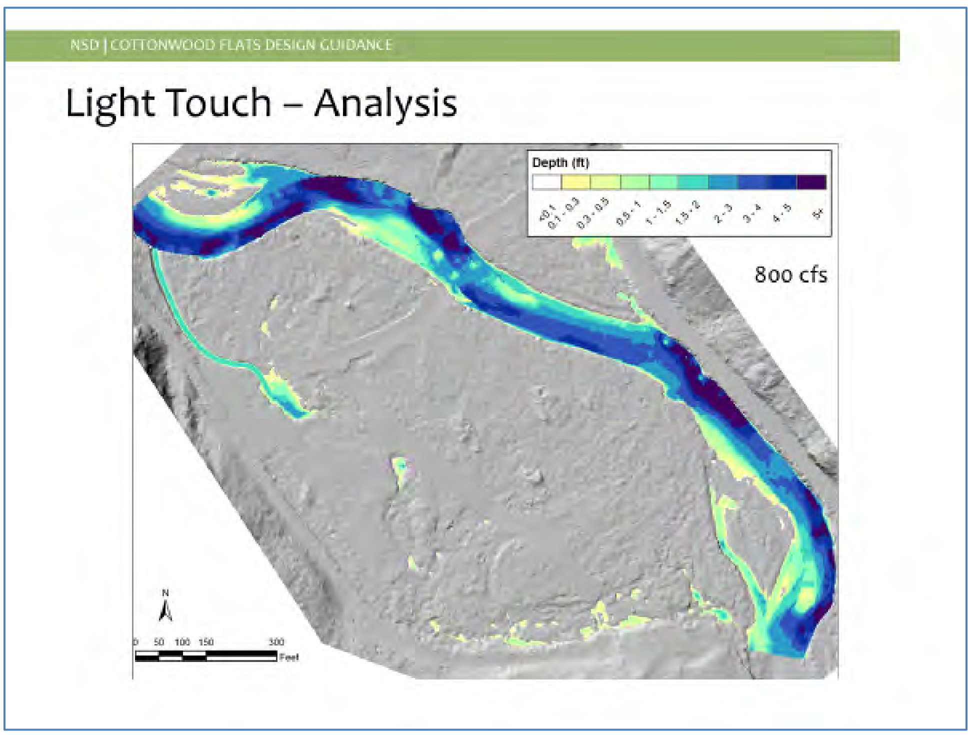

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Design Guidance
Create pilot channel
Allow water to find its way across floodplain and establish preferential flow paths rather than creating them
N
0 50 100 150 300 Feet

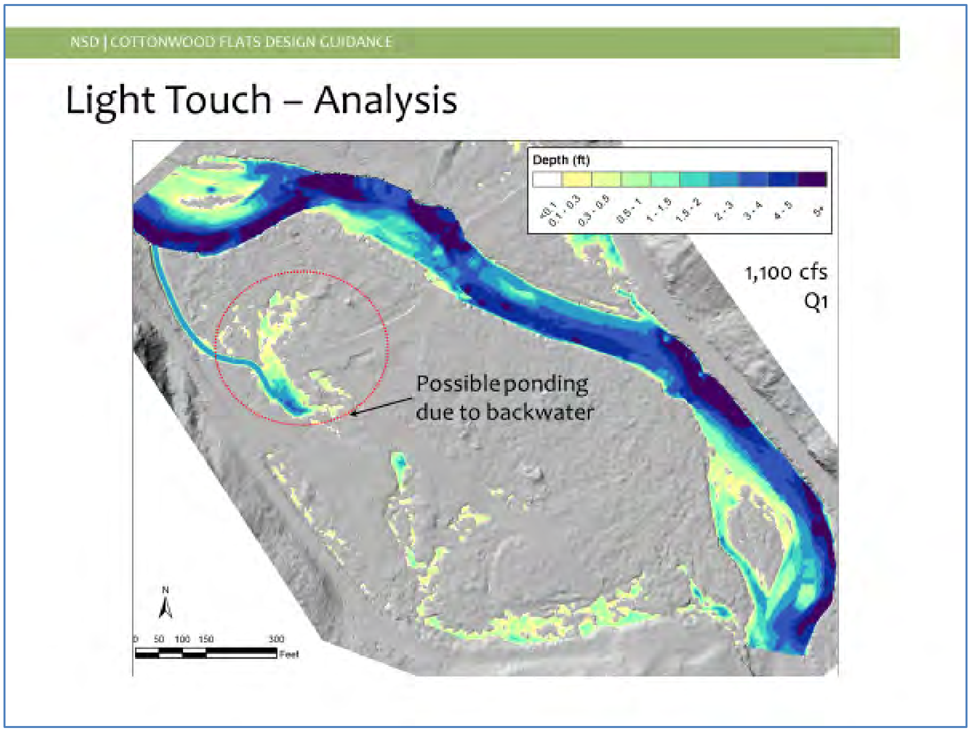

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Design Concern – High point in existing ground.
N
0 50 100 150 300 Feet
1572
1570
1568
1566
1564
1562
1560
1558
0 100 200 300 400 500 600 700

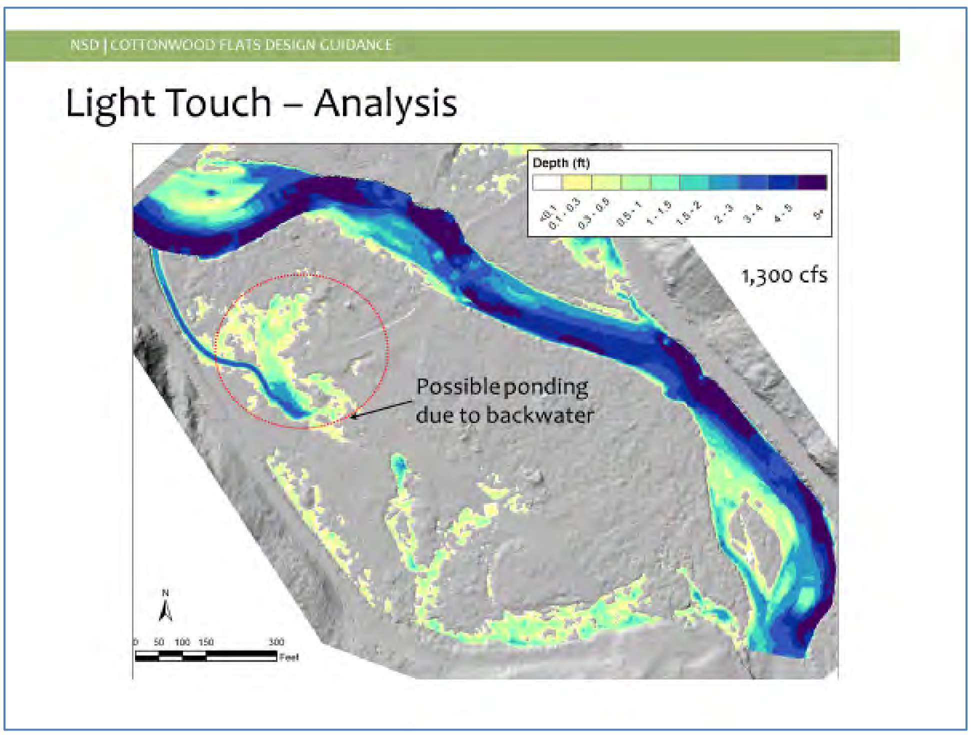

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Design Concern – Water will pond here rather than finding its way downstream
N
0 50 100 150 300
Feet

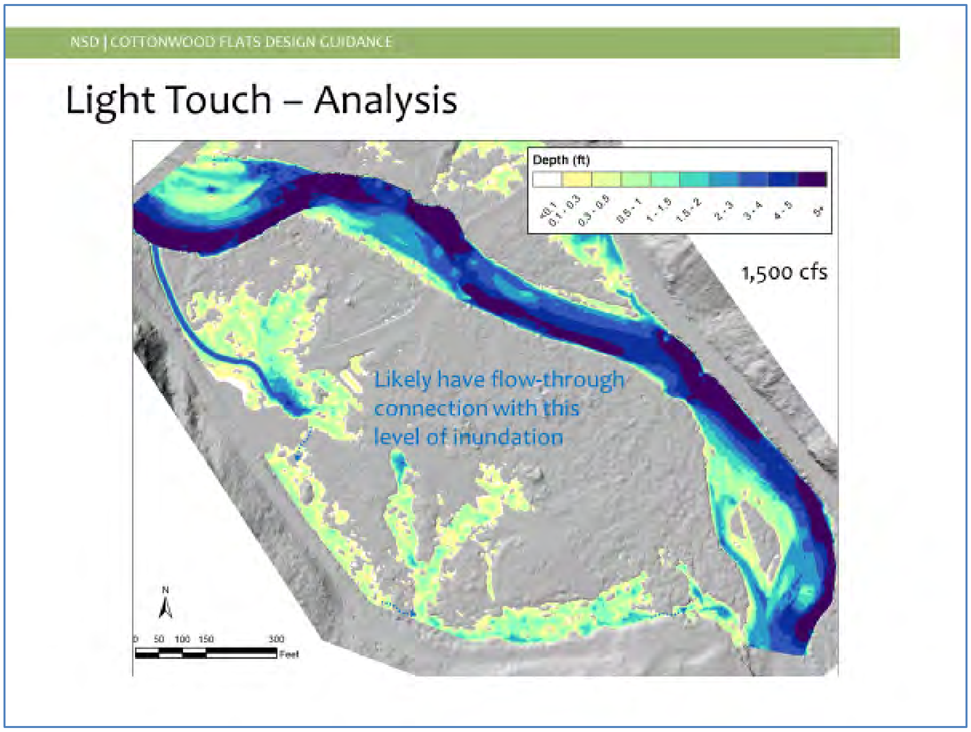

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
240 cfs
N
0 50 100 150 300
Feet

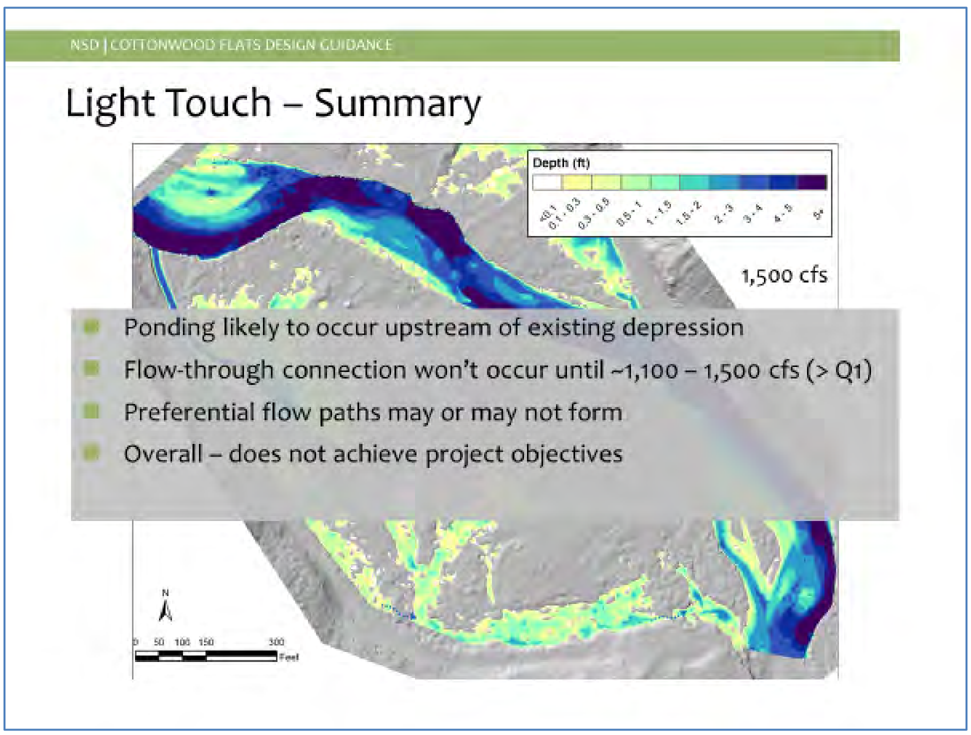

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
<0.1
0.1 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5+
500 cfs
N
0 50 100 150 300
Feet

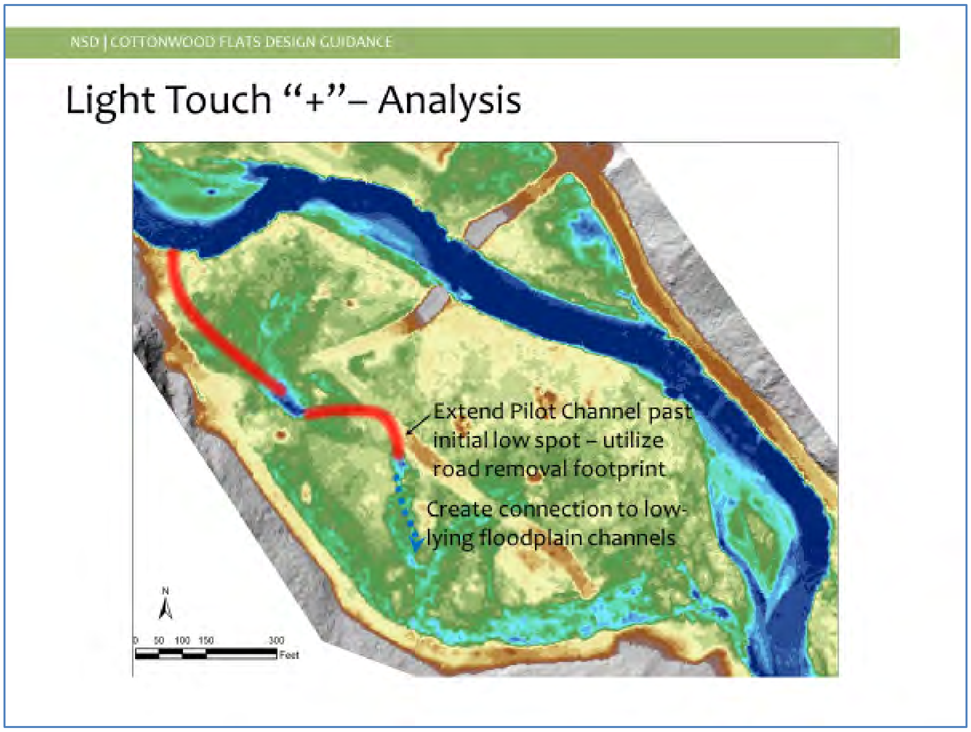

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
<0.1
0.1 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5+
800 cfs
N
0 50 100 150 300
Feet

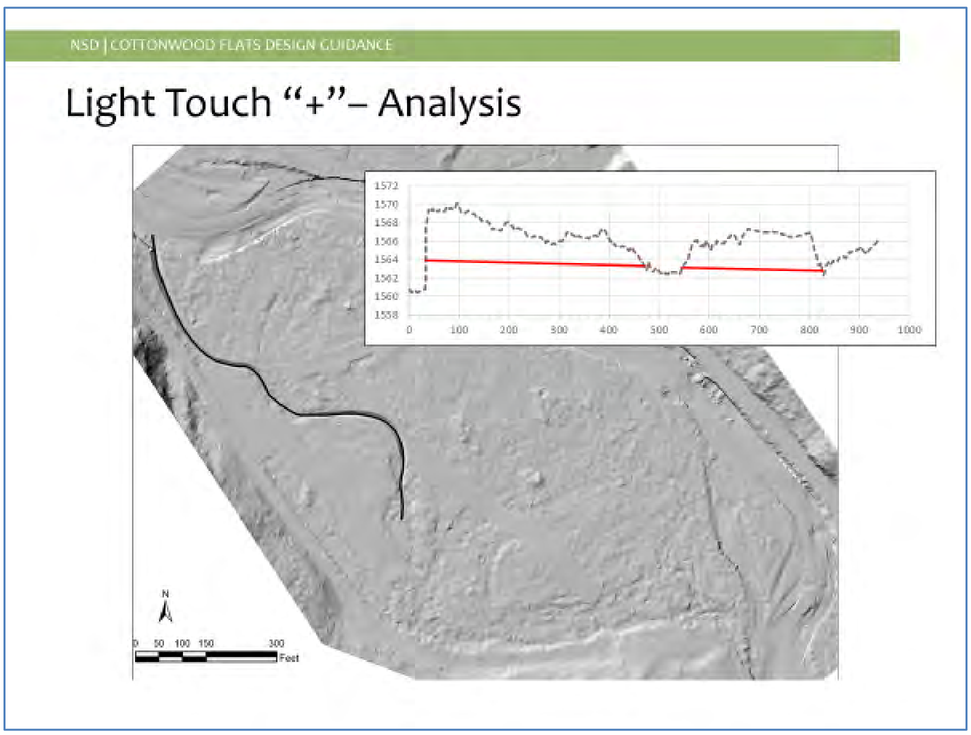

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
1,100 cfs
Q1
Possible ponding
due to backwater
N
Feet

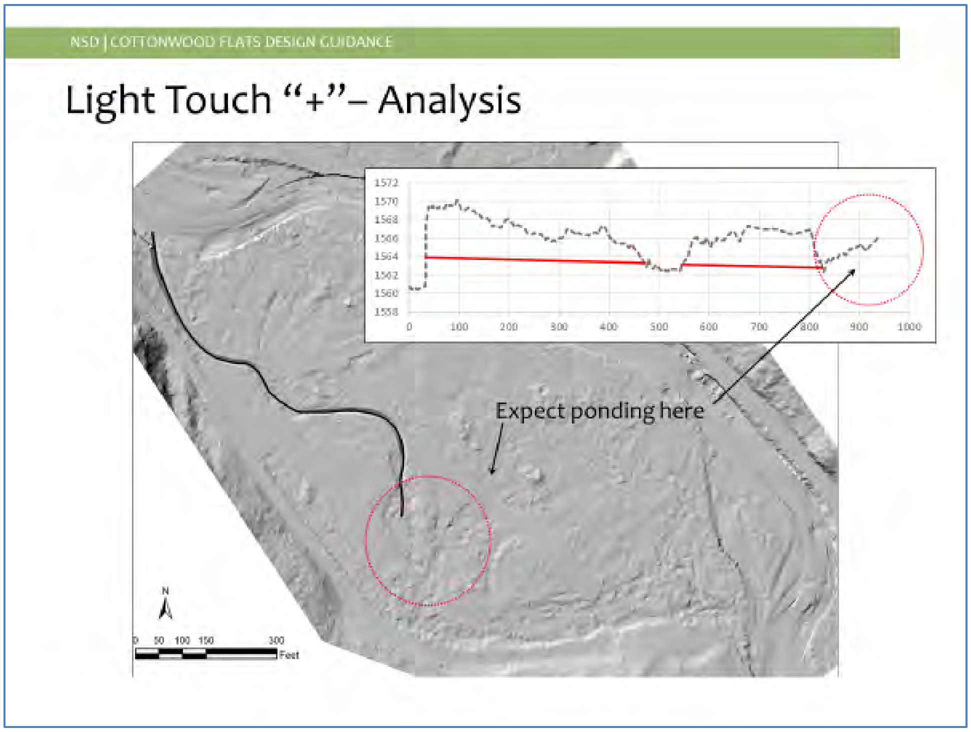

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
1,300 cfs
Possible ponding
due to backwater
N
Feet

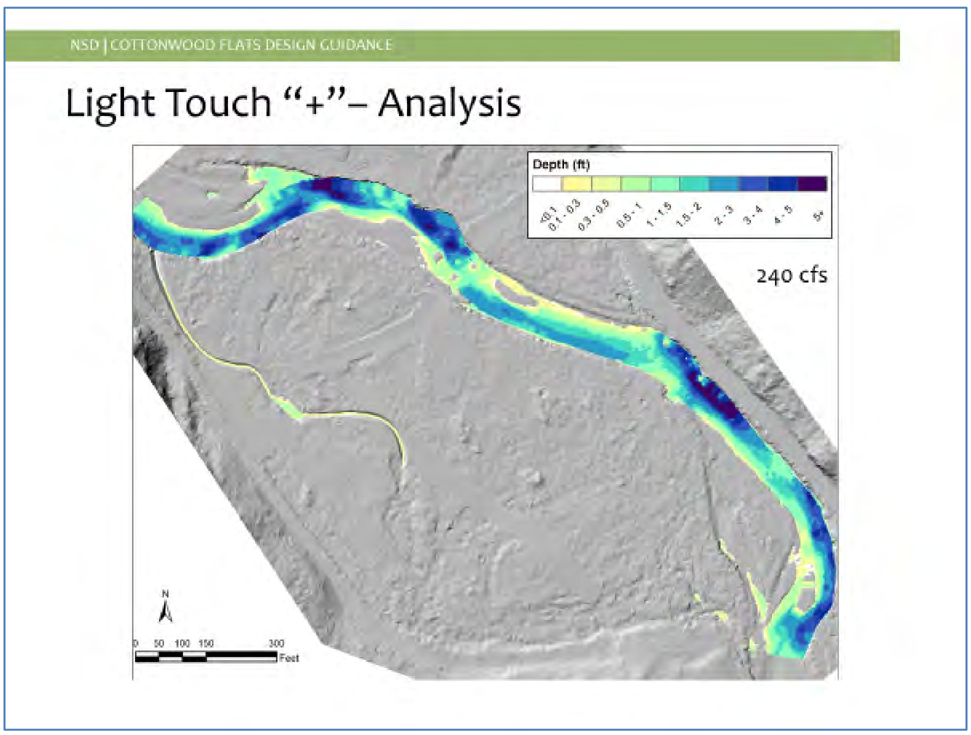

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Analysis
Depth (ft)
1,500 cfs
Likely have flow-through connection with this level of inundation

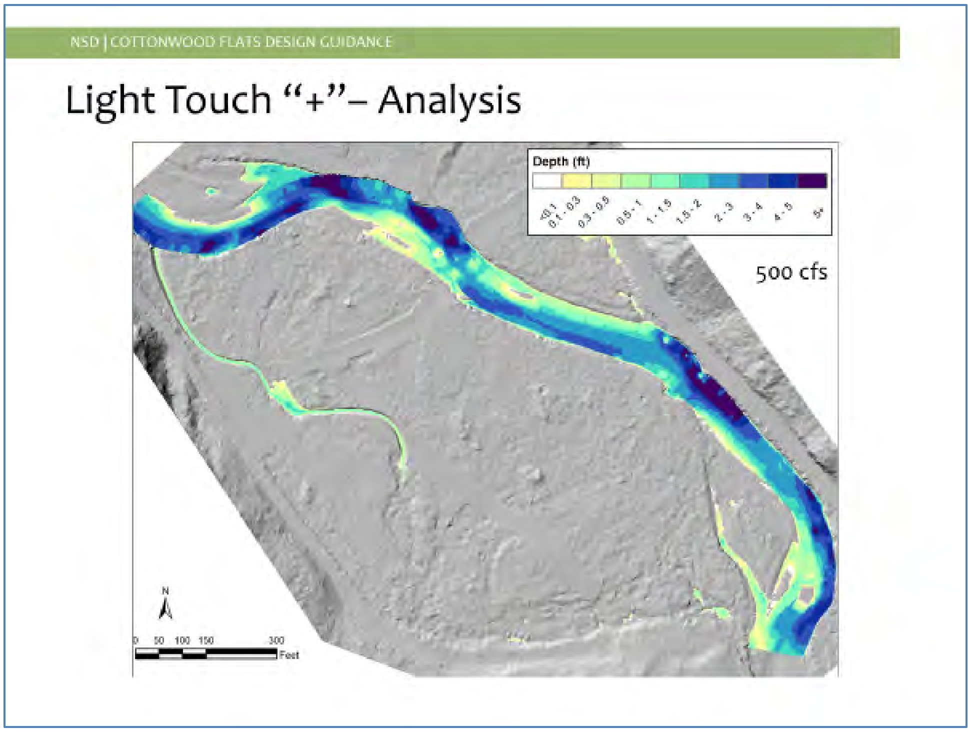

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch – Summary
Depth (ft)
1,500 cfs
Ponding likely to occur upstream of existing depression
Flow-through connection won't occur until ~1,100 – 1,500 cfs (> Q1)
Preferential flow paths may or may not form
Overall – does not achieve project objectives

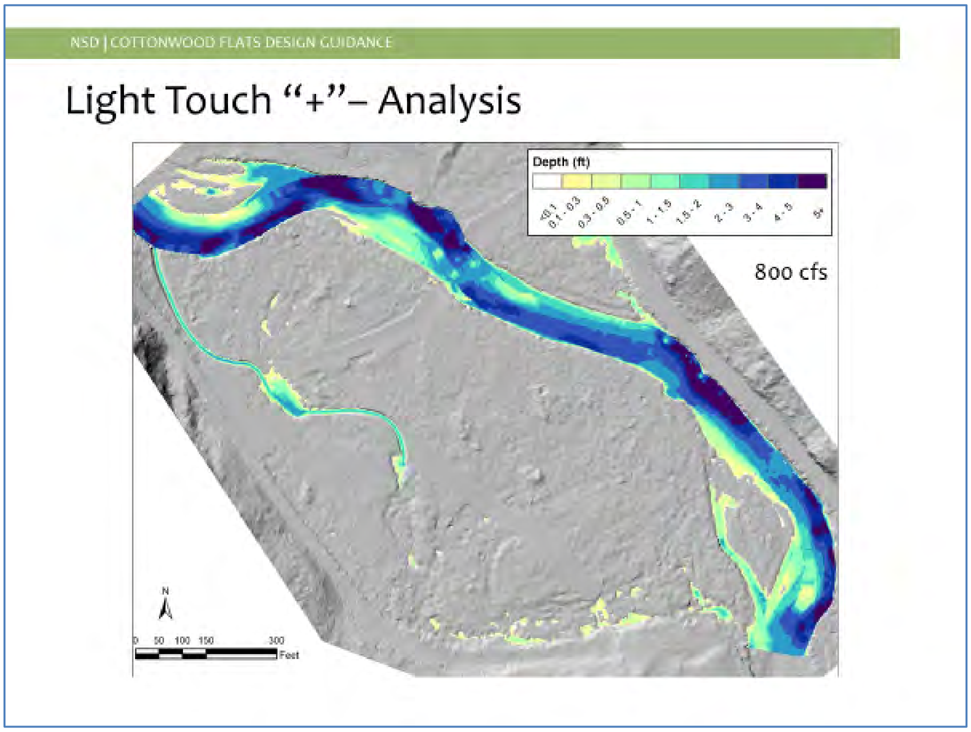

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Extend Pilot Channel past initial low spot – utilize road removal footprint
Create connection to low-lying floodplain channels
N
0 50 100 150 300
Feet

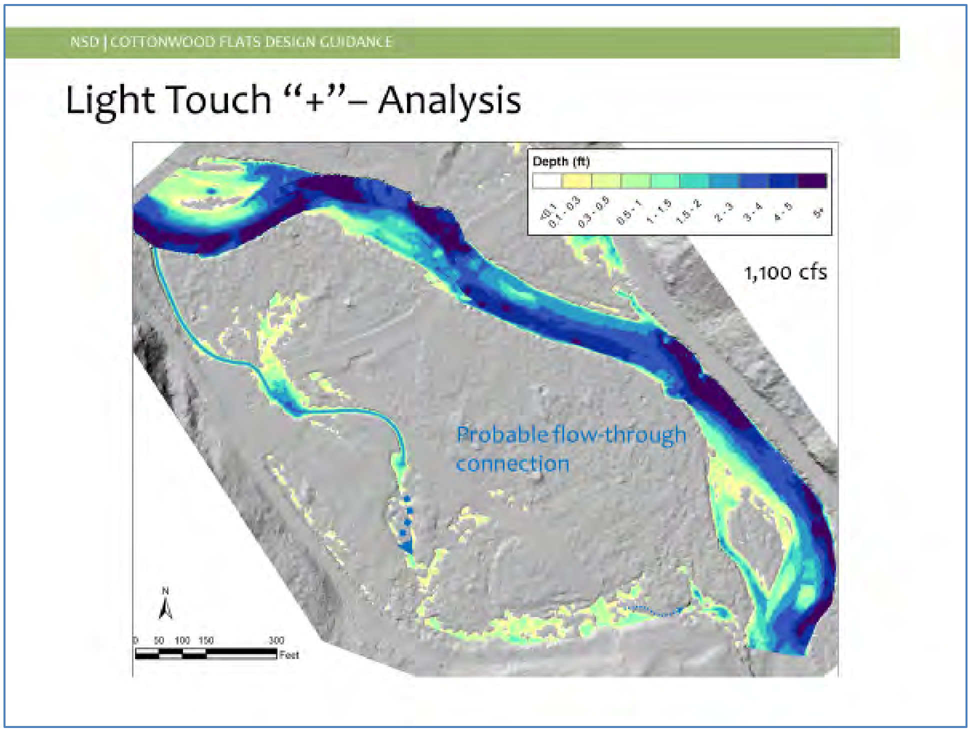

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
1572
1570
1568
1566
1564
1562
1560
1558
0 100 200 300 400 500 600 700 800 900 1000
N
0 50 100 150 300
Feet

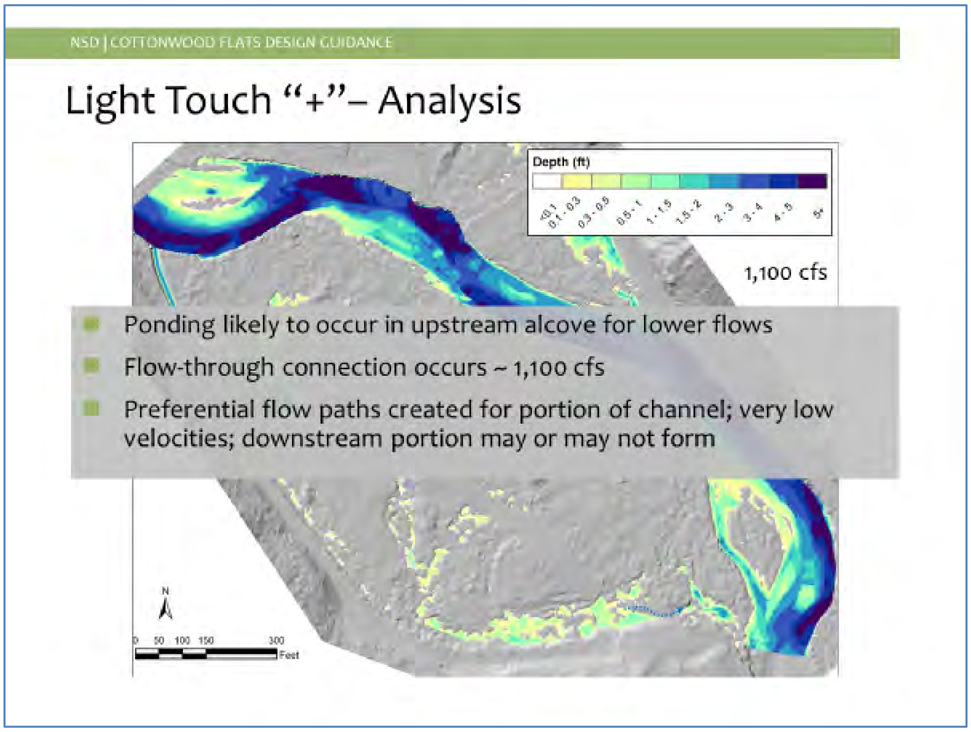

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Expect ponding here
N
0 50 100 150 300
Feet

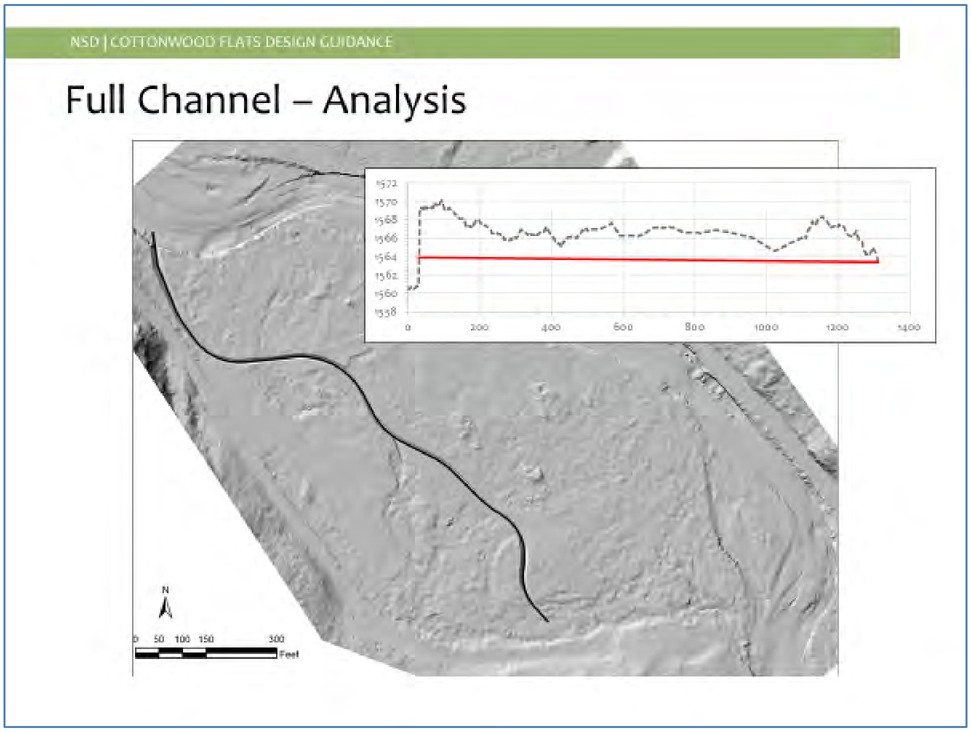

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Depth (ft)
240 cfs
N
0 50 100 150 300
Feet

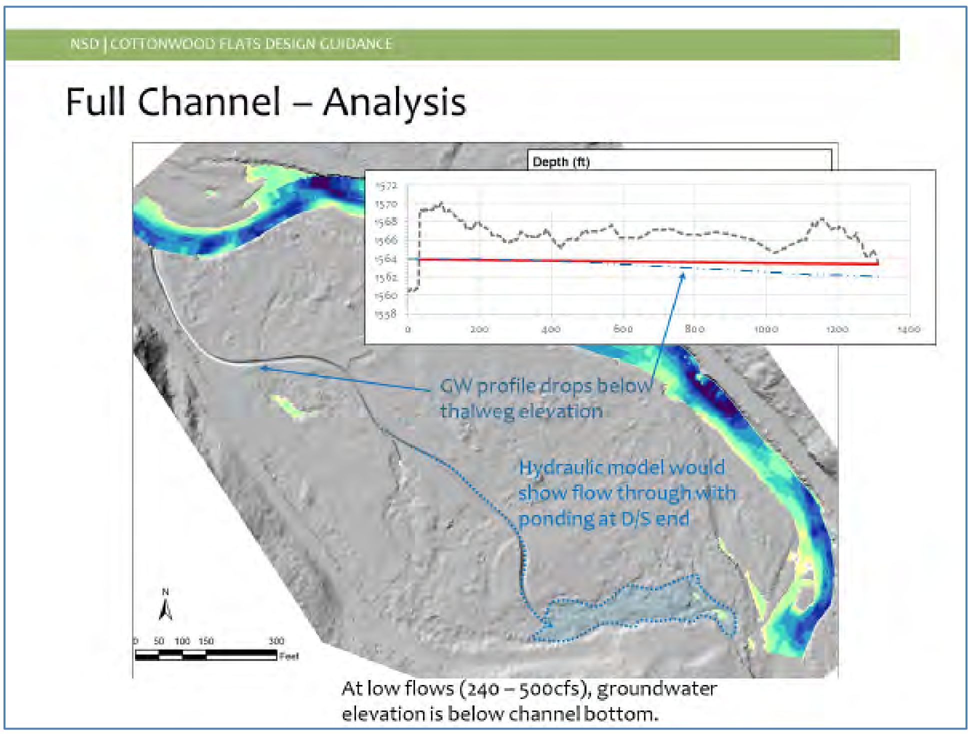

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Depth (ft)
500 cfs
N
Feet

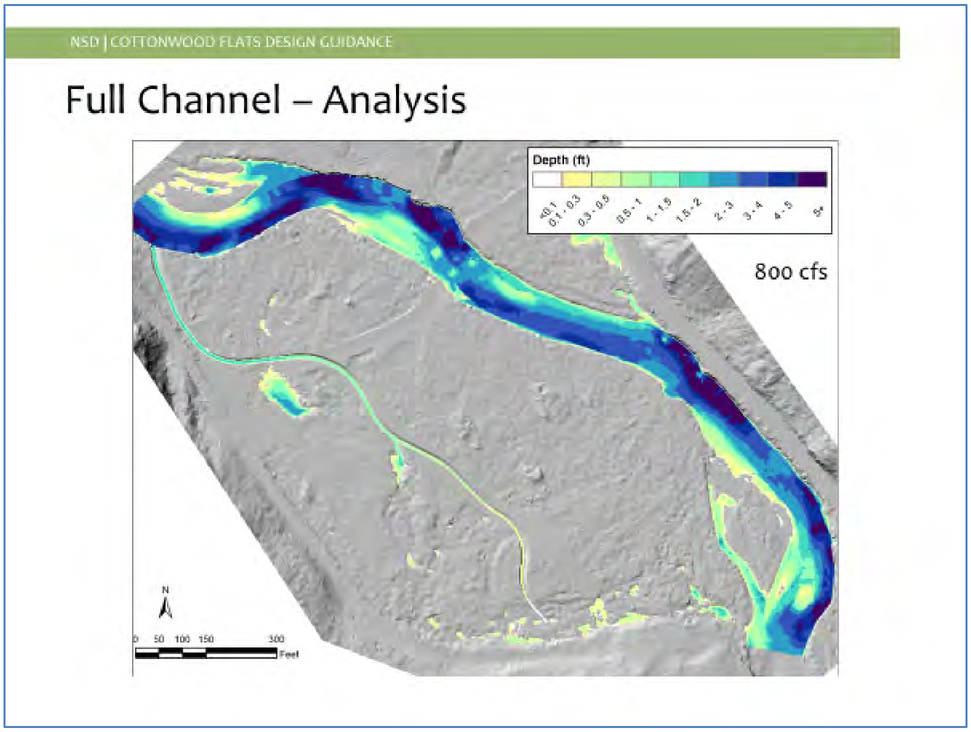

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Depth (ft)
800 cfs
N
Feet

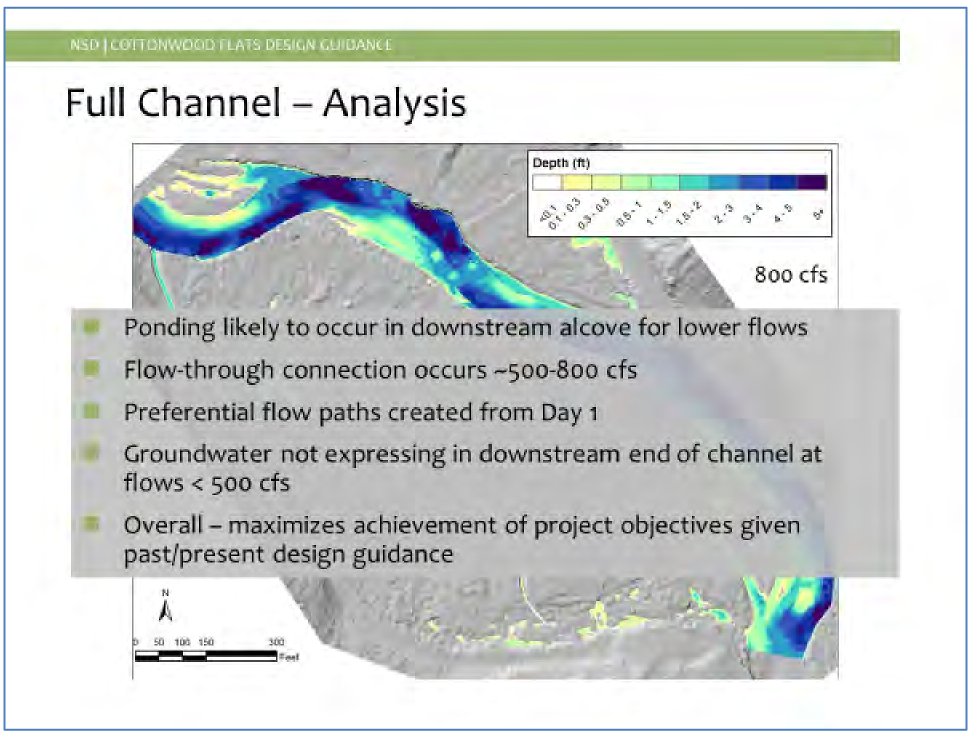

NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Depth (ft)
1,100 cfs
Probable flow-through connection
N
Feet


NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Light Touch "+"– Analysis
Depth (ft)
1,100 cfs
Ponding likely to occur in upstream alcove for lower flows
Flow-through connection occurs ~ 1,100 cfs
Preferential flow paths created for portion of channel; very low velocities; downstream portion may or may not form
N
Feet


NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Full Channel – Analysis
N
0 50 100 150 300 Feet


NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Full Channel – Analysis
Depth (ft)
GW profile drops below thalweg elevation
Hydraulic model would show flow through with ponding at D/S end
N
0 50 100 150 300 Feet
At low flows (240 – 500cfs), groundwater elevation is below channel bottom.


NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Full Channel – Analysis
Depth (ft)
800 cfs


NSD | COTTONWOOD FLATS DESIGN GUIDANCE
Full Channel – Analysis
Depth (ft)
800 cfs
Ponding likely to occur in downstream alcove for lower flows
Flow-through connection occurs ~500-800 cfs
Preferential flow paths created from Day 1
Groundwater not expressing in downstream end of channel at flows < 500 cfs
Overall – maximizes achievement of project objectives given past/present design guidance

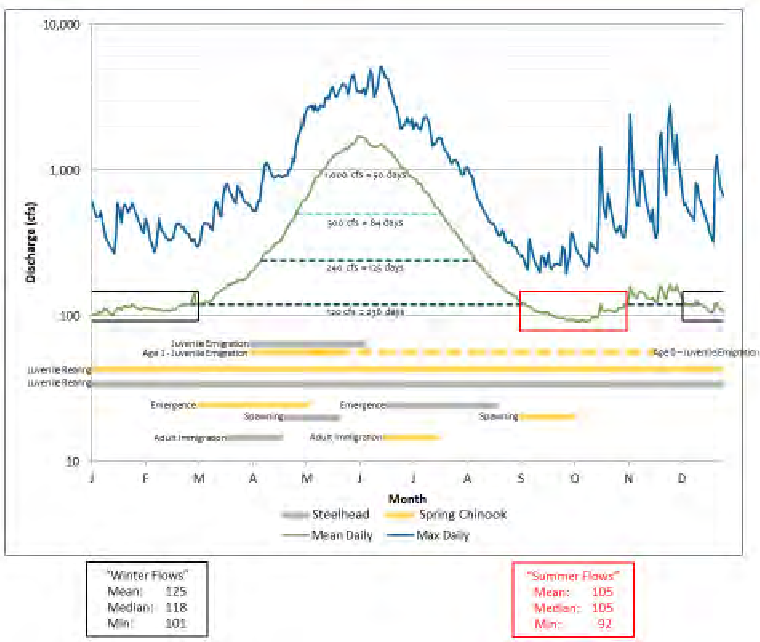
NED | COTTONWOOD FLATS DESIGN GUIDANCE

Comparison

	Light Touch	Light Touch +	Full Channel
Flow Through Connection	Flow-through connection won't occur until ~1,100 – 1,500 cfs (> Q1) Ponding likely to occur upstream of existing depression	Flow-through connection occurs ~1,100 cfs very low velocities; Ponding likely to occur in alcove for lower flows >800 CFS	Flow-through connection occurs ~500-800 cfs Ponding likely to occur in downstream alcove for lower flows > 500 CFS
Design Certainty	Preferential flow paths may or may not form	Preferential flow paths created for portion of channel; Downstream portion may or may not form	Preferential flow paths created from Day 1
Meets Project Objectives?	Overall – does not achieve project objectives	Partially meets project objectives	Overall – maximizes achievement of project objectives given past/present design guidance

31

NED | COTTONWOOD FLATS DESIGN GUIDANCE



Appendix D
Habitat Conservation Plan Policy Committees 2019 Meeting Minutes

FINAL

1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Policy Committees

Date: September 26, 2019

From: John Ferguson, HCP Policy Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the July 9, 2019 HCP Policy Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Policy Committees met at the Chelan PUD office in Wenatchee, Washington, on Tuesday, July 9, 2019, from 9:00 a.m. to 12:40 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Steve Parker (Yakama Nation [YN] HCP Policy Committees Representative) and Cody Desautel (Colville Confederated Tribes [CCT] Natural Resources Director) will discuss with their respective policy staff about convening the YN and CCT Tribal Councils to discuss potential paths forward for the Scaffold Camp Acquisition #2 Project, including third-party ownership (Item V-A).
- Tracy Hillman (HCP Tributary and Hatchery Committees Chairman) will communicate HCP Policy Committees guidance to the HCP Tributary and Hatchery Committees to base funding decisions on technical merit, and to notify respective HCP Coordinating and Policy Committees representatives of any potential policy issues needing to be addressed in those forums (Item V-A). *(Note: Hillman communicated this guidance to the HCP Tributary and Hatchery Committees, as discussed.)*
- Steve Parker and Cody Desautel will discuss with their respective policy staff about convening the YN and CCT Tribal Councils to: 1) attend a joint meeting and presentation by Chelan PUD, Douglas PUD, and YN and CCT HCP technical representatives about the function of the HCPs; and 2) provide guidance on land ownership issues that might impact implementation of the HCPs (Item V-A).
- HCP Policy Committees representatives will each discuss with their respective HCP Tributary and Hatchery Committees representatives the option of abstaining in lieu of a disapproval vote to preserve a policy position (Item V-A).
- John Ferguson (HCP Policy and Coordinating Committees Chairman) will coordinate with each HCP signatory about an optimal date, time, and location for an annual meeting of the HCP Policy Committees (Item VI-A).

Decision Summary

- There were no HCP Policy Committees Decision Items approved during today's meeting.

Agreements

- There were no HCP Policy Committees Agreements discussed during today's meeting.

Review Items

- There are no HCP Policy Committees items that are currently available for review.

Finalized Documents

- There are no HCP Policy Committees documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Policy Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Kirk Truscott (CCT HCP Coordinating Committees Representative) said Cody Desautel will be 30 minutes late and requested that the YN agenda item be postponed until Desautel arrives. No other changes were requested.

B. Purpose and Objectives (John Ferguson)

John Ferguson summarized the three objectives for this meeting are to: 1) have a clear exchange of thoughts, opinions, and position on this issue; 2) develop guidance for the HCP Tributary and Hatchery Committees; and 3) maintain the proper functioning and implementation of the HCPs.

Ferguson said as history shows, implementation of the HCPs is going extremely well. He recalled in 2013, the first official check-in was very positive. He said the HCP Coordinating Committees have worked through all issues, fish passage goals have been met, and spill is in compliance. He said the HCP Hatchery Committees have been successful in meeting the hatchery production and mitigation goals, and the HCP Tributary Committees have funded many projects and have now built up the fund accounts to be able to implement large-scale projects. He said the issue at hand is just one small sliver in a hugely successful program.

II. HCP Tributary Committees

A. Review of Events and Revisions to Decision Evaluation Criteria (Tracy Hillman)

Tracy Hillman said a document titled, "Dispute Regarding Basis for Decision Making in the HCP Tributary Committees," (information package; Attachment B) was prepared by the HCP Tributary Committees in response to a formal dispute submitted by the YN, dated May 23, 2019. Hillman clarified that the YN has since withdrawn the formal dispute; however, the information package, as distributed to the HCP Policy and Coordinating Committees on June 11, 2019, refers to the issue as a dispute, which is not the case at this time. Hillman said the information package reviews the sequence of events concerning this issue including two parallel paths: 1) development of scoring criteria for funding projects; and 2) review and voting on a draft Statement of Agreement (SOA).

Hillman said the HCP Tributary Committees have always followed criteria outlined in the "HCP Tributary Committees Policies and Procedures for Funding Projects," (Policies and Procedures document) when making funding decisions. He said the criteria consider the biological benefit, technical merit, durability, feasibility, and cost effectiveness of a proposed project. He said in 2018, Brandon Rogers (YN) and Catherine Willard (Chelan PUD) became new representatives on the HCP Tributary Committees. Hillman said both Rogers and Willard have experience working on the Upper Columbia Regional Technical Team where there are very specific scoring criteria for evaluating projects. Hillman recalled that Willard asked about detailed evaluation criteria in the Policies and Procedures document, and at the time there were only general criteria. Hillman said Willard expressed interest in developing specific criteria and Rogers agreed. Hillman said as suggested, the HCP Tributary Committees started the process of developing specific scoring criteria to include in an updated Policies and Procedures document.

Hillman said the other path began in December 2018, when the HCP Tributary Committees received a General Salmon Habitat Program Proposal from the YN titled, "Scaffold Camp Acquisition #2 Project." Hillman said the HCP Tributary Committees evaluated the project and based on the general criteria in the Policies and Procedures document, agreed this is an important property to protect and a good opportunity to restore a side-channel. Hillman said Chris Fisher (CCT HCP Tributary Committees Representative) agreed with the biological importance of the project; however, he received policy-level direction to vote "no" because approving the project meant the YN would own property in the Methow River Basin. Hillman clarified a "no" vote from the CCT had nothing to do with the HCP Tributary Committees evaluation criteria; rather, it was a policy-level directive that overrode the Committees criteria. He said at that time, the HCP Tributary Committees brainstormed what could be done to protect this property and recommended that the YN discuss the acquisition of the parcel with other conservation-minded entities such as the Methow Salmon Recovery Foundation, Methow Conservancy, Washington Department of Fish and Wildlife (WDFW), or the CCT, and coordinate enhancement work on the property with the YN. Hillman said the YN was not supportive of this recommendation and indicated they would likely dispute the decision based on principle. He said after internal deliberation, the YN elected not to dispute the decision on the Scaffold Camp Acquisition #2 Project but decided to develop an SOA that places boundaries on how the HCP Tributary Committees make funding decisions. He said on February 25, 2019, the YN distributed a draft SOA titled, "Basis for Decision Making in HCP Tributary Committees," which stated that the HCP Tributary Committees will make mitigation funding decisions based exclusively on the merits of proposed projects (biological benefit, technical merit, feasibility, durability, and cost effectiveness) having a direct nexus to plan species, plan species habitat, or plan species management. Hillman said the draft SOA was available for a 45-day review. He said no edits to the draft SOA were received and during the HCP Tributary Committees meeting on April 11, 2019, he asked each HCP Tributary Committees representative to vote on the SOA as well as provide justification for their vote. He said all representatives voted "no" except for the YN. He said the reasons for voting "no" on the draft SOA included: 1) the representatives believe the evaluation criteria in the Policies and Procedures document are sufficient for evaluating project proposals; 2) the representatives believe this is more of a tribal issue and not an HCP issue; and 3) representatives do not want to lose their discretionary rights to vote "no" on a project for reasons that may not entirely fit within the Policies and Procedures criteria.

Hillman said while the SOA was under review, the HCP Tributary Committees were also reviewing and updating their criteria for evaluating restoration, protection, design, and assessment projects. He said specific criteria for biological benefit, technical merit, durability, feasibility, and cost effectiveness were developed for each project type. He said this is when the two parallel paths converged. He said there were now more robust and specific criteria to evaluate projects and the HCP Tributary Committees decided an SOA was not needed to stipulate the use of these criteria. He said because the draft SOA was rejected, the YN elected to submit a formal dispute in accordance with Section 11 of the HCPs, which was the impetus for developing the information package (Attachment B). He said since announcing the formal dispute, the YN has withdrawn the dispute and the HCP Policy Committees are convened today to further discuss this topic.

Hillman said he appreciates that this is no longer a formal dispute. He said when an HCP Tributary Committees representative votes "no" on a proposed project, as Chair of the Committees he must understand the reasonings for the "no" vote because he has to communicate the decision and the reason for the decision to the project sponsor. He said the sponsor then has an opportunity to address the issues and resubmit an application, which they often do. Hillman said a "no" vote is often due to the project sponsor proposing the wrong project, in the wrong place, at the wrong time, any combination of these factors, or the cost effectiveness of the project. He said, however, Fisher supported the project based on the benefits to the resource but was directed by policy staff to vote "no." Hillman argued that the HCP Tributary Committees Policies and Procedures are not the issue; rather, the issue is policy-level decisions that override HCP Tributary Committee criteria. He said the HCP Tributary Committees have criteria in place; however, policy staff can override these criteria. He said if this topic was still a formal dispute that went to the HCP Coordinating Committees, he believes the vote at the HCP Coordinating Committees level would be similar. He asked then, do the HCP Coordinating Committees also have an issue with their criteria for making decisions? He said the HCP Coordinating Committees also receive direction from policy staff. He said, therefore, this discussion within the HCP Policy Committees is valuable because this group oftentimes is providing guidance to the technical representatives. He said he is in the position where he needs to defend the HCP Tributary Committees position with project sponsors. He said he needs to understand and believe the decisions are correct, and this Scaffold Camp Acquisition #2 Project is the first case where he could not defend the decision based on what was best for the resource. He said the HCP Tributary Committees decision was trumped by policy staff, which is not the fault of the HCP Tributary Committees and is why he believes the HCP Policy Committees need to address this issue.

John Ferguson asked to what extent is ownership captured in the HCP Tributary Committees criteria. Hillman said ownership only applies to protection projects where the land is typically owned by the project sponsor. He said when a protection project is evaluated, the HCP Tributary Committees consider who will hold the title. He said, for example, if the entity has a bad reputation for allowing disturbances to occur, the HCP Tributary Committees would vote "no" based on biological merit and durability and would indicate they do not believe the entity would adequately protect the resource. He said the criteria do not indicate who can or cannot own a property, but the criteria do question whether the landowner is appropriate. He said, for example, anytime a Plan Species Account is used to fund projects, the landowner must allow public access and maintain the resources. Jim Craig asked, so the criteria do give the HCP Tributary Committees the ability to say who owns the property? Hillman said yes, the HCP Tributary Committees could say they believe that a property should be protected but that a certain entity should not hold title and recommend that another entity hold the title. He said similar language is included in the HCPs.

Alene Underwood (Chelan PUD HCP Policy Committees Representative) clarified that per Section 7.4.4 of the Rock Island and Rocky Reach HCPs,[1] "Title may be held by the District, by a resource agency or tribe or by a land or water conservancy group, as determined by the Tributary Committee." Tom Kahler (Douglas PUD HCP Coordinating and Tributary Committees Representative and HCP Hatchery Committees Alternate) said, importantly, there are separate sections in the HCPs describing ownership of assets and funding decisions, which are distinct from each other. Kirk Truscott said Section 7.4.4 of the Rock Island and Rocky Reach HCPs[2] also states, "Unless the Tributary Committee

[1] Also, per Section 7.3.7.4 of the Wells HCP.
[2] Also, per Section 7.3.7.4 of the Wells HCP.

determines that there is a compelling reason for ownership by another entity, the District shall have the right to hold title." Truscott said it may not be who is the best entity to hold the title; rather, it is more a function of multiple entities are capable of holding titles.

Jim Brown (WDFW HCP Policy Committees Representative) asked if the HCPs include reserved rights, and Kahler said there are sections describing authorities to whom each of the signatories are subject. Kahler said the HCPs were not intended to take away rights granted in other documents; rather, the HCPs are a recovery plan. Brown said it seems then by signing the HCPs, the signatories agreed to comply with the processes and criteria contained within the HCPs. Kahler explained that the HCPs define each committee and state that it is up to each committee to develop its own operating procedures and submit them to the HCP Coordinating Committees. He said ultimately, the HCP Coordinating Committees deferred management of the respective operating procedures to each committee so long as the procedures uphold the tenants of the HCPs and accomplish the objectives outlined in the HCPs. Ferguson also noted that Section 9.7 of the Wells HCP[3] states "However, the Party shall use reasonable efforts to exercise their rights and authority under such statutes, regulations, and treaties (consistent with their duties and responsibilities under those statutes, regulations and treaties) in a manner that allows this Agreement to be fulfilled."

Hillman said the HCP Tributary Committees review their Policies and Procedures document every year and evaluate whether the document needs revising. He said, for example, conservation easements formerly did not require public access, but the HCP Tributary Committees changed this to allow public access.

Ferguson said the HCP Coordinating Committees discussed this potential dispute in December 2018, after it was first discussed within the HCP Tributary Committees. He said there was general agreement that this issue could not be resolved within the HCP Coordinating Committees and would need to be elevated to the HCP Policy Committees. He said this general thought did not change when the topic was discussed again in January and February 2019. He said there was never a vote, but this was the way the discussion was headed, which is what led him to contact the YN to convene the HCP Policy Committees for further discussion of this issue outside the formal dispute process.

Brown said he believes caution needs to be taken about overly focusing on the HCP Tributary Committees policies and procedures and to keep the focus of the discussion at the policy level. He suggested focusing on how to make policy decisions that translate into marching orders to technical staff.

Ritchie Graves (National Marine Fisheries Service [NMFS] HCP Policy Committees Representative) said he is interested in the unbiased implementation of the HCPs and believes it is worth refreshing

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[3] Also, per Section 9.4 of the Rock Island and Rocky Reach HCPs.

representatives' memories on how the HCPs got to where they are today. He recalled back in the 1980s, there was a lot of litigation, fisheries managers were operating under court orders, there was a very prescribed but miniscule amount of spill for fish passage, and everything was tied strictly to monetary value. He said in the mid-1990s, after the Snake River stocks started to be listed and stocks in the Upper Columbia River Basin were not in good shape, these statuses were reviewed. He said it is his understanding that the U.S. Fish and Wildlife Service was very pro-HCP and convinced Will Stelle (NMFS Regional Administrator) there should be an effort devoted towards developing HCPs for the Mid-Columbia PUDs. Graves said he was part of the third team for NMFS to participate in this process, which took 8 to 10 years to finish. He said in 2001, he participated in the final effort to complete the process. He said key improvements in the final effort included a better understanding of the Tributary Program portion of the HCPs and the addition of the decision matrix the HCP Coordinating Committees use to make sure survival standards[4] are being met and determine how to continue to achieve those performance standards. He said there were also clarifications concerning the Hatchery Program portion of the HCPs. He said in August 2003, forward progress of the HCPs slowed when NMFS was issuing permits for Grant, Chelan, and Douglas PUDs. He said it was at this time that Grant PUD elected to leave the HCP development process. He said by the end of 2003 when the Biological Opinions (BiOps) were submitted to the Federal Energy Regulatory Commission (FERC), there were still some disputes; several parties were not enamored with the HCPs and even submitted filings to FERC expressing disapproval of components of the HCPs. He said ultimately, FERC approved the interim BiOps and NMFS issued a second round of BiOps.

Graves said there is a lot of history here and a lot of effort went into getting the HCPs to where they are today. He said following FERC's approvals he believes the Columbia River Inter-Tribal Fish Commission and the YN was in the process of formally disputing the FERC approvals. He said after a tribal meeting, the YN ultimately decided it would be more beneficial to join the HCPs rather than challenge them. Graves said some environmental groups had the option to join but declined, he believes due to staffing reasons. He agreed with Ferguson that implementation of the HCPs to date has gone well. He said he believes the framers of the HCPs did a good job in laying out the key issues, and he views the issue today as a bit outside of what anyone was entertaining would be an issue at the time the HCPs were negotiated—where there are policy goals over-riding technical goals and how to address this. He said he also agrees with Ferguson's and Hillman's appreciation for the HCP Policy Committees convening to address this issue because he does not want to see technical staff tearing each other up over this when it is really out of their control. He said this type of thing hurts working relationships and he believes the HCP Policy Committees owe the technical committees some guidance on this issue. He said he is still trying to understand if there is an issue with this particular

[4] Figure 1. in Section 4.1.2 of the Wells HCP (and, as included in the RI and RR HCPs).

project other than ownership. He said he understands the tribes have relationships, some good some bad, and the job of the HCP Policy Committees is to uphold the viability of the HCP process. He asked how to steer this process so it cannot be accused of being prejudice on behalf of one tribe or another. He said decisions need to be made to make sure this process is fair and objective. He said to this day, he does not know of any HCPs for a hydropower project in the country and he believes the Mid-Columbia HCPs are working well. He said the signatories have really focused on benefiting the species. He said he personally has a lot of pride in how the HCPs have functioned over time and he hopes to see them continue to function in the future.

Steve Parker explained the reason why the YN initially did not want to sign the HCPs was based on concern about the voting procedures being consensus-based, and the perceived conveyance of rights and authorities to the HCPs, which they did not possess. He said the YN has worked very hard to establish themselves as a self-regulating fisheries manager and the Tribal Council takes this very seriously. He said the YN is reluctant to share authorities with other entities that do not share the same views for the resources; however, at that time, it was decided it was better to be in the room where the HCP decisions are being made rather than dealing with the outcomes, and so the YN signed onto the HCPs.

III. Yakama Nation

A. Basis for Decision Making in the HCP Tributary Committees (Steve Parker)

Steve Parker thanked the HCP Policy Committees for convening today. He said this is not a typical issue and his key objectives today are to make sure the HCP Policy Committees understand what the YN perceptions are and the reasoning behind this issue. He said it is equally important to determine what remedies may exist. He said this is a difficult situation to deal with at this level. He said he wants to separate the specific example that precipitated this meeting from the principle the YN is trying to bring to the HCP Policy Committees for awareness and guidance, which is to define the acceptable criteria for voting procedures.

Parker said stepping back several months, the YN was taken by surprise by the decision on the Scaffold Camp Acquisition #2 Project. He clarified the CCT position was no surprise to the YN, as both tribes have historically been very candid about circumstances of geographic regions in the Upper Columbia River Basin. He said the YN has an appreciation for the CCT position and understands it. He said the YN's greater concern was not about the specific detail of this vote but rather about the larger principle of what criteria can be brought into a vote. He questioned where there should be bounds around what is considered acceptable criteria. He recalled when the HCPs were developed, the Parties agreed there would likely be 9% unavoidable project mortality even with all measures to improve passage survival. He said of this 9% only about 7% could be mitigated through hatchery production, which he believes was based on limitations in hatchery capacity. He said the other 2% was to be mitigated through habitat improvements. He said then as now, there was no way to document whether the 2% was being achieved; however, it was taken in good faith that by implementing the Tributary Habitat Program this would satisfy this portion of the mitigation program. He said based on this agreed upon level of mitigation required, implementation plans and procedures were developed and incorporated into the FERC licenses to operate the respective projects. He said the YN's concern is about the new criteria developed and incorporated into the HCP Tributary Committees Policies and Procedures document, which in the YN's view presents a material modification to the FERC license terms. He said the YN is conducting an internal analysis of this; however, they have not yet come to a final determination. He said the analysis is looking into the possibility of having FERC weigh in on a dispute; however, it appears this might not be possible. He said it is not clear to him after reading the HCPs what happens after an HCP Policy Committees decision. He said the HCPs just state other remedies are available. He said the YN is in a quandary being the Party bringing this dispute. He said if the dispute cannot be resolved within the HCP Policy Committees, what happens next? He said he hoped to discuss this with the HCP Policy Committees to search for solutions.

Parker said the YN is struggling with the potential that Parties can bring criteria to a funding decision that do not relate to benefiting the resource. He said this establishes a precedent that the YN does not want to contemplate. He said each Party potentially has differences in policy perspectives and management priorities. He said if these differences can drive the decision-making, he views this as a degradation in the process of the mitigation program and what the signatories signed up for.

IV. Discussion

A. Comments and Perspectives (All)

Ritchie Graves said one of his concerns is starting a dynamic within the committees whereby anyone who feels slighted will elevate a topic to the policy level. John Ferguson said he believes all HCP Policy Committees representatives share this concern, which gets to the heart of his third objective of today's meeting, which is to maintain the proper implementation of the HCPs.

Tom Kahler asked Steve Parker to clarify what he said about changes to the FERC license. Parker explained that his hypothesis is that to the extent the HCP Tributary Committees policies and procedures are part of the FERC license terms, by incorporation (i.e., the HCP and all its derivative parts, including its operating procedures, are considered part of the license), any change to those voting criteria represent a change to the license terms. Ferguson said the HCP Tributary Committees Policies and Procedures document is not part of the HCP text; rather, the HCP states that the HCP Tributary Committees will develop these criteria. Parker said it is a negotiated process. He said thinking back to when the HCPs were negotiated, if someone had suggested a decision criterion based on policy goals other than mitigation priorities, this would be hard to agree to (i.e., decision criteria based on territorial claims or political aspirations would not have been acceptable then and, accordingly, should not be acceptable now). He said this is adding an element that has nothing to do with mitigation itself.

Kahler said early on, there were a lot of questions about how the implementation of the tributary program would work. He said it started with an agreement to coordinate the selection of habitat projects for funding with the ongoing annual project-funding cycle of the Washington State Salmon Recovery Funding Board (SRFB) and adapted to accommodate other regional funding needs over time. He recalled Bob Rose (YN HCP Tributary Committees Representative, retired) wanted the HCP Tributary Committees to be self-directed in project development and funding, and now the committees have finally achieved this, while maintaining their integration with the SRFB annual funding cycle. Kahler said the approach to implementing the tributary program has always been an adaptive process tailored to what the HCP Tributary Committees view as being needed, and the committees have adapted their policies and procedures accordingly. He said the HCP Tributary Committees are unique in that all representatives are truly only interested in benefiting the resource. He said the HCP Tributary Committees are not flawless, but there has never been an atmosphere of partisanship. He said he believes the HCP Tributary Committees have done a lot of good things and now the committees have encountered a new issue. He said he believes it is important that the HCP Policy Committees provide direction to the HCP Tributary Committees regarding Section 7.3.7.4 of the Wells HCP[5] (Ownership of Assets).

Ferguson said he is not sure that tying the five general criteria outlined in the HCP Tributary Committees Policies and Procedures document to the FERC requirement is accurate. He said the HCP is what is in the FERC license, and the HCP states "The Tributary Committee shall select projects and approve project budgets from the Plan Species Account by joint written request of all members of the Tributary Committee." Ferguson said he is unsure whether there is a nexus between the five general criteria and FERC license because the HCP Tributary Committees Policies and Procedures document is not part of the actual HCP text. Alene Underwood said however, each year the PUDs submit an annual report to FERC for approval, which outlines the activities conducted that year for all HCP committees. She said FERC approves the annual reports, and therefore, the changes noted within.

Cody Desautel said he does not recall this being an issue prior to 3 years ago, and he believes the concern started when the YN opened the coho salmon fishery in the Methow River basin. He said historically, the CCT have been supportive of habitat work; however, the incident with the fishery

[5] Also, per Section 7.4.4 of the Rock Island and Rocky Reach HCPs.

threw up a red flag for the CCT Council who now thinks the YN uses habitat work to leverage work on certain lands. He said this is why the CCT Council is opposed to land purchases by the YN in the CCT territory. He said the question is how to move forward from here. He recalled some discussion about third-party ownership where there is still benefit to the resource but that avoids territory issues. He suggested developing alternatives that need to be presented to, and approved, by the respective tribal officials. He said he and Phil Rigdon (YN Natural Resources Manager) both want to see habitat work done, and this situation is difficult for everyone. Jim Brown asked Desautel if he and Rigdon have discussed this issue. Desautel said yes, and they discussed attempting to convene the YN and CCT Tribal Councils because ultimately those are the people who have the concerns. Desautel said this meeting would also need someone with an HCP background to help find a workable solution. Ferguson agreed with Desautel and said the principle issue is outside the HCPs. Ferguson said the HCP Policy Committees can try and provide guidance to the HCP Tributary Committees; however, this would only be a work-around and not a solution. He said the solution needs to fit within the respective Tribal Councils' guidance.

Parker said the YN has discovered that in the course of implementing the Columbia River Accord Habitat Program in the Upper Columbia River Basin, it is in the best interest for the YN to own the property where work is being done because there can be constraints with working with a property owner. Parker said constraints may take the form of differences in opinion on project objectives, design and implementation, or the terms of a conservation easement on the property after restoration work is completed. He said he does not believe the YN is interested in owning a lot of land because this comes with liabilities and responsibility, and he does not believe it is the best use of the YN restoration funding to buy and hold property. Desautel agreed with Parker noting that property owners with little technical background can get very opinionated about what needs to be done. He said, however, from the CCT Tribal Council's view, the CCT would prefer to own the land if it is located within the CCT territory. He asked about the possibility of WDFW being a third-party owner. Ferguson agreed this might be a solution and suggested perhaps identifying the geographic region where the tribes agree third-party ownership is required to address future similar issues.

Brown said he was directly involved with the YN coho salmon fishery incident. He clarified it was an unfortunate case of a lower-level staff person establishing a regulation that was not fully vetted with policy staff and the regulation was withdrawn shortly after it was released. Parker agreed it was an oversight, which caused a bit of friction between the tribes. Desautel suggested if the YN and CCT Tribal Councils convene, this should be explained and clarified. Parker agreed and said the YN action did not consider the CCT's likely reaction.

Kirk Truscott said he believes this issue can only be resolved at the Tribal Council level. He said what is needed is solution-oriented direction from the Tribal Councils, whether it be identifying a geographic area or other options for what can be done in these situations. He said it is too cumbersome to take every solitary issue to a council, on a case-by-case basis. He said this puts staff in a difficult position and may result in lost opportunities due to the time involved to seek council approvals. He said further, he believes the HCP Tributary Committees should continue evaluating projects based on technical merit and this should be set apart from policy decisions.

Graves recalled several regulating documents and discussions behind the language in the HCPs regarding decision making by unanimous consent, and he said the focus at that time was keeping the committees from misusing funds on poor projects. He said he thinks the Parties were reviewing all the FERC orders and everybody took comfort in the idea that if something was bad for a habitat project, the Parties would have the ability to veto the decision. He said, however, the Parties did not account for good projects that could be funded, but which would not be funded for policy reasons. He said this was a bit of a blind spot in the HCPs. He agreed convening the Tribal Councils seems to be a positive step because he is unsure the HCP Policy Committees have any more ability to resolve this issue than the technical staff in the other committees. He said regarding the YN going to FERC for resolution, he said he believes it will be difficult to get FERC to weigh in on tribal issues; rather, he believes convening the Tribal Councils is the better option. He asked what the HCP Policy Committees can do to help move this forward.

Desautel said he can contact Rigdon to start these discussions of trying to convene the Tribal Councils. Parker agreed this is worth doing to resolve this specific issue; however, he noted there is still the broader principle to remain focused on. He said regarding Graves's comment about contacting FERC, the YN believes the substance of the principle has merit but questions the procedural hurdles in place to access FERC. He said the substantive issue in his mind is to what extent can other factors besides fish and wildlife restoration be a basis for decision-making. He said FERC may not want to get involved in a tribal dispute; however, the YN does not view the larger principle as a tribal dispute. Graves said he understands the broader principle and agrees it is a fair question to ask.

Brown said he has participated on a workgroup that had a consensus-driven model where parties departed from the workgroup because consensus could not be reached on particular issues. He said when there are ideological or policy opinions that underpin a decision it can wreak havoc on a consensus-driven process. He asked where is the line, what is on or off the table?

Jim Craig said for the Scaffold Camp Acquisition #2 Project, it seems the HCP Tributary Committees diverged from the established Policies and Procedures document and did not vote based on technical merit. He said this is a unique situation given that all HCP Tributary Committees representatives were initially supportive of the project before policy-level aspects to the proposed project intervened. He said to date, the HCP Tributary Committees have functioned very well and he hopes this continues in the future. He said Section 7.3.7.4 of the Wells HCP and Sections 7.4.4 in the Rock Island and Rocky Reach HCPs discuss ownership of assets and indicate the HCP Tributary Committees may make ownership determinations of real and personal property purchased with funds from the Plan Species Account. He said the sections state that title may be held by a PUD, resource agency, tribe, or a land or water conservation group. He said it seems in this case, where the title holder is the issue, the YN and the CCT should be exploring options for a third-party to hold the title. He said this could be a PUD, WDFW, or a conservation group such as the Salmon Recovery Foundation or the Methow Conservancy, both of which have proven track records of outstanding land conservation and habitat recovery implementation.

Underwood said in her experience on the HCP Hatchery Committees, staff have worked very hard to accommodate work-arounds and she believes the HCP Tributary Committees do the same. She applauded these committees for this; however, she asked how long can staff be asked to do this? She said she advocates on behalf of the HCPs and the fantastic track record so far, and she hopes for more transparent, repeatable criteria to evaluate projects. She said she does not believe this can be achieved on this level; rather, it needs to be addressed at the highest level to continue the good work. She said continuing to have staff do work-arounds is not a long-term solution. She said it would be a real shame if after so many years of demonstrated successes in all committees, this one thing puts a blight on the successful implementation of the HCPs, and how decisions have historically been made. She said the fact that all signatories can sit down in this room together is a testament to how well this process has worked. She said it is important to pass on these sentiments and information to the Tribal Councils. She said Chelan PUD is willing to do whatever they can to help.

Tracy Hillman said a lot of what is being discussed today has also been discussed within the HCP Tributary Committees. He agreed with Parker about the benefits of owning the property where habitat restoration work is being conducted, not only for implementing actions but also for ongoing monitoring. He said determining what is in and what is out is a difficult question. He recalled reviewing the YN's draft SOA and asking the HCP Tributary Committees about other issues that might fall outside the established criteria, and the committees could not think of any. He said after this discussion, the HCP Tributary Committees were reviewing a protection project on Nason Creek that would be a great property to protect; however, a voting member received input that if agreement cannot be reached with the project sponsor on another project, that entity would not approve the Nason Creek project. He said there is no issue with the HCP Tributary Committees general and specific evaluation criteria; rather, the issue is with policy-level input that overrides the HCP Tributary Committees criteria. He said this could happen in any HCP Committee. He agreed with Parker that this is about the principle of decision-making. He said HCP Tributary Committees representatives could not agree on the YN's draft SOA because in part it did not allow policy-level authority. Brown said further, sometimes technical staff are not aware of the reasoning behind policy decisions, which can lead to conflict.

Kahler said he has been an HCP Tributary Committee representative since March 2005. He recalled in the early years discussing similar issues of what and how to do things and when and where can policy intervene. He said this reminded him of the Enloe Dam removal project that never came through the HCP Tributary Committees because of a policy issue. From a biological-benefit level, removing the dam and opening the Similkameen habitat is perhaps the most profound action that could be taken for certain salmonid species. He said that, before submitting the proposal to the HCP Tributary Committees, project proponents asked the PUDs whether they could support this project. He said prior to Okanogan PUD's recent decision to not energize Enloe Dam, Douglas PUD was constrained because Douglas PUD has a basic operating principle to not interfere in the affairs of other PUDs. He said although he believes this is a great project, he could not have voted yes had it been brought to a vote prior to Okanogan PUD's decision to not energize. Therefore, the proponents never submitted a proposal for assisting with dam removal, knowing that the PUD could not approve it. He said another situation might be when an entity known to have done great harm in the grand scheme of resource management proposes a project with biological benefit, can the PUD support this? He said there was another project where design work was already being conducted, another entity proposed to do something there, and the project was rejected because someone else was already working there. He said a few projects have also been approved with relatively low biological benefit because of an expectation of realizing greater habitat benefits in the future with the relationships fostered by approval. These examples represent a few instances that did not cleanly fit within the evaluation criteria. Kahler said over time, there has been a pattern of approving good projects. He said there have also been projects that were not approved because the committees could not reach a consensus on benefits. He said overall, the evaluation criteria have served the committees well, and now include more specificity the HCP Tributary Committees representatives asked for. He said these policies and criteria act as a filter in how projects are evaluated. He said there is nothing wrong with these; rather, ownership of assets needs to be clarified by policy staff.

Parker said for this specific case, it seems seeking third-party ownership is the optimal route, which will need to be a council-level decision. He said for the larger principle, he believes technical staff should only be tasked to vote based on technical merit and if a policy issue arises this should be elevated to the next level. He said from the YN's point of view, the *US v. Oregon* process has been effective and can be viewed as a successful model. He said under *US v. Oregon* there are two technical committees (Production Advisory Committee and the Technical Advisory Committee) that must reach a consensus on the technical aspects of an issue so that the policy aspects can be elevated to the Policy Committee or argued in front of a judge. He said in the event of a dispute, the topic is not about the data; rather, it is a policy issue.

Hillman noted that the Scaffold Camp Acquisition #2 Project is a rare situation where a technical team made a technical decision but was given policy direction to not approve the project. He said he does not believe this is a conflict with the HCPs, it is just a single issue that needs to be addressed at the highest policy level.

Underwood said the HCPs specifically describe the role of the HCP Tributary Committees including their right to make decisions within the committees. She said she is hesitant to change this. She said, however, to Hillman's point, this is a rare situation.

V. Summary

A. Consensus on Recommendations (All)

The HCP Policy Committees discussed and summarized four key recommendations and associated action items based on comments and perspectives expressed, as follows:

<u>Recommendation #1: The YN and CCT Tribal Councils meet and discuss potential paths forward for the Scaffold Camp Acquisition #2 Project, including third-party ownership.</u>

John Ferguson asked if there is time sensitivity associated with this project. Tracy Hillman said he is unsure whether the landowner has sold the property yet, but if it is still available, the HCP Tributary Committees are interested in protecting it.

Ferguson recalled Tom Kahler providing a number of examples of past history where decisions were made based on factors outside of the formal criteria. Ferguson said this spoke to what is the principle solution here. He said it seems this can only be answered by the Tribal Councils. He asked if the HCP Policy Committees want to suggest defining acceptable land ownership in geographical terms, should they simply indicate this decision is outside the HCPs, or are there other recommendations? Cody Desautel said he believes that it is important to educate the Tribal Councils about the mitigation resources, the intent and background of the FERC license and HCPs, and provide a clear understanding of what the signatories are trying to do and why. He said he believes this will provide better context for funding decisions. Ferguson agreed and said it would also be good to clarify the coho fishery incident by explaining that history, too. Kirk Truscott cautioned that there is much more history between the YN and the CCT on fisheries and natural resource management activities than just the coho salmon fishery incident. He suggested staying focused on reaching agreement on a predetermined path forward on land acquisition. Steve Parker said he would like to reach a process that is not rights based; rather, it would be solely based on best mitigation for the resources.

Jim Brown said WDFW is interested in helping in any way possible and hopes to see continued successful implementation of the HCPs in the future. Ritchie Graves agreed and said the decision-making process needs to be monitored carefully and if this begins to happen regularly it will need to be revisited.

Kahler noted that more than 90% of project applications received are from entities who have no voice in the process. He said if an entity outside the HCP Tributary Committees brings in a project for funding and the project is rejected, there is no disagreement that can be disputed. He said as signatories to the HCPs bring forth projects for funding, this has placed the signatory at a different level of consideration compared to a non-signatory. He said the HCP Tributary Committees try to treat all projects the same, but project sponsors who are also a signatory to the HCPs have the right to dispute.

Ferguson said Parker and Desautel will discuss convening the YN and CCT Tribal Councils with their respective policy staffs and potential paths forward for the Scaffold Camp Acquisition #2 Project, including third-party ownership.

Recommendation #2: Provide HCP Policy Committees guidance to the HCP Tributary and Hatchery Committees regarding funding criteria.

John Ferguson said Tracy Hillman will communicate HCP Policy Committees guidance to the HCP Tributary and Hatchery Committees to base funding decisions on technical merit, and to notify respective HCP Coordinating and Policy Committees representatives of any potential policy issues needing to be addressed in those forums.

Recommendation #3: Request Guidance from the YN and CCT Tribal Councils on land ownership issues.

Kirk Truscott reiterated Cody Desautel's suggestion to first provide context about the HCPs before requesting guidance. Alene Underwood and Tom Kahler agreed.

John Ferguson said Steve Parker and Desautel will discuss with their respective policy staffs about convening the YN and CCT Tribal Councils to: 1) attend a joint meeting and presentation by Chelan PUD, Douglas PUD, and YN and CCT HCP technical representatives about the function of the HCPs; and 2) provide guidance on land ownership issues, which might impact implementation of the HCPs.

Recommendation #4: Consider abstention in lieu of disapproval to preserve respective policy positions.

Alene Underwood suggested considering using discretion in the form of abstention as opposed to a "no" vote. She said this approach preserves policy views but also maintains the HCPs. She said this has been discussed before within the HCP Hatchery Committees. She said understanding that abstention is not perfect, it seems it would occur rarely, and it give Parties the ability to state their policy position in a more transparent manner. She said this does not necessarily address the issues, but it preserves the functionality of the HCPs and the HCP committees.

Steve Parker agreed there is a lot of merit to this. John Ferguson said by abstaining the project still goes forward. Parker said, however, the Parties can still preserve their policy position. Underwood said, for example, there was a project within the HCP Tributary Committees from the Cascade Columbia Fisheries Enhancement Group for work at Tumwater Dam. She said after discussing this internally, Chelan PUD chose to abstain because the PUD thought approving or disapproving the project would be unfair to one party or another. She said abstaining preserved Chelan PUD's policy position while also recognizing the PUD signed onto something that needed to happen. Tom Kahler said for the Scaffold Camp Acquisition #2 Project, the intent of voting "no" was to keep the action from moving forward and abstaining would not do this. Kirk Truscott agreed abstention might work if the Party does not want to side with one position or the other; however, with the Scaffold Camp Acquisition #2 Project, abstaining would not work. Underwood said unless the direction from policy is that this outcome is acceptable. Jim Brown agreed with Underwood that this is something to consider in order to preserve the opportunity for the HCP Policy Committees to gather outside a formal dispute.

Brown said this also illustrates the need for the HCP Policy Committees to meet more frequently, to build a regular rapport within the committees and perhaps help with scheduling meetings. Underwood agreed it makes sense to gather under conditions other than just a dispute.
Tracy Hillman also agreed and said projects where there may be policy concerns will most likely happen with protection projects; and typically, if the HCP Tributary Committees are interested in using the Plan Species Accounts for protection it means the resource is in imminent danger of being lost and action needs to be taken as soon as possible. Ferguson agreed and said if the HCP Policy Committees met more frequently in person, the committees could convene by conference call on short notice if needed to address a time-sensitive issue.

HCP Policy Committees representatives will each discuss with their respective HCP Tributary and Hatchery Committees representatives the option of abstaining in lieu of a disapproval vote to preserve a policy position.

B. Final Remarks (All)

The HCP Policy Committees representatives thanked each other for the productive discussions during today's meeting.

VI. HCP Administration

A. Next Steps (John Ferguson)

John Ferguson will coordinate with each HCP signatory about an optimal date, time, and location for an annual meeting of the HCP Policy Committees.

VII. List of Attachments

Attachment A List of Attendees

Attachment B Dispute Regarding Basis for Decision Making in the HCP Tributary Committees

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman	BioAnalysts
Alene Underwood*	Chelan PUD
Tom Kahler	Douglas PUD
Ritchie Graves†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jim Brown*	Washington Department of Fish and Wildlife
Steve Parker*	Yakama Nation
Kirk Truscott	Colville Confederated Tribes
Cody Desautel	Colville Confederated Tribes

Notes:
* Denotes HCP Policy Committees member or alternate
† Joined by phone

Habitat Conservation Plan
Wells, Rocky Reach, Rock Island Tributary Committees

MISSION: To fund and support sustainable, long-term, cost-effective projects that protect and restore Plan Species habitats and to foster partnerships with those that implement such projects.

Dispute Regarding Basis for Decision Making in the HCP Tributary Committees

June 10, 2019

Report from the Tributary Committees Chair

Wells, Rocky Reach, and Rock Island
Habitat Conservation Plans

TABLE OF CONTENTS

1 Introduction

The Yakama Nation has initiated the dispute resolution process as defined in Section 11 of the Anadromous Fish Agreement and Habitat Conservation Plans.[1] The dispute centers around the HCP Tributary Committees (HCP TCs) rejection of the Statement of Agreement (SOA) proffered by the Yakama Nation titled, *Basis for Decision Making in HCP Tributary Committees*. To be clear, the Yakama Nation is not disputing the HCP TCs decision to not fund the Scaffold Camp #2 Acquisition Project. This dispute is only about the HCP TCs rejection of the SOA. That said, I will provide some background beginning with the Scaffold Camp #2 Project, because the HCP TCs response to that project sets the stage for the disputed issue.

In December 2018, the HCP TCs evaluated an application from the Yakama Nation titled, *Scaffold Camp Acquisition #2 Project.* During the December meeting, all members except the Colville Confederated Tribes (CCT) supported the project. Even though all members (including the CCT) acknowledged the benefits of the project and believed the proposed property should be protected, the CCT representative was directed by the CCT Natural Resources Committee to vote "no" because the CCT Natural Resources Committee does not want the Yakama Nation owning land in the Upper Columbia (Wenatchee, Entiat, Methow, or Okanogan sub-basins).[2] Based on this outcome, during the December meeting, the Yakama Nation indicated they would dispute the HCP TCs decision. During the December meeting, the HCP TCs suggested ways to avoid a dispute (e.g., finding a different conservation-minded entity to own the land). Those suggestions were dismissed.

The Yakama Nation elected to not dispute the decision by the HCP TCs on the Scaffold Camp Acquisition #2 Project. Rather, in February 2019, the Yakama Nation offered a draft SOA titled, *Basis for Decision Making in HCP Tributary Committees,* which addresses the process and criteria by which the HCP TCs make funding decisions. The purpose of the SOA was to make sure all funding decisions made by the HCP TCs are based <u>only</u> on the merits of the project (biological benefit, technical merit, durability, feasibility, and cost effectiveness).[3] Any criteria having no direct nexus to Plan species, their habitat, or their management cannot be considered when evaluating proposed projects.[4] The SOA also noted that any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from voting. The Yakama Nation asked the HCP TCs to consider the draft SOA, make revisions/edits as necessary, and be prepared to vote on the SOA during the April meeting.

Because HCP TCs members provided no edits or revisions to the draft SOA, during the April meeting, I asked each member to vote on the SOA and provide justification for their vote. All members except the Yakama Nation voted "no" on the SOA. In general, most members voted "no" because they believed the SOA was not necessary (details of the reasons are found in the April meeting notes). The CCT said they

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[1] The dispute resolution process is described in Section 11 of all three (Rock Island, Rocky Reach, and Wells) Hydroelectric Project Anadromous Fish Agreement and Habitat Conservation Plans.

[2] During TCs meetings, the CCT also referred to the Upper Columbia as "CCT Territory."

[3] As noted in the Yakama Nation Issue Statement, these evaluation criteria are not new. Although they were not defined explicitly, they were included in the earliest draft of the HCP TCs Policies and Procedures for Funding Projects. As long as I have been with the HCP TCs, they have used these criteria to make funding decisions. The one exception was the Scaffold Camp #2 Acquisition Project; but even then, all members (including CCT) acknowledged the biological benefit associated with the project. For the CCT, the issue was land ownership.

[4] Importantly, the draft SOA goes beyond the issue between the CCT and the Yakama Nation. The SOA targets the fundamental basis by which the HCP TCs make funding decisions.

could not support any SOA that removes their right to not approve HCP TCs funding to the Yakama Nation to purchase property in the Upper Columbia.

During the process of evaluating the draft SOA, HCP TCs also reviewed and updated their project evaluation criteria. Although the Policies and Procedures for Funding Projects included general criteria (i.e., biological benefit, technical merit, durability, feasibility, and cost effectiveness), there were no specific definitions or evaluation metrics associated with the general criteria. During March and April 2019, the HCP TCs identified and approved specific criteria for each general criterion for restoration, protection, design, and assessment projects. It was in part because of these approved evaluation criteria that several members indicated that an SOA was unnecessary. The HCP TCs did not exclude other criteria from being included in the evaluation of projects. However, they included the following language:

> *During review of project proposals, the Committees will act in good faith and within the spirit of the collaborative nature of the HCPs to make project funding decisions and having a direct nexus to plan species, plan species habitat, or plan species management. Furthermore, consistent with Section 9 of the HCPs, voting members shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled. Importantly, as agreed to during HCP negotiations, funding decisions require unanimous approval of the Committees (as described in HCPs Section 7), affording each member discretionary rights when reviewing and voting on project proposals.*

This is a brief summary of the events leading up to the disputed issue. The remainder of this document includes more specific information that may be useful in resolving the dispute. I include the letter from the Yakama Nation indicating their desire to dispute the decision by the HCP TCs to not support the SOA; the Yakama Nation Issue Statement; the draft SOA, which is the focus of the dispute; excerpts from HCP TCs final meeting notes (I only included sections of the final notes that are relevant to the disputed issue); and the evaluation criteria that the HCP TCs approved in April 2019.

I am available to answer any questions the HCP Coordinating Committees or HCP Policy Committees may have regarding the disputed issue.

Tracy W. Hillman, Ph.D.
HCP TCs Chair

2 Yakama Nation Letter to Initiate Dispute Resolution

On May 23, 2019, the Yakama Nation submitted a letter to the HCP TCs Chair indicating that they are formally disputing the decision by the HCP TCs regarding the draft SOA titled, *Basis for Decision Making in HCP Tributary Committees*. Below is the letter from the Yakama Nation initiating the dispute resolution process.

Yakama Nation Fisheries

MEMORANDUM

Columbia River
Honor. Protect. Restore

OFFICE

PHONE

FAX

EMAIL

WEB

Date:	May 23, 2019
To:	Dr. Tracy Hillman, Chair Tributary Committee
cc:	Paul Ward, Manager, Yakama Nation Fisheries Lee Carlson, Tributary Committee Delegate Brandon Rogers, Tributary Committee Alternate
From:	Steve Parker, Technical Services Coordinator Yakama Nation Fisheries
Subject:	Tributary Committee dispute

The Yakama Nation herewith raises a dispute under Section 11 of the Rock Island HCP (and others by reference) regarding the project review procedures utilized by the Tributary Committee (TC) pursuant to Section 5 of *Tributary, Fund Policies and Procedures for Funding Projects, April 2017*. The dispute specifically concerns the rejection by the TC of a SOA offered at its April meeting which sought to affirm the scope of voting criteria given in Section 5 of the HCP. This action raises significant questions about the interpretation of voting criteria given in Section 5 that we feel need to be addressed outside of the TC membership. Bringing the issue through formal dispute resolution offers the best opportunity for a full exchange of views that we hope will lead to resolution.

Section 11.1.1 of the HCP is not entirely clear on the initial step of the dispute resolution process but it can be inferred that the Tributary Committee, presumably its Chair, submits the dispute to the Coordinating Committee for review. I request that you initiate that step upon receipt of this memo. To that end I have submitted an Issue Statement delineating the substance of the dispute that you are at liberty to distribute as appropriate.

Thank you for your assistance in advancing this matter.

3 Yakama Nation Issue Statement

Below is the Issue Statement, which attended the Initiation of Dispute Letter from the Yakama Nation.

ISSUE STATEMENT: Shall habitat project funding decisions by the Tributary Committee be required to demonstrate a nexus to Tributary Plan goals and objectives?

Background

The HCP Tributary Committee (TC) considered at its monthly December, 2018 meeting a funding proposal by the Yakama Nation to purchase a property in the Methow watershed for the purpose of fish habitat restoration. The TC members expressed support for the biological merit of the proposal but the representative for Colville Confederated Tribes indicated he was required by his policy leadership to reject any proposal by another tribe to acquire property in the Methow watershed. Operating procedures for the TC require consensus so funding for the proposed project was denied despite its biological merit.

Yakama Nation is appealing the decision on the basis that the CCT vote was politically-driven and unrelated to the voting criteria described in the TC operating procedures, *Policies and Procedures for Funding Projects*, *April 2017*. Section 5 of that document, entitled *Review Procedures*, states that, "The Committees will make funding decisions based on the above eligibility criteria, fund availability, and if necessary, the recommendations from technical advisors (discussed below). The Committees will use a more detailed review procedure for the General Salmon Habitat Program than for the Small Projects Program. *However, proposals to both programs will be evaluated for biological and technical merit, feasibility, durability, and cost-effectiveness.*" (emphasis added). While these voting criteria are general and allow broad discretion in the review of project proposals, they specifically do not include factors unrelated to the mitigation purpose of the Tributary Plan[5] or the TC's responsibility to implement it.[6] Yakama Nation proffered a SOA at the April TC meeting that would limit voting criteria to those explicitly described in Section 5 but the TC soundly rejected it.

Prospectus

The Yakama Nation is concerned that TC members apparently do not adhere to, by vote or action, the project review criteria agreed to in the HCPs and, hence, the FERC licenses. The converse of this failure to adhere to specific voting criteria is to conclude that the TC does not feel bound by *any* criteria in its project selection process. This is to say that any member can veto any project proposal for any reason without reason or recourse. The CCT vote is evidence of this and the TC's rejection of the SOA confirms it. To allow, and then endorse, voting criteria that lack any nexus to the mitigation purpose of the Tributary Plan risks the integrity of the Tributary Fund and the TC's fiduciary accountability for expenditures from it.

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[5] Sec 7.2 of the HCP describes the purpose of the Tributary Plan as "compensating for two percent of Unavoidable Project Mortality."

[6] Sec 7.3.1 creates and charges the TC with the task of implementing the Tributary Plan.

Perceptions about the nature of this dispute vary widely but seem to be clouded by the inter-tribal aspect of it. To be clear, this issue is fundamentally not an inter-tribal dispute, it is a deficiency in TC voting procedures. Below we attempt to clarify some of the confusion and misunderstanding reflected in statements from some parties about the basis for this dispute:

- This is an inter-tribal dispute best left to the tribes to sort out. The substance of this dispute arose from policy interference by CCT in TC voting procedure, but it became a dispute only when the TC failed to invalidate policy interference as a basis for voting. The procedural issue is TC's willingness to allow irrelevant and extraneous voting criteria into the funding decision. Accordingly, any TC member now can veto any proposal by any entity for any reason without explanation or consequence. This is an egregious violation of the intent of the Tributary Plan and the written funding review procedures the TC must follow to implement it.
- Why not allow another entity to hold title to properties? This would address the substance of this dispute but would not resolve the underlying procedural problem that could produce future disputes if the TC does not clarify and abide by a set of voting criteria.
- The TC has been working well for 18 years and does not need to review voting procedures. The TC has worked well because the members adhered to criteria nominally compliant with policies and procedures in the guidance to the TC. The dispute arose only when that guidance was ignored for reasons unrelated to the mitigation purposes of the Tributary Fund.
- The TC does not want to lose flexibility and discretion in selecting projects for funding. The Yakama Nation has no interest in narrowing the latitude and discretion currently available to the TC in the existing five project selection criteria. However, we believe that any member's voting position must have at least a colorable nexus to the purpose and objectives of the Tributary Plan. It is not in any member's interest to accept voting criteria that have no relevance to implementing the Tributary Plan. To do so invites gaming, positioning, and leveraging to become part of funding decisions and potentially exposes the TC to criticism from an objective public reviewer.[7]

Proposed Settlement

The source of this dispute is relatively simple and its solution is equally simple. The Yakama Nation alleges that members of the TC voting on the basis of any factor not linked to the habitat restoration goals of the Tributary Plan violates the intent and specific terms of the funding review guidance by which the TC implements the plan. Accordingly, the solution is for TC members to clarify by SOA that valid voting criteria must have a demonstrable nexus to the mitigation purpose of the Tributary Plan and Fund. We are open to developing such language jointly to ensure that TC members' concerns are addressed in a way that still upholds the intent of the guidance given in *Policies and Procedures for Funding Projects*.

[7] Section 2 of *Policies and Procedures* states, "The Committees may hold annual public workshops to review its (sic) funding policies and procedures (Section 6.8)."

4 Yakama Nation Draft SOA

On February 25, 2019, the Yakama Nation submitted the following draft SOA for HCP TCs review and approval. On April 11, 2019, the HCP TCs voted on the SOA. All members except the Yakama Nation voted "no" on the SOA.

Rocky Reach, Rock Island, and Wells HCP Tributary Committees
DRAFT Statement of Agreement

Basis for Decision Making in HCP Tributary Committees
February 25, 2019

Statement

The Rocky Reach, Rock Island, and Wells Habitat Conservation Plans (HCP) Tributary Committees (TCs) agree that mitigation funding decisions will be based exclusively on the merit of proposed projects (biological benefit, technical merit, feasibility, durability, and cost effectiveness) having a direct nexus to plan species, plan species habitat, or plan species management. Signatories agree not to base funding decisions on criteria other than project merit.

Background

The Wells, Rocky Reach, and Rock Island HCP Tributary Committees' Policies and Procedures for Funding Projects (January 10, 2019) describes the eligibility and review criteria for evaluating project funding decisions. Section 5 of that document specifies that project funding decisions are made on the basis of biological benefit, technical merit, feasibility, durability, and cost effectiveness. However, Section 5 does not explicitly disallow criteria unrelated to resource benefits to be introduced into decision-making. The purpose of this SOA is to clarify that the Tributary Committees intend that all funding or other decisions regarding how PUD mitigation is implemented will have a direct nexus to the expected benefits to a plan species or plan species habitat. Decision making by a signatory for reasons unrelated to mitigation benefits are not within the spirit or intent of the HCPs and will impede the operation of the Committees. Any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from 'voting'.

5 Excerpts from HCP TCs Notes

This section includes excerpts from HCP TCs final meeting notes that are relevant to the dispute. Excerpts include HCP TCs discussions associated with the Scaffold Camp #2 Acquisition Project and the draft SOA. I included discussions associated with the Scaffold Camp #2 Acquisition Project because, in part, it precipitated the need for the draft SOA.

5.1 Excerpts from the December 2018 Notes

Scaffold Camp Acquisition #2 Project

The Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Scaffold Camp Acquisition #2 Project*. The purpose of the project is to acquire and protect a 1.3-acre parcel of floodplain/riparian habitat at RM 15.7 on the Twisp River. This project, along with the already protected 13-acre adjacent parcel, will not only protect high quality habitat, but it will allow the enhancement of a side channel, which would provide biological benefit for HCP Plan Species. The total cost of the project is $104,950. The sponsor requested $94,500 from HCP Plan Species Account Funds. The Tributary Committees elected not to fund this project.

On a technical level, the Committees support protecting the 1.3 acres of floodplain and riparian habitat along the Twisp River. On a policy level, however, this project was not supported by CCT and therefore HCP Plan Species Account funds cannot be used by YN to acquire the property. In an effort to avoid the possibility of the current landowner selling the 1.3-acre parcel to someone who is not interested in the conservation value of the property, the Committees recommend that YN discuss the acquisition of the parcel with other conservation-minded entities such as the Methow Salmon Recovery Foundation, Methow Conservancy, WDFW, or CCT. The Committees would be able to provide funding to one of these entities if the entity is willing to hold the fee title for the parcel and coordinate enhancement work on the property with YN.

Following the funding decision on the proposed project, Brandon Rogers indicated YN will dispute the Tributary Committees' decision and elevate this issue to the HCP Coordinating Committees and HCP Policy Committees. In order to avoid a dispute, members asked Brandon whether YN would be willing to ask another conservation group to hold the fee title for the parcel. Brandon indicated that YN wants to hold the fee title. Members asked Brandon whether the policy representatives from YN and CCT could discuss and resolve this issue without going through the "formal" dispute resolution process. Brandon indicated this will not happen. He said YN will dispute the decision based on principle.

Tracy Hillman reviewed the HCP dispute resolution process with the Tributary Committees. He asked Brandon to provide him with an official letter from YN. He said the letter should include a brief description of the issue under dispute (Scaffold Camp Acquisition proposal), the reason for the dispute, and the reason why YN is disputing the Tributary Committees' decision to not fund the project. Tracy said the letter will provide the basis for initiating the dispute resolution process. Tracy said he will contact Dr. John Ferguson, Chair of the HCP CC and HCP PC, and inform him of the likely dispute. Tracy also asked Tributary Committees members to contact their HCP CC and HCP PC representatives and let them know that they will likely be dealing with a dispute.

5.2 Excerpts from the March 2019 Notes

Review of the Yakama Nation Draft SOA

On 25 February, YN submitted a draft Statement of Agreement (SOA) to the Committees for review (see Attachment 1). Brandon Rogers said the purpose of the draft SOA is to provide a basis for decision making in the HCPs Tributary Committees. He indicated the SOA is draft and asked members to review and discuss it, edit it as necessary, and vote on it during the April meeting. Justin Yeager asked what precipitated the need for an SOA on decision making. Brandon responded the "NO" vote on the Scaffold Camp Acquisition #2 Project and the fact that the Committees have no clearly defined criteria for evaluating project proposals. Chris Fisher stated CCT cannot support the draft SOA nor will they support an SOA that will take away their right to prevent the YN from owning land in the Upper Columbia River basin. Jeremy Cram noted the language in the draft SOA is too strong and would force the Committees to vote "YES" on any project that has biological benefit. He said it appears to take way the Committees ability to require cost shares, to save money for future projects, and to reject projects based on a sponsor's ability to implement the project. He added it places too much emphasis on cost-benefit relationships. Others agreed and said it takes away rights to reject projects based on criteria that may not be included in the draft SOA.

Tom Kahler reminded members that funding decisions require unanimous approval of the Committees (as described in HCPs), affording each member discretionary rights when reviewing and voting on project proposals. Tom provided examples within other HCP committees where parties have exercised this right and stated that Douglas PUD could not approve any agreement that would limit those discretionary rights. Furthermore, editing the draft SOA to preserve the discretionary voting rights of signatory parties would result in a very complicated document that would no longer fulfill the intent of YN in preparing the SOA. Catherine Willard pointed members to Section 9.4 of the Rock Island HCP, which states voting members "shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled."

Kate Terrell and Justin asked why an SOA is necessary. The Committees have made funding decisions and justified those decisions for several years. Brandon responded that without some side boards, the Committees can make decisions based on anything they want, and these decisions may have nothing to do with what is best for the resource. Catherine again reminded members of the language in the HCPs. Chris commented that except for the Scaffold Camp Acquisition Project (and a YN protection project that was submitted through the PRCC Habitat Subcommittee), he has always voted based on what he believes is best for the resource. He said he can do nothing about Tribal politics and the issues between CCT and YN cannot be resolved within the HCP Committees.

Kate asked, given that CCT cannot support an SOA that takes away their right to prevent the YN from owning land within the Methow River basin, what is YN trying to accomplish with the draft SOA? Brandon stated that the SOA is less about the issues between the tribes and more about how the Tributary Committees make funding decisions. To that end, YN wants clear, transparent criteria that focus funding decisions on what is best for the resource. Kate asked what if the SOA is not approved. Brandon said YN will consider disputing the decision and they are also evaluating other options.

Tracy Hillman reminded the Committees that they directed him to identify possible criteria for evaluating project proposals (see Attachment 2). He reviewed those criteria with the Committees and asked if these provide the clarity and transparency the Committees desire. He added that these could be appended to an SOA or added to the Committees' Policies and Procedures for Funding Projects document (Section 5). Tracy also noted that YN is not the only party who has requested evaluation criteria. Others have as well, and Tracy said the criteria will help him prepare responses to project sponsors. Members liked the idea of having transparent criteria and Kate noted that she used the criteria when evaluating the Eightmile Creek Fisheries Assessment Project. She said the criteria were very useful and were consistent with how she has evaluated projects in the past.

Members discussed the idea of updating Section 5 in the Policies and Procedures for Funding Projects. Some members believe this would eliminate the need for an SOA. Kate and Jeremy noted this would allow the Committees to review and update evaluation criteria annually or more frequently if necessary. Brandon said he will discuss this internally, but still wants the Committees to review and edit (if necessary) the draft SOA. He said the YN will ask for a vote on the draft SOA (or edited version) during the April meeting.

Members will review and edit, if necessary, the draft SOA and be prepared to discuss it and vote on it during the April meeting. In addition, Tracy will recast the evaluation criteria, so they fit within the Policies and Procedures for Funding Projects document.

5.3 Excerpts from the April 2019 Notes

Review of Yakama Nation Draft SOA

On 25 February, the Yakama Nation submitted a draft Statement of Agreement (SOA) to the Committees for review (see Attachment 2). During the March meeting of the Tributary Committees, Brandon Rogers said the purpose of the draft SOA is to provide a basis for decision making in the HCPs Tributary Committees. He indicated the SOA is draft and asked members to review and discuss it, edit it as necessary, and vote on it during the April meeting. Although members discussed the need (or no need) for an SOA during the March meeting, the Yakama Nation asked members to edit the draft SOA if necessary and be prepared to vote on it during the April meeting.

Tracy Hillman reported that he received no edits to the draft SOA. Therefore, he asked each member to vote on the draft SOA as written and provide their reasons for their yes or no vote. Members voted as follows:

- YN voted yes because there are no written rules for what criteria can and cannot be used to evaluate proposed projects. For example, a member can vote no on a proposed project based on criteria that have nothing to do with the project.
- NMFS voted no because they see no need for an SOA, and it does not address the issue between the tribes (between YN and CCT).
- CCT voted no because they cannot support an SOA that removes their right to prevent the Yakama Nation from owning property in the Upper Columbia.
- USFWS voted no because they see no need for an SOA. They believe the evaluation criteria developed for the Policies and Procedures document provide a sufficient foundation for evaluating project proposals.
- WDFW voted no because the SOA is too restrictive and other factors need to be evaluated in making funding decisions (e.g., competency of the project sponsor to implement the project, cost shares, etc.).

- CPUD voted no because they see no need for the SOA. They support the proposed evaluation criteria in the Policies and Procedures document.
- DPUD voted no because they see no need for the SOA and believe the evaluation criteria being developed are sufficient for evaluating proposed projects. In addition, they do not want members to lose their discretionary voting rights.

Tracy summarized the votes and reasons for the votes and asked the Yakama Nation if they intend to dispute the decision by the Tributary Committees. Brandon said they will discuss this internally and decide what they intend to do. Several members indicated that their organization's vote today will not change in the Coordinating Committee or Policy Committee. Thus, this issue is unlikely to be resolved in any of the HCP Committees. Tracy asked Brandon to let him (Tracy) know if the Yakama Nation needs guidance on initiating the dispute resolution process should they choose to dispute the Tributary Committees decision.

Chris Fisher reminded the group that except for the Scaffold Camp Acquisition #2 Project, the Committees have always made funding decisions based on the cost and biological merits of the proposed project. He said Tracy requires us to provide justification for our decisions. This gives Tracy and Becky the information they need to respond to project sponsor when sponsors question our funding decisions. Chris stated the issue with the Scaffold Project was a policy-level decision for which he had no control. He said policy-level intervention is not likely to change anytime soon.

Tracy thanked everyone for their candid and open discussion on the draft SOA.

6 Revised HCP TCs Evaluation Criteria

During the period when the HCP TCs were reviewing the Yakama Nation draft SOA, the HCP TCs were also reviewing and updating their criteria for evaluating restoration, protection, design, and assessment projects. Although the Yakama Nation SOA helped push the HCP TCs into updating their evaluation criteria, this was something the HCP TCs were considering before the review of the Yakama Nation SOA or the Scaffold Camp Acquisition #2 Project. Indeed, Chelan PUD asked the HCP TCs to provide more specific criteria for evaluating project proposals. The updated criteria are in Section 5 of the Tributary Committees Policies and Procedures for Funding Projects (April 12, 2019 version). For your convenience, I provided the updated and approved criteria below.

Review Procedures

The Committees will make funding decisions based on eligibility criteria (see Section 4), fund availability, and if necessary, the recommendations from technical advisors. During review of project proposals, the Committees will act in good faith and within the spirit of the collaborative nature of the HCPs to make project funding decisions and having a direct nexus to plan species, plan species habitat, or plan species management. Furthermore, consistent with Section 9 of the HCPs, voting members shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled. Importantly, as agreed to during HCP negotiations, funding decisions require unanimous approval of the Committees (as described in HCPs Section 7), affording each member discretionary rights when reviewing and voting on project proposals.

Project proposals will be evaluated based on general and specific criteria. Below we identify the general criteria, which are from the HCPs, and specific criteria, which are based on biological and technical merit, feasibility, durability, and cost-effectiveness. The Committees may also solicit reviews of project proposals from technical experts outside the Committees.

Committees will make funding decisions based on the above eligibility criteria, fund availability, and if necessary, the recommendations from technical advisors (discussed below). The Committees will use a more detailed review procedure for the General Salmon Habitat Program than for the Small Projects Program. However, proposals to both programs will be evaluated for biological and technical merit, feasibility, durability, and cost-effectiveness.

General Criteria

Project proposals will first be evaluated based on the following general criteria.

Target Species

Does the proposed project address HCP Plan Species (spring Chinook, summer/fall Chinook, coho, sockeye, and/or steelhead)?

Target Area

Is the proposed project located within the geographic scope of the HCPs (projects must be in the Columbia River watershed from Rock Island Dam tailrace to Chief Joseph Dam tailrace)?

Specific Criteria

Project proposals that address target species within the target area will be evaluated based on biological and technical merit, feasibility, durability, and cost-effectiveness. Separate criteria were established for restoration, protection, design, and assessment projects.

Restoration Projects

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration?[8]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Does the proposed project reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Does the proposed project address limiting life stages of Plan Species within the watershed or AU?

Is the proposed project sited within an important spawning/rearing area, or provides access to habitat that would function as important spawning/rearing habitat for Plan Species?

Does the proposed project increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Does the proposed project promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

How long will it take for the proposed project to achieve its intended response?

How long will the proposed project and its benefits persist?

Will the proposed project ameliorate the effects of climate change?

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[8] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the proposed project from being implemented?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

Protection Projects

Biological Benefit

Is the proposed project located within a priority assessment unit or area for protection? [9]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

To what extent does the proposed project protect high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?

What would be the anticipated loss in freshwater survival, capacity, spatial structure, and/or diversity of Plan Species at the project or reach scale if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of Plan Species at the project/reach scale)?

Technical Merit

How imminent is the threat of habitat degradation to the proposed land if the project is not implemented?

Will the landowner allow public access?

Will the landowner allow restoration actions?

Durability[10]

[9] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

[10] In Section 7 under Ownership of Assets, the HCPs state that "[a]ll real property purchased shall include permanent deed restrictions to assure protection and conservation of habitat."

Does the proposed project protect watershed processes or important high-quality habitat in perpetuity?

Are there any conditions regarding the protection of the property that could limit the existing high-quality habitat?

Will the proposed project help ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

Design Projects

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration? [11]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Will the proposed design lead to development of projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed design lead to development of projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed design sited within an important spawning/rearing area, or will provide access to habitat that would function as important spawning/rearing habitat for Plan Species?

If the design is implemented, will it increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

[11] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Is the proposed project sequenced properly?

Durability

Will the proposed design lead to development of projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

If the design is implemented, how long will it take for the proposed project to achieve its intended response?

If the design is implemented, how long will the proposed project and its benefits persist?

If the design is implemented, will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the design from being implemented?

Are there funding constraints that will prevent the design from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the designs?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

Assessment Projects

Biological Benefit

Is the proposed assessment located within a priority assessment unit or area? [12]

Is the proposed assessment sited within an important spawning/rearing area for Plan Species?

Will the proposed assessment lead to projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed assessment lead to projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed assessment sited within an important spawning/rearing area, or in an area that could function as important spawning/rearing habitat for Plan Species?

[12] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Durability

Will the proposed assessment lead to projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

Will the proposed assessment lead to projects that ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the assessment from being implemented?

Are there funding constraints that will prevent the assessment from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the assessment?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

All decisions on funding will be held in a closed executive session. The Committees reserve the right to hold closed sessions on other issues, when necessary. Project proposal presentations may be open to the public. All other meetings will be open by invitation only. The Committees may use the Mid-Columbia Forum[13] to inform stakeholders of the status of the Plan Species Account(s). Decisions by the Committees are final and not subject to review by any entity.

The Committees may sponsor workshops for all stakeholders to present the annual Plan activities and project selection policies and procedures. Successful project applicants may be asked to present the status of their projects during these workshops.

[13] The Mid-Columbia Forum is a meeting of the HCP Coordinating, Hatchery, and Tributary Committees with stakeholders, including the Confederated Tribes of the Umatilla Indian Reservation and American Rivers, who were involved in negotiating the HCPs but elected to not sign the HCPs. The purpose of the meeting is to provide stakeholders with a progress report on implementation, as well as give them an opportunity to ask questions of the Committee members.

Appendix E
List of Rocky Reach Habitat Conservation Plan Committees Members

Rocky Reach Mid-Columbia HCP Committees, 2019

Policy Committee

Name	Organization
John Ferguson (Chairman)	Anchor QEA, LLC
Randy Friedlander	Colville Confederated Tribes
Alene Underwood	Chelan PUD
Ritchie Graves	National Marine Fisheries Service
Jim Craig	U.S. Fish and Wildlife Service
Jim Brown	Washington Department of Fish and Wildlife
Steve Parker	Yakama Nation

Coordinating Committee

Name	Organization
John Ferguson (Chairman)	Anchor QEA, LLC
Kirk Truscott	Colville Confederated Tribes
Lance Keller	Chelan PUD
Scott Carlon	National Marine Fisheries Service
Jim Craig	U.S. Fish and Wildlife Service
Chad Jackson	Washington Department of Fish and Wildlife
Keely Murdoch	Yakama Nation

Hatchery Committee

Name	Organization
Tracy Hillman (Chairman)	BioAnalysts, Inc.
Kirk Truscott	Colville Confederated Tribes
Catherine Willard	Chelan PUD
Brett Farman	National Marine Fisheries Service
Matt Cooper	U.S. Fish and Wildlife Service
Mike Tonseth	Washington Department of Fish and Wildlife
Tom Scribner	Yakama Nation

Tributary Committee

Name	Organization
Tracy Hillman (Chairman)	BioAnalysts, Inc.
Chris Fisher	Colville Confederated Tribes
Catherine Willard	Chelan PUD
Justin Yeager	National Marine Fisheries Service
Kate Terrell	U.S. Fish and Wildlife Service
Jeremy Cram	Washington Department of Fish and Wildlife
Lee Carlson (Jan to Sep) Brandon Rogers (Sep to Dec)	Yakama Nation

Appendix F
Statements of Agreement for Habitat Conservation Plan Coordinating Committees

Final
Rock Island and Rocky Reach Habitat Conservation Plans
Coordinating Committees

Statement of Agreement

Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to three years

(Approved September 26, 2019)

Agreement Statement

The Rock Island and Rocky Reach HCP Coordinating Committees (CC) were presented data regarding the requirements of statistical survival models, tag technology, and life-history attributes for subyearling summer Chinook project survival studies in the Mid-Columbia, and agree that valid juvenile project survival measurements are not currently feasible. The CC agrees to maintain subyearling Chinook in Phase III (Additional Juvenile Studies) for three years (September 2022) at Rock Island and Rocky Reach and to continue to evaluate or monitor study design, tag technology, and life history information on a quarterly basis to better understand future survival study feasibility by 2022.

Background

Throughout the months of June through August, 2019, the HCP CCs were provided updates regarding key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history.

Current statistical survival models cannot calculate project survival as they are currently unable to address variable juvenile migration characteristics. Acoustic tag technology remains insufficient to conduct project survival studies required by the HCPs. Tag miniaturization resulting in smaller batteries and reduced battery life, although improving, are still insufficient for full project survival estimations, with tags still too large for small run of river subyearling Chinook originating from the Upper-Columbia sub-basins. These factors, in combination with unknown proportions of variable juvenile migration characteristics within the population remain impediments to project survival estimations for subyearling Chinook.

Final
Rocky Reach Habitat Conservation Plan
Coordinating Committees

Statement of Agreement

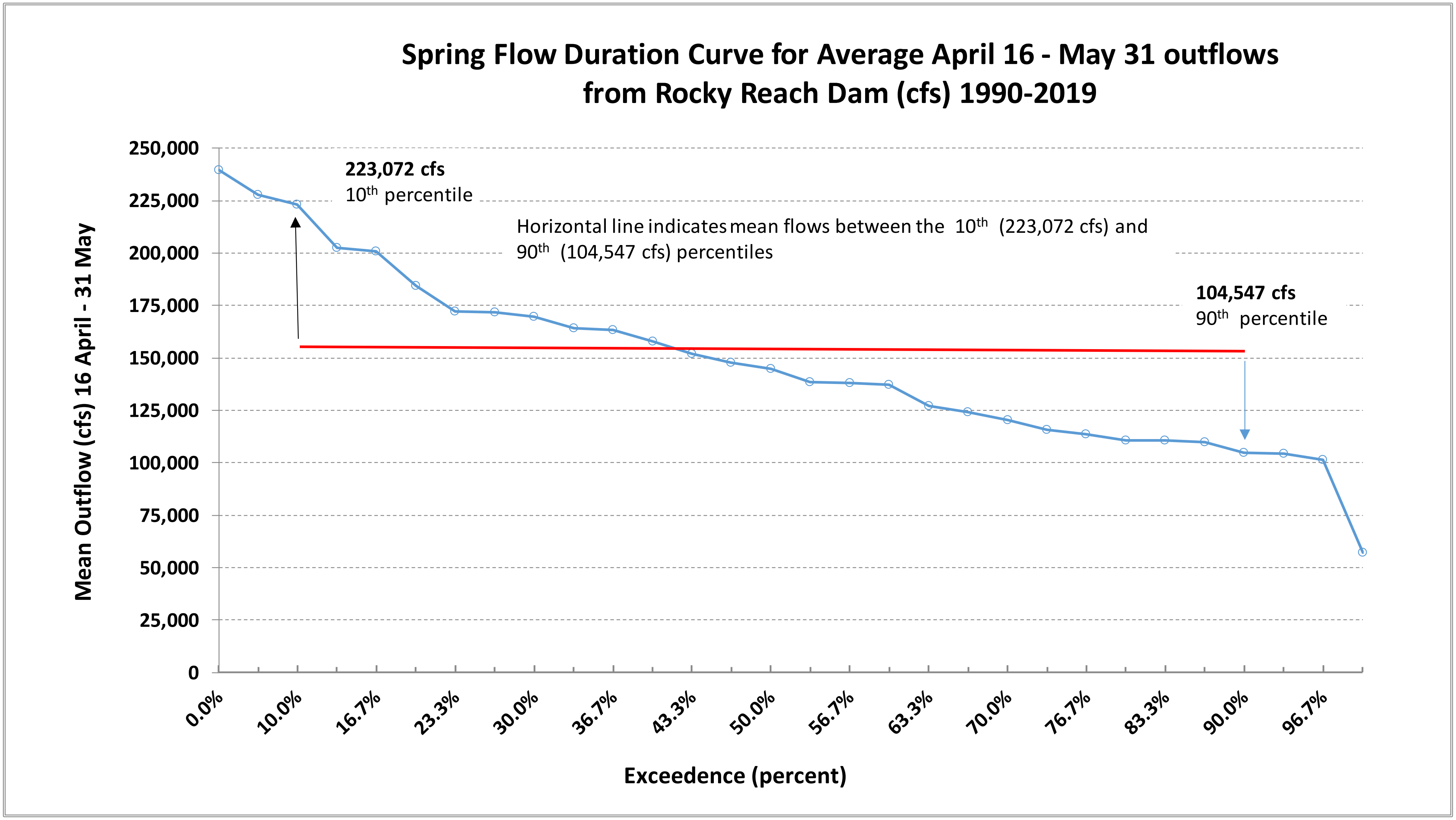
Updated Flow Duration Curves for the Rocky Reach Project for Establishing Representative Flow Conditions

(Approved December 17, 2019)

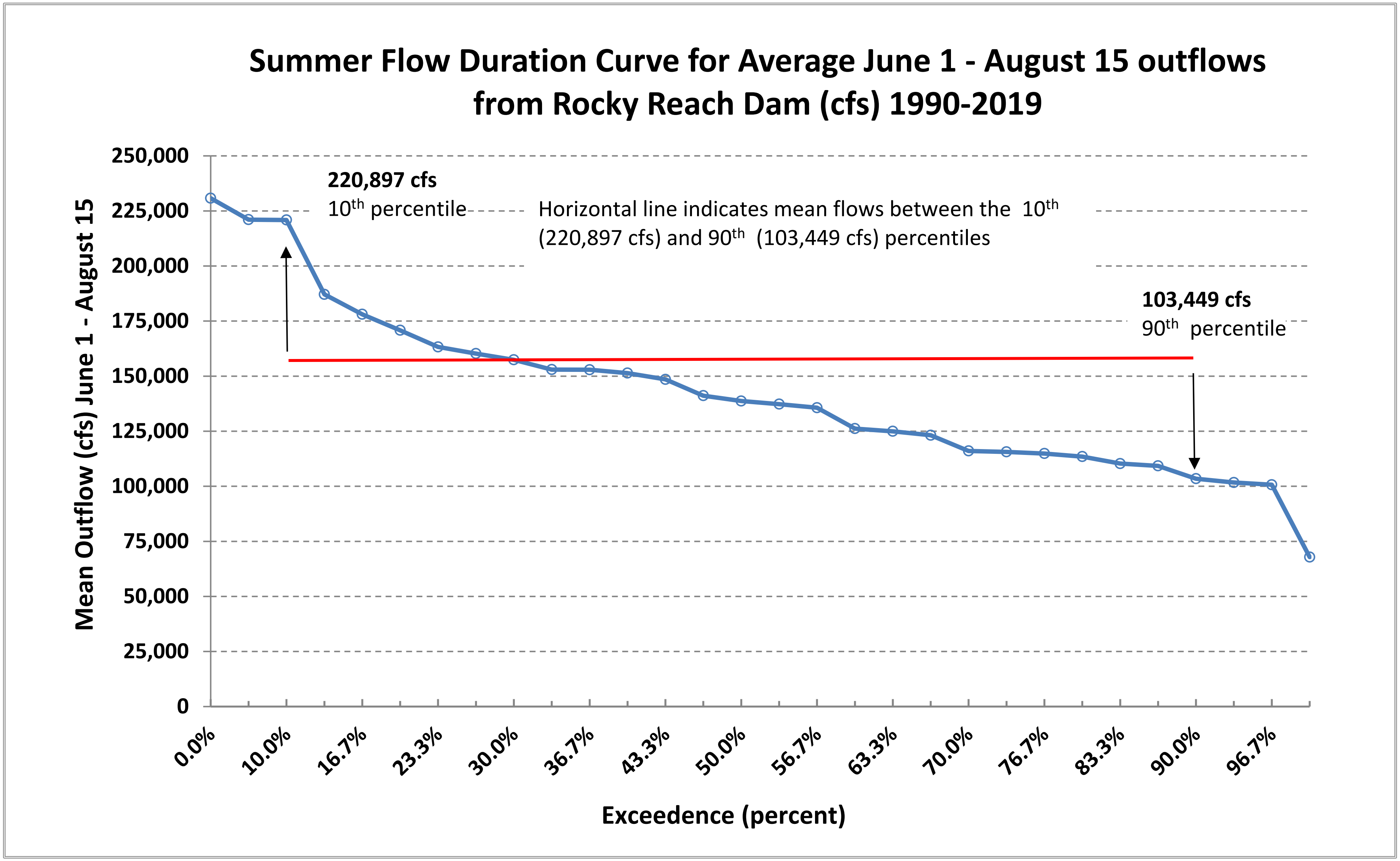
Agreement Statement
The Rocky Reach Coordinating Committee (Rocky Reach CC) approves the attached updated Flow Duration Curves for Spring (Attachment A) and Summer (Attachment B) Plan Species as the basis for determining whether survival study testing is conducted under Representative Flow Conditions at the Rocky Reach Project. In doing so, the Rocky Reach CC agrees to determine appropriate Flow Duration Curves on observed discharges from the Rocky Reach Project, rather than from Grand Coulee Dam as was done in years past. The Rocky Reach CC also agrees to include June in the Summer Flow Duration Curve, as reflected in Attachment B. The Rocky Reach CC also agrees to update the Flow Duration Curves using a rolling 30 year data set, with these updated Duration Curves encompassing data from 1990 through 2019 as Attachments A and B. Future updates will be conducted every 10 years hereafter by incorporating the most recent 10 years of data while excluding the oldest 10 years of data.

Background
Section 5.2.3 Of the Rocky Reach HCP describes methodologies for measuring survival of Plan Species, including the specification that studies "took place during Representative Flow Conditions" The Rocky Reach HCP defines Representative Flow Conditions with Flow Duration Curves for both spring and summer emigration periods. The original Flow Duration Curves were derived from Grand Coulee discharge data, incorporating measured data from 1983-2001, and modeled data from 1929-1978. Section 13.24 of the Rocky Reach HCP indicates that "Starting as part of the 2013 comprehensive review, and every ten years thereafter, the Coordinating Committee shall update the flow duration curve and the river flow amounts contained in this definition." Utilizing project specific data versus Grand Coulee Dam, as well as a rolling 30 year dataset, allows Representative Flow Conditions to account for localized dynamic freshet timing and influence by regional tributaries, as well as any changes in Columbia River operations. Additionally, adding the month of June to the Summer Flow Duration Curve more accurately reflects the Representative Flow Conditions that would occur in a subyearling Chinook survival study.

Attachment A



Attachment B



Appendix G
Statements of Agreement for Habitat Conservation Plan Hatchery Committees

Rock Island and Rocky Reach HCP Hatchery Committees
Final Statement of Agreement
Annual Broodstock Collection Protocols

Approved as follows: Chelan PUD, WDFW, USFWS, NMFS, YN and CCT approved on September 18, 2019

In fulfillment of requirements of existing and forthcoming Endangered Species Act permits for the Rock Island and Rocky Reach Habitat Conservation Plan (HCP) Hatchery Programs, the Rock Island and Rocky Reach HCP Hatchery Committees (HCP-HCs) agree to develop and submit to the National Marine Fisheries Service (NMFS) annual Broodstock Collection Protocols each year by April 15. The purpose of this agreement is to provide an annual schedule that allows for adequate discussion and review of plans prior to approval of the protocols.

Process and Schedule: The Permit Holders will prepare a draft Broodstock Collection Protocol for review by the Rock Island and Rocky Reach HCP-HCs no later than 10 days prior to their respective February meetings. Following Committees review and revision, a final Broodstock Collection Protocols will be subject to approval at the March HCP-HCs meetings and submitted to NMFS by April 15. The HCP-HCs will reevaluate this schedule in August 2020 and determine if changes are necessary.

Timeline:

- September HCP-HC meetings: Initial flagging/introduction of major changes/deviations/issues to existing programs/methods/schedules/etc. to the respective committee(s). Individual assignments outlined.
- No later than November 15: Individual BSP assignments due.
- December HCP-HC meetings: Finalization of discussions/agreements relating to major changes proposed in September by the respective committee(s).
- No later than January 10: Internal permit holders draft circulation for review
- No later than 10 days prior to the respective committee(s) February meetings: First draft circulation of Broodstock Collection Protocols for committee representative review/commenting.
- March Rock Island and Rocky Reach HCP-HC committee meetings: Approval of final annual Broodstock Collection Protocols
- No later than April 15: Submission of final approved annual Broodstock Collection Protocols to NMFS and USFWS.

NMFS/USFWS Approval: Participation in the development, submission, and approval of the annual Broodstock Collection Protocols within the Committees by the NMFS/USFWS HCP-HC representatives will constitute NMFS/USFWS acceptance and approval of the annual Broodstock Collection Protocols.

Appendix H
2019 Rock Island and Rocky Reach HCP Action Plan

2019 Rocky Reach and Rock Island
HCP Action Plan

COORDINATING COMMITTEE

		Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
Deliver 2018 RR Bypass Evaluation Report				D				F																												
Deliver 2019 RR Bypass Operations Plan				D					F																											
Deliver 2018 RI Bypass Evaluation Report				D					F																											
Deliver 2019 RI Bypass Operations Plan				D				F																												
Update HCP CC on RR Unit Repairs																																				
Update HCP CC on RI PH1 B1-B4 Unit Repairs																																				
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring										S																										C
Deliver 2019 RR/RI Spill Plan							D			F																										
Deliver 2019 RR/RI Spill Report																										D			F							
RR 9% Summer Spill																S							C													
RI 10% Spring Spill											S												C													
RI 20% Summer Spill																S							C													
RR Juvenile Fish Bypass Operations										S														C												
RI Juvenile Bypass Trap Operations										S														C												
2018 HCP Annual Report							D			F																										

HATCHERY COMMITTEE

		Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
2018 Hatchery M & E Report																	D								F											
2020 Hatchery M & E Implementation Plan																						D						F								
Broodstock Collection Protocols	S										C																									
Dryden Water Quality Monitoring (Year 8)								S																			C									
Chelan Falls Broodstock Collection-Pilot Seining and Temporary Weir																				S							C									
Chelan Hatchery Rehabilitation Engineering Feasibility	D																																			
Chiwawa Weir Maintenance Engineering Permitting	D																																			
Eastbank Well Generator Installation									C																											
Pilot Outplant adult MetComp spr Chinook to Chewuch																							S				C									
Steelhead Residualism Plan - *Permit No. 18583*	D																																			
Implement Year 2 of 3 of the Steelhead Release Plan to inform the Steelhead Residualism Plan					S													C																		
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							
Receive Unlisted Permit (Wenatchee and Chelan Falls summer Chinook)	D																								C											

TRIBUTARY COMMITTEE

		Jan 2019			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
RR and RI Plan Species Account Annual Deposit			C																																	
General Salmon Fund Approval	→ Ongoing																																			
General Salmon Fund Implementation	→ Ongoing																																			
Small Project Review and Approval	→ Ongoing																																			
Small Project Implementation	→ Ongoing																																			

D = Draft Document
F = Final Document

S = Start Project
C = Complete Project

Appendix I
2019 Rocky Reach Juvenile Fish Bypass System Operations Plan

2019 Rocky Reach Juvenile Fish Bypass System Operations Plan

Final Plan

Prepared By:

Lance Keller
&
Scott Hopkins

Public Utility District No. 1 of Chelan County
P.O. Box 1231
327 North Wenatchee Avenue
Wenatchee, Washington 98801

January 2019

Introduction

The Public Utility District of Chelan County (District) constructed and installed a permanent fish bypass system (FBS) in 2002/2003. The bypass system is designed to guide juvenile salmon and steelhead away from turbine intakes at Rocky Reach Dam. The system consists of one surface collector entrance (SC) and the intake screen (IS) system in turbine units 1 and 2. Please refer to Mosey (2004) for a detailed description of the bypass production system.

Studies and data collection at the Rocky Reach FBS fall under one of two general categories "Standard Operations" or "Special Operations" for bypass evaluations. Activities and data collection under standard operations include day to day sampling of run-of-river (ROR) fish to evaluate run timing, species composition, and fish condition after passage. Special operations may include additional sampling time to supply fish for marked fish releases.

2019 Evaluation Requirements

Run-of-river fish collected at the Juvenile Sampling Facility (JSF) are used to evaluate and provide fish for the following:

1. Run timing of target species:
    a. Provide standardized juvenile capture rate data to supplement Program RealTime (UW) run-timing predictions
    b. Guide decisions about initiating summer fish spill

2. Fish species composition:
    a. Guide decisions about starting or stopping spill
        i. Currently summer fish spill occurs at Rocky Reach (9% of the daily average river flow).

3. Origin of fish stock:
    a. Fin clips/marks

4. Interrogate for tags:
    a. PIT tags
    b. Acoustic tags (sutures)

5. Fish condition:
    a. Ensure that the bypass system remains safe for migrating juvenile salmon and steelhead by evaluating:
        i. Descale: 20% or more scale loss on either side
        ii. Injury: Scratches, bruises, or hemorrhages
        iii. Mortality: Any fish dead on arrival to sampling facility

2019 Study Methods

For more information about the study methods please refer to Mosey (2004).

Standard Operations:

1. Sampling Periods (1 April to 31 August):
    a. Monday through Sunday
    b. Collections Times
        i. 30 minute maximum **(or)**
            i. 0800-0830
            ii. 0900-0930
            iii. 1000-1030
            iv. 1100-1130
        ii. Target number of fish
            i. 350 spring species
            ii. 125 summer species
2. Fish Length:
    a. Up to 100 fish of each species will be measured for fork length (mm).

3. Fish Condition:
    a. All fish of each species are examined for condition:
        i. Descale
        ii. Injury
        iii. Mortality

4. Species Composition:
    a. ROR fish collected are enumerated by species
    b. Collect data for Program RealTime to determine start and end of spill
    c. Currently summer fish spill occurs at Rocky Reach

5. Origin of fish stocks and identification of marked individuals:
    a. PIT tags
    b. Fin clips

Special Operations:

1. Marked Fish Releases (Prior 1 April):
    a. Prior to the 1 April system start-up, hatchery yearling Chinook from East Bank Hatchery will be used for marked fish releases to determine if the JFBS is causing descale, injury, or mortality.
        i. Releases will be conducted with hatchery summer Chinook prior to the 1 April start date to determine if the JFBS is working properly and to help isolate potential sources of descale, injury, and mortality.
        ii. Fish (n = 100/release) of varying sizes will be randomly selected from hatchery Chinook. Only those with no scale loss or injury will be marked.
        iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system and into the intake screens in C2.
        iv. If potential problems are identified, resolve problems by 1 April system start-up.

2. Marked Fish Releases (1 April to 31 August):
    a. A phased approach will be used to evaluate the descaling rate, injury rate, and mortality rate of fish passing through the bypass system. We developed a sampling protocol and threshold percentages (Table 1) for descale, injury, and mortality that will trigger study phases.
    b. Identify "ambient" rates of descale, injury, and mortality.
    c. Once the ambient rate is estimated and if further sampling shows descale problems continuing at 5%, (3% for injury, 2% for mortality) <u>*above*</u> ambient level for three consecutive samples.
        i. If variable rates of descale, injury, or mortality do occur between species, then collection of yearling chinook, sockeye, or steelhead may be necessary for marked releases.
        ii. Fish (n = 100/release) of varying sizes will be randomly selected at the juvenile facility and only those migrants with no scale loss or injury will be marked.
        iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system until the problem area is isolated.
    d. Identify circumstances when we would refer to the HCP Coordinating Committee.
    e. The District will consult with the Coordinating Committee if any abnormal fish conditions (within values outlined in Table 1) are observed in the sample population.

Table 1. Flow diagram of phased approach and threshold values for conducting marked-fish releases in the juvenile bypass system at Rocky Reach Dam *(Skalski and Townsend 2003)*

	Phase 1		Phase 2		Phase 3		Phase 4
Threshold		**5% initl**		**A*+5%**		**A*+15%**	
Descale	Index sampling for for descale rate	→	Mark-releases to est. ambient descale	→	In-system mark-releases to isolate descale problem	→	refer to HCP Coord. Comm.
Threshold		**3% initl**		**A*+3%**		**A*+10%**	
Injury	Index sampling for for inury rate	→	Mark-releases to est. ambient injury	→	In-system mark-releases to isolate injury problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.
Threshold		**2% initl**		**A*+2%**		**A*+4%**	
Mortality	Index sampling for for mortality rate	→	Mark-releases to est ambient mortality	→	In-system mark-releases to isolate mortality problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.

A* = Ambient percentage

3. Collection of Bull Trout:
    a. Document:
        i. Fork Length and weight measurements
        ii. Condition (descale, injury, or mortality)
        iii. Interrogate for PIT tags
        iv. Examine for fin clips/marks
    b. Allow to recover, then release

Daily Protocol for Fish Collection

Standard Operations:

1. Deploy sampling screen at beginning of each hour (0800, 0900, 1000, 1100 hours).
2. Use direct enumeration to count fish entering the sampling facility
3. Collect for 30 minutes **or** until approximately 350 spring migrants/125 summer migrants have been collected, whichever comes first. RETRACT SCREEN IF 200 TO 300 FISH ARE COLLECTED IN FIRST TWO MINUTES.
4. Retract screen when time period or target number of fish has been reached.
5. Determine species composition of all collected fish in the hourly sample.
6. Scan/examine each fish for PIT tags, fin clips, and acoustic tags.
7. Evaluate fish length (first 100 fish per species) and condition (all fish).
8. If needed, collect and hold fish for marked releases (Special Operations).
9. Return to step 1 for next sample period. After the 1100 hour sample, go to step 11.
10. See Special Operations (if applicable).
11. Allow anesthetized fish (examined for species composition and fish condition) to recover in the facility's holding tank for at least 1.5 hours.

Special Operations:

1. If fish are collected for marked fish releases, verify that the required number of target species has been set aside from the four sample periods.
2. If the required number of fish are not collected by the 1100 hour sample period, deploy the sampling screen and repeat steps 2 and 4 under standard operations.
3. Scan/check all anesthetized fish for PIT and acoustic tags.
4. Collect and hold fish at the facility for transport and/or marking (marked fish releases).
5. Determine species composition for any remaining anesthetized fish and scan for PIT tags.
6. After fish have been collected to meet study needs, estimate the number of fish remaining in the raceway (by species to the extent practical), record the number, and immediately release the fish back into the bypass pipe.
7. Return to step 11 under Standard Operations.

Contingencies:

1. If, after start-up of the bypass system, we encounter any unforeseen problem(s) with fish collection, we will immediately consult with the HCP Coordinating Committee on how to correct the problem(s).
2. If we accumulate many fish during a collection period (e.g. just after a hatchery release), we will only handle/sample the number of fish needed to satisfy the study requirements and then immediately release the remaining fish back into the bypass pipe.

Alternative Operations Due to Unit 1 Outage

Unit 1 is expected to be inoperable for the majority of the 2019 RR FBS season to address trunnion bushing issues. With Unit 1 inoperable, the surface collector will utilize three additional pumps to increase the attraction flow at the entrances from 6,000 cfs to 6,660 cfs (3,330 cfs per entrance). The soft-limit set point for Unit 2 operation will be increased from 12.2 kcfs to 15.2 kcfs. These operations were implemented in 2018, and no negative effects to fish collection or fish health were observed.

Diversion Screen and Trashrack Cleaning (Unit 2):

During the last week of March, the trashracks in front of Unit 2 (three intakes total) will be cleaned by divers and clammed to remove any dislodged debris. The trash rack cleaning will be repeated as differentials increase across the racks due to debris load. A mid-season cleaning will be scheduled in June. Starting 1 April, the vertical barrier and diversion screens (IS system) will be cleaned one to two times per week or as needed with an automated screen cleaner. Careful observation of trash build up will also be monitored and the screens will be cleaned on a more regular basis if warranted. Frequency of the cleanings may increase depending on debris load during spring run-off and aquatic plant load in the summer. The District will log each screen cleaning, and in the event of high descaling/injury in a single sample, the vertical barrier and diversion screens will be inspected prior to releasing marked fish.

Discussion

The 2019 biological studies at Rocky Reach will encompass the following: 1) a continuing evaluation of the juvenile bypass system, and 2) a daily sampling program to monitor fish passage for run timing. Representatives of various research agencies and the HCP Coordinating Committee will be consulted about the development of detailed study plans and protocols. A time line showing important activities and deadlines for these activities has been developed and is presented in Table 2.

Table 2. Tasks and deadlines for the Rocky Reach 2019 biological evaluations.

Task	Deadline
Present 2019 study plan to Committee	**Winter 2018-2019**
Committee discussion/comments on study plan	**Jan. 31, 2019-Mar. 26, 2019**
Pre-season JFB operations testing (marked fish releases prior to 1 April)	March 18, 2019-March 31, 2019
Begin biological evaluation of JFB	April 1, 2019
Complete 2019 biological evaluation	August 31, 2019
Present 2019 evaluation report to Committee	**December 31, 2019**
Committee comments on 2019 report	**February 1, 2019**
Present 2019 report to Committee	March 1, 2019

****Tasks printed in bold text require action by the HCP Coordinating Committee.**

References

Mosey, T. R., S. L. Hemstrom, and J. R. Skalski. 2004. Study Plan for the Biological Evaluation for the Rocky Reach Fish Bypass System-2004. Chelan County Public Utility District, Wenatchee, Washington.

Skalski, J. R., and R. L. Townsend. 2003. Protocol for conducting marked-releases in the bypass system at Rocky Reach Dam. Prepared for Chuck Peven and Thad Mosey, Chelan County Public Utility District. Columbia Basin Research School of Aquatic and Fishery Sciences, University of Washington.

Appendix J
2019 Rocky Reach and Rock Island Fish Spill Plan

2019 Fish Spill Plan

Rock Island and Rocky Reach Dams

Public Utility District No. 1 of Chelan County

Prepared By:

Thad Mosey
Fisheries Biologist

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

Final

February 8, 2019

Introduction and Summary

In 2019, Public Utility No. 1 of Chelan County (Chelan PUD) will implement spill operations for fish passage at the Rock Island and Rocky Reach and projects. Spill timing and spill percentages are specified by the anadromous Habitat Conservation Plans (HCP) for each respective project. Chelan PUD conducted juvenile project survival studies from 2002 through 2011 at Rocky Reach and Rock Island under varying spill levels in order to achieve HCP survival standards. The Rock Island Project completed multiple survival studies over a nine year period (17 total studies) for spring migrating Plan Species (yearling Chinook, steelhead, sockeye), first using a 20 percent spill level, then a 10 percent spill level. Rock Island will continue to spill 10 percent of day average flow during the spring outmigration period through at least year 2021. The Rocky Reach Project completed its suite of HCP survival studies for spring migrating Plan Species in 2011 (14 studies), under spill and no-spill operation at the dam. HCP juvenile survival standards were achieved for species tested with a no spill operation (yearling Chinook, steelhead, sockeye). Project spill levels are summarized in Tables 2 and 4 of this plan. Chelan PUD holds valid Incidental Take Statements (ITS) from National Oceanic and Atmospheric Administration Fisheries (NOAA) and the United States Fish and Wildlife Service (USFWS) for HCP fish spill operations at Rocky Reach and Rock Island dams.

For the 2019 juvenile outmigration, Chelan PUD will operate the Rocky Reach juvenile fish bypass system (JFBS) starting 1 April for the spring juvenile outmigration of yearling Chinook, steelhead, and sockeye. Spring spill at Rocky Reach Dam will consist of hydraulic spill for reservoir control only. HCP Project survival standards were achieved with bypass-only operations. During the subyearling Chinook outmigration in 2019, Rocky Reach will spill 9 percent of day average river flow for a duration covering 95 percent of subyearling outmigration past the dam.

At Rock Island Dam in 2019, Chelan PUD will operate the Project with a 10 percent day-average spill level for the spring outmigration period. Rock Island has also completed HCP spring Plan Species survival testing for all Plan Species with a 10 percent spill level at the dam and has achieved juvenile survival standards for yearling Chinook, steelhead and sockeye and combined adult-juvenile survival for all three species.

During the summer period in 2019, Rock Island Dam will spill 20 percent of the day-average river flow for the outmigration of subyearling (summer) Chinook. Spill is the primary means of juvenile salmon and steelhead passage at Rock Island per Section 5.4.1(a) of the Rock Island HCP. Spring and summer spill will cover 95 percent of the juvenile fish outmigration for yearling/subyearling Chinook, steelhead, and sockeye in 2019.

Rocky Reach Juvenile Fish Bypass Operations

Rocky Reach will operate its JFBS continuously through the spring outmigration period, beginning 1 April 2019. Daily index sampling (for steelhead, yearling Chinook, and sockeye) will be performed at the bypass sampling facility to estimate the outmigration percentiles for each species through the spring period. During "index sampling" each day, a total of four 30-minute samples (Table 1) will be taken beginning at the top of each hour, 0800 to 1100 hours. Spring spill for fish passage is not required at Rocky Reach, but periods of forced spill may occur under high river flows. Some level of forced spill (river flow above 201 kcfs turbine capacity) normally occurs at Rocky Reach in the spring. Over the past 20 years, forced spill has occurred approximately 28 percent of all hours, April through June. With the projected repair/rehabilitation work on turbine units 1 and 9 this summer, instances of forced spill may occur more frequently in late spring/early summer 2019 due to reduced turbine or powerhouse capacity.

Sampling protocols at the Rocky Reach bypass system in 2019 will remain consistent with those used in 2004-2018. Daily sampling in spring and summer periods (Monday through Sunday) will use four 30-minute "index periods" at 0800, 0900, 1000, and 1100 hours (Table 1). The sample target for each 30-minute sample will be 350 smolts during the spring period (yearling Chinook, steelhead, and sockeye combined), and 125 smolts for summer period (subyearling Chinook). If the number of fish collected in the bypass sampling raceway is estimated to reach the maximum number prior to completion of the 30-minute sample, the sampling screen will be retracted from the bypass conduit, and the number of fish collected in the shortened sample period will be proportionately expanded to the entire 30-minute period.

Table 1. Index sampling times at the Rocky Reach juvenile fish bypass and the number of smolts per sample. Sample times and sample targets have remained consistent since 2004.

Time	Sample Duration	Number of Smolts	Day of Week
08:00-08:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
09:00-09:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
10:00-10:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
11:00-11:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday

*Sample duration may be less than 30 minutes if smolt numbers are met prior to full 30-minute sample time

Rocky Reach 2019 Summer Spill Operations

Rocky Reach Dam will spill 9 percent of the estimated day average river flow for the subyearling Chinook outmigration (Table 2). Spill will commence in late May to early June upon arrival of subyearling Chinook smolts in the Rocky Reach bypass samples. Juvenile run-timing information at Rocky Reach will be used to estimate subyearling Chinook passage percentiles (from the University of Washington's Program RealTime run forecaster) and guide spill operations to cover 95 percent of the summer outmigration. Actual subyearling counts in combination with juvenile passage estimates from the University of Washington's Program RealTime run forecaster will determine start and stop dates for the summer spill program.

The HCP guidelines for starting and ending summer spill at Rocky Reach are as follows:

1. Summer spill will start at midnight no later than the day on which the estimated 1-percentile passage point is reached, as indicated by Program RealTime run-forecast model. Subyearling Chinook will be defined as any Chinook having a fork length from 76 to 150 mm.

2. Summer spill season will generally end no later than 15 August, but not until subyearling index counts from the juvenile bypass sampling facility are 0.3 percent or less of the cumulative run for three out of any five consecutive days (same protocol used 2004-2017) and Program RealTime is estimating that the 95th percentile passage point has been reached. In addition, spill operations must cover at least 95% of the subyearling outmigration

Diel Spill Shaping at Rocky Reach and Rock Island Dams

Daily spill volumes will be shaped within each 24-hour period at Rocky Reach Dam during the summer spill period, and at Rock Island Dam during both spring and summer spill periods (Tables 2 and 4).

Spill-shaping attempts to optimize spill water volume to maximize spill passage effectiveness for smolts. The diel spill shape functions to provide either higher or lower spill volume during periods of either higher or lower fish passage. Spill-shaping is based on the observed diel (24-hour) passage distributions of smolts at each project during spring and summer (Steig et al. 2009, Steig et al. 2010, Skalski et al. 2008, Skalski et al. 2010, Skalski et al. 2011, Skalski et al. 2012). The different spill percentages and time blocks are shaped such that the summation of water volume from all time blocks within the day equals the volume of water that would have been spilled under a constant, unshaped spill level (i.e. spill at 9 percent day-average river flow at Rocky Reach with no shaping). The hourly spill shape in 2019 will remain consistent with previous years, 2004-2018. Spill gates 2 through 8 will be used to meet daily spill percentage targets.

Table 2. Fish spill percentages and spill shape for the Rocky Reach spill program, 2019.

Project	Season	Daily Spill Average	Within-Day Spill Levels	Duration (# of hours each day)	Hourly Blocks of Spill	Spill Shape %
Rocky Reach	Spring	none	--	--	--	--
Rocky Reach	Summer*	9%	Med	1	0000-0100	9.0
			Low	6	0100-0700	6.0
			Med	2	0700-0900	9.0
			High	6	0900-1500	12.0
			Med	9	1500-2400	9.0

*Spill for subyearling Chinook

2019 Run-Timing Predictions

Chelan PUD contracts with the University of Washington (UW) to provide run-timing predictions and year-end observed values for spring and summer out-migrating percentiles for salmon and steelhead. UW's Program RealTime run-time forecasting model is used for this purpose. Program Real-Time provides daily forecasts and cumulative passage percentiles for steelhead, yearling/subyearling Chinook and sockeye at both Rocky Reach and Rock Island dams. This program enables Chelan PUD to better predict the time when a selected percentage of these species will arrive, and when a given percentage of any stock has passed. The program utilizes daily fish counts from the Rocky Reach bypass sampling facility and the juvenile fish bypass trap at Rock Island Dam. Estimates of passage percentiles are generated with the model's forecast error and are displayed with the daily predictions at:

http://www.cbr.washington.edu/crisprt/

Historic Run Timing

Estimated mean passage dates (first percentile to the 95th percentile) for each species at Rocky Reach and Rock Island dams are summarized in Table 3. Run-timing dates are estimated from daily index sample counts at the Rocky Reach JFBS (2004-2018), and from the Rock Island bypass trap, (2002-2018). At Rocky Reach Dam, the subyearling Chinook run generally begins the last week of May, with the one-percentile passage date on 30 May (mean date for years 2004-2018). Rocky Reach subyearling passage reaches the 95th percentile, on average, around 7 August (2004-2018, range: 21 July to 24 August).

Rock Island Dam juvenile salmon and steelhead sampling from the Smolt Monitoring Program (SMP; 2002-2018) indicates that the first percentile (one-percent passage) mean passage date for combined spring migrants (yearling Chinook, steelhead, and sockeye) occurs around 18 April (Table 3). The latest start date for spring spill at Rock Island Dam per the HCP is 17 April. The summer outmigration of subyearling Chinook smolts at Rock Island Dam generally begins in early June (although fry are encountered earlier), and on average, reaches the 95th percentile passage point around 6 August (range: 22 July to 19 August, 2002-2018).

Table 3. Spill percentages, bypass operation dates, and mean passage percentile dates (2002-2018) for the 1st and 95th percentile passage points for HCP spring and summer outmigrants at Rocky Reach and Rock Island dams.

Rocky Reach	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	0% Spring	0% Spring	0% Spring	9% Summer
1st, 95th percentile Passage Dates	4/15, 5/31	4/15, 5/27	5/4, 5/23	5/30, 8/7
RR Bypass System Operation	4/1 – 8/31	4/1 – 8/31	4/1 – 8/31	4/1 – 8/31
Rock Island	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	10% Spring	10% Spring	10% Spring	20% Summer
1st, 95th percentile Passage Dates	4/22, 6/7	4/15, 5/31	4/16, 6/4	6/2, 8/6
RI Bypass Trap Operation	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31

Source - Rock Island: http://www.cbr.washington.edu/crisprt/index_midcol2_pi.html
Source- Rocky Reach: http://www.cbr.washington.edu/crisprt/index_midcol2_che.html

Rock Island 2019 Spring Spill Operations

In 2019, Rock Island Dam will spill 10 percent of the estimated day average river flow starting no later than 17 April and will end spill after 95 percent of spring outmigrants have passed the dam (usually the first week of June), with spill being provided for at least 95% of the spring species outmigration. Spill volume will be shaped to maximize spill efficiency (Table 4). Chelan PUD personnel will operate the Rock Island bypass trap, an upper Columbia SMP site, continuously from 1 April through 31 August (seven days per week) to provide daily smolt counts. Index counts will provide the basis to determine the start and end of the spring and summer outmigration periods. The HCP guidelines to start and end the spring spill program at Rock Island Dam are as follows:

1. The Rock Island spring spill program will begin when the daily smolt passage index count exceeds 400 fish for more than 3 days (this corresponds to the approximately 5 percent passage date), or no later than 17-April, as outlined in Section 5.4.1. (a) of the Rock Island HCP.

2. Rock Island spring spill will end 1) following completion of the spring outmigration (95 percent passage point), and 2) when subyearling (summer) Chinook have arrived at the Project.

Operators will utilize the following spill gate sequence to meet daily spill percentage targets in 2019: 32, 31, 30, 1, 26*, 16, 18*, 24, 29, 19, 20, 22, 27, 6, 7, and 8.

*Gates 26 and 18 will be converted to full-gate function prior to the spring spill season and remain in place until increased spring runoff has passed Rock Island, at which point they will be returned to notched gate operations. This change provides project flexibility to address periods of high flows while automatic gate capacity is reduced.

Rock Island 2019 Summer Spill Operations

Rock Island will spill 20 percent of the estimated daily average river flow for a duration covering 95 percent of the summer outmigration of subyearling Chinook. Daily smolt counts from the Rock Island bypass trap will inform decisions on when to start and stop spill. The HCP guidelines to start and stop summer spill at Rock Island Dam are outlined as follows:

1. Rock Island summer spill in 2019 will begin immediately after completion of the spring spill. The summer spill level will be 20 percent of day average flow, shaped to increase spill efficiency. Spill will continue for a duration covering 95 percent of the subyearling Chinook outmigration.

2. Summer spill will generally end no later than 15 August, or when subyearling Chinook counts from the Rock Island trap are 0.3 percent or less of the cumulative run total for three out of any five consecutive days, and UW's Program RealTime is estimating 95 percent run completion (same protocol used in 2004-2018).

Operators will utilize the following spill gate sequence to meet daily spill percentage targets in 2019: 32, 31, 30, 1, 26*, 16, 18*, 24, 29, 19, 20, 22, 27, 6, 7, and 8.

*Gates 26 and 18 will be converted to full-gate function prior to the spring spill season and remain in place until increased spring runoff has passed Rock Island, at which point they will be returned to notched gate operations. This change provides project flexibility to address periods of high flows while automatic gate capacity is reduced.

Table 4. Spill percentages and hourly spill shape for the Rock Island spring and summer fish spill program, 2019.

Project/Season	Daily Spill Average	With-in Day Spill Levels	Duration (# of hours each day)	Hourly Blocks of Spill	Spill Shape %
Rock Island Spring*	10%	High	4	0000-0400	12.5
		Med	3	0400-0700	10.0
		Low	5	0700-1200	6.0
		Med	8	1200-2000	10.0
		High	4	2000-2400	12.5
Rock Island Summer**	20%	High	1	0000-0100	23.0
		Med	1	0100-0200	19.0
		low	8	0200-1000	15.0
		Med	1	1000-1100	19.0
		High	13	1100-2400	23.0

*Spring spill for yearling Chinook, steelhead, and sockeye; **summer spill for subyearling Chinook.

Spill Program Communication

Chelan PUD's HCP representative will notify the HCPCC not less than once per week when fish passage numbers indicate that specific triggers for starting or stopping spill are likely to occur in the immediate future. Chelan PUD will notify the HCPCC regarding any unforeseen issues that pertain to the spill program as the season progresses. Communications with the HCPCC on spill information will generally be made by email, pre-scheduled conference calls, and HCPCC monthly meetings.

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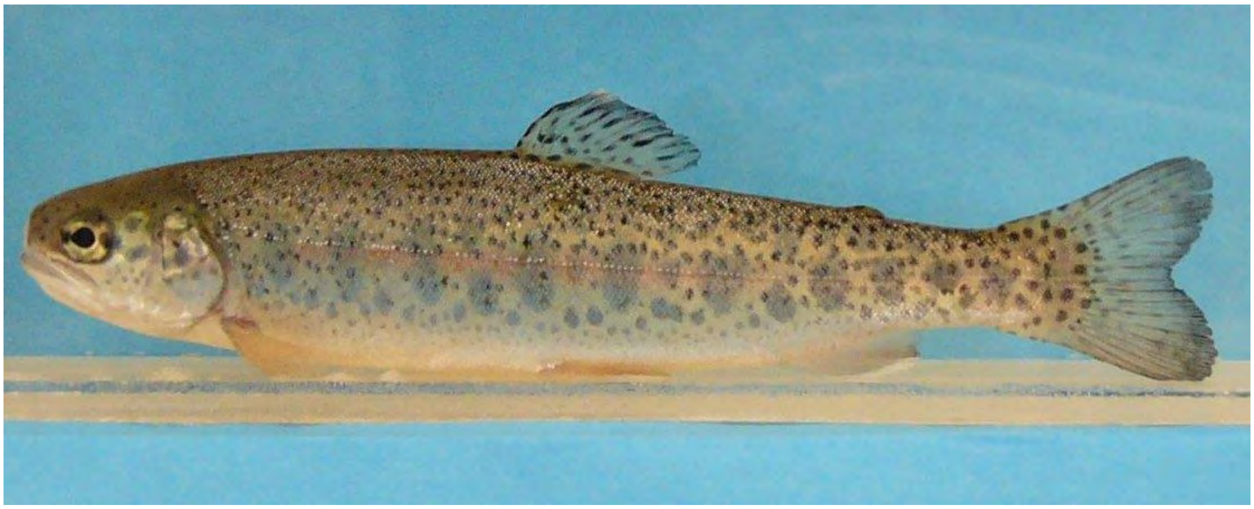
Appendix K
2018 Rocky Reach Juvenile Fish Bypass System Report

2018
Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System

Final Report



Steelhead *(Oncorhynchus mykiss)* Chelan County PUD, Juvenile Bypass Facility, 2004.

Chelan County Public Utility District #1
Wenatchee, Washington

By

Scott A. Hopkins
&
Lance M. Keller

January 2019

Table of Contents

List of Tables

List of Figures

List of Appendices

Glossary of Abbreviations, Acronyms, and Terms
for the 2018 Report

Acoustic Tag. A surgically implanted device that offers an efficient means of remotely tracking fish in three dimensions with sub-meter resolution.

BC Bypass Conduit. Fish transportation pipe that includes all fish conveyance structures (pipe, flumes, channels, and outfall) downstream of the ring-follower gates on the forebay wall to the discharge point in the tailrace.

Diversion Screen. The inclined section of the intake screen system, extending from the bottom of the VBS used to divert fish from water entering the turbine intake.

FBE Fish Bypass Efficiency. The percentage of fish passing the project through the fish bypass system (surface collector and screens).

FPE Fish Passage Efficiency. The percentage of fish passing the project through non-turbine routes.

IS Intake screen. The combined diversion screen and vertical barrier screen system installed in a turbine intake to divert fish from the flow entering the turbine.

ISS Intake Screen System. Screens (diversion and vertical barrier) and associated screen cleaner, bulkheads, closures, roof seals, weir boxes, slide gates, and controls which are found within the turbine intakes of units 1 and 2.

JFBS Juvenile Fish Bypass System. The overall fish bypass system consisting of the surface collector and the intake screen system.

JSF Juvenile Sampling Facility. A structure that includes conduits, channels, a raceway, pumping equipment, and systems used for fish monitoring and sampling activities.

PIT Passive Integrated Transponder. Small radio frequency tags with unique identification codes that are injected into fish for identification at specific monitoring locations after releases.

ROR Run of River. Used in reference to actively outmigrating smolts that are captured at the JSF.

SC Surface Collector. A structure positioned in the forebay to collect juvenile salmon and steelhead from surface flows, before the flows dive and enter a turbine intake. The structure includes components such as an entrance, dewatering screens, weir box, and transportation channel.

VBS Vertical Barrier Screen. The vertical section of the intake screen.

Summary

The District constructed and installed a permanent bypass system from September 2002 to March 2003. The system consists of one surface collector (SC) and the intake screen system (ISS) in turbine units 1 and 2. Flow through the current SC entrance is designed for 6 thousand cubic feet per second (kcfs). For additional information referring to the construction and configuration of the juvenile fish bypass system, please refer to the *Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System 2005* (Schoolcraft and Mosey 2006).

Multiple studies were conducted during the 2018 biological evaluation. The first priority and primary goal was to assure that the system was safe for fish prior to and during the juvenile outmigration. Marked fish releases with hatchery spring Chinook Salmon yearlings were conducted in late March to verify that the system was working properly and to locate any areas where descale, injury, and mortality might occur. The District's goal was to find and immediately repair any problems prior to the 1 April start date. Ongoing sampling at the juvenile sampling facility (JSF) occurred throughout the outmigration to: 1) assure that the system remained safe for migrating juveniles and 2) provide standardized juvenile fish capture rate data to supplement Program RealTime's (University of Washington) run-timing predictions at Rocky Reach. The bypass capture rate, along with Program RealTime and species composition data, guided decisions about initiating 2018 operations for the timing of summer fish spill.

A total of 55,419 juvenile salmonids and steelhead were collected during the 2018 sampling season; 47,886 fish were collected in the spring (1 April to 31 May) and 7,533 fish were collected in the summer (1 June to 31 August). The season-wide species composition for 2018 is as follows: 15.9% yearling Chinook Salmon (*Oncorhynchus tshawytscha*), 14.1% subyearling Chinook Salmon (*O. tshawytscha*), 1.9% steelhead (*O. mykiss*), 63.4% Sockeye Salmon (*O. nerka*), and 4.7% Coho Salmon (*O. kisutch*).

The season-wide estimates for all species in 2018 for descale, injury, and mortality are as follows: descale (0.07%), injury (0.26%), and mortality (0.03%). None of the three metrics (descale, injury, mortality) exceeded the critical thresholds over three consecutive days of sampling and no marked fish releases through the bypass system were required during bypass operations in 2018.

Introduction

In 2018, the Rocky Reach juvenile fish bypass system (JFBS) began operation on 1 April. The Chelan County Public Utility District (District) used the JSF for monitoring the physical condition of fish and species composition. The District also used the facility to evaluate seasonal run timing for target species. For additional history and developmental test of the juvenile fish bypass system, please refer to Schoolcraft and Mosey (2006).

Juvenile salmonids were routinely sampled to determine run timing and to visually examine fish for any descale, injury, and mortality. Species that were monitored on a daily basis during the 2018 out-migration for species composition and species condition included yearling and subyearling Chinook Salmon, steelhead, Sockeye Salmon, and Coho Salmon.

Major objectives for the 2018 biological evaluations were:

- to examine the daily species composition of fish using the JFBS
- to use bypass capture rate data, along with Program RealTime and species composition data to guide decisions about initiating 2018 operations for the timing of summer fish spill (Mosey, 2018), and
- to evaluate the physical condition of fish using the JFBS.

Materials and Methods

<u>Guidance Equipment</u>

Surface Collector (SC)
The SC is located in the cul-de-sac of Rocky Reach Dam, adjacent to the forebay wall and generating units 1, 2, and 3. The SC consists of three major subparts: entrance, dewatering and passage channels, and pump station (Figures 1 and 2). These components were designed to meet specific hydraulic performance criteria which provided for collection of outmigrating juvenile fish. For more detail about SC configuration and operations, please refer to Schoolcraft and Mosey (2006).

Intake Screen System (ISS) – Units 1 & 2
The ISS encompasses the intake screens in Generating Units 1 and 2 (Figure 3). This system is designed to guide fish that have been drawn into the intakes up into the gate well slot for collection. For more detail about ISS configuration and operations, please refer to Schoolcraft and Mosey (2006).

Debris accumulations on the diversion and Vertical Barrier Screens (VBS) were monitored by measuring head loss across the screens and by visual observations with an underwater camera. The screens in Units 1 and 2 were cleaned by an automated screen cleaner system.

Juvenile Fish Bypass System Operations

SC and ISS operations for the JFBS began on 1 April and continued through 31 August 2018.

Sampling Protocol
Sampling at the juvenile collection facility began on 1 April 2018. Juvenile salmonids were primarily collected during four 30 minute periods each day (7 days/week). In 2018, no collections were performed outside of the primary collection period (0800 to 1100 hours). In previous years, during afternoon and late-night collections (outside of the aforementioned periods), the juvenile facility was routinely monitored to avoid collecting and holding more fish than necessary for daily acoustic tagging and releases. The length of time needed to collect adequate numbers of fish for District studies varied depending on the number of spring migrants in the river. The collection and sampling schedules conformed to the schedules developed for acoustic tag evaluations and descale and injury evaluations. Please refer to Schoolcraft and Mosey (2006) to review the procedure for handling and sampling fish at the juvenile facility.

In 2018, collections occurred every day from 1 April to 31 August. A single collection was missed on the morning of 3 April due to a loss of power to the Rocky Reach JSF including the fish handling building. All systems were restored in time for the remaining three daily collections.

Species Composition
The primary collection period was used as the index to estimate daily run timing for each species. Sampling occurred seven days a week, April through August.

Run-of-River Fish Condition Evaluations
Fish that entered the JFBS were routinely monitored for descale, injury, and mortality from 1 April to 31 August. Please refer to Pacific States Marine Fisheries Commission (2003) for classification of descale and injury guidelines. Fish condition evaluations were conducted by trained surface collector personnel to maintain consistency in interpretations. All fish from species of interest were examined from each day's primary collection period.

Marked Fish Condition Evaluations
To determine if the JFBS was causing descale, injury, or mortality prior to system start-up on 1 April, hatchery fish were marked with either a right or left ventral fin clip and released into the bypass system at established release sites. Only fish with no previous descale or injury were used in these evaluations. Upon recapture, marked fish were re-examined and levels of descale, injury, and mortality were summarized using the same guidelines and procedures as described above for ROR condition evaluations.

The three locations for marked fish releases in 2018 included: 1) the SC north channel upstream from trashrack, 2) the SC south channel upstream of trashrack, and 3) Unit C-2. A test release for Unit C-1 was not performed in 2018 as the unit was down for maintenance for the entirety of the 2018 sampling season. Releases were conducted with hatchery spring chinook prior to the 1 April start date to determine if the JFBS was working properly and to help isolate potential sources of descale, injury, and mortality. Routine marked fish releases were not done after initial evaluations and were not resumed because the percentage of descale, injury or mortality never exceeded the levels established in the 2004 Rocky Reach study plan for the biological evaluation (Mosey et al. 2004).

Results

Hydraulic Conditions

Juvenile Fish Bypass System (JFBS) Flows
The 24-hr average entrance flows for the SC (both channels) and ISS weir box flows (combined flow for the 12 weirs) are presented in Appendix A along with river temperatures. Actual SC entrance flow at the North Channel averaged 3,251.1 cfs and flow at the south channel averaged 3,228.4 cfs; ISS collection flow averaged 77.5 cfs from 1 April to 31 August. Flows through the ISS were below historic average flows due to the unavailability of Unit C-1 during maintenance.

Juvenile Fish Bypass System (JFBS) Sampling

Overview of 2018 JFBS Operations
The SC and ISS operated throughout the season, except when they were temporarily shut down for repairs or debris removal. Unit 2 intake screens were cleaned with an automated screen cleaner. The unit was not shut down while the intake screens were cleaned, however a reduction in load (15.2 kcfs to 7.0 kcfs) was necessary to move the screen cleaner across the screens. As the amount of debris increased with spring runoff and growth of milfoil, frequency of cleaning was adjusted accordingly to keep up with the influx of debris. The JFBS was monitored 24-hours/7-days a week for debris build-up on the SC trash racks, SC dewatering screens and turbine unit intake screens. Racks, screens, gates and pipes were cleaned daily as needed by District bypass attendants. When high differentials were observed at the trashracks in Unit 2, an outage period of 5 to 6 hours was usually required for divers to manually remove debris from the trashracks.

Species Composition
A total of 55,419 fish were collected during the 2018 sampling season; 47,886 fish were collected in the spring (1 April to 31 May) and 7,533 fish were collected in the summer (1 June to 31 August). The season-wide species composition for 2018 was as follows: 15.9% yearling Chinook Salmon, 14.1% subyearling Chinook Salmon, 1.9% steelhead, 63.4% Sockeye Salmon, and 4.7% Coho Salmon (Figure 4). For the entire 2018 outmigration, the collection of fish from the JFBS for the biological evaluation took approximately 279 hours. Species composition of smolts in daily samples is summarized for the spring and summer study periods in Appendix B. In general, yearling Chinook Salmon and Sockeye Salmon were the predominant species captured during April into early June. Steelhead and Coho Salmon migrated through Rocky Reach Dam in early April through late May. Subyearling Chinook Salmon were the dominant species collected in June through the end of August comprising 89.0% of the daily totals during the summer months. Proportions of adipose-clipped salmonids sampled at Rocky Reach Dam (2003-2018) are summarized in Table 1, and daily adipose-clipped rates can be found in appendix B.

Table 1. Proportions of adipose-clipped juvenile salmonids sampled at the Rocky Reach JSF from 2003-2018.

Percent of Adipose-Clipped Fish Sampled					
Year	**Chinook Yearlings**	**Chinook Subyearlings**	**Steelhead**	**Sockeye**	**Coho**
2018	84.9%	51.4%	55.2%	0.0%	0.0%
2017	87.6%	29.1%	58.1%	0.1%	0.2%
2016	91.8%	34.7%	34.9%	0.0%	0.3%
2015	91.6%	30.5%	68.5%	0.0%	1.2%
2014	88.8%	37.7%	51.8%	0.0%	0.3%
2013	84.8%	15.2%	62.6%	0.1%	0.0%
2012	75.4%	65.4%	52.5%	1.0%	6.7%
2011	74.2%	47.3%	56.5%	2.9%	0.3%
2010	76.7%	28.9%	60.1%	0.03%	0.1%
2009	86.3%	34.6%	66.0%	0.1%	0.1%
2008	79.9%	29.0%	70.6%	2.1%	1.7%
2007	82.9%	43.1%	62.6%	0.01%	0.4%
2006	79.7%	22.9%	47.4%	0.7%	2.4%
2005	78.9%	27.9%	60.7%	3.3%	1.1%
2004	70.8%	18.7%	59.0%	0.1%	1.1%
2003	59.5%	9.4%	76.7%	0.2%	0.5%
Average	**80.9%**	**32.9%**	**59.0%**	**0.7%**	**1.0%**

During both the spring and summer migration, salmonid species were the primary species captured. During the migration seasons, other 'resident' fishes were captured, including Chiselmouth (*Acrocheilus alutaceus*), Peamouth *(Mylocheilus caurinus)*, Northern Pikeminnow (*Ptychocheilus oregonensis),* Mountain Whitefish (*Prosopium williamsoni*), Redside Shiners (*Richardsonius balteatus*), Yellow Perch (*Perca flavescens*), Smallmouth Bass (*Micropterus dolomieu*), Common Carp (*Cyprinus carpio*), Walleye (*Sander vitreus*), bullhead species (*Ameiurus sp*.), Threespine Sticklebacks (*Gasterosteus aculeatus)*, sucker species (*Catostomas sp.*), Rainbow Trout (*Oncorhynchus mykiss*), kokanee (*Oncorhynchus nerka*), and Bluegill (*Lepomis marcochirus*).

Other resident fish of special interest include juvenile and adult Pacific Lamprey (*Entosphenus tridentatus*), Bull Trout (*Salvelinus confluentus*), and White Sturgeon (*Acipenser transmontanus*). During 2018, a total of 13 juvenile Pacific Lamprey (6 migratory, 7 non-migratory), one juvenile Bull Trout, and four White Sturgeon were collected. There were also 46 adult Pacific Lamprey collected and released upstream near Lincoln Rock Park. Any fish that were exposed to anesthesia were allowed to recover for 2 hours before being released (Appendix C).

Run-of-River Fish Condition Evaluations
Yearling and subyearling Chinook Salmon, steelhead, Sockeye Salmon, and Coho Salmon were collected at the juvenile facility from the JFBS and routinely inspected for descale, injury and mortality. The results from daily samples are reported in Appendix D. The District, with

guidance from the Habitat Conservation Plan Coordinating Committee (HCPCC), set descale, injury, and mortality critical threshold levels at 5%, 3% and 2%, respectively. For more information about the threshold levels for fish condition, please refer to Schoolcraft and Mosey (2006). Descale estimates for combined species was below 0.1% in 2018. Figure 5 compares the season-wide descale percentage for each species from 2009 to 2018.

Injury is characterized by lacerations or bruises occurring to any part of the head or body. These types of injuries as well as severe descaling can lead to mortality. Injury estimates for combined species was below 0.3% in 2018. Figure 6 compares the season-wide injury percentage for each species from 2009-2018.

Mortalities collected during the spring and summer sampling were categorized as being *river*, *facility*, *sample*, or *research* mortalities. A *river* mortality is any fish "long-dead" on arrival in the raceway and defined by body characteristics such as pale or blotchy coloration and soft body condition. A *facility* mortality is classified as any fish recently dead, or near death upon arrival in the raceway, and exhibits fresh descale or injury. A *sample* mortality is any fish that dies as a result of the sampling activity itself. A *research* mortality is any fish that dies as a result of transferring and/or holding fish in research holding tanks for the purpose of further study or evaluation. In 2018, the percent mortality estimate for combined species was below 0.1%. Figure 7 compares the season-wide mortality percentage for each species from 2009-2018. The results from daily samples are reported in Appendix D. Proportions of descale, injury, and mortality of salmonids sampled at Rocky Reach Dam (2009-2018) are summarized in Table 2.

***Table 2. Comparison of descale, injury and mortality rates at the Rocky Reach JSF* Years 2009 through 2018.**

Descale %										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Yearlings	0.12%	0.12%	0.06%	0.04%	0.21%	0.05%	0.15%	0.05%	0.10%	0.12%
Subyearling	0.31%	0.17%	0.07%	0.13%	0.16%	0.09%	0.19%	0.89%	0.10%	0.08%
Steelhead	0.20%	0.51%	0.31%	0.07%	0.65%	0.23%	0.42%	0.66%	0.48%	0.68%
Sockeye	0.03%	0.01%	0.05%	0.01%	0.01%	0.00%	0.05%	0.05%	0.08%	0.03%
Coho	0.11%	0.11%	0.11%	0.11%	0.31%	0.00%	0.51%	0.15%	0.20%	0.11%
Injury %										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Yearlings	0.17%	0.17%	0.07%	0.00%	0.24%	0.12%	0.15%	0.13%	0.19%	0.41%
Subyearling	0.30%	0.14%	0.10%	0.26%	0.08%	0.08%	0.19%	0.26%	0.16%	0.22%
Steelhead	0.50%	0.70%	0.47%	0.17%	0.32%	0.90%	0.42%	0.99%	0.57%	2.03%
Sockeye	0.06%	0.00%	0.08%	0.01%	0.07%	0.05%	0.05%	0.06%	0.11%	0.13%
Coho	0.18%	0.19%	0.09%	0.16%	0.40%	0.39%	0.51%	0.67%	0.65%	1.03%
Mortality %										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Yearlings	0.05%	0.00%	0.01%	0.05%	0.01%	0.01%	0.01%	0.00%	0.02%	0.00%
Subyearling	0.12%	0.08%	0.11%	0.09%	0.06%	0.05%	0.04%	0.06%	0.09%	0.08%
Steelhead	0.00%	0.00%	0.03%	0.00%	0.41%	0.00%	0.03%	0.00%	0.00%	0.00%
Sockeye	0.01%	0.01%	0.00%	0.04%	0.05%	0.02%	0.02%	0.01%	0.03%	0.03%
Coho	0.09%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%

Marked Fish Condition Evaluations

Fish recovered from marked fish releases (prior to bypass operation on 1 April) were examined for descale, injury, and mortality associated with passage through the JFBS. Results from individual test groups are summarized in Appendix E. On March 22, 2018, the District conducted marked fish releases. Marked releases were performed in the north and south channels of the surface collector as well as Unit 2. A test release of Unit 1 was not performed as the unit was down for maintenance and stayed out of service for the duration of the sampling season. Of the initial 330 fish released, 325 were recaptured. All of the recaptured fish were examined for descale, injury, and mortality. There were no signs of descale or injury and no mortality occurred in the 325 recaptured fish. Fish appeared healthy and energetic.

Discussion

Juvenile Fish Bypass System Species Composition and Observations

Species composition of smolts migrating through Rocky Reach Dam in 2018 varied somewhat from that observed in 2017. Sockeye Salmon comprised the largest percentage of smolts sampled in the JFBS, with the percentage increasing from last year (63.4% of the total composition in 2018 compared with 28.9% in 2017). Meanwhile yearling Chinook Salmon decreased to 15.9% in 2018 compared to 33.8% in 2017, while subyearling Chinook Salmon decreased from 28.8% to 14.1% in 2018. Steelhead also decreased from 2.9% to 1.9% in 2018. The proportion of Coho Salmon decreased from 5.6% to 4.7% in 2018.

Composition of adipose-clipped smolts also varied in 2018. There was a slight decrease in the percentage of adipose-clipped Chinook Salmon yearlings from 2017 to 2018, 87.6% to 84.9% respectively, while subyearling Chinook Salmon increased from 29.1% to 51.4% respectively. Steelhead smolts decreased from 58.1% proportion of adipose-clipped smolts in 2017 to 55.2% in 2018. The proportion of adipose-clipped Sockeye Salmon decreased slightly from 0.1% in 2017 to 0.01% in 2018, and Coho Salmon decreased from 0.2% in 2017 to 0.0% in 2018.

Season-wide estimates of descale, injury, and mortality for all species combined was 0.11%, 0.19%, and 0.04% respectively (Appendix D). There was an observed increase in the injury rate of steelhead in 2018 as the rate went from 0.57% in 2017 to 2.03% in 2018 (n=21). However, the 21 instances of injury were irregular and spread out over the collection season and were not tied to operations of the JFB. At no time during the 2018 spring and summer sampling months did fish condition reach critical threshold levels triggering marked fish releases.

Observed incidence of predations marks on smolts utilizing the JFBS in 2018 was 0.4%.

Conclusions from the 2018 Evaluations

- Flow spreaders with PIT antennas continue to be fish-friendly
- Unavailability of Unit C-1 had no impact to descale, injury, or mortality.
- Season-wide estimates of descale, injury, and mortality did not exceed 0.3% for combined species during the seventeenth year of operation of the permanent bypass system.

2019 Bypass Operations and Survival Studies

In 2019, the District will not be conducting a survival study at Rocky Reach, as Phase 3 Standards Achieved has been reached for all planned spring migrants. The District will continue to evaluate seasonal run-timing, species composition, and physical condition of ROR fish at the JSF in 2019.

Acknowledgements

Several District employees assisted in the implementation of the 2018 evaluations. Alene Underwood, Todd West, and Thad Mosey provided logistical and administrative help. Chris Nystrom and the bypass operators oversaw day to day operation of the JFBS. CM mechanics and wiremen performed critical maintenance and repairs. Fish and Wildlife personnel assisting with the 2018 Rocky Reach evaluations included: Dennis Litchfield, Dave Beardsley, Todd Jackson, Josh Boyd, Nathan Clark, and Paul Edwards.

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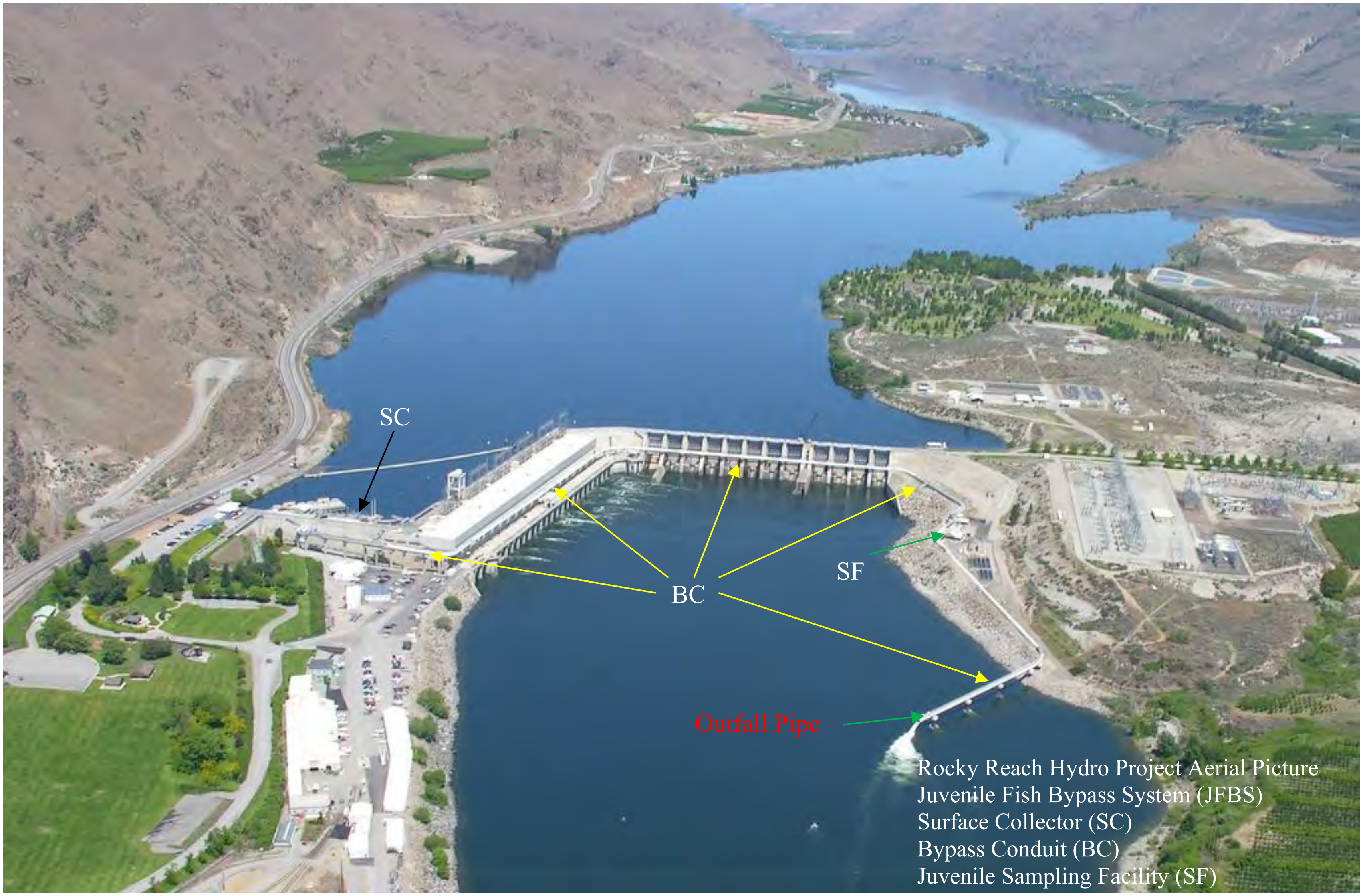


Figure 1. Aerial view of Rocky Reach Dam and the JFBS.

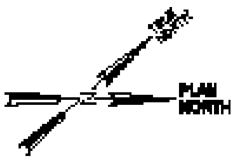


Figure 2. Plan view of Rocky Reach Dam and the JFBS

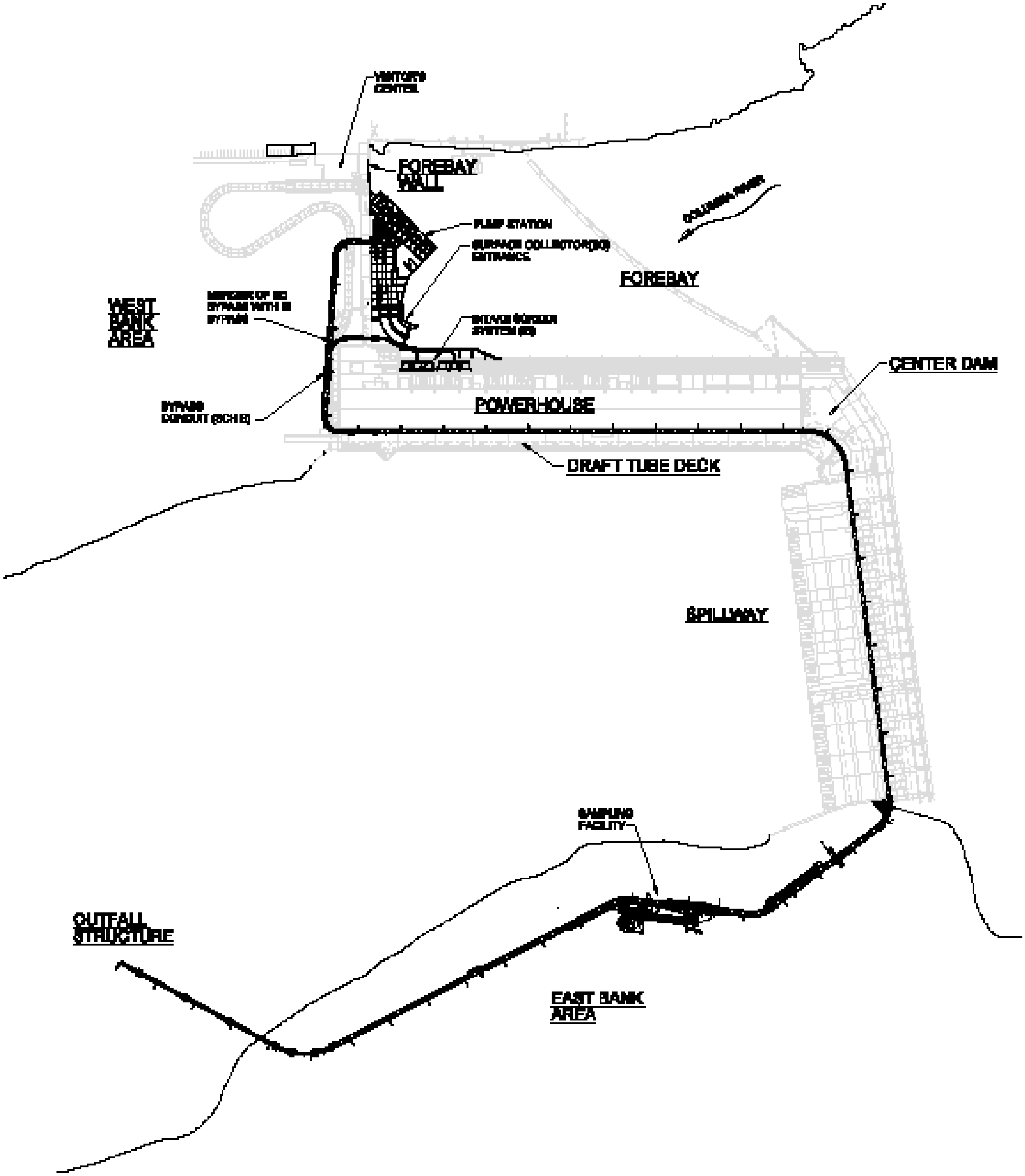
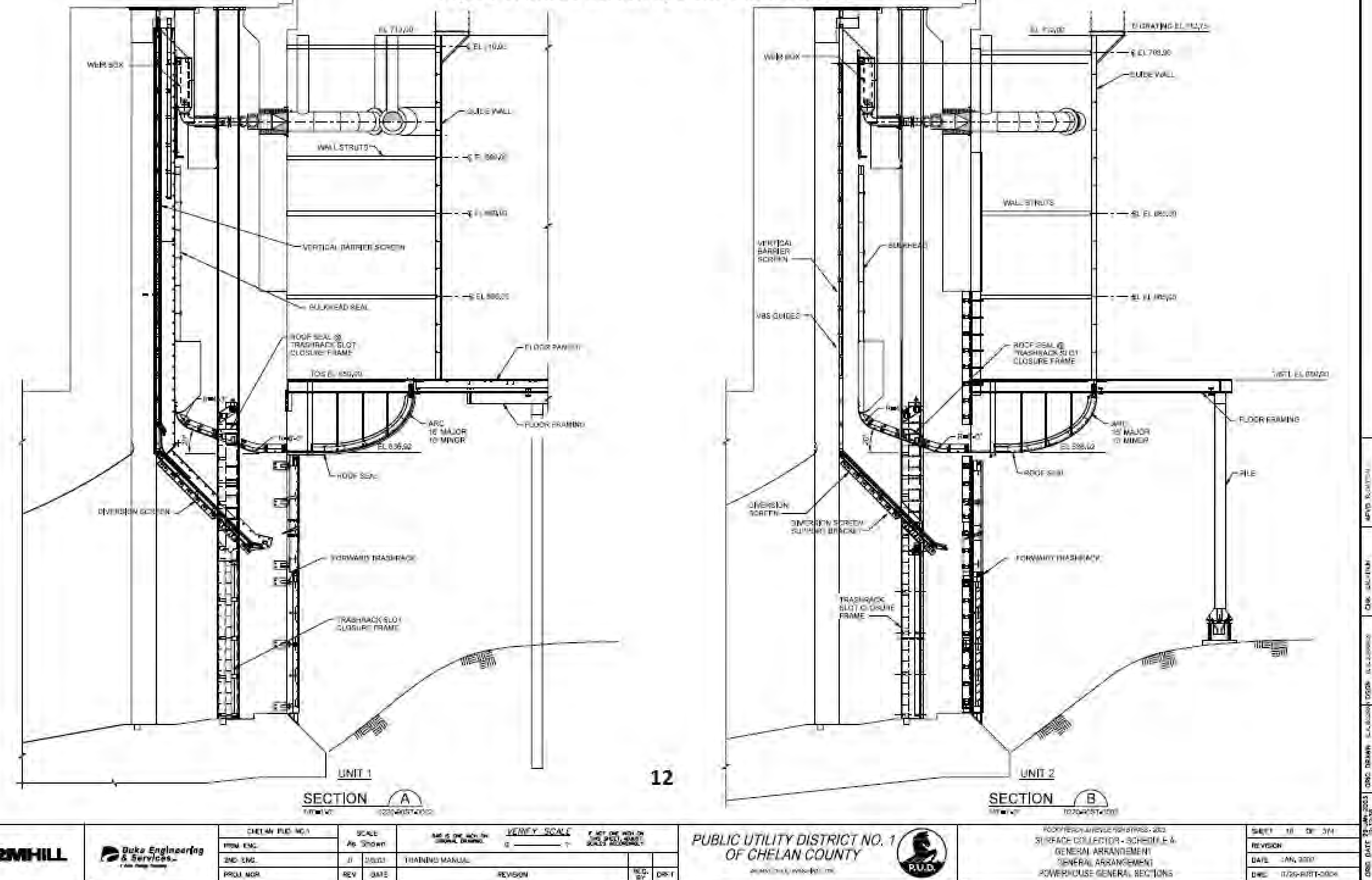


Figure 3. Intake screen system, units 1 and 2.



12

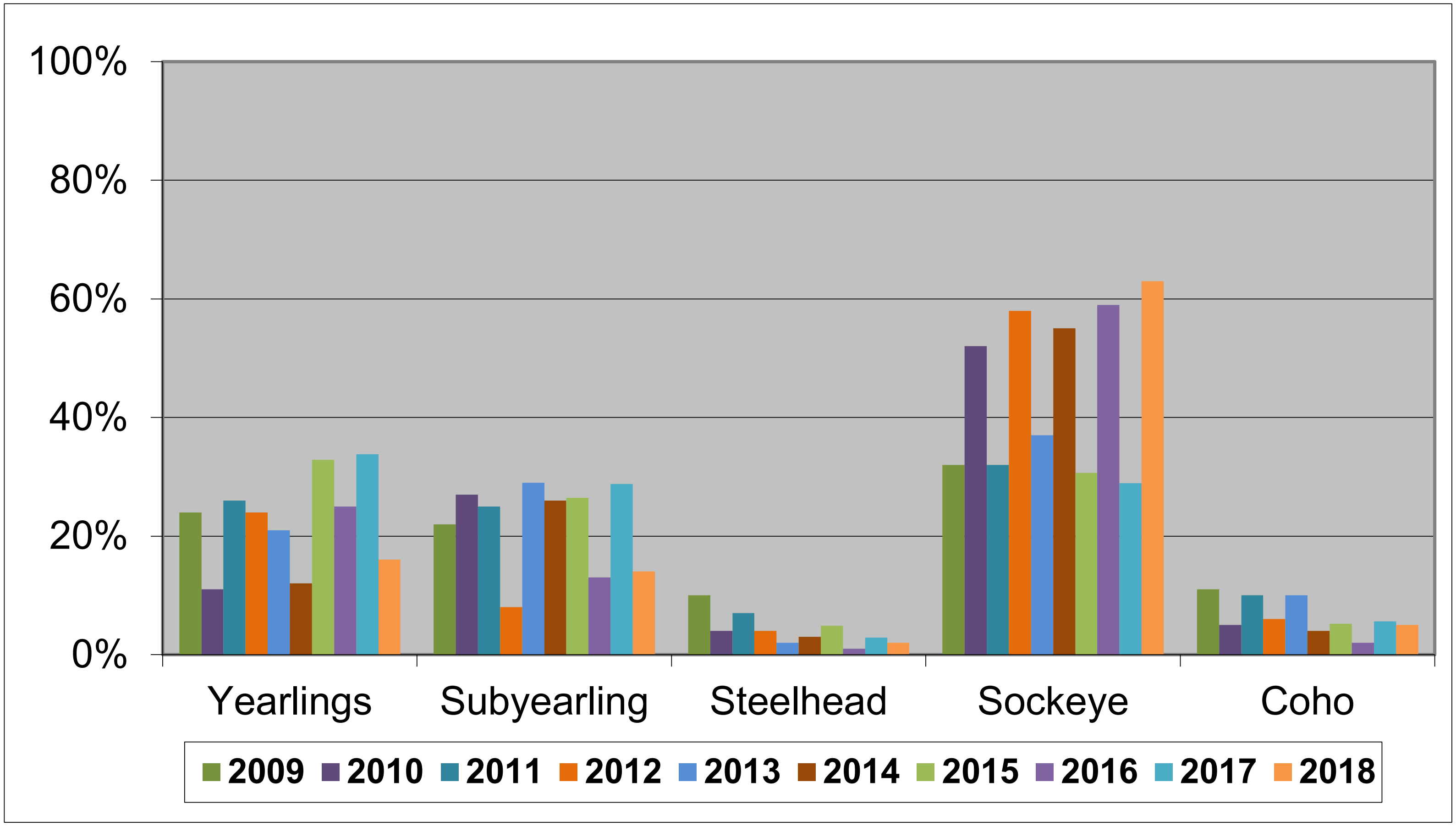


Figure 4. Ten year annual species percent composition of fish collected at the RRJSF 2009-2018.

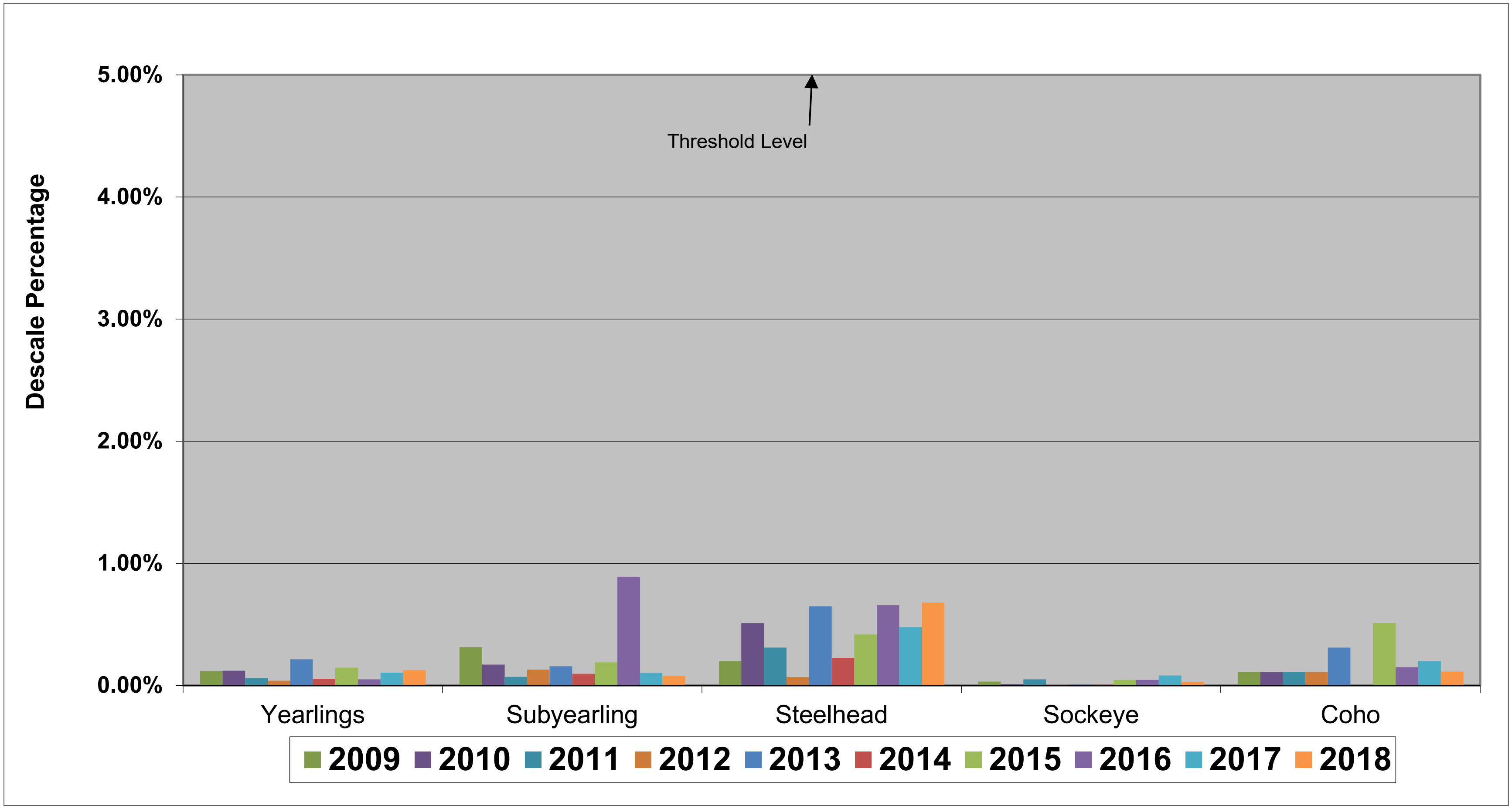


Figure 5. Ten year annual percent descale for salmon and steelhead at the RRJSF, 2009-2018.

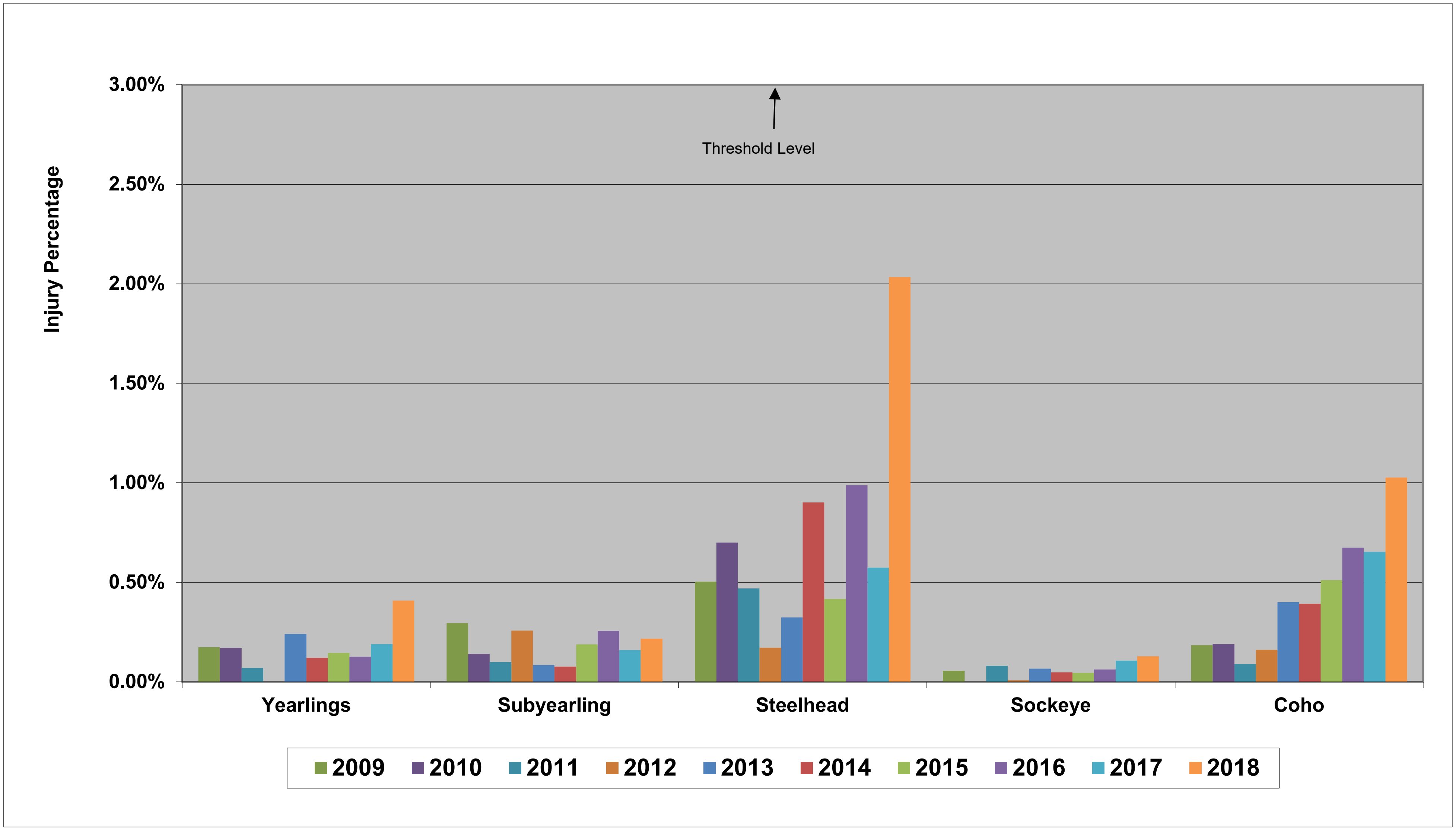


Figure 6. Ten year annual percent injury for salmon and steelhead at the RRJSF, 2009-2018.

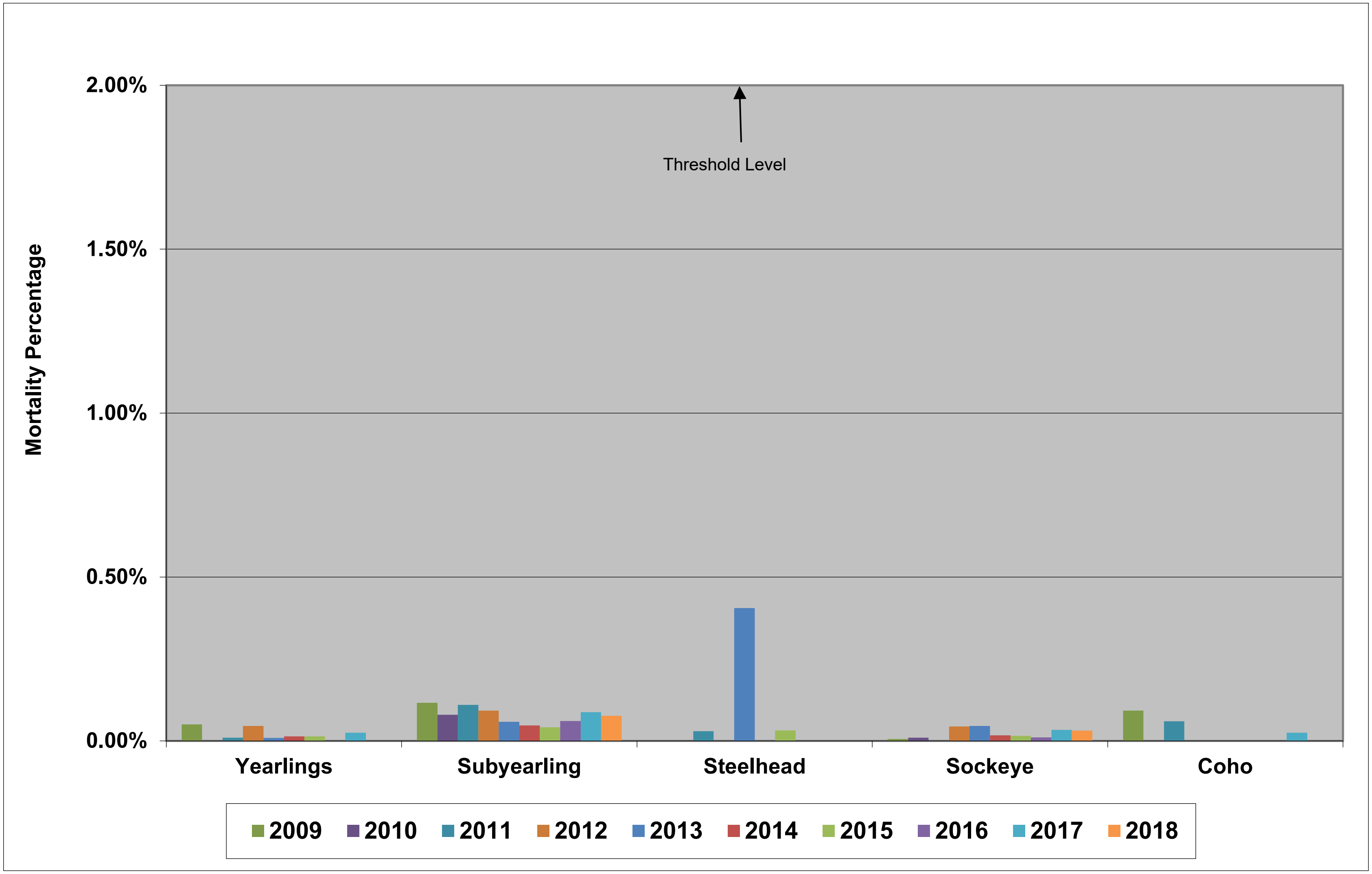


Figure 7. Ten year annual percent mortality for salmon and steelhead at the RRJSF, 2009-2018.

APPENDIX A. COLLECTION FLOWS IN THE JFBS, 2018.

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2018.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
4/1/18	3285.9	3264.0	54.0	4.7
4/2/18	3150.5	3182.8	34.3	4.9
4/3/18	3193.0	3221.1	84.1	4.8
4/4/18	3252.4	3237.8	110.6	4.8
4/5/18	3207.8	3223.2	107.5	4.7
4/6/18	3264.8	3285.7	109.7	4.8
4/7/18	3289.2	3272.7	110.5	4.8
4/8/18	3257.4	3244.6	119.0	4.9
4/9/18	3211.5	3244.7	114.3	5.1
4/10/18	3264.9	3230.8	110.2	5.5
4/11/18	3221.4	3187.5	114.8	5.7
4/12/18	3193.3	3165.6	119.4	5.8
4/13/18	3189.3	3144.2	116.7	5.9
4/14/18	3164.7	3147.0	119.6	6.1
4/15/18	3209.7	3188.4	116.5	6.2
4/16/18	3219.4	3186.0	117.6	6.3
4/17/18	3183.2	3134.3	119.6	6.4
4/18/18	3130.4	3160.1	119.6	6.5
4/19/18	3167.2	3197.2	119.4	6.8
4/20/18	3158.7	3147.6	119.6	6.9
4/21/18	3151.8	3173.0	119.4	7.1
4/22/18	3214.5	3214.7	119.6	7.2
4/23/18	3164.5	3219.0	116.0	7.3
4/24/18	3175.6	3216.2	82.0	7.5
4/25/18	3171.1	3217.2	83.9	7.7
4/26/18	3214.6	3234.3	119.5	7.9
4/27/18	3183.3	3180.4	119.5	8.2
4/28/18	3311.5	3125.3	119.6	8.4
4/29/18	3311.2	3140.7	119.7	8.4
4/30/18	3307.8	3129.9	119.6	8.4
5/1/18	3308.3	3371.2	119.8	8.4
5/2/18	3310.1	3373.1	119.7	8.4
5/3/18	3311.5	3374.5	119.7	8.6
5/4/18	3311.9	3374.9	119.6	8.9
5/5/18	3311.5	3374.5	119.5	9.1
5/6/18	3305.9	3368.8	119.6	9.1
5/7/18	3310.9	3373.9	119.7	9.4
5/8/18	3310.8	3373.9	119.7	9.5
5/9/18	3309.0	3372.0	119.5	9.8
5/10/18	3309.8	3372.8	119.8	10.1

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2018.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
5/11/18	3311.1	3374.1	119.8	10.2
5/12/18	3311.1	3374.1	119.6	10.3
5/13/18	3311.8	3374.8	119.7	10.6
5/14/18	3308.4	3371.3	119.8	10.8
5/15/18	3306.1	3369.1	119.6	11.1
5/16/18	3308.1	3371.1	119.7	11.4
5/17/18	3312.0	3375.1	119.5	11.7
5/18/18	3308.3	3371.2	119.9	11.7
5/19/18	3307.2	3370.1	119.7	11.5
5/20/18	3307.4	3370.3	119.8	11.6
5/21/18	3308.3	3371.2	119.7	13.7
5/22/18	3308.1	3371.0	119.7	12.0
5/23/18	3309.1	3372.1	93.9	12.3
5/24/18	3309.5	3372.5	59.9	12.6
5/25/18	3310.0	3373.0	59.9	12.6
5/26/18	3307.2	3370.2	59.9	12.7
5/27/18	3306.9	3369.8	59.9	12.8
5/28/18	3306.3	3369.2	59.9	14.1
5/29/18	3307.6	3370.6	59.8	12.9
5/30/18	3301.5	3364.3	59.9	12.6
5/31/18	3304.0	3366.8	59.9	12.6
6/1/18	3306.3	3369.3	59.9	12.5
6/2/18	3306.2	3369.1	59.9	12.6
6/3/18	3306.4	3369.4	59.9	12.9
6/4/18	3307.9	3370.9	59.9	13.1
6/5/18	3304.6	3367.5	59.9	13.3
6/6/18	3305.3	3368.2	59.9	13.4
6/7/18	3305.7	3368.7	59.9	13.6
6/8/18	3306.0	3368.9	59.9	13.6
6/9/18	3305.5	3368.4	59.9	13.8
6/10/18	3293.8	3356.5	59.9	13.9
6/11/18	3305.0	3368.0	59.8	14.0
6/12/18	3303.9	3366.8	59.9	14.0
6/13/18	3305.1	3368.0	59.9	14.0
6/14/18	3293.0	3355.7	59.9	14.1
6/15/18	3303.8	3366.7	59.9	14.3
6/16/18	3252.5	3314.5	58.0	14.5
6/17/18	3245.7	3307.5	58.9	14.8
6/18/18	3276.0	3338.3	59.8	15.0
6/19/18	3254.7	3316.6	59.7	15.2

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2018.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
6/20/18	3226.5	3287.9	57.4	15.4
6/21/18	3243.6	3305.4	58.7	15.8
6/22/18	3252.7	3314.8	58.6	16.1
6/23/18	3252.9	3314.8	59.7	16.1
6/24/18	3288.8	3351.4	59.9	16.0
6/25/18	3288.7	3351.3	59.9	16.2
6/26/18	3303.0	3365.8	59.9	16.1
6/27/18	3299.9	3362.7	59.9	15.8
6/28/18	3304.1	3366.9	59.9	15.9
6/29/18	3298.7	3361.5	59.9	15.4
6/30/18	3277.8	3340.2	59.7	15.4
7/1/18	3253.4	3315.5	58.2	15.6
7/2/18	3268.5	3330.8	59.8	15.6
7/3/18	3249.1	3310.9	59.3	15.5
7/4/18	3259.3	3321.3	59.8	15.7
7/5/18	3251.3	3313.2	59.3	16.1
7/6/18	3246.9	3308.8	58.4	16.3
7/7/18	3257.2	3319.2	59.1	16.5
7/8/18	3245.3	3307.1	57.8	16.7
7/9/18	3260.2	3322.3	59.2	16.6
7/10/18	3275.2	3337.6	59.9	17.0
7/11/18	3217.2	3278.5	55.1	17.2
7/12/18	3271.3	3333.6	59.9	17.2
7/13/18	3266.7	3328.9	59.8	17.2
7/14/18	3277.4	3339.8	59.7	17.6
7/15/18	3234.5	3296.0	56.8	17.6
7/16/18	3243.6	3305.4	57.0	17.7
7/17/18	3260.8	3322.8	58.5	17.9
7/18/18	3252.8	3314.7	58.0	18.1
7/19/18	3205.1	3266.1	53.2	17.9
7/20/18	3200.9	3261.9	52.4	17.8
7/21/18	3213.6	3274.8	53.3	18.1
7/22/18	3271.8	3334.1	59.4	18.3
7/23/18	3292.5	3355.2	59.6	18.2
7/24/18	3205.0	3175.0	53.2	18.2
7/25/18	3195.7	2993.5	53.3	18.4
7/26/18	3025.7	2912.2	55.9	18.2
7/27/18	3073.2	2855.8	57.6	18.3
7/28/18	3087.3	2842.7	56.4	18.4
7/29/18	3142.4	2813.8	55.1	18.6

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2018.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
7/30/18	3129.4	2844.5	54.4	18.7
7/31/18	3156.9	2784.0	52.4	18.9
8/1/18	3156.5	2765.5	52.2	19.1
8/2/18	3125.3	2764.9	52.1	19.3
8/3/18	3148.3	2925.4	59.9	19.4
8/4/18	3388.6	3202.3	59.8	19.2
8/5/18	3384.5	3146.2	59.9	19.6
8/6/18	2722.0	2505.0	59.9	19.6
8/7/18	3375.4	3144.3	59.9	19.6
8/8/18	3398.0	3041.2	59.6	19.0
8/9/18	3449.1	2943.9	59.9	18.9
8/10/18	3546.9	2852.2	59.8	19.0
8/11/18	3194.9	3083.1	60.0	19.1
8/12/18	3225.9	3079.8	59.9	19.3
8/13/18	3268.8	3015.4	59.6	19.3
8/14/18	3167.3	2994.0	58.8	19.4
8/15/18	3185.9	3042.8	59.5	19.5
8/16/18	3222.8	3007.7	59.9	19.6
8/17/18	3287.2	3002.7	60.0	19.3
8/18/18	3267.2	3006.5	59.9	19.1
8/19/18	3232.2	2952.0	59.9	19.0
8/20/18	3176.6	3128.5	59.9	19.1
8/21/18	3175.2	3099.4	59.9	19.7
8/22/18	3239.5	3046.7	59.9	19.2
8/23/18	3179.3	3073.7	59.9	19.1
8/24/18	3176.8	3074.2	59.9	19.1
8/25/18	3212.8	3086.7	59.9	19.0
8/26/18	3191.4	3052.3	60.0	19.1
8/27/18	3166.0	3094.0	59.9	19.2
8/28/18	3196.2	3110.5	58.9	20.0
8/29/18	3219.6	3118.0	59.9	19.4
8/30/18	3133.4	3103.3	59.9	19.6
8/31/18	3196.5	3117.8	59.7	19.5
Average	**3251.1**	**3228.4**	**77.5**	**13.8**

APPENDIX B. ROCKY REACH JSF DAILY COUNTS AND AD-CLIP %, SPRING AND SUMMER, 2018.

Appendix B. Rocky Reach JSF daily counts and ad-clip %, spring and summer, 2018.

Numbers of Smolts Handled and Ad-Clip %											
Date	Yearlings		Subyearling		Steelhead		Sockeye		Coho		Total Handled
1-Apr	1	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	1
2-Apr	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
3-Apr	1	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	1
4-Apr	4	0.00%	0	N/A	1	0.00%	1	0.00%	0	N/A	6
5-Apr	3	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	3
6-Apr	0	N/A	0	N/A	0	N/A	1	0.00%	0	N/A	1
7-Apr	0	N/A	0	N/A	1	0.00%	1	0.00%	0	N/A	2
8-Apr	4	0.00%	0	N/A	1	100.00%	0	N/A	0	N/A	5
9-Apr	2	0.00%	0	N/A	1	0.00%	0	N/A	0	N/A	3
10-Apr	6	0.00%	0	N/A	3	33.33%	2	0.00%	0	N/A	11
11-Apr	3	0.00%	0	N/A	0	N/A	1	0.00%	0	N/A	4
12-Apr	3	0.00%	0	N/A	0	N/A	1	0.00%	1	0.00%	5
13-Apr	3	0.00%	0	N/A	3	0.00%	0	N/A	1	0.00%	7
14-Apr	17	76.47%	0	N/A	2	0.00%	2	0.00%	0	N/A	21
15-Apr	53	96.23%	0	N/A	1	0.00%	0	N/A	0	N/A	54
16-Apr	28	89.29%	0	N/A	0	N/A	0	N/A	0	N/A	28
17-Apr	33	75.76%	0	N/A	3	66.67%	0	N/A	0	N/A	36
18-Apr	207	95.65%	0	N/A	10	10.00%	1	0.00%	0	N/A	218
19-Apr	301	74.75%	0	N/A	8	0.00%	2	0.00%	1	0.00%	312
20-Apr	558	91.76%	0	N/A	8	12.50%	6	0.00%	0	N/A	572
21-Apr	977	92.22%	0	N/A	26	65.38%	3	0.00%	0	N/A	1006
22-Apr	508	91.73%	0	N/A	173	97.11%	7	0.00%	0	N/A	688
23-Apr	93	89.25%	0	N/A	35	60.00%	12	0.00%	0	N/A	140
24-Apr	75	94.67%	0	N/A	18	77.78%	8	0.00%	1	0.00%	102
25-Apr	47	93.62%	0	N/A	11	90.91%	69	0.00%	1	0.00%	128
26-Apr	104	90.38%	0	N/A	3	66.67%	52	0.00%	1	0.00%	160
27-Apr	129	92.25%	0	N/A	18	50.00%	46	0.00%	4	0.00%	197
28-Apr	892	91.14%	0	N/A	50	30.00%	194	0.52%	19	0.00%	1155
29-Apr	336	88.99%	0	N/A	24	25.00%	191	0.52%	6	0.00%	557
30-Apr	281	85.05%	0	N/A	21	57.14%	1330	0.00%	7	0.00%	1639
1-May	506	87.15%	0	N/A	49	59.18%	727	0.00%	26	0.00%	1308
2-May	33	63.64%	0	N/A	1	100.00%	2329	0.00%	7	0.00%	2370
3-May	387	81.91%	0	N/A	43	79.07%	1006	0.00%	42	0.00%	1478
4-May	70	84.29%	0	N/A	4	100.00%	1790	0.00%	10	0.00%	1874
5-May	31	90.32%	0	N/A	2	0.00%	2412	0.00%	6	0.00%	2451
6-May	31	80.65%	0	N/A	1	100.00%	1675	0.00%	13	0.00%	1720
7-May	45	84.44%	0	N/A	1	100.00%	1562	0.00%	21	0.00%	1629
8-May	161	83.85%	0	N/A	1	100.00%	1182	0.00%	52	0.00%	1396
9-May	100	87.00%	0	N/A	1	0.00%	1611	0.00%	73	0.00%	1785
10-May	79	81.01%	0	N/A	0	N/A	1817	0.00%	51	0.00%	1947
11-May	201	72.64%	0	N/A	15	33.33%	1132	0.00%	123	0.00%	1471
12-May	131	72.52%	0	N/A	6	50.00%	1364	0.00%	137	0.00%	1638

13-May	55	78.18%	0	N/A	2	50.00%	1740	0.00%	57	0.00%	1854
14-May	173	73.99%	0	N/A	9	33.33%	1191	0.08%	177	0.00%	1550
15-May	167	73.05%	0	N/A	5	20.00%	862	0.00%	149	0.00%	1183
16-May	132	65.15%	0	N/A	13	53.85%	1026	0.00%	155	0.00%	1326
17-May	108	58.33%	0	N/A	11	45.45%	1097	0.00%	136	0.00%	1352
18-May	218	63.30%	6	0.00%	5	0.00%	1097	0.00%	99	0.00%	1425
19-May	122	72.13%	0	N/A	3	66.67%	1358	0.00%	37	0.00%	1520
20-May	140	71.43%	9	0.00%	17	11.76%	895	0.00%	77	0.00%	1138
21-May	78	66.67%	6	0.00%	22	18.18%	618	0.00%	142	0.00%	866
22-May	42	80.95%	6	0.00%	12	0.00%	1021	0.00%	106	0.00%	1187
23-May	84	72.62%	85	95.29%	11	45.45%	684	0.00%	86	0.00%	950
24-May	98	75.51%	92	92.39%	8	50.00%	570	0.00%	59	0.00%	827
25-May	220	80.91%	192	97.92%	36	50.00%	648	0.00%	117	0.00%	1213
26-May	161	86.96%	183	100.00%	32	46.88%	563	0.00%	86	0.00%	1025
27-May	179	90.50%	152	96.71%	40	45.00%	356	0.00%	92	0.00%	819
28-May	128	95.31%	49	89.80%	31	41.94%	137	0.00%	62	0.00%	407
29-May	75	96.00%	114	95.61%	28	39.29%	58	0.00%	69	0.00%	344
30-May	66	95.45%	63	95.24%	41	53.66%	100	1.00%	73	0.00%	343
31-May	112	99.11%	157	98.09%	15	66.67%	98	0.00%	46	0.00%	428
1-Jun	13	100.00%	153	94.12%	13	76.92%	62	0.00%	41	0.00%	282
2-Jun	6	100.00%	91	95.60%	8	37.50%	21	0.00%	11	0.00%	137
3-Jun	0	N/A	395	98.73%	8	37.50%	14	0.00%	4	0.00%	421
4-Jun	2	100.00%	372	97.31%	12	33.33%	63	0.00%	34	0.00%	483
5-Jun	0	N/A	294	93.88%	16	50.00%	38	0.00%	42	0.00%	390
6-Jun	0	N/A	202	90.59%	18	55.56%	37	0.00%	16	0.00%	273
7-Jun	0	N/A	106	80.19%	8	50.00%	50	0.00%	11	0.00%	175
8-Jun	0	N/A	85	47.06%	2	50.00%	8	0.00%	0	N/A	95
9-Jun	0	N/A	209	72.25%	7	57.14%	19	0.00%	2	0.00%	237
10-Jun	0	N/A	138	60.14%	10	70.00%	22	0.00%	1	0.00%	171
11-Jun	0	N/A	111	63.06%	3	0.00%	12	0.00%	3	0.00%	129
12-Jun	1	0.00%	132	85.61%	1	100.00%	5	0.00%	2	0.00%	141
13-Jun	0	N/A	105	83.81%	3	100.00%	3	0.00%	4	0.00%	115
14-Jun	0	N/A	240	59.17%	6	0.00%	25	0.00%	5	0.00%	276
15-Jun	0	N/A	245	66.53%	4	25.00%	3	0.00%	2	0.00%	254
16-Jun	1	0.00%	354	61.30%	1	0.00%	11	0.00%	3	0.00%	370
17-Jun	1	0.00%	42	61.90%	2	0.00%	1	0.00%	2	0.00%	48
18-Jun	0	N/A	23	82.61%	0	N/A	2	0.00%	0	N/A	25
19-Jun	0	N/A	16	68.75%	1	100.00%	11	0.00%	1	0.00%	29
20-Jun	0	N/A	49	81.63%	1	100.00%	11	0.00%	1	0.00%	62
21-Jun	0	N/A	42	76.19%	0	N/A	4	0.00%	1	0.00%	47
22-Jun	0	N/A	14	85.71%	1	100.00%	9	0.00%	0	N/A	24
23-Jun	0	N/A	7	42.86%	0	N/A	3	0.00%	0	N/A	10
24-Jun	0	N/A	14	14.29%	2	0.00%	2	50.00%	1	0.00%	19
25-Jun	0	N/A	6	83.33%	1	0.00%	1	0.00%	0	N/A	8
26-Jun	0	N/A	11	36.36%	2	50.00%	0	N/A	0	N/A	13
27-Jun	0	N/A	9	11.11%	1	0.00%	4	0.00%	1	0.00%	15
28-Jun	0	N/A	10	20.00%	1	100.00%	0	N/A	0	N/A	11

29-Jun	0	N/A	12	66.67%	0	N/A	4	0.00%	0	N/A	16
30-Jun	0	N/A	26	46.15%	2	0.00%	0	N/A	0	N/A	28
1-Jul	0	N/A	8	37.50%	0	N/A	0	N/A	0	N/A	8
2-Jul	0	N/A	9	22.22%	2	0.00%	1	0.00%	2	0.00%	14
3-Jul	0	N/A	3	33.33%	1	0.00%	1	0.00%	2	0.00%	7
4-Jul	0	N/A	21	47.62%	0	N/A	1	0.00%	1	0.00%	23
5-Jul	0	N/A	22	45.45%	0	N/A	0	N/A	1	0.00%	23
6-Jul	0	N/A	87	32.18%	0	N/A	2	0.00%	1	0.00%	90
7-Jul	0	N/A	83	54.22%	0	N/A	1	0.00%	0	N/A	84
8-Jul	0	N/A	83	33.73%	0	N/A	1	0.00%	0	N/A	84
9-Jul	0	N/A	614	5.05%	0	N/A	2	0.00%	1	0.00%	617
10-Jul	0	N/A	149	7.38%	0	N/A	1	0.00%	1	0.00%	151
11-Jul	0	N/A	143	0.00%	2	0.00%	0	N/A	0	N/A	145
12-Jul	0	N/A	35	17.14%	2	50.00%	0	N/A	1	0.00%	38
13-Jul	0	N/A	47	4.26%	3	66.67%	0	N/A	0	N/A	50
14-Jul	0	N/A	408	1.23%	1	100.00%	1	0.00%	1	0.00%	411
15-Jul	0	N/A	17	0.00%	0	N/A	0	N/A	0	N/A	17
16-Jul	0	N/A	277	1.44%	2	100.00%	0	N/A	3	0.00%	282
17-Jul	0	N/A	240	0.42%	0	N/A	0	N/A	0	N/A	240
18-Jul	0	N/A	124	1.61%	0	N/A	0	N/A	1	0.00%	125
19-Jul	0	N/A	55	3.64%	0	N/A	0	N/A	0	N/A	55
20-Jul	0	N/A	117	0.00%	0	N/A	0	N/A	0	N/A	117
21-Jul	0	N/A	37	0.00%	0	N/A	1	0.00%	0	N/A	38
22-Jul	0	N/A	61	1.64%	0	N/A	0	N/A	0	N/A	61
23-Jul	0	N/A	39	0.00%	0	N/A	0	N/A	0	N/A	39
24-Jul	0	N/A	6	0.00%	0	N/A	0	N/A	0	N/A	6
25-Jul	0	N/A	21	0.00%	0	N/A	0	N/A	0	N/A	21
26-Jul	0	N/A	8	0.00%	0	N/A	0	N/A	0	N/A	8
27-Jul	0	N/A	11	0.00%	0	N/A	0	N/A	0	N/A	11
28-Jul	0	N/A	7	0.00%	0	N/A	0	N/A	0	N/A	7
29-Jul	0	N/A	8	0.00%	0	N/A	0	N/A	0	N/A	8
30-Jul	0	N/A	13	0.00%	0	N/A	0	N/A	0	N/A	13
31-Jul	0	N/A	14	0.00%	0	N/A	0	N/A	0	N/A	14
1-Aug	0	N/A	8	0.00%	0	N/A	0	N/A	1	0.00%	9
2-Aug	0	N/A	22	0.00%	0	N/A	0	N/A	0	N/A	22
3-Aug	0	N/A	24	0.00%	0	N/A	0	N/A	0	N/A	24
4-Aug	0	N/A	15	0.00%	0	N/A	0	N/A	0	N/A	15
5-Aug	0	N/A	19	0.00%	0	N/A	0	N/A	0	N/A	19
6-Aug	0	N/A	11	0.00%	0	N/A	0	N/A	0	N/A	11
7-Aug	0	N/A	51	0.00%	0	N/A	0	N/A	0	N/A	51
8-Aug	0	N/A	51	0.00%	0	N/A	0	N/A	0	N/A	51
9-Aug	0	N/A	46	0.00%	0	N/A	1	0.00%	0	N/A	47
10-Aug	0	N/A	6	0.00%	0	N/A	0	N/A	0	N/A	6
11-Aug	0	N/A	19	0.00%	0	N/A	0	N/A	0	N/A	19
12-Aug	0	N/A	27	0.00%	0	N/A	0	N/A	0	N/A	27
13-Aug	0	N/A	14	0.00%	0	N/A	0	N/A	0	N/A	14
14-Aug	0	N/A	15	0.00%	0	N/A	0	N/A	0	N/A	15

15-Aug	0	N/A	17	0.00%	0	N/A	0	N/A	0	N/A	17
16-Aug	0	N/A	11	0.00%	0	N/A	0	N/A	0	N/A	11
17-Aug	0	N/A	18	0.00%	0	N/A	0	N/A	0	N/A	18
18-Aug	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
19-Aug	0	N/A	1	0.00%	0	N/A	0	N/A	0	N/A	1
20-Aug	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
21-Aug	0	N/A	9	0.00%	0	N/A	0	N/A	0	N/A	9
22-Aug	0	N/A	3	0.00%	0	N/A	0	N/A	0	N/A	3
23-Aug	0	N/A	1	0.00%	0	N/A	0	N/A	0	N/A	1
24-Aug	0	N/A	1	0.00%	0	N/A	0	N/A	0	N/A	1
25-Aug	0	N/A	3	0.00%	0	N/A	0	N/A	0	N/A	3
26-Aug	0	N/A	6	0.00%	0	N/A	0	N/A	0	N/A	6
27-Aug	0	N/A	6	0.00%	0	N/A	0	N/A	0	N/A	6
28-Aug	0	N/A	4	0.00%	0	N/A	0	N/A	0	N/A	4
29-Aug	0	N/A	1	0.00%	0	N/A	0	N/A	0	N/A	1
30-Aug	0	N/A	5	0.00%	0	N/A	0	N/A	0	N/A	5
31-Aug	0	N/A	5	20.00%	0	N/A	1	0.00%	0	N/A	6
Totals	**8826**		**7813**		**1033**		**35115**		**2632**		**55419**

APPENDIX C. ANNUAL COLLECTION OF LAMPREY, BULL TROUT, AND WHITE STURGEON AT THE ROCKY REACH JSF, 2003 TO 2018.

Appendix C. Annual Collections of Pacific Lamprey, Bull Trout, and White Sturgeon at the Rocky Reach JSF, 2003 to 2018.

Lamprey		
Year	Number of Juveniles	Number of Adults
2003	122	5
2004	6	8
2005	11	3
2006	35	0
2007	3	0
2008	10	1
2009	13	3
2010	70	0
2011	1147	0
2012	5	0
2013	6	0
2014	7	7
2015	4	5
2016	3	5
2017	5	6
2018	13	42

Bull Trout	
Year	Number
2003	N/A
2004	N/A
2005	1
2006	1
2007	1
2008	14
2009	30
2010	11
2011	9
2012	0
2013	0
2014	0
2015	0
2016	1
2017	2
2018	1

White Sturgeon	
Year	Number
2003	N/A
2004	N/A
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	2
2012	0
2013	0
2014	0
2015	1
2016	0
2017	1
2018	4

APPENDIX D. DAILY DESCALE, INJURY, AND MORTALITY DATA FOR JUVENILE RUN-OF-RIVER SALMONIDS, SPRING AND SUMMER, 2018.

Appendix D. Daily descale, injury, and mortality data for juvenile run-of-river salmonids, April to August, 2018.

All Species								
Date	Number Examined	Number OK	Number Descaled >2	Percent Descale	Number Injured	Percent Injured	Mortality	Percent Mortality
1-Apr	1	1	0	0.00%	0	0.00%	0	0.00%
2-Apr	0	0	0	N/A	0	N/A	0	N/A
3-Apr	1	1	0	0.00%	0	0.00%	0	0.00%
4-Apr	6	6	0	0.00%	0	0.00%	0	0.00%
5-Apr	3	3	0	0.00%	0	0.00%	0	0.00%
6-Apr	1	1	0	0.00%	0	0.00%	0	0.00%
7-Apr	2	2	0	0.00%	0	0.00%	0	0.00%
8-Apr	5	5	0	0.00%	0	0.00%	0	0.00%
9-Apr	3	3	0	0.00%	0	0.00%	0	0.00%
10-Apr	11	11	0	0.00%	0	0.00%	0	0.00%
11-Apr	4	4	0	0.00%	0	0.00%	0	0.00%
12-Apr	5	5	0	0.00%	0	0.00%	0	0.00%
13-Apr	7	7	0	0.00%	0	0.00%	0	0.00%
14-Apr	21	20	0	0.00%	1	4.76%	0	0.00%
15-Apr	54	54	0	0.00%	0	0.00%	0	0.00%
16-Apr	28	28	0	0.00%	0	0.00%	0	0.00%
17-Apr	36	36	0	0.00%	0	0.00%	0	0.00%
18-Apr	218	217	0	0.00%	1	0.46%	0	0.00%
19-Apr	312	311	0	0.00%	1	0.32%	0	0.00%
20-Apr	572	564	1	0.17%	7	1.22%	0	0.00%
21-Apr	1006	1005	0	0.00%	1	0.10%	0	0.00%
22-Apr	688	681	0	0.00%	7	1.02%	0	0.00%
23-Apr	140	138	0	0.00%	2	1.43%	0	0.00%
24-Apr	102	101	1	0.98%	0	0.00%	0	0.00%
25-Apr	128	126	1	0.78%	1	0.78%	0	0.00%
26-Apr	160	160	0	0.00%	0	0.00%	0	0.00%
27-Apr	197	195	0	0.00%	2	1.02%	0	0.00%
28-Apr	1155	1153	1	0.09%	1	0.09%	0	0.00%
29-Apr	557	556	0	0.00%	1	0.18%	0	0.00%
30-Apr	1639	1636	1	0.06%	2	0.12%	0	0.00%
1-May	1308	1304	0	0.00%	2	0.15%	2	0.15%
2-May	2370	2369	0	0.00%	0	0.00%	1	0.04%
3-May	1478	1473	3	0.20%	2	0.14%	0	0.00%
4-May	1874	1872	0	0.00%	2	0.11%	0	0.00%
5-May	2451	2450	0	0.00%	1	0.04%	0	0.00%
6-May	1720	1719	0	0.00%	1	0.06%	0	0.00%
7-May	1629	1629	0	0.00%	0	0.00%	0	0.00%
8-May	1396	1393	0	0.00%	1	0.07%	2	0.14%
9-May	1785	1785	0	0.00%	0	0.00%	0	0.00%
10-May	1947	1944	0	0.00%	3	0.15%	0	0.00%
11-May	1471	1467	2	0.14%	2	0.14%	0	0.00%

12-May	1638	1634	1	0.06%	3	0.18%	0	0.00%
13-May	1854	1845	0	0.00%	8	0.43%	1	0.05%
14-May	1550	1537	2	0.13%	11	0.71%	0	0.00%
15-May	1183	1176	0	0.00%	7	0.59%	0	0.00%
16-May	1326	1316	3	0.23%	7	0.53%	0	0.00%
17-May	1352	1336	4	0.30%	12	0.89%	0	0.00%
18-May	1425	1423	0	0.00%	1	0.07%	1	0.07%
19-May	1520	1518	1	0.07%	0	0.00%	1	0.07%
20-May	1138	1133	0	0.00%	2	0.18%	3	0.26%
21-May	866	861	1	0.12%	4	0.46%	0	0.00%
22-May	1187	1186	0	0.00%	1	0.08%	0	0.00%
23-May	950	948	0	0.00%	2	0.21%	0	0.00%
24-May	827	822	1	0.12%	4	0.48%	0	0.00%
25-May	1213	1208	1	0.08%	4	0.33%	0	0.00%
26-May	1025	1023	0	0.00%	2	0.20%	0	0.00%
27-May	819	817	0	0.00%	2	0.24%	0	0.00%
28-May	407	405	0	0.00%	2	0.49%	0	0.00%
29-May	344	343	0	0.00%	1	0.29%	0	0.00%
30-May	343	336	3	0.87%	4	1.17%	0	0.00%
31-May	428	428	0	0.00%	0	0.00%	0	0.00%
1-Jun	282	279	1	0.35%	2	0.71%	0	0.00%
2-Jun	137	137	0	0.00%	0	0.00%	0	0.00%
3-Jun	421	421	0	0.00%	0	0.00%	0	0.00%
4-Jun	483	481	0	0.00%	2	0.41%	0	0.00%
5-Jun	390	386	0	0.00%	4	1.03%	0	0.00%
6-Jun	273	273	0	0.00%	0	0.00%	0	0.00%
7-Jun	175	172	0	0.00%	3	1.71%	0	0.00%
8-Jun	95	95	0	0.00%	0	0.00%	0	0.00%
9-Jun	237	237	0	0.00%	0	0.00%	0	0.00%
10-Jun	171	167	0	0.00%	4	2.34%	0	0.00%
11-Jun	129	128	0	0.00%	0	0.00%	1	0.78%
12-Jun	141	141	0	0.00%	0	0.00%	0	0.00%
13-Jun	115	115	0	0.00%	0	0.00%	0	0.00%
14-Jun	276	275	0	0.00%	1	0.36%	0	0.00%
15-Jun	254	252	1	0.39%	1	0.39%	0	0.00%
16-Jun	370	369	0	0.00%	1	0.27%	0	0.00%
17-Jun	48	47	0	0.00%	0	0.00%	1	2.08%
18-Jun	25	25	0	0.00%	0	0.00%	0	0.00%
19-Jun	29	27	1	3.45%	0	0.00%	1	3.45%
20-Jun	62	62	0	0.00%	0	0.00%	0	0.00%
21-Jun	47	47	0	0.00%	0	0.00%	0	0.00%
22-Jun	24	24	0	0.00%	0	0.00%	0	0.00%
23-Jun	10	10	0	0.00%	0	0.00%	0	0.00%
24-Jun	19	19	0	0.00%	0	0.00%	0	0.00%
25-Jun	8	7	0	0.00%	0	0.00%	1	12.50%
26-Jun	13	12	0	0.00%	1	7.69%	0	0.00%
27-Jun	15	15	0	0.00%	0	0.00%	0	0.00%

28-Jun	11	11	0	0.00%	0	0.00%	0	0.00%
29-Jun	16	16	0	0.00%	0	0.00%	0	0.00%
30-Jun	28	28	0	0.00%	0	0.00%	0	0.00%
1-Jul	8	8	0	0.00%	0	0.00%	0	0.00%
2-Jul	14	14	0	0.00%	0	0.00%	0	0.00%
3-Jul	7	7	0	0.00%	0	0.00%	0	0.00%
4-Jul	23	23	0	0.00%	0	0.00%	0	0.00%
5-Jul	23	23	0	0.00%	0	0.00%	0	0.00%
6-Jul	90	89	0	0.00%	1	1.11%	0	0.00%
7-Jul	84	82	0	0.00%	2	2.38%	0	0.00%
8-Jul	84	84	0	0.00%	0	0.00%	0	0.00%
9-Jul	617	615	1	0.16%	0	0.00%	1	0.16%
10-Jul	151	150	0	0.00%	1	0.66%	0	0.00%
11-Jul	145	145	0	0.00%	0	0.00%	0	0.00%
12-Jul	38	38	0	0.00%	0	0.00%	0	0.00%
13-Jul	50	49	1	2.00%	0	0.00%	0	0.00%
14-Jul	411	410	1	0.24%	0	0.00%	0	0.00%
15-Jul	17	16	0	0.00%	1	5.88%	0	0.00%
16-Jul	282	281	0	0.00%	1	0.35%	0	0.00%
17-Jul	240	238	1	0.42%	0	0.00%	1	0.42%
18-Jul	125	125	0	0.00%	0	0.00%	0	0.00%
19-Jul	55	55	0	0.00%	0	0.00%	0	0.00%
20-Jul	117	116	0	0.00%	1	0.85%	0	0.00%
21-Jul	38	38	0	0.00%	0	0.00%	0	0.00%
22-Jul	61	61	0	0.00%	0	0.00%	0	0.00%
23-Jul	39	39	0	0.00%	0	0.00%	0	0.00%
24-Jul	6	6	0	0.00%	0	0.00%	0	0.00%
25-Jul	21	21	0	0.00%	0	0.00%	0	0.00%
26-Jul	8	8	0	0.00%	0	0.00%	0	0.00%
27-Jul	11	11	0	0.00%	0	0.00%	0	0.00%
28-Jul	7	7	0	0.00%	0	0.00%	0	0.00%
29-Jul	8	8	0	0.00%	0	0.00%	0	0.00%
30-Jul	13	13	0	0.00%	0	0.00%	0	0.00%
31-Jul	14	13	1	7.14%	0	0.00%	0	0.00%
1-Aug	9	9	0	0.00%	0	0.00%	0	0.00%
2-Aug	22	22	0	0.00%	0	0.00%	0	0.00%
3-Aug	24	24	0	0.00%	0	0.00%	0	0.00%
4-Aug	15	15	0	0.00%	0	0.00%	0	0.00%
5-Aug	19	19	0	0.00%	0	0.00%	0	0.00%
6-Aug	11	11	0	0.00%	0	0.00%	0	0.00%
7-Aug	51	50	1	1.96%	0	0.00%	0	0.00%
8-Aug	51	50	1	1.96%	0	0.00%	0	0.00%
9-Aug	47	47	0	0.00%	0	0.00%	0	0.00%
10-Aug	6	6	0	0.00%	0	0.00%	0	0.00%
11-Aug	19	18	0	0.00%	1	5.26%	0	0.00%
12-Aug	27	27	0	0.00%	0	0.00%	0	0.00%
13-Aug	14	14	0	0.00%	0	0.00%	0	0.00%

14-Aug	15	15	**0**	0.00%	**0**	0.00%	**0**	0.00%
15-Aug	17	16	**0**	0.00%	**1**	5.88%	**0**	0.00%
16-Aug	11	11	**0**	0.00%	**0**	0.00%	**0**	0.00%
17-Aug	18	18	**0**	0.00%	**0**	0.00%	**0**	0.00%
18-Aug	0	0	**0**	N/A	**0**	N/A	**0**	N/A
19-Aug	1	1	**0**	0.00%	**0**	0.00%	**0**	0.00%
20-Aug	0	0	**0**	N/A	**0**	N/A	**0**	N/A
21-Aug	9	9	**0**	0.00%	**0**	0.00%	**0**	0.00%
22-Aug	3	3	**0**	0.00%	**0**	0.00%	**0**	0.00%
23-Aug	1	1	**0**	0.00%	**0**	0.00%	**0**	0.00%
24-Aug	1	1	**0**	0.00%	**0**	0.00%	**0**	0.00%
25-Aug	3	3	**0**	0.00%	**0**	0.00%	**0**	0.00%
26-Aug	6	6	**0**	0.00%	**0**	0.00%	**0**	0.00%
27-Aug	6	6	**0**	0.00%	**0**	0.00%	**0**	0.00%
28-Aug	4	4	**0**	0.00%	**0**	0.00%	**0**	0.00%
29-Aug	1	1	**0**	0.00%	**0**	0.00%	**0**	0.00%
30-Aug	5	5	**0**	0.00%	**0**	0.00%	**0**	0.00%
31-Aug	6	6	**0**	0.00%	**0**	0.00%	**0**	0.00%
Totals	**55419**	**55219**	**37**	**0.07%**	**146**	**0.26%**	**17**	**0.03%**

Descale = 5% for 3 consecutive days
Injury = 3% for 3 consecutive days
Mortality = 2% for 3 consecutive days

APPENDIX E. SUMMARY OF MARKED FISH RELEASES (MFR) WITHIN THE JFBS FOR EVALUATION OF DESCALE, INJURY, AND MORTALITY, SPRING, 2018.

Appendix E. Summary of Marked Fish Releases (MFR) within the JFBS for evaluation of descale, injury, and mortality, spring, 2018.

Purpose: Locate potential source of descale, injury, and mortality in bypass system pryor to season startup.

Date	Release Location*	Number Released	Number Recaptured	Number Partially Descaled (<10%)	Number Descaled (>20%)	Percent Descaled	Injured	Percent Injured	Mortality	Percent Mortality	"Apparent" Conclusion
3/22/18	SC (upstream of trashrack, north channel)	100	96	0	0	0.00%	0	0.00%	0	0.00%	No injury or mortality observed. No descale greater than 10% for either channel.
	SC (upstream of trashrack, south channel)	130	129	0	0	0.00%	0	0.00%	0	0.00%	
3/22/18	Unit 2	100	100	0	0	0.00%	0	0.00%	0	0.00%	

*Test release for Unit 1 was not performed as unit was down for maintenance for the entirety of the 2018 sampling season
SC - surface collector

APPENDIX F. SUMMARY OF HISTORIC FISH BYPASS EFFICIENCY (FBE) FOR ROCKY REACH DAM, 2003 TO 2011.

Appendix F. Summary of Historic Fish Bypass Efficiency (FBE) for Rocky Reach Dam JFBS, 2003-2011.

Fish Bypass Efficiency					
		Radio Tags (2003) Acoustic Tags (2004-2011)			
Year	Species-(river mile release site)	SC	ISS	SC2/GCS	Total
2003[1]	Chinook Yearlings-RM 484	44.2%	9.8%	N/A	54.0%
2003[1]	Steelhead-RM 484	51.5%	7.3%	N/A	58.8%
2003[1]	Sockeye Salmon-RM 484	10.6%	6.7%	N/A	17.3%
2003[1]	Subyearling Chinook-RM 484	31.0%	6.4%	N/A	37.4%
2004	Chinook Yearlings-RM 515.8	26.8%	5.8%	N/A	32.6%
2004	Steelhead-RM 515.8	66.8%	3.6%	N/A	70.4%
2004	Sockeye Salmon-RM 515.8	38.3%	1.2%	N/A	39.5%
2004	Subyearling Chinook-RM 515.8	24.7%	6.4%	N/A	31.1%
2005	Chinook Yearlings-RM 515.8	31.7%	9.2%	N/A	40.9%
2005	Steelhead-RM 515.8	67.5%	6.3%	N/A	73.8%
2005	Sockeye Salmon-RM 515.8	31.0%	8.2%	N/A	39.2%
2006	Steelhead-RM 515.8	64.0%	4.1%	N/A	68.1%
2006	Sockeye Salmon-RM 515.8	38.9%	3.4%	N/A	42.3%
2007	Sockeye Salmon-RM 515.8	36.9%	3.5%	N/A	40.4%
2008	Sockeye Salmon-RM 515.8	41.2%	4.5%	N/A	45.7%
2009	Sockeye Salmon-RM 515.9	56.3%	3.4%	N/A	59.7%
2010	Yearling Chinook Salmon-RM 515.9	48.4%	5.2%	N/A	53.6%
2011	Yearling Chinook Salmon-RM 515.9	42.6%	6.5%	N/A	49.1%

SC = Surface Collector; ISS = Intake Screen System; GCS = Gatewell Collection System; RM = River Mile

[1] First year of FBE studies with the permanent juvenile fish bypass system.

APPENDIX G. HISTORICAL DESCALE, INJURY, AND MORTALITY PATTERNS OBSERVED AT THE ROCKY REACH JSF (2005).

Appendix G. Historical descale, injury, and mortality patterns observed at Rocky Reach JSF (2005).

<u>Scratch Pattern Descale</u>

<u>Circular Pattern Descale</u>

Patch Pattern Descale

Injury (Herring Bone Injury)

Mortality

APPENDIX H. HISTORICAL PIKEMINNOW PREDATION EVENTS OBSERVED AT THE ROCKY REACH JSF (2005).

Appendix H. Historical pikeminnow predation events observed at the Rocky Reach JSF (2005).

Left side of smolt showing descale and lacerations

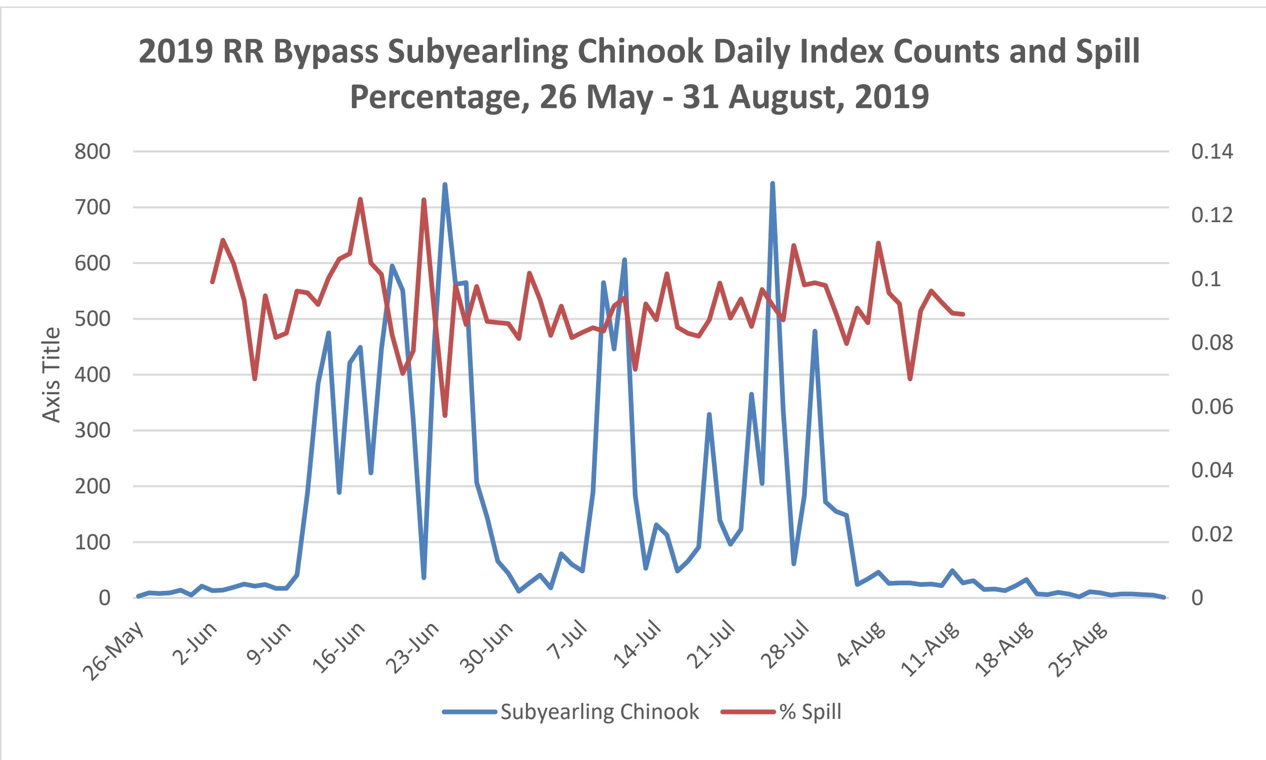
Pikeminnow (350 mm) and smolt (144 mm) size comparison

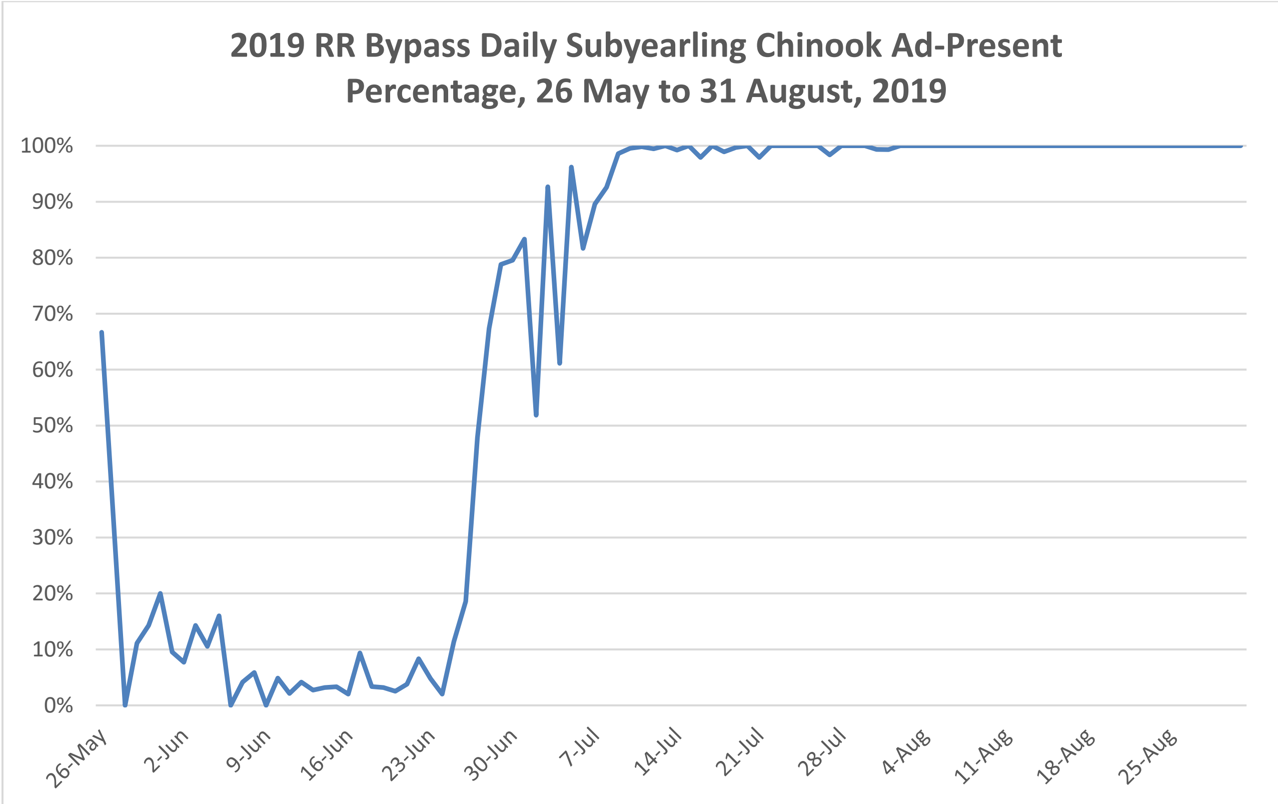
Appendix L
2019 Rocky Reach and Rock Island Fish Spill Report

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2019 Fish Spill Report

<u>2019 ROCKY REACH</u>
Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	2 June, 0001 hours
Spill stop date:	12 August, 2400 hours
95% Est. passage date:	28 July
Percent of run with spill:	99.1 % on 12 August (estimated as of 31 August)
Cumulative index count:	33,299 subyearling Chinook (as of 31 August)
Summer spill percentage:	9.09% (9.02% fish spill, plus 0.07% forced spill)
Avg river flow at RR:	100,417 cfs (2 June - 12 August)
Avg spill rate at RR:	9,131 cfs (2 June - 12 August)
Total spill days:	72

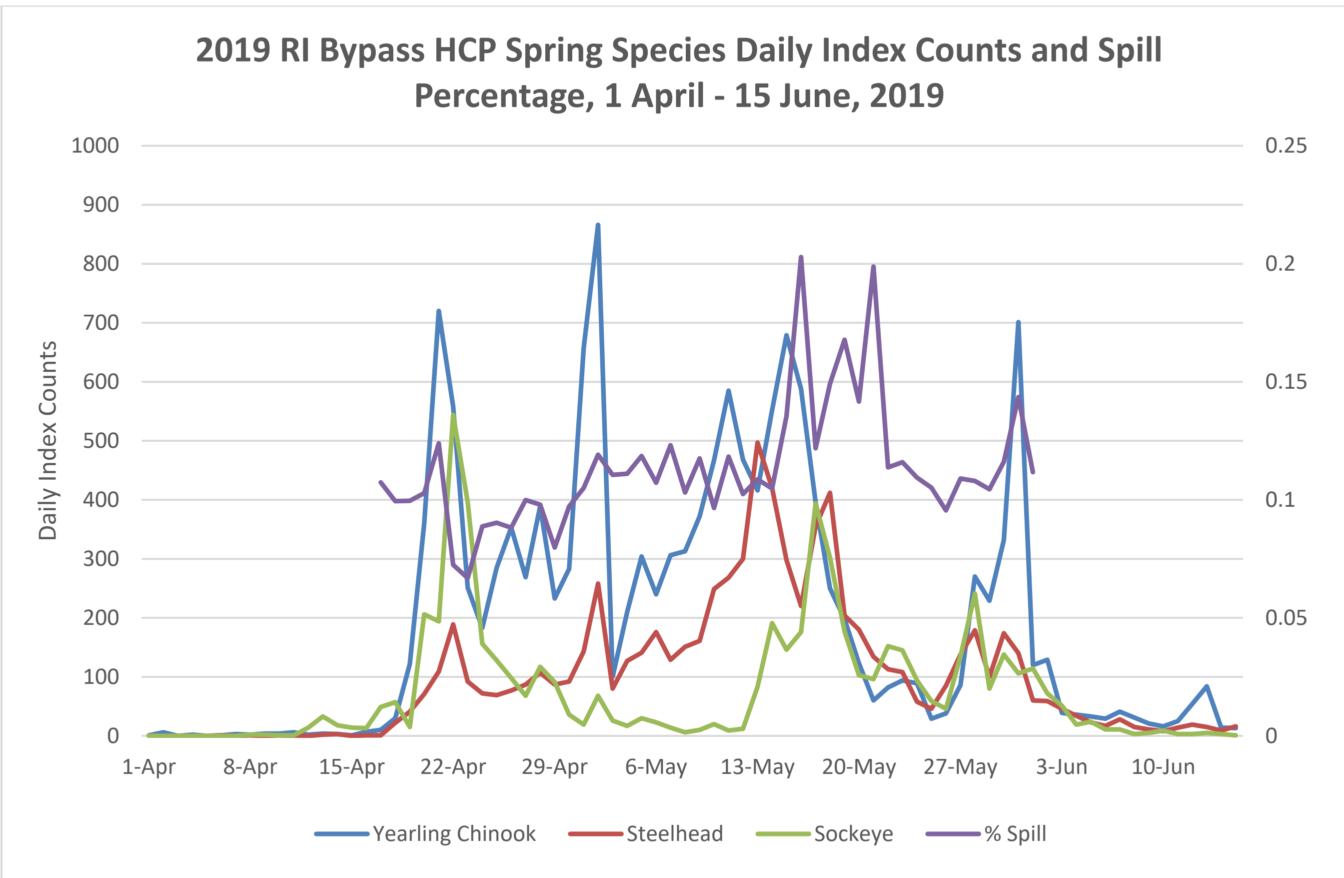



2019 RR Bypass Daily Subyearling Chinook Ad-Present
Percentage, 26 May to 31 August, 2019
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
26-May
2-Jun
9-Jun
16-Jun
23-Jun
30-Jun
7-Jul
14-Jul
21-Jul
28-Jul
4-Aug
11-Aug
18-Aug
25-Aug

2019 ROCK ISLAND

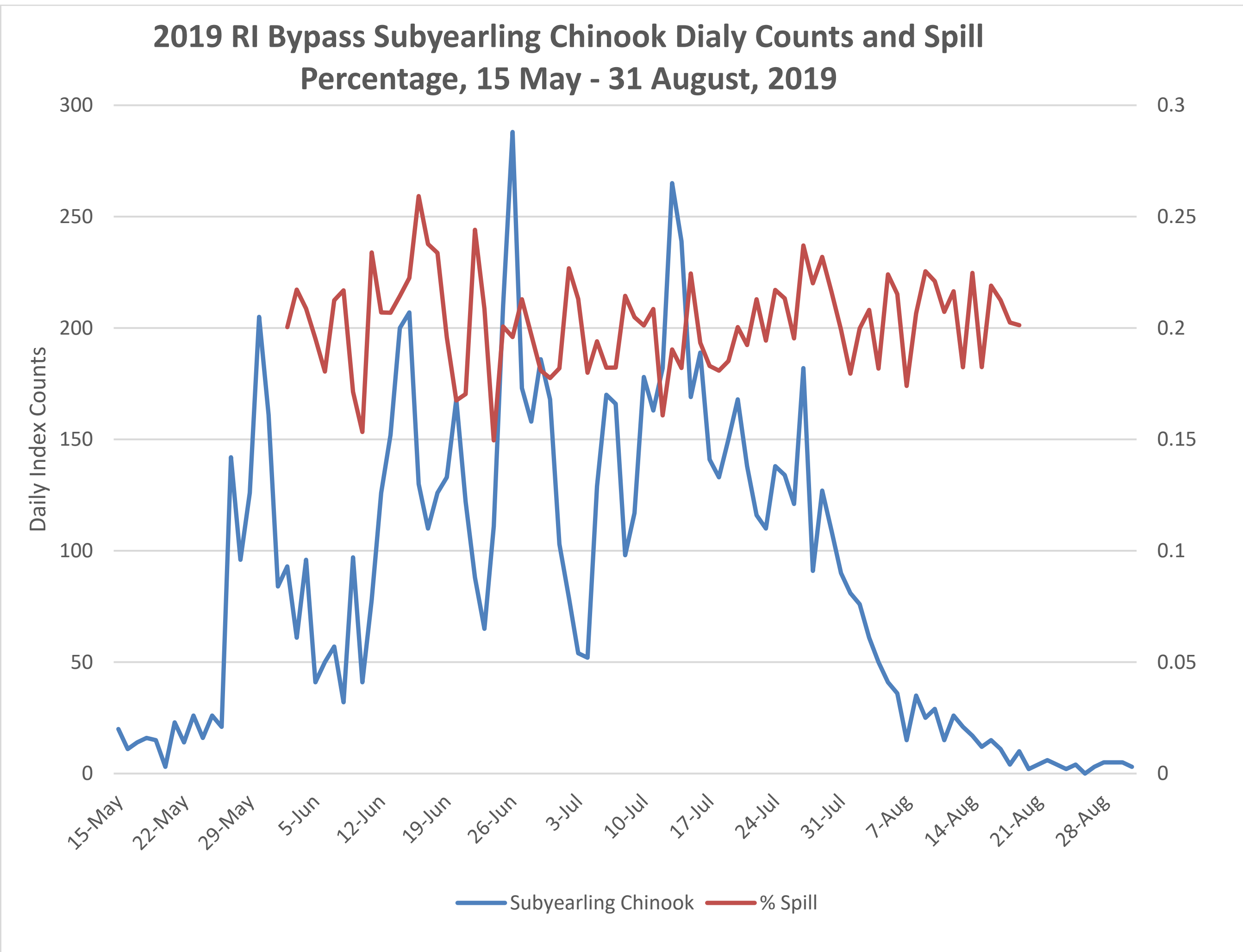
Spring Spill

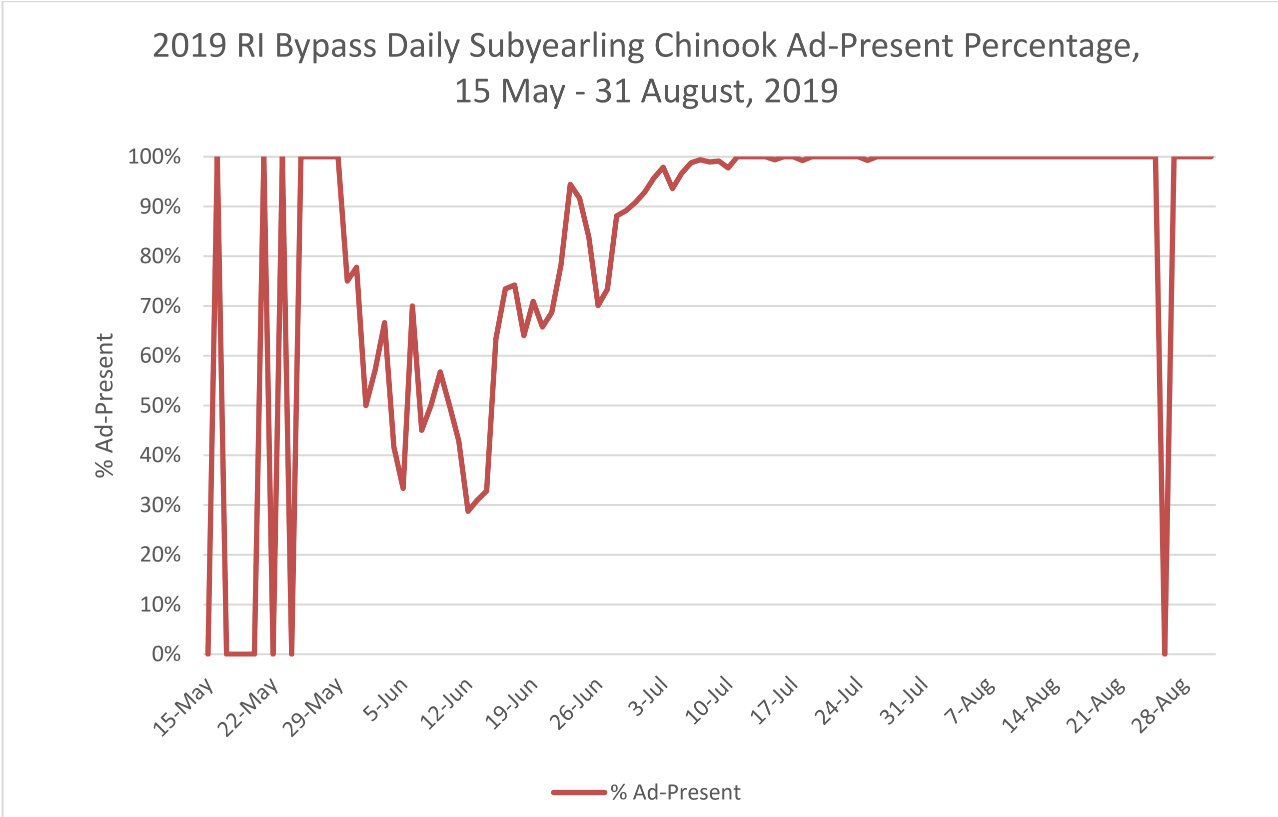
Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	17 April, 0001 hours
Spill stop date:	1 June, 2400 hours (immediate increase to 20% summer spill)
Percent of run with spill:	Yearling Chinook – 99.7%; steelhead – 99.9%; sockeye – 98.5% (spring and summer fish spill combined)
Cumulative index count:	18,855 yearling Chinook**;** 9,881 steelhead**;** 7,416 sockeye (as of 31 August)
Spring spill percentage:	11.67% (10.03% fish spill, plus 1.64% forced spill)
Avg river flow at RI:	128,137 cfs (17 April – 1 June)
Avg spill flow at RI:	14,948 cfs (17 April – 1 June)
Total spill days:	46



Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	2 June, 0001 hours
Spill stop date:	19 August, 2400 hours
95% Est. passage date:	3 August
Percent of run with spill:	98.5% on 19 August (estimated as of 31 August)
Cumulative index count:	11,876 subyearling Chinook (as of 31 August)
Summer spill percentage:	20.13% (19.90% fish spill, plus 0.23% forced spill)
Avg river flow at RI:	101,744 cfs (2 June - 19 August)
Avg spill flow at RI:	20,482 cfs (2 June - 19 August)
Total spill days:	79




2019 RI Bypass Daily Subyearling Chinook Ad-Present Percentage,
15 May - 31 August, 2019
% Ad-Present
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15-May
22-May
29-May
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
% Ad-Present

Juvenile Index Counts 2009-2019 from the Rocky Reach Juvenile Fish Bypass Sampling Facility and Rock Island Bypass Trap Smolt Monitoring Program (SMP) 1 April – 31 August (Tables 1 and 2).

Table 1. Rocky Reach Juvenile Bypass index sample counts, 2009-2019

Species	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018	2019
Sockeye	40,758	724,394	67,879	384,224	199,497	553,645	53,575	1,374,418	**60,432**	**597,162**	**34,212**
Steelhead	6,309	4,931	5,683	4,902	2,528	5,270	4,157	1,478	**2,928**	**1,458**	**3,769**
Yearling Chinook	18,946	33,840	24,400	95,207	29,018	15,871	32,220	41,676	**37,302**	**23,274**	**15,610**
Subyearling Chinook	11,944	59,751	17,246	5,774	22,073	22,327	37,104	8,905	**27,404**	**9,122**	**33,299**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2009-2019

Species	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018	2019
Sockeye	4,926	37,404	18,697	46,788	25,111	38,596	4,128	56,638	**11,117**	**76,245**	**7,416**
Steelhead	17,636	17,194	28,408	16,957	15,099	28,299	12,549	17,663	**32,135**	**24,731**	**9,881**
Yearling Chinook	9,225	11,802	26,407	25,759	28,324	26,429	16,762	44,784	**50,604**	**49,702**	**18,855**
Subyearling Chinook	8,189	23,205	27,397	27,298	17,170	34,527	15,349	13,270	**63,579**	**27,540**	**11,876**

* In 2014, as directed by the HCP, Chelan PUD conducted bypass operations outside of the normal operating period of 1 April to 31 August to assess achievement of bypass operations for 95% of the subyearling Chinook outmigration. The Rocky Reach juvenile fish bypass operated from 1 April through 15 September, and the Rock Island bypass facility at powerhouse 2 operated from 1 April through 15 September.

Appendix M
2017 Rock Island and Rocky Reach Pikeminnow Control Program Summary Report

Northern Pikeminnow Predator Control Program
Rocky Reach and Rock Island Hydroelectric Projects
Final Summary Report
2017

Northern Pikeminnow *(Ptychocheilus oregonensis)* Chelan County PUD Rocky Reach Dam, 2006.

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December 27, 2017

Abstract

This report provides information on Chelan PUD's Northern Pikeminnow (*Ptychocheilus oregonensis*) control programs for 2017. This program entails the use of deck and boat fishermen (USDA), long liners (Columbia Research), the East Wenatchee Rotary Club Pikeminnow Derby, as well as several miscellaneous efforts throughout the year.

Northern Pikeminnow are one of the most abundant predators of juvenile steelhead and salmonids (*Oncorhynchus spp.*) in the Columbia River. In 1998, the American Fisheries Society (AFS) formally changed the common name of this fish from Northern Squawfish to Northern Pikeminnow. Pikeminnow may concentrate in hydroelectric project tailraces during the late spring and summer months, concurrent with the juvenile salmonid migrations. The Public Utility District No. 1 of Chelan County (District) initiated a pikeminnow removal program in 1994 at Rocky Reach dam and extended the program to include Rock Island in 1995. Since 1996, the District has contracted annually with the United States Department of Agriculture Wildlife Services (USDA) to carry out this program. In addition to the USDA program, Chelan PUD conducted a pilot study using set-lines in 2005 under contract with Columbia Research. The objective of the set-line program was to remove pikeminnow from over-wintering habitats before the start of out-migration of salmonid smolts. The District also provides funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club. This year marked the 25th consecutive year for the annual derby and the 22nd consecutive year that the District has provided funding for the event.

In 2017, a total of 91,147 pikeminnow were removed from Rocky Reach and Rock Island reservoirs (62,387 by USDA, 24,981 by Columbia Research, 2,628 during the Pikeminnow Derby, and 1,151 by miscellaneous projects).

Table of Contents

List of Tables

List of Figures

Introduction

Northern Pikeminnow (*Ptychocheilus oregonensis*) are native to the Columbia River. Burley and Poe (1994) identified pikeminnow as the most abundant predator on out-migrating juvenile steelhead and salmonids (*Oncoryhynchus spp*.) in the mid-Columbia River between Priest Rapids and Chief Joseph dams. They also concluded that the highest abundance of pikeminnow concentrate in the tailrace areas. Loch et al (1994) reported that the highest consumption of juvenile salmonids takes place within the tailraces of dams and those pikeminnow densities in these areas increase during the late spring and summer. Pikeminnow are believed to become highly piscivorous on juvenile salmonids at approximately 280 mm (11 inches) and their predation rate on juvenile salmonids increase significantly as their size and age increases (Peterson, 2001).

In an effort to reduce predation on juvenile salmonids, the District implemented a pikeminnow removal program (Program) in 1994 in the Rocky Reach project area and in 1995 the program was expanded to include the Rock Island project area. From 1996 to present time, the District has contracted with the United States Department of Agriculture, Wildlife Services (USDA) to employ anglers to fish for pikeminnow during the summer months from the District's dams and reservoirs. The program has continued to focus on increasing fishing effort, increasing pikeminnow catch totals, and evaluating catch data to characterize attributes of the pikeminnow populations in the reservoirs. As a result, the USDA fish for a longer duration and with multiple boats. From 2005 to current, the District has contracted Columbia Research to fish for pikeminnow within the District's reservoirs with set-lines in an effort to remove pikeminnow from deeper over-wintering areas. Chelan PUD has also provided funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club. This year marked the 22nd consecutive year that the District has partnered with the Rotary Club.

Program Objectives

The objectives for the 2017 pikeminnow removal program were three-fold:

1) Reduce the number of pikeminnow in the Rocky Reach and Rock Island tailraces and reservoirs in order to reduce predation on juvenile anadromous salmon and steelhead smolts.

2) Continue to evaluate the efficiency of angling methods and the timing of seasonal fish movement to improve the efficiency and harvest.

3) Continue to evaluate current and historic catch statistics characterize effects of the removal program on pikeminnow populations in Rocky Reach and Rock Island reservoirs.

Methods and Materials

USDA
Since 1996, the District has contracted the USDA to conduct pikeminnow fishing from Rocky Reach and Rock Island projects. The USDA employs approximately 17 anglers to fish during the summer months. Crews consist of four 3-person boat crews, one 3-person crew at Rocky Reach dam, and one 2-person crew at Rock Island dam. Boat crews fished for 23 weeks from 25 April to 29 September. Deck crews fished for 14 weeks from 15 May to 18 August.

Each angler is outfitted with two fishing rods and reels, assorted tackle, tackle box, small ice chest (for keeping bait cool), fillet knife (for cutting bait), pliers, line clippers, personal floatation device, hard hat, 5 gallon bucket, and data sheets to record weekly catch. Each crew also carries a District radio or cell phone for communication. For more detail description of equipment used by anglers, please refer to West (2001).

Anglers fish a variety of locations within the tailraces and reservoirs in search of the most productive fish locations. Early in the fishing season when catch rates are low, anglers move in search of "hot spots". Later in the season when flows reside, water temperatures increase, and when anglers become more familiar with pikeminnow holding areas and feeding activity, the anglers are able to concentrate their efforts in established locations.

Each crew leader is in charge of recording specific information. Data is collected weekly from each crew including: total number of pikeminnow caught, total number of hours fished, fishing locations, number of non-target fish captured, and the dates that were fished. Twice a week anglers are required to measure fork length on all pikeminnow in order to evaluate the size distribution. Upon capture, pikeminnow are measured, euthanized, and their carcasses are returned to the river. All non-target species are released immediately back into the reservoir.

Columbia Research
Set-lines are the primary fishing technique used by Columbia Research to capture and remove pikeminnow. Set-lines are long weighted nylon lines with buoys attached at each end. The weighted rope allows the set-line to sink and remain on the bottom of the reservoir where pikeminnow tend to congregate during the winter months. Approximately 120 small hooks are attached to each line. Each hook is tied to a leader that contains a small float, which allows the hook to float slightly off the bottom substrate. An 8-pound test leader allows non-target species to break free from the set-line upon capture.

Each day, between 15 and 20 set-lines are deployed and allowed to fish for 24 hours. Deployment of set-lines occurs in the Rocky Reach and Rock Island reservoirs and varies in depth between 10 feet to 150 feet. Once set-lines are retrieved and non-target species are released, pikeminnow are measured (fork length), tails are removed and carcasses returned to the river, and tails are turned into the District for rendering. Columbia Research provides the District with specific information including: the number of pikeminnow caught on each set-line, fork length (mm), depth and location of each set-line, and set-line time. They also provide the District with a tally of any incidental species encountered during set-line retrieval.

East Wenatchee Rotary Club

The East Wenatchee Rotary Club takes place during the last week in June. During this two-day event, sportsmen fish Rocky Reach and Rock Island reservoirs for pikeminnow. After each day, the anglers submit their fish for count and total weight. Prizes are awarded to individuals who catch the most pikeminnow by weight. Daily prizes are awarded for the largest fish and the most fish as well.

Chelan County PUD #1

In past years, the District has either contracted or operated a pikeminnow trapping project using modified lamprey traps. Traps were very effective during peak pikeminnow migration season. However, trap efficiency is significantly decreased during seasons of above average adult Sockeye Salmon runs. The last year traps were used was in 2010. For an overview on trap configurations, please refer to Mallas and Stevenson, 2008. For past catch data, please refer to Keller et. al., 2010.

Program Contracts and Compensation

USDA

The USDA receives compensation on an hourly basis for labor through an annual contract. The contract is typically less than 7 months in duration, from May through mid-October. In 2017, the contract payout was $418,575.33. USDA rod and reel fishing activities for the tailrace and boat crews takes place 5 days a week for 8 hours each day.

Columbia Research

In 2017, Columbia Research received $3.00 for each fish between 127 mm and 227 mm and $7.75 for each fish great than 227 mm in fork length. Columbia Research received no compensation for fish measuring less than 127 mm. Columbia Research anglers fish 7 days a week, for up to 15 hours a day during the contract period. In 2017, Columbia Research conducted set-line fishing in the Rocky Reach and Rock Island reservoirs from April through the end of June. The total contract payout was $179,742.25.

East Wenatchee Rotary Club

The District contracts with the East Wenatchee Rotary Club to hold the annual Pikeminnow Derby. In 2017, this contract was $20,000 with specific requirements for anglers to fish in Rocky Reach and Rock Island reservoirs only.

Results

USDA

Since 2003, the USDA has removed 669,901 pikeminnow from the Rocky Reach and Rock Island projects. In 2017, USDA crews removed 62,387 pikeminnow from April through the end of September. (Table 1).

Table 1. Total pikeminnow removed from Rocky Reach and Rock Island projects by USDA from May through October 2003 to 2017.

Year	USDA
2003	19,754
2004	36,145
2005	39,818
2006	40,747
2007	46,240
2008	42,158
2009	50,333
2010	47,354
2011	36,401
2012	36,118
2013	47,563
2014	44,826
2015	59,730
2016	60,327
2017	62,387
Total	**669,901**

Pikeminnow Size Distribution

The USDA submitted length measurements to the District weekly. Fish lengths are recorded into size categories 10 mm in length. A total of 23,521 pikeminnow were measured in 2017. Of the pikeminnow measured, 19,533 were less than or equal to 250 mm, and 3,988 were greater than 250 mm (Table 2).

Table 2. Size and number of pikeminnow captured by USDA that were measured from the Rocky Reach and Rock Island reservoirs in 2017.

Size (mm)	USDA
100-110	749
111-120	982
121-130	1,273
131-140	1,608
141-150	1,921
151-160	1,898
161-170	1,998
171-180	1,774
181-190	1,433
191-200	1,585
201-210	1,103
211-220	1,029
221-230	948
231-240	665
241-250	567

251-260	468
261-270	412
271-280	390
281-290	380
291-300	396
301-310	276
311-320	275
321-330	241
331-340	212
341-350	163
351-360	136
361-370	116
371-380	105
381-390	70
391-400	88
401-410	52
411-420	45
421-430	40
431-440	38
441-450	25
451-460	14
461-470	16
471-480	6
481-490	8
491-500	6
501-510	3
511-520	1
521-530	2
531-540	3
541-550	0
551-560	1
561-570	0
571-580	0
581-590	0
591-600	0

The overall mean fork length of pikeminnow removed from both Rocky Reach and Rock Island in 2017 was 194 mm. The mean length for Rocky Reach and Rock Island were 186 mm and 248 mm respectively. Mean lengths are slightly up from 2016. Overall mean lengths have been generally decreasing over time since measurements began in 2003 (Table 3).

Table 3. The mean fork length (mm) of pikeminnow removed during USDA fishing at Rocky Reach and Rock Island projects, 2003 to 2017.

Year	Rocky Reach Mean Length (mm)	Rock Island Mean Length (mm)	Overall Mean Length (mm)
2003	232	249	236
2004	231	264	239
2005	223	254	237
2006	235	257	244
2007	236	251	244
2008	229	254	242
2009	239	252	245
2010	219	248	229
2011	200	262	218
2012	202	263	219
2013	195	247	207
2014	204	252	212
2015	181	262	192
2016	177	233	183
2017	186	248	194

Pikeminnow Catch Rates

In 2003, 2004, and 2005 the angler hours were reported as fishing day (8 hours). From 2006 through 2017, anglers fishing from the dam reported their time as "angling hours" while boat anglers reported fishing time as boat hours". Angling hours were just that – defined as the number of hours the tailrace crews spent fishing. Boat hours are defined as the number of hours the boat was in the water. It does not include the time required to launch or load the boat, refuel, or purchasing equipment. The catch per angler hour (CPAH) increased every year through 2008. The CPAH then began to decrease through 2012 before it began to generally increase again to 5.8 in 2017 (Table 4).

Table 4. The overall rod and reel CPAH for USDA pikeminnow anglers from May to October, 2003 to 2017.

Year	Angler Hours	Fish Captured	CPAH
2003	6,857.00	19,754	2.9
2004	11,676.00	36,145	3.1
2005	10,849.00	39,818	3.7
2006	9,159.50	40,747	4.4
2007	9,513.50	46,240	4.9
2008	8,317.50	42,158	5.1
2009	10,004.50	50,333	5.0
2010	10,187.50	47,354	4.6

2011	10,300.75	36,401	3.5
2012	10,261.05	36,118	3.5
2013	10,387.75	47,563	4.6
2014	10,333.60	44,826	4.3
2015	10,251.00	59,730	5.8
2016	10,438.50	60,327	5.8
2017	10,718.50	62,387	5.8

Cost Benefit Analysis

Expenditures for the USDA portion of the pikeminnow predator program have fluctuated since the initial start of the contract in 1996. Since 2013, the cost per fish has been near or below $7.00 with the exceptions of years 2011 through 2014 when prices reached a peak in 2012 at $9.85 per fish (Table 5).

Table 5. Cost of USDA pikeminnow program and the cost per fish breakdown from 2003 to 2017.

Year	Cost of Program	Fish Captured	Cost per fish
2003	$135,709.98	19,754	$6.87
2004	$237,834.10	36,145	$6.58
2005	$255,233.38	39,818	$6.41
2006	$263,225.62	40,747	$6.46
2007	$253,395.20	46,240	$5.48
2008	$264,752.24	42,158	$6.28
2009	$327,164.50	50,333	$6.50
2010	$332,425.08	47,354	$7.02
2011	$342,533.41	36,401	$9.41
2012	$355,685.00	36,118	$9.85
2013	$360,780.96	47,563	$7.59
2014	$373,112.00	44,826	$8.32
2015	$397,619.00	59,730	$6.66
2016	$402,710.00	60,327	$6.68
2017	$418,575.33	62,387	$6.71

Non-Target Fish Species

Rod and reel angling is one preferred pikeminnow removal method because baits can be tailored to exploit primarily pikeminnow and is the least harmful to non-target species. Non target species caught in 2017 included; Chiselmouth (*Acrocheilus alutaceus*), Peamouth (*Mylocheilus caurinus*), sucker species (*Catostomus sp*.), Mottled Sculpin (*Cottus bairdii*), Redside Shiners (*Richardsonius balteatus*), Smallmouth Bass (*Micropterus dolomieu*), Mountain Whitefish (*Prosopium williamsoni*), Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), White Sturgeon (*Acipenser transmontanus*), Common Carp (*Cyprinus carpio*), adult and juvenile salmon, and adult steelhead and resident Rainbow Trout (*Oncorhynchus mykiss*). In 2017, all non-target fish were released unharmed back to the river.

Columbia Research

Columbia Research has removed 345,846 pikeminnow from Rocky Reach and Rock Island reservoirs from 2005-2017. In 2017, set-lines run by Columbia Research produced 24,981 pikeminnow (Table 6).

Table 6. Total pikeminnow removed from Rocky Reach and Rock Island projects by Columbia Research from 2005 to 2017.

Year	Columbia Research
2005	19,337
2006	22,418
2007	21,301
2008	21,472
2009	31,683
2010	31,620
2011	32,846
2012	29,526
2013	29,310
2014	27,090
2015	26,790
2016	27,472
2017	24,981
Total	345,846

Pikeminnow Size Distribution

Columbia Research submitted length measurements to the District for all pikeminnow captured. Fish lengths are recorded into size categories 10 mm in length. Of the pikeminnow measured, 7,917 were less than or equal to 250 mm, and 17,064 were greater than 250 mm (Table 7).

Table 7. Size and number of pikeminnow captured by Columbia Research in Rocky Reach and Rock Island reservoirs in 2017.

Size (mm)	Columbia Research
100-110	0
111-120	0
121-130	0
131-140	238
141-150	279
151-160	219
161-170	168
171-180	156
181-190	153

191-200	185
201-210	238
211-220	470
221-230	992
231-240	2,178
241-250	2,641
251-260	2,866
261-270	2,333
271-280	2,572
281-290	2,444
291-300	1,910
301-310	1,463
311-320	1,046
321-330	710
331-340	511
341-350	360
351-360	224
361-370	158
371-380	110
381-390	69
391-400	71
401-410	42
411-420	49
421-430	27
431-440	26
441-450	26
451-460	13
461-470	8
471-480	11
481-490	6
491-500	5
501-510	1
511-520	1
521-530	0
531-540	2
541-550	0

Because the set-line program is an incentive based contract and that the main objective is to target deep over wintering habitats, Columbia Research is required to measure every pikeminnow captured. Both of these factors contribute to Columbia Research producing larger mean lengths compared to other District pikeminnow capture projects. In 2017, the average mean fork lengths in the Rocky Reach reservoir and Rock Island reservoir were 268 mm and 269 mm respectively. The overall 2017 mean fork length was 268 mm. The overall mean fork length for Columbia Research has been insignificantly trending downwards with the largest mean fork length (282 mm) in 2005 and the smallest mean fork length in 2016 (Table 8).

Table 8. The mean fork length of pikeminnow removed by Columbia Research set-line fishing at Rocky Reach and Rock Island projects, 2005 to 2017.

Year	Rocky Reach Mean Length (mm)	Rock Island Mean Length (mm)	Overall Mean Length (mm)
2005	N/A	N/A	282
2006	N/A	N/A	281
2007	269	294	281
2008	269	268	269
2009	274	272	274
2010	267	256	261
2011	258	270	261
2012	293	288	275
2013	268	273	270
2014	262	274	268
2015	268	276	270
2016	260	252	258
2017	268	269	268

Pikeminnow Catch Rates

In 2017, Columbia Research removed 24,981 pikeminnow during 39,288 hours of set-line effort. This equates to 4,714,560 hook hours as each set line has 120 hooks. The overall catch per unit effort (CPUE) was 0.53 for 2017. This was the highest CPUE in the last ten years. The District calculates CPUE as the number of pikeminnow captured per 100 hook hours. In general, the CPUE for Columbia Research has remained fairly constant (Table 9).

Table 9. Annual catch per unit effort (CPUE) for Columbia Research in Rocky Reach and Rock Island reservoirs, 2008 to 2017.

Year	Total Hook Hours	Fish Captured	CPUE*
2008	6,624,000	21,472	0.32
2009	10,980,000	31,683	0.29
2010	8,517,600	31,620	0.37
2011	10,332,000	32,846	0.32
2012	9,388,800	29,526	0.31
2013	9,129,600	29,310	0.32
2014	8,643,600	27,090	0.31
2015	6,402,240	26,790	0.42
2016	7,430,400	27,472	0.37
2017	4,714,560	24,981	0.53

*CPUE is calculated as the number of pikeminnow per 100 hook hours.

Cost Benefit Analysis

Columbia Research is compensated on a per-fish basis. Fish captured between 127 mm and 227 mm were compensated at a lower rate than fish captured that measured greater than 227 mm in length. These two size categories are considered "Under" and "Over" the 227 mm delineation. In 2005, Columbia Research received $2.75 or $5.50 per fish depending on size. In 2006, compensation rate increased to $3.00 and $6.00 respectively. In 2007, the compensation rate increased to $3.00 and $6.25 depending on fish size. From 2008 to 2011, Columbia Research received $3.00 or $6.50 per fish. For years 2012 and 2013 the compensation rate increased to $3.00 and $6.75 respectively. From 2014 to 2016 the compensation rate was $3.00 and $7.25 per fish. In 2017, the compensation rate increased to $3.00 for fish 127 mm to 227 mm and $7.75 for fish greater than 227 mm in length. No compensation was awarded for any fish measuring less than 127 mm. For the District's total annual compensation to Columbia Research for their pikeminnow efforts and the equivalent annual cost per fish refer to Table 10.

Table 10. Cost of Columbia Research set-line program in Rocky Reach and Rock Island and the cost per fish breakdown from 2005 to 2017.

Year	Cost of Program	Fish Captured	Cost per fish
2005	$99,726.00	19,337	$5.16
2006	$125,000.00	22,418	$5.58
2007	$124,998.75	21,301	$5.87
2008	$124,997.50	21,472	$5.82
2009	$174,999.50	31,683	$5.52
2010	$174,999.50	31,620	$5.53
2011	$180,250.50	32,846	$5.49
2012	$180,000.00	29,526	$6.10
2013	$179,988.75	29,310	$6.14
2014	$179,742.50	27,090	$6.64
2015	$179,998.50	26,790	$6.72
2016	$179,906.75	27,472	$6.55
2017	$179,742.25	24,981	$7.20

Non-Target Fish Species

The non-target fish species caught by Columbia Research included Chiselmouth, Peamouth, sucker species, Mottled Sculpin, Mountain Whitefish, White Sturgeon, and Burbot (*Lota lota*). In 2017, no adult or juvenile salmon or steelhead were captured. All non-target fish were released unharmed back into the river.

East Wenatchee Rotary Club

The East Wenatchee Rotary Club Annual Pikeminnow Derby has captured 63,043 pikeminnow in 44 days of total fishing since 1996. In 2017, the annual derby produced 2,628 pikeminnow over the 2-day event. There were 75 tickets sold (65 adults and 10 youth). Of the participants, all 75 people turned in fish. While participation was slightly down (76 active participants in 2016), total pikeminnow captured increased in 2017 (Table 11).

Table 11. Total pikeminnow removed from Rocky Reach and Rock Island reservoirs during the annual Pikeminnow Derby from 1996 to 2017.

Year	Pikeminnow Captured
1996	1,800
1997	2,240
1998	1,847
1999	2,294
2000	1,370
2001	1,601
2002	2,783
2003	2,568
2004	2,943
2005	3,950
2006	3,445
2007	3,812
2008	4,474
2009	3,812
2010	5,027
2011	3,274
2012	2,894
2013	2,944
2014	2,563
2015	2,427
2016	2,347
2017	2,628
Total	63,043

Discussion

USDA

The continued success of the USDA program is likely a result from a variety of factors. A key efficiency is credited to a core group of veteran anglers who return to work in the program each year, resulting in high catch rates overall. Experienced anglers are more productive, relying on their knowledge of pikeminnow holding areas in the reservoirs, effective baits, and presentation methods. While the USDA continues to catch similar numbers of pikeminnow each year, the overall average size has dropped considerably over the course of the program. The lowest three years for overall average size have occurred the last three years. The start and duration of the USDA pikeminnow program is designed to coincide with the outmigration period of juvenile salmonids. Smolts arrive at Rocky Reach and Rock Island Dams in early April, and continue passing the dams through the end of August. Pikeminnow primarily ascend the adult fish ladders during mid-May through September. Peak ladder passage occurs in August at Rocky Reach and in mid-July at Rock Island. The highest catch rates for pikeminnow usually occur in July and August for Rocky Reach and Rock Island.

Columbia Research

The objective for the Columbia Research set-line program was to remove large pikeminnow that congregate in deep over-wintering areas. Columbia Research has become very efficient at using set-lines. Because set-line angling is designed to capture fish that hold on or near the river bottom, targeting deep areas within the reservoir where pikeminnow congregate in colder months is effective. Pikeminnow likely move into deep pools where the daily water temperature remains more constant. A fish's metabolic rate decreases over winter periods, and hence it needs less food to survive (Sauter et. al, 1994). By presenting pikeminnow with food that they do not have to chase, they likely expend very little effort and energy to obtain the bait. The boat crew deployed 20 set-lines nearly every day at various depths. In 2017, all fish were caught at depths between the surface and 120 feet with most fish being caught between the surface and 90 feet.

Fishing with set-lines and at deeper depths has resulted in Columbia Research having a larger mean length than USDA over the years. From year to year there is some overlap but it can be seen that the two programs are targeting pikeminnow from different size classes (Figure 1). Also seen in Figure 1 is that the trend for both programs is a reduction in mean length over time. If capture rates can outpace the recruitment rate then this would result in a reduction in mean length over time. Columbia Research's mean length has steadily declined despite the fact they are targeting larger fish for a higher payout. It is predicted that the programs will reach a point where capture rates will off-set the recruitment rates and mean lengths will start to level off.

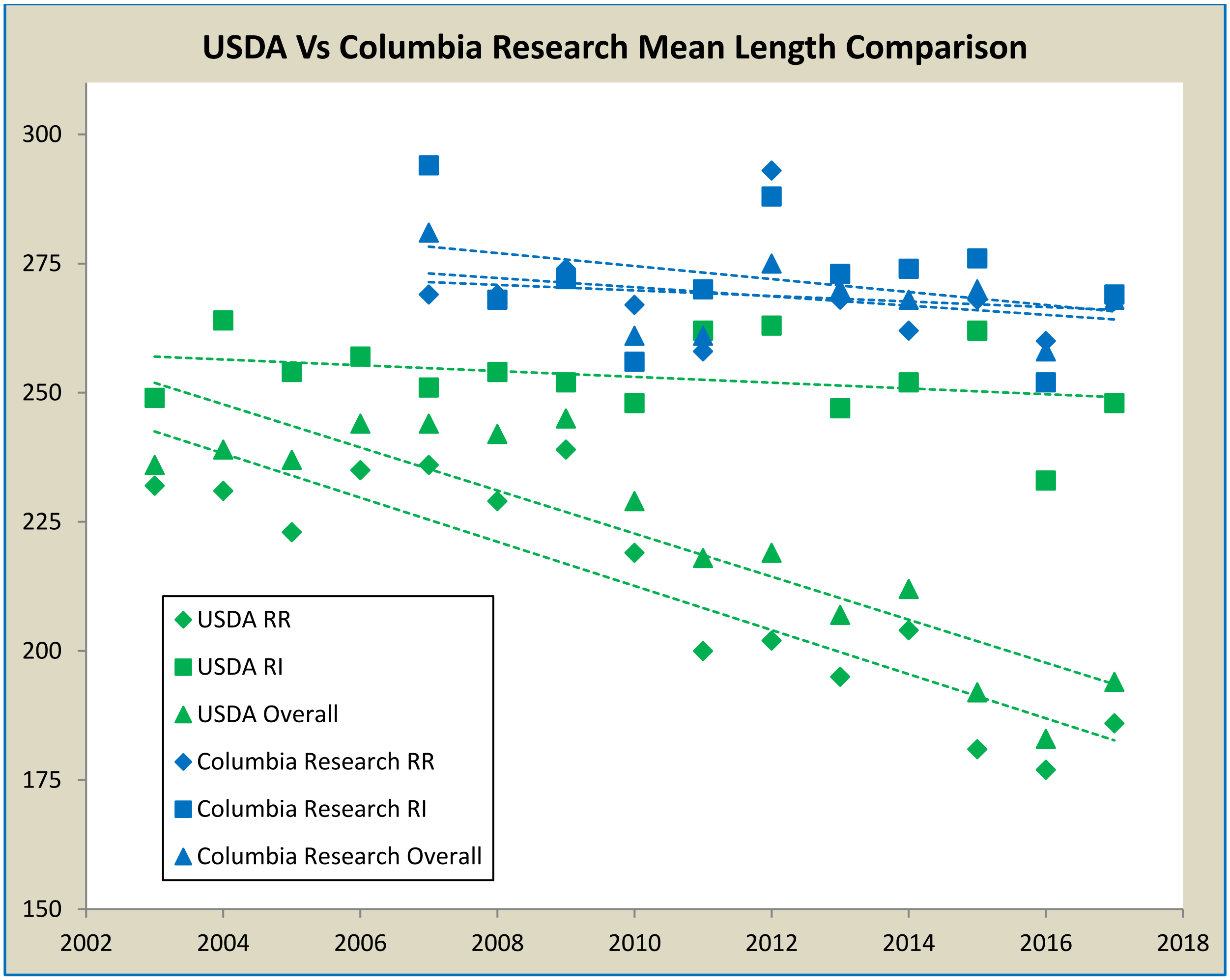

Figure 1. Mean fork lengths (mm) for pikeminnow captured by Columbia Research and the USDA from 2003 to 2017.

East Wenatchee Rotary Derby

The Pikeminnow Derby is in its 25th year and marks the District's longest effort toward reduction in pikeminnow numbers. While numbers in the past have been higher, this year's effort was impacted by high flows. The derby is only a two-day event and can be influenced heavily by weather and river conditions. Since the limiting factor is the number of anglers on the river, additional efforts should be put into increasing the number of anglers participating. This was addressed in 2015 by doubling the prize contribution by the District from $10,000 to $20,000. The District will continue to evaluate how this increase impacts the level of participation over the next few years.

Chelan County PUD (miscellaneous)

In past years the District has conducted pikeminnow ladder trapping efforts in both Rocky Reach and Rock Island fish ladders. These efforts were abandoned in the 2011 season due to the increased bycatch of adult Sockeye Salmon. With the increased run sizes of Sockeye Salmon and the overall success of the District's other pikeminnow programs, the District abandoned the ladder trapping completely in 2012.

In 2017, there were 1,151 pikeminnow caught in miscellaneous instances. Some of these miscellaneous captures included bycatch at facilities, fish ladder outage rescues, bycatch during miscellaneous studies, and a few targeted angling efforts by District employees. These various events accounted for 1.3% of the total pikeminnow catch in 2017. An overall visual of the District's different pikeminnow programs can be seen in Figure 2.

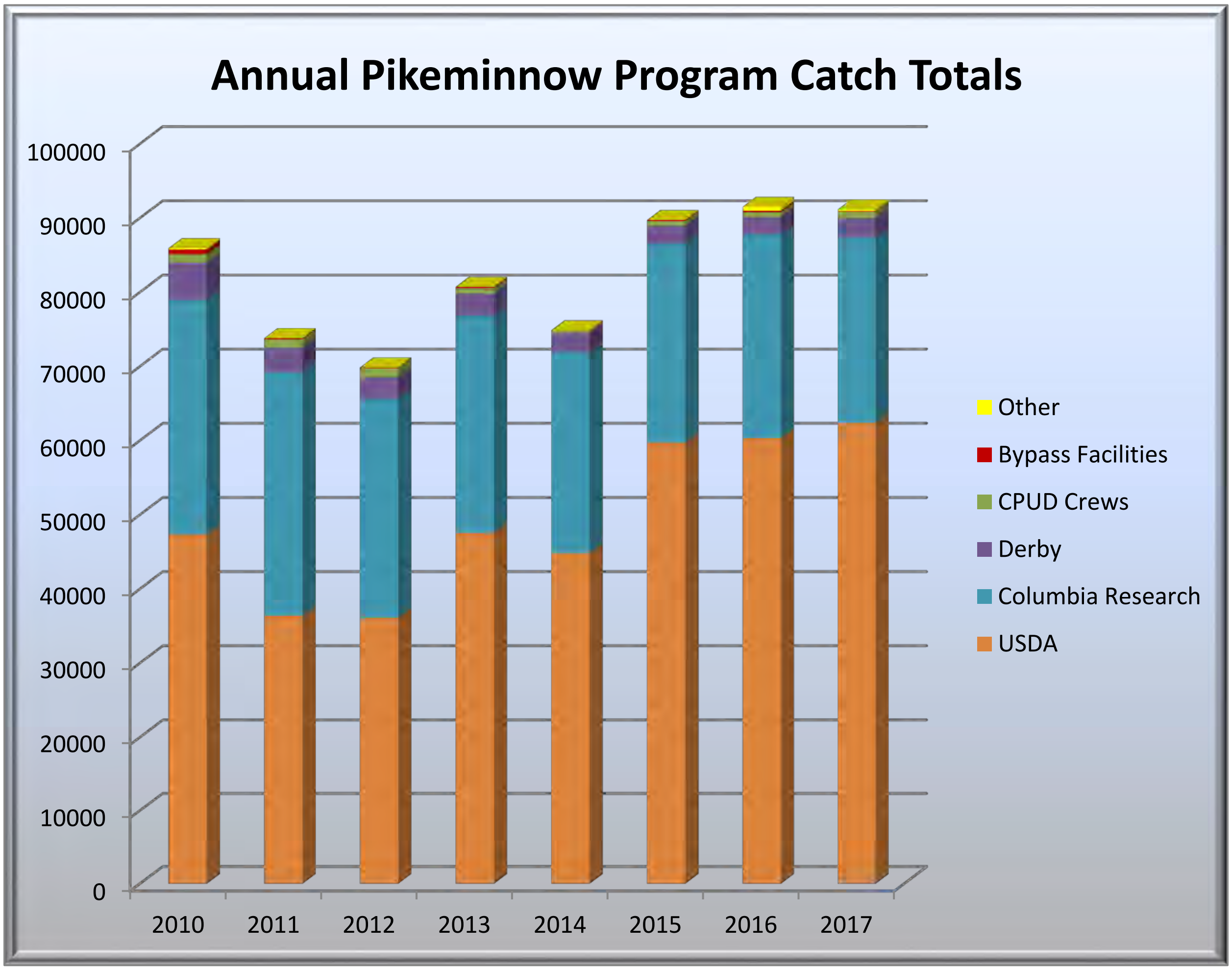

Figure 2. Breakdown of pikeminnow contributions from Chelan County PUD's different pikeminnow programs from 2010 to 2017.

Project Recommendations

USDA

Several factors, including USDA angler skills, reservoir knowledge, increased efforts, and overall program duration combined to make the 2017 the most successful pikeminnow effort to date for the USDA. The USDA anglers continue to maintain excellent pikeminnow catch rates by documenting fish movements and holding locations. We expect that overall catch may increase as anglers continue to learn where pikeminnow reside during the summer and fall months. However, if the program has started to outpace the recruitment efforts, then we may start to see a decrease in total capture numbers. If possible, the District should continue to utilize

USDA anglers with experience and knowledge of the reservoirs and who are familiar and adept at the angling techniques used in the program.

Columbia Research

We recommend continuing the set-line program at the 2017 funding and effort level. This program is productive because it compensates on a per fish basis, with no equipment, fuel, or administrative costs. The current recommendation is to continue to start the program in February and continue through November to take advantage of favorable CPUE documented during past fishing efforts in November.

East Wenatchee Rotary Derby

The District should continue to fund the East Wenatchee Rotary Club Pikeminnow Derby at its current funding level. The derby removes a large number of fish in a short time frame of two days. This likely provides an immediate within-year benefit to juvenile survival in the reservoirs. Since 1996 the derby has removed 63,043 pikeminnow in just 44 days of effort. In order to increase overall angler turn out the District should increase efforts to advertise the derby. The increased advertising along with the contribution increase from $10,000 to $20,000 in 2015 should help encourage higher participation. The Rotary Club should continue to host the event concurrent with the peak smolt migrations through Rocky Reach and Rock Island Reservoirs.

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Appendix N
2018 Rock Island and Rocky Reach Pikeminnow Control Program Summary Report

Northern Pikeminnow Predator Control Program
Rocky Reach and Rock Island Hydroelectric Projects
Final Summary Report
2018

Northern Pikeminnow *(Ptychocheilus oregonensis)* Chelan County PUD Rocky Reach Dam, 2006.

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Abstract

This report provides information on Chelan PUD's Northern Pikeminnow (*Ptychocheilus oregonensis*) control programs for 2018. This program entails the use of deck and boat fishermen (USDA), long liners (Columbia Research), the East Wenatchee Rotary Club Pikeminnow Derby, as well as several miscellaneous efforts throughout the year.

Northern Pikeminnow are one of the most abundant predators of juvenile steelhead and salmonids (*Oncorhynchus spp.*) in the Columbia River. In 1998, the American Fisheries Society (AFS) formally changed the common name of this fish from Northern Squawfish to Northern Pikeminnow. Pikeminnow may concentrate in hydroelectric project tailraces during the late spring and summer months, concurrent with the juvenile salmonid migrations. The Public Utility District No. 1 of Chelan County (District) initiated a pikeminnow removal program in 1994 at Rocky Reach dam and extended the program to include Rock Island in 1995. Since 1996, the District has contracted annually with the United States Department of Agriculture Wildlife Services (USDA) to carry out this program. In addition to the USDA program, Chelan PUD conducted a pilot study using set-lines in 2005 under contract with Columbia Research. The objective of the set-line program was to remove pikeminnow from over-wintering habitats before the start of out-migration of salmonid smolts. The District also provides funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club. This year marked the 26th consecutive year for the annual derby and the 23rd consecutive year that the District has provided funding for the event.

In 2018, a total of 84,218 pikeminnow were removed from Rocky Reach and Rock Island reservoirs (54,410 by USDA, 25,412 by Columbia Research, 3,209 during the Pikeminnow Derby, and 1,187 by miscellaneous projects).

Table of Contents

List of Tables

List of Figures

Introduction

Northern Pikeminnow (*Ptychocheilus oregonensis*) are native to the Columbia River. Burley and Poe (1994) identified pikeminnow as the most abundant predator on out-migrating juvenile steelhead and salmonids (*Oncoryhynchus spp*.) in the mid-Columbia River between Priest Rapids and Chief Joseph dams. They also concluded that the highest abundance of pikeminnow concentrate in the tailrace areas. Loch et al (1994) reported that the highest consumption of juvenile salmonids takes place within the tailraces of dams and those pikeminnow densities in these areas increase during the late spring and summer. Pikeminnow are believed to become highly piscivorous on juvenile salmonids at approximately 280 mm (11 inches) and their predation rate on juvenile salmonids increase significantly as their size and age increases (Peterson, 2001).

In an effort to reduce predation on juvenile salmonids, the District implemented a pikeminnow removal program (Program) in 1994 in the Rocky Reach project area and in 1995 the program was expanded to include the Rock Island project area. From 1996 to present time, the District has contracted with the United States Department of Agriculture, Wildlife Services (USDA) to employ anglers to fish for pikeminnow during the summer months from the District's dams and reservoirs. The program has continued to focus on increasing fishing effort, increasing pikeminnow catch totals, and evaluating catch data to characterize attributes of the pikeminnow populations in the reservoirs. As a result, the USDA fish for a longer duration and with multiple boats. From 2005 to current, the District has contracted Columbia Research to fish for pikeminnow within the District's reservoirs with set-lines in an effort to remove pikeminnow from deeper over-wintering areas. Chelan PUD has also provided funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club. This year marked the 23rd consecutive year that the District has partnered with the Rotary Club.

Program Objectives

The objectives for the 2018 pikeminnow removal program were three-fold:

1) Reduce the number of pikeminnow in the Rocky Reach and Rock Island tailraces and reservoirs in order to reduce predation on juvenile anadromous salmon and steelhead smolts.

2) Continue to evaluate the efficiency of angling methods and the timing of seasonal fish movement to improve the efficiency and harvest.

3) Continue to evaluate current and historic catch statistics characterize effects of the removal program on pikeminnow populations in Rocky Reach and Rock Island reservoirs.

Methods and Materials

USDA

Since 1996, the District has contracted the USDA to conduct pikeminnow fishing from Rocky Reach and Rock Island projects. The USDA employs approximately 17 anglers to fish during the summer months. Crews consist of four 3-person boat crews, one 3-person crew at Rocky Reach dam, and one 2-person crew at Rock Island dam. Boat crews fished for 23 weeks from 1 May to 10 October. Deck crews fished for 14 weeks from 14 May to 21 August. A partial week of fishing by both the boat crews and deck crews was missed in mid-August due to hazardous air quality conditions. These missed fishing days were made up on the backside of the season for each respective group.

Each angler is outfitted with two fishing rods and reels, assorted tackle, tackle box, small ice chest (for keeping bait cool), fillet knife (for cutting bait), pliers, line clippers, personal floatation device, hard hat, 5 gallon bucket, and data sheets to record weekly catch. Each crew also carries a District radio or cell phone for communication. For more detail description of equipment used by anglers, please refer to West (2001).

Anglers fish a variety of locations within the tailraces and reservoirs in search of the most productive fish locations. Early in the fishing season when catch rates are low, anglers move in search of "hot spots". Later in the season when flows reside, water temperatures increase, and when anglers become more familiar with pikeminnow holding areas and feeding activity, the anglers are able to concentrate their efforts in established locations.

Each crew leader is in charge of recording specific information. Data is collected weekly from each crew including; total number of pikeminnow caught, total number of hours fished, fishing locations, number of non-target fish captured, and the dates that were fished. Twice a week anglers are required to measure fork length on all pikeminnow in order to evaluate the size distribution. Upon capture, pikeminnow are measured, euthanized, and their carcasses are returned to the river. All non-target species are released immediately back into the reservoir.

Columbia Research

Set-lines are the primary fishing technique used by Columbia Research to capture and remove pikeminnow. Set-lines are long weighted nylon lines with buoys attached at each end. The weighted rope allows the set-line to sink and remain on the bottom of the reservoir where pikeminnow tend to congregate during the winter months. Approximately 120 small hooks are attached to each line. Each hook is tied to a leader that contains a small float, which allows the hook to float slightly off the bottom substrate. An 8-pound test leader allows non-target species to break free from the set-line upon capture.

Each day, between 15 and 20 set-lines are deployed and allowed to fish for 24 hours. Deployment of set-lines occurs in the Rocky Reach and Rock Island reservoirs and varies in depth between 5 feet to 115 feet. Once set-lines are retrieved and non-target species are released, pikeminnow are measured (fork length), tails are removed and carcasses returned to the river, and tails are turned into the District for rendering. Columbia Research provides the District with specific information including; the number of pikeminnow caught on each set-line, fork length (mm), depth and location of each set-line, and set-line time. They also provide the District with any incidental species encountered during set-line retrieval.

East Wenatchee Rotary Club

The East Wenatchee Rotary Club takes place during the last week in June. During this two-day event, sportsmen fish Rocky Reach and Rock Island reservoirs for pikeminnow. After each day, the anglers submit their fish for count and total weight. Prizes are awarded to individuals who catch the most pikeminnow by weight. Daily prizes are awarded for the largest fish and the most fish as well.

Chelan County PUD #1

In past years, the District has either contracted or operated a pikeminnow trapping project using modified lamprey traps. Traps were very effective during peak pikeminnow migration season. However, trap efficiency is significantly decreased during seasons of above average adult Sockeye Salmon runs. The last year traps were used was in 2010. For an overview on trap configurations, please refer to Mallas and Stevenson, 2008. For past catch data, please refer to Keller et. al., 2010.

Program Contracts and Compensation

USDA

The USDA receives compensation on an hourly basis for labor through an annual contract. The contract is typically less than 7 months in duration, from May through mid-October. In 2018, the total contract payout was $410,822.76. USDA rod and reel fishing activities for the tailrace and boat crews takes place 5 days a week for 8 hours each day.

Columbia Research

In 2018, Columbia Research received $3.00 for each fish between 127 mm and 227 mm and $7.75 for each fish great than 227 mm in fork length. Columbia Research received no compensation for fish measuring less than 127 mm. Columbia Research anglers fish 7 days a week, for up to 15 hours a day during the contract period. In 2018, Columbia Research conducted set-line fishing in the Rocky Reach and Rock Island reservoirs from March through the first week of July. The total contract payout was $180,000.00.

East Wenatchee Rotary Club

The District contracts with the East Wenatchee Rotary Club to hold the annual Pikeminnow Derby. In 2018, this contract was $20,000 with specific requirements for anglers to fish in Rocky Reach and Rock Island reservoirs only.

Results

USDA

Since 2003, the USDA has removed 724,311 pikeminnow from the Rocky Reach and Rock Island projects. In 2018, USDA crews removed 54,410 pikeminnow from May through the first week of October. (Table 1).

Table 1. Total pikeminnow removed from Rocky Reach and Rock Island projects by USDA from May through October 2003 to 2018.

Year	USDA
2003	19,754
2004	36,145
2005	39,818
2006	40,747
2007	46,240
2008	42,158
2009	50,333
2010	47,354
2011	36,401
2012	36,118
2013	47,563
2014	44,826
2015	59,730
2016	60,327
2017	62,387
2018	54,410
Total	**724,311**

Pikeminnow Size Distribution

The USDA submitted length measurements to the District weekly. Fish lengths are recorded into size categories 10 mm in length. A total of 23,141 pikeminnow were measured in 2018. Of the pikeminnow measured, 18,721 were less than or equal to 250 mm, and 4,420 were greater than 250 mm (Table 2).

Table 2. Size and number of pikeminnow captured by USDA that were measured from the Rocky Reach and Rock Island reservoirs in 2018.

Size (mm)	USDA
100-110	594
111-120	885
121-130	1,263
131-140	1,458
141-150	1,640
151-160	1,475
161-170	1,673

171-180	1,448
181-190	1,165
191-200	1,523
201-210	982
211-220	1,299
221-230	1,438
231-240	974
241-250	904
251-260	631
261-270	532
271-280	516
281-290	403
291-300	424
301-310	352
311-320	299
321-330	249
331-340	189
341-350	167
351-360	145
361-370	104
371-380	76
381-390	73
391-400	72
401-410	42
411-420	39
421-430	28
431-440	19
441-450	18
451-460	11
461-470	12
471-480	10
481-490	4
491-500	1
501-510	2
511-520	1
521-530	0
531-540	1
541-550	0
551-560	0
561-570	0
571-580	0
581-590	0
591-600	0

The overall mean fork length of pikeminnow removed from both Rocky Reach and Rock Island in 2018 was 200 mm. The mean length for Rocky Reach and Rock Island were 188 mm and 228 mm respectively. Overall mean lengths are slightly up from 2017 but have been generally decreasing over time since measurements began in 2003 (Table 3).

Table 3. The mean fork length (mm) of pikeminnow removed during USDA fishing at Rocky Reach and Rock Island projects, 2003 to 2018.

Year	Rocky Reach Mean Length (mm)	Rock Island Mean Length (mm)	Overall Mean Length (mm)
2003	232	249	236
2004	231	264	239
2005	223	254	237
2006	235	257	244
2007	236	251	244
2008	229	254	242
2009	239	252	245
2010	219	248	229
2011	200	262	218
2012	202	263	219
2013	195	247	207
2014	204	252	212
2015	181	262	192
2016	177	233	183
2017	186	248	194
2018	188	228	200

Pikeminnow Catch Rates

In 2003, 2004, and 2005 the angler hours were reported as fishing day (8 hours). From 2006 through 2018, anglers fishing from the dam reported their time as "angling hours" while boat anglers reported fishing time as "boat hours". Angling hours were just that – defined as the number of hours the tailrace crews spent fishing. Boat hours are defined as the number of hours the boat was in the water. It does not include the time required to launch or load the boat, refuel, or purchasing equipment. The catch per angler hour (CPAH) decreased from 5.8 in 2017 to 4.9 in 2018. The initial CPAH increased through 2008. The CPAH then began to decrease through 2012 before it began to generally increase again through 2017 (Table 4).

Table 4. The overall rod and reel CPAH for USDA pikeminnow anglers from May to October, 2003 to 2018.

Year	Angler Hours	Fish Captured	CPAH
2003	6,857.00	19,754	2.9
2004	11,676.00	36,145	3.1
2005	10,849.00	39,818	3.7

2006	9,159.50	40,747	4.4
2007	9,513.50	46,240	4.9
2008	8,317.50	42,158	5.1
2009	10,004.50	50,333	5.0
2010	10,187.50	47,354	4.6
2011	10,300.75	36,401	3.5
2012	10,261.05	36,118	3.5
2013	10,387.75	47,563	4.6
2014	10,333.60	44,826	4.3
2015	10,251.00	59,730	5.8
2016	10,438.50	60,327	5.8
2017	10,718.50	62,387	5.8
2018	11,160.50	54,410	4.9

Cost Benefit Analysis

Expenditures for the USDA portion of the pikeminnow predator program have fluctuated since the initial start of the contract in 1996. Since 2013, the cost per fish has been near or below $7.00 with the exceptions of years 2011 through 2014 when prices reached a peak in 2012 at $9.85 per fish (Table 5). In 2018, the cost per fish was slightly up due in most part to a lower number of fish captured.

Table 5. Cost of USDA pikeminnow program and the cost per fish breakdown from 2003 to 2018.

Year	Cost of Program	Fish Captured	Cost per fish
2003	$135,709.98	19,754	$6.87
2004	$237,834.10	36,145	$6.58
2005	$255,233.38	39,818	$6.41
2006	$263,225.62	40,747	$6.46
2007	$253,395.20	46,240	$5.48
2008	$264,752.24	42,158	$6.28
2009	$327,164.50	50,333	$6.50
2010	$332,425.08	47,354	$7.02
2011	$342,533.41	36,401	$9.41
2012	$355,685.00	36,118	$9.85
2013	$360,780.96	47,563	$7.59
2014	$373,112.00	44,826	$8.32
2015	$397,619.00	59,730	$6.66
2016	$402,710.00	60,327	$6.68
2017	$418,575.33	62,387	$6.71
2018	$410,822.76	54,410	$7.55

Non-Target Fish Species

Rod and reel angling is one preferred pikeminnow removal method because baits can be tailored to exploit primarily pikeminnow and is the least harmful to non-target species. Non target species caught in 2018 included; Chiselmouth (*Acrocheilus alutaceus*), Peamouth (*Mylocheilus caurinus*), sucker species (*Catostomus sp*.), sculpin species (*Cottus sp.*), Redside Shiners (*Richardsonius balteatus*), Smallmouth Bass (*Micropterus dolomieu*), Mountain Whitefish (*Prosopium williamsoni*), Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), White Sturgeon (*Acipenser transmontanus*), Burbot (*Lota lota*), bullhead species (*Ameiurus sp.*), Common Carp (*Cyprinus carpio*), adult and juvenile salmon, and adult steelhead and resident Rainbow Trout (*Oncorhynchus mykiss*). In 2018, all non-target fish were released unharmed back to the river.

Columbia Research

Columbia Research has removed 371,258 pikeminnow from Rocky Reach and Rock Island reservoirs from 2005-2018. In 2018, set-lines run by Columbia Research produced 25,412 pikeminnow (Table 6).

Table 6. Total pikeminnow removed from Rocky Reach and Rock Island projects by Columbia Research from 2005 to 2018.

Year	Columbia Research
2005	19,337
2006	22,418
2007	21,301
2008	21,472
2009	31,683
2010	31,620
2011	32,846
2012	29,526
2013	29,310
2014	27,090
2015	26,790
2016	27,472
2017	24,981
2018	25,412
Total	371,258

Pikeminnow Size Distribution

Columbia Research submitted length measurements to the District for all pikeminnow captured. Fish lengths are recorded into size categories 10 mm in length. Of the pikeminnow measured, 5,035 were less than or equal to 250 mm, and 20,377 were greater than 250 mm (Table 7).

Table 7. Size and number of pikeminnow captured by Columbia Research in Rocky Reach and Rock Island reservoirs in 2018.

Size (mm)	Columbia Research
100-110	0
111-120	0
121-130	6
131-140	34
141-150	73
151-160	103
161-170	179
171-180	255
181-190	328
191-200	418
201-210	495
211-220	582
221-230	732
231-240	840
241-250	990
251-260	1,137
261-270	1,383
271-280	1,640
281-290	1,973
291-300	2,159
301-310	2,270
311-320	2,050
321-330	1,760
331-340	1,431
341-350	1,139
351-360	932
361-370	732
371-380	564
381-390	411
391-400	275
401-410	179
411-420	139
421-430	70
431-440	57
441-450	30
451-460	29
461-470	12
471-480	2
481-490	0
491-500	3

501-510	0
511-520	0
521-530	0
531-540	0
541-550	0

Because the set-line program is an incentive based contract and that the main objective is to target deep over wintering habitats, Columbia Research is required to measure every pikeminnow captured. Both of these factors also contribute to Columbia Research producing larger mean lengths compared to other District pikeminnow capture projects. In 2018, the average mean fork lengths in the Rocky Reach reservoir and Rock Island reservoir were 294 mm and 295 mm respectively. The overall 2018 mean fork length was the largest to date at 294 mm. Again, being an incentive based contract has brought about the targeting of larger pikeminnow by using selective gear and focusing on fishing locations that produce higher mean lengths in general. This has resulted in a fairly consistent overall mean fork length with the largest mean fork length (294 mm) in 2018 and the smallest mean fork length (258 mm) in 2016 (Table 8).

Table 8. The mean fork length of pikeminnow removed by Columbia Research set-line fishing at Rocky Reach and Rock Island projects, 2005 to 2018.

Year	Rocky Reach Mean Length (mm)	Rock Island Mean Length (mm)	Overall Mean Length (mm)
2005	N/A	N/A	282
2006	N/A	N/A	281
2007	269	294	281
2008	269	268	269
2009	274	272	274
2010	267	256	261
2011	258	270	261
2012	293	288	275
2013	268	273	270
2014	262	274	268
2015	268	276	270
2016	260	252	258
2017	268	269	268
2018	294	295	294

Pikeminnow Catch Rates

In 2018, Columbia Research removed 25,412 pikeminnow during 44,040 hours of set-line effort. This equates to 5,284,800 hook hours as each set line has 120 hooks. The overall catch per unit effort (CPUE) was 0.48 for 2018. The District calculates CPUE as the number of pikeminnow captured per 100 hook hours. The last two years have produced the two highest CPUE rates for Columbia Research (Table 9).

Table 9. Annual catch per unit effort (CPUE) for Columbia Research in Rocky Reach and Rock Island reservoirs, 2008 to 2018.

Year	Total Hook Hours	Fish Captured	CPUE*
2008	6,624,000	21,472	0.32
2009	10,980,000	31,683	0.29
2010	8,517,600	31,620	0.37
2011	10,332,000	32,846	0.32
2012	9,388,800	29,526	0.31
2013	9,129,600	29,310	0.32
2014	8,643,600	27,090	0.31
2015	6,402,240	26,790	0.42
2016	7,430,400	27,472	0.37
2017	4,714,560	24,981	0.53
2018	5,284,800	25,412	0.48

*CPUE is calculated as the number of pikeminnow per 100 hook hours.

Cost Benefit Analysis

Columbia Research is compensated on a per-fish basis. Fish captured between 127 mm and 227 mm were compensated at a lower rate than fish captured that measured greater than 227 mm in length. These two size categories are considered "Under" and "Over" the 227 mm delineation. In 2005, Columbia Research received $2.75 or $5.50 per fish depending on size. In 2006, compensation rate increased to $3.00 and $6.00 respectively. In 2007, the compensation rate increased to $3.00 and $6.25 depending on fish size. From 2008 to 2011, Columbia Research received $3.00 or $6.50 per fish. For years 2012 and 2013 the compensation rate increased to $3.00 and $6.75 respectively. From 2014 to 2016 the compensation rate was $3.00 and $7.25 per fish. For 2017 and 2018, the compensation rate was $3.00 for fish 127 mm to 227 mm and $7.75 for fish greater than 227 mm in length. No compensation was awarded for any fish measuring less than 127 mm. For the District's total annual compensation to Columbia Research for their pikeminnow efforts and the equivalent annual cost per fish refer to Table 10.

Table 10. Cost of Columbia Research set-line program in Rocky Reach and Rock Island and the cost per fish breakdown from 2005 to 2018.

Year	Cost of Program	Fish Captured	Cost per fish
2005	$99,726.00	19,337	$5.16
2006	$125,000.00	22,418	$5.58
2007	$124,998.75	21,301	$5.87
2008	$124,997.50	21,472	$5.82
2009	$174,999.50	31,683	$5.52
2010	$174,999.50	31,620	$5.53
2011	$180,250.50	32,846	$5.49
2012	$180,000.00	29,526	$6.10
2013	$179,988.75	29,310	$6.14

2014	$179,742.50	27,090	$6.64
2015	$179,998.50	26,790	$6.72
2016	$179,906.75	27,472	$6.55
2017	$179,742.25	24,981	$7.20
2018	$180,000.00	25,412	$7.08

Non-Target Fish Species

The non-target fish species caught by Columbia Research included Chiselmouth, Peamouth, sucker species, sculpin species, Mountain Whitefish, White Sturgeon, and Burbot. In 2018, no adult or juvenile salmon or steelhead were captured. All non-target fish were released unharmed back into the river.

East Wenatchee Rotary Club

The East Wenatchee Rotary Club Annual Pikeminnow Derby has captured 66,252 pikeminnow in 46 days of total fishing since 1996. In 2018, the annual derby produced 3,209 pikeminnow over the 2-day event. There were 67 tickets sold (60 adults and 7 youth). While participation was slightly down (75 active participants in 2017), total pikeminnow captured increased in 2018 (Table 11).

Table 11. Total pikeminnow removed from Rocky Reach and Rock Island reservoirs during the annual Pikeminnow Derby from 1996 to 2018.

Year	Pikeminnow Captured
1996	1,800
1997	2,240
1998	1,847
1999	2,294
2000	1,370
2001	1,601
2002	2,783
2003	2,568
2004	2,943
2005	3,950
2006	3,445
2007	3,812
2008	4,474
2009	3,812
2010	5,027
2011	3,274
2012	2,894
2013	2,944
2014	2,563
2015	2,427
2016	2,347

2017	2,628
2018	3,209
Total	66,252

Discussion

USDA

The continued success of the USDA program is likely a result from a variety of factors. A key efficiency is credited to a core group of veteran anglers who return to work in the program each year, resulting in better catch rates overall. Experienced anglers are more productive, relying on their knowledge of pikeminnow holding areas in the reservoirs, effective baits, and presentation methods. While the USDA continues to catch similar numbers of pikeminnow each year, the overall average size has dropped considerably over the course of the program. The lowest four years for overall average size have occurred the last four years. The start and duration of the USDA pikeminnow program is designed to coincide with the outmigration period of juvenile salmonids. Smolts arrive at Rocky Reach and Rock Island Dams in early April, and continue passing the dams through the end of August. Pikeminnow primarily ascend the adult fish ladders during mid-May through September. Peak ladder passage occurs in August at Rocky Reach and in mid-July at Rock Island. The highest catch rates for pikeminnow usually occur in July and August for Rocky Reach and Rock Island.

Columbia Research

The objective for the Columbia Research set-line program was to remove large pikeminnow that congregate in deep over-wintering areas. Columbia Research has become very efficient at using set-lines. Because set-line angling is designed to capture fish that hold on or near the river bottom, targeting deep areas within the reservoir where pikeminnow congregate in colder months is effective. Pikeminnow likely move into deep pools where the daily water temperature remains more constant. A fish's metabolic rate decreases over winter periods, and hence it needs less food to survive (Sauter et. al, 1994). By presenting pikeminnow with food that they do not have to chase, they likely expend very little effort and energy to obtain the bait. The boat crew deployed 20 set-lines nearly every day at various depths. In 2018, all fish were caught at depths between the surface and 120 feet.

Fishing with set-lines and at deeper depths has resulted in Columbia Research having a larger mean length than USDA over the years. Also contributing to these larger lengths by Columbia Research is the incentive in the contract to catch larger fish. Set-lines are placed in areas that have the highest return for their effort which equates to a larger and consistent mean length. Columbia Research, in general, from 2005-2016 has recorded a higher mean pikeminnow length caught on set-line gear when compared to the hook and line fishery (Jerald 2017). This can also be seen in Figure 1 for years 2003-2018. Unlike the set-line effort, the hook and line effort has seen a steady decline in mean fork length. This could mean that catch is outpacing recruitment and resulting in the decline in mean fork length of this targeted age class.

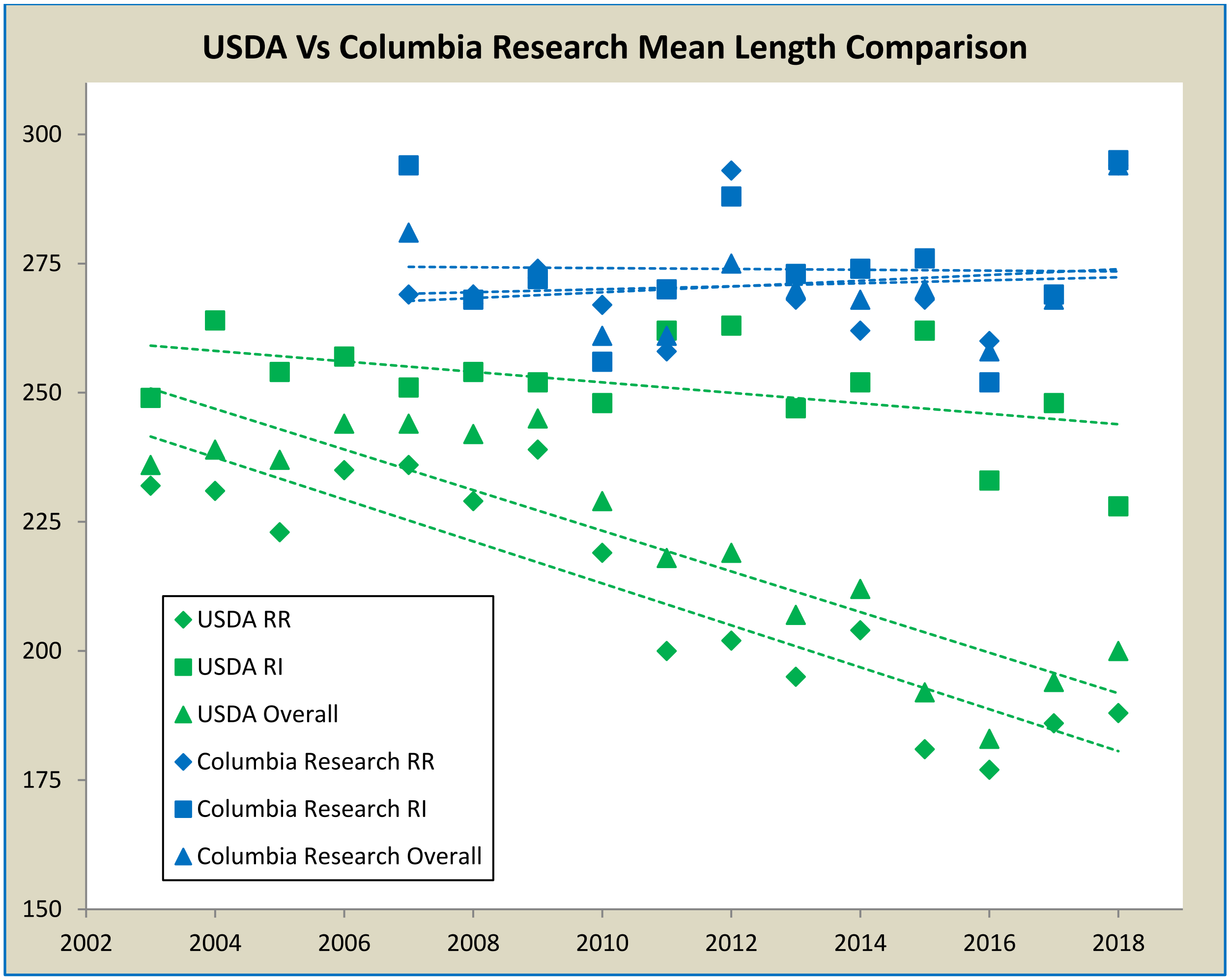

Figure 1. Mean fork lengths (mm) for pikeminnow captured by Columbia Research and the USDA from 2003 to 2018.

East Wenatchee Rotary Derby

The Pikeminnow Derby is in its 26th year and marks the District's longest effort toward reduction in pikeminnow numbers. While numbers in the past have been higher, this year's effort was the highest in the most recent seven years. There were a few thunderstorms during this two-day event which may have impacted the number of participants. Since the limiting factor is the number of anglers on the river, additional efforts should be put into increasing the number of anglers participating. This was addressed in 2015 by doubling the prize contribution by the District from $10,000 to $20,000. The District will continue to evaluate how this increase impacts the level of participation over the next few years.

Chelan County PUD (miscellaneous)

In past years the District has conducted pikeminnow ladder trapping efforts in both Rocky Reach and Rock Island fish ladders. These efforts were abandoned in the 2011 season due to the increased bycatch of adult Sockeye Salmon. With the increased run sizes of Sockeye Salmon and the overall success of the District's other pikeminnow programs, the District abandoned the ladder trapping completely in 2012.

In 2018, there were 1,187 pikeminnow caught in miscellaneous instances. Some of these miscellaneous captures included bycatch at facilities, fish ladder outage rescues, bycatch during miscellaneous studies, and a few targeted angling efforts by District employees. These various events accounted for 1.4% of the total pikeminnow catch in 2018. An overall visual of the District's different pikeminnow programs can be seen in Figure 2.

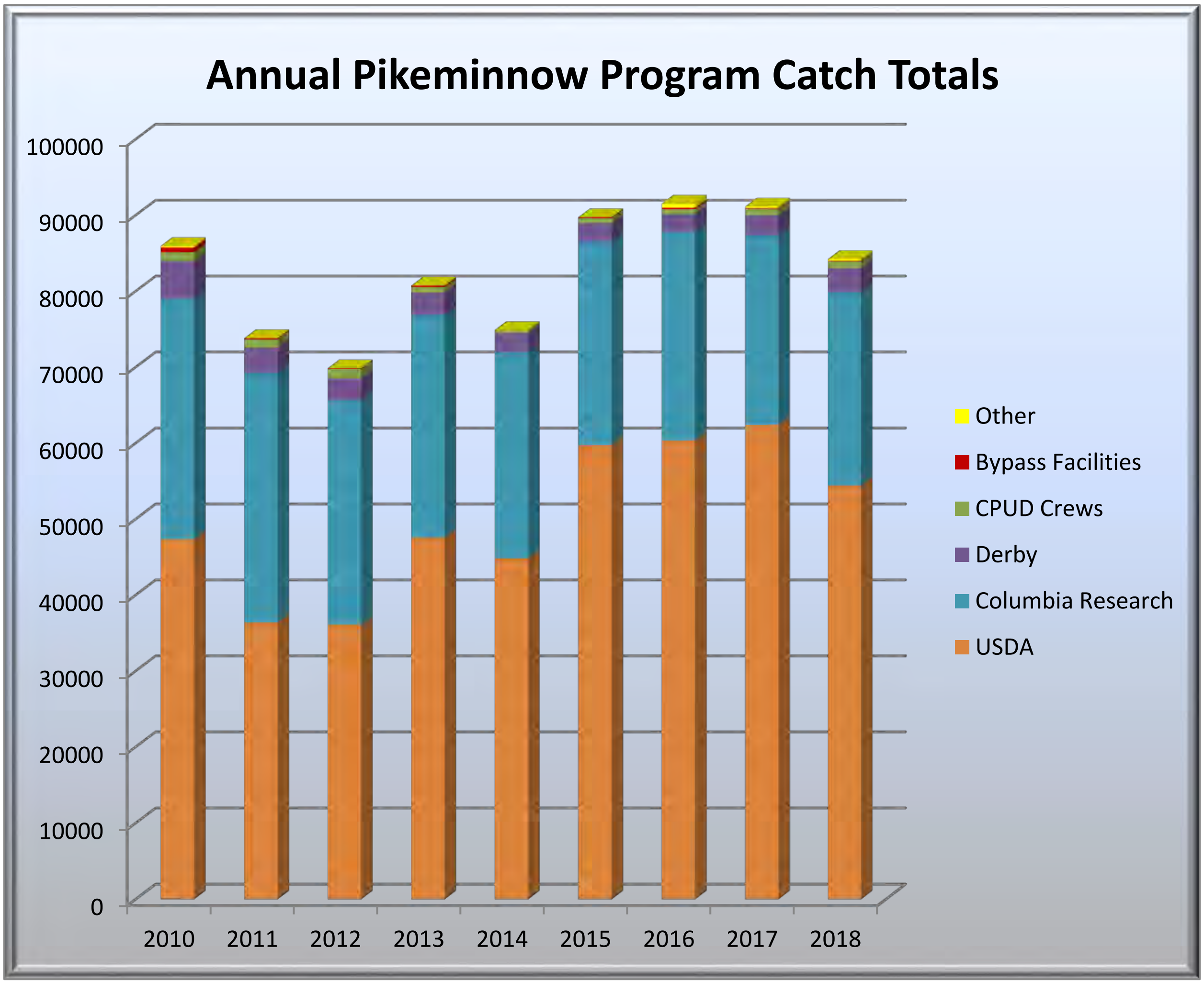

Figure 2. Breakdown of pikeminnow contributions from Chelan County PUD's different pikeminnow programs from 2010 to 2018.

Project Recommendations

USDA

Several factors, including USDA angler skills, reservoir knowledge, increased efforts, and overall program duration combined to make another successful pikeminnow removal effort by the USDA. The USDA anglers continue to maintain excellent pikeminnow catch rates by documenting fish movements and holding locations. We expect that overall catch may increase as anglers continue to learn where pikeminnow reside during the summer and fall months. However, if the program has started to outpace the recruitment efforts, then we may start to see a decrease in total capture numbers. If possible, the District should continue to utilize USDA anglers with experience and knowledge of the reservoirs and who are familiar and adept at the angling techniques used in the program.

Columbia Research

We recommend continuing the set-line program at the 2018 funding and effort level. This program is productive because it compensates on a per fish basis, with no equipment, fuel, or administrative costs. The current recommendation is to continue to start the program in February and continue through November to take advantage of favorable CPUE documented during past fishing efforts in November.

East Wenatchee Rotary Derby

The District should continue to fund the East Wenatchee Rotary Club Pikeminnow Derby at its current funding level. The derby removes a large number of fish in a short time frame of two days. This likely provides an immediate within-year benefit to juvenile survival in the reservoirs. Since 1996 the derby has removed 66,252 pikeminnow in just 46 days of effort. In order to increase overall angler turn out the District should increase efforts to advertise the derby. The increased advertising along with the contribution increase from $10,000 to $20,000 in 2015 should help encourage higher participation. The Rotary Club should continue to host the event concurrent with the peak smolt migrations through Rocky Reach and Rock Island Reservoirs.

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Appendix O
2019 Broodstock Collection Protocols

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March 28, 2019

To: NMFS, HCP HC's, and PRCC HSC

From: Mike Tonseth, WDFW

Subject: **FINAL HCP HC and PRCC HSC APPROVED UPPER COLUMBIA RIVER 2019 BY SALMON AND 2020 BY STEELHEAD HATCHERY PROGRAM MANAGEMENT PLAN AND ASSOCIATED PROTOCOLS FOR BROODSTOCK COLLECTION, REARING/RELEASE, AND MANAGEMENT OF ADULT RETURNS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, summer Chinook salmon, Coho salmon, and summer steelhead associated with the mid-Columbia HCPs; spring Chinook salmon, summer Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project and Salmon and Steelhead Settlement Agreement (FERC No. 2114); and fall Chinook salmon consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams (ACOE funded), respectively. These programs are funded by Chelan, Douglas, and Grant County Public Utility Districts (PUDs), and ACOE, and are predominately operated by the Washington Department of Fish and Wildlife (WDFW) with the exceptions of: 1) the Omak Creek/Okanogan Basin steelhead broodstock collection, and acclimation/release of Omak Creek steelhead, which is implemented by the Confederated Tribes of the Colville Reservation (CTCR), and 2) The Wells and Methow fish hatcheries operated by Douglas PUD.

This protocol is intended to be a guide for 2019 collection of salmon (19BY) and steelhead (20BY) broodstocks in the Methow, Okanogan, Wenatchee, and Columbia River basins. It is consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation), mitigation production levels (e.g., HCPs and Priest Rapids Salmon and Steelhead Settlement Agreement/2008 BiOp), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, USFWS consultation requirements.

Notable in this year's protocols are:

- Continuing for 2019, no age-2 or 3 males will be incorporated into spring or summer/fall Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only) and to minimize the necessity of using hatchery origin males in lieu of.

- Elimination of fall adult hatchery steelhead collections for the Methow Safety Net (MSN), Columbia Safety Net (CSN), and Okanogan programs. In-season run escapement forecasting will be used to determine if some level of fall broodstock collection will be needed for the CSN program to ensure the production obligation can be met. Otherwise the default brood collection period will be spring 2020.

- Continuation of spring Chinook trapping efforts at the Wells Dam East and West ladder traps consistent with 2018 operations.

- Inclusion of Appendix I, which summarizes program specific rearing/release plans (if available) outside the body of the protocols.

- Inclusion of Appendix J, which summarizes 2019BY spring and summer Chinook disease management plans.

- Inclusion of Appendix K: BY19 YN UCR coho broodstock plans.

- Expansion of Appendix G to include species/program specific management plans for managing surplus juvenile spring Chinook and summer steelhead.

- Continued inclusion of Appendix H, which describes a draft preferred approach to integration of the Methow conservation steelhead programs as well as minimize the potential for or increase the risk of a Ryman-Laikre effect in the Twisp River watershed.

- Chelan Falls broodstock collection will be prioritized at Wells Dam volunteer trap (WDVT), sufficient to meet the entire Chelan Falls yearling program of 576K while concurrently piloting alternate broodstocking methodologies. Adults collected via a temporary weir within the Chelan River Habitat Channel and beach seining in the Chelan Tailrace may be used to offset the number of brood needed at Wells FH if timing and fish condition are supportive of retaining them. In the event Wells FH and the two proposed pilot efforts cannot secure the appropriate number of summer Chinook broodstock for the Chelan Falls program, other locations (as determined by the Hatchery Committees) may be used. .

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net smolts (up to 17 adults). The remainder of the broodstock (51) will be WNFH returns collected at WNFH (or by angling/trapping for WNFH program) and/or Methow Hatchery and surplus to the WNFH program needs. Collection of Wells stock may be used if WNFH and Twisp returns are insufficient. The collection of adults will occur in spring of 2020.

- Summer Chinook collections at Wells Dam ladder traps to support the CJH integrated program (adipose present non-wired adults) and Well Dam ladder traps and the Wells Hatchery volunteer trap to support the CJH segregated program (adipose clipped adults) may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Spring Chinook eggs identified through CWTs from ad-clipped + CWT CJH segregated returns that occur during spawning at Methow FH or WNFH may be transferred to the CJH Program for inclusion in the CJH spring Chinook segregated program.

- Reduction of NO fall Chinook broodstock from the OLAFT from 1,000 to 650.

- Targeted collection of about 600 adipose present, non-coded wire tagged fall Chinook using hook-and-line efforts in the Hanford Reach.

- Continuation of Tumwater trap operations to facilitate lamprey passage. Using Rocky Reach and Rock Island lamprey passage data as a surrogate, it is proposed to open the Tumwater Dam fishway to passage between 10PM and 6AM daily from September 1 to mid-December. This should allow open passage for at least 60%-70% of the lamprey while still accommodating coho and steelhead broodstocking and steelhead adult management. Because this is the second year to operate under this schedule, some in-season adjustments may need to be made based on lamprey observations (during trapping periods) and the magnitude of steelhead adult management required.

- Addition of the 2019 YN UCR coho broodstock collection plans (includes the DPUD Coho program brood).

These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and/or other sampling locations. Additional adaptive management actions as they relate to broodstock objectives may be implemented as determined by the HCP-HC or PRCC-HSC and within the boundaries of applicable permits.

Also included in the 2019 Broodstock Collection Protocols are:

Appendix A: 2019 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2020 BY Summer Steelhead Hatchery Programs
Appendix B: Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations
Appendix C: Return Year Adult Management Plans
Appendix D: Site Specific Trapping Operation Plans
Appendix E: Columbia River TAC Forecast
Appendix F: Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans
Appendix G: DRAFT Hatchery Production Management Plan
Appendix H: DRAFT Preferred Alternative for 2020 BY and beyond, Methow Sub-basin Conservation Steelhead Programs
Appendix I: Program Specific Rearing and Release Descriptions
Appendix J: 2019 BY spring and Summer Chinook Disease Management Plans
Appendix K: 2019 YN Coho Broodstock Collection Plans

Methow River Basin

Coho - Douglas PUD Program- Methow Basin – Twisp River

The Douglas PUD (DPUD) coho program began with brood year 2018. The target release is 37,000 yearling coho. Broodstock are collected for the Yakama Nation (YN) and the DPUD program collectively by the YN at Wells Dam and Hatchery, Winthrop National Fish Hatchery (WNFH), and Methow Hatchery. The broodstock are transported to, held, and spawned at WNFH. The DPUD program obtains eggs to rear at Wells Hatchery from WNFH. See Appendix K for a complete description of the YN coho program and broodstock collection.

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be prioritized for the aggregate conservation program in the Methow Basin. Collections of natural-origin fish will not exceed 33% of the Methow Composite (i.e., non-Twisp) and Twisp natural-origin run escapement consistent with take provisions in Section 10 (a)(1)(A) Permits 18925 and 20533.

Hatchery-origin spring Chinook, if needed, will be collected in numbers excess to program production requirements to facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production shortfalls. Based on historical Methow FH spring Chinook ELISA levels above 0.12, any hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 20% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch/Twisp programs). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permits 18925 and 20533, culling will include the destruction of eggs from hatchery-origin females with ELISA levels greater than 0.12 and/or that number of hatchery-origin eggs required to maintain an aggregate production of 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by DPUD Fish Health and the Wells, Rocky Reach, and Rock Island HCP's- and the Priest Rapids CC - HSC to be a substantial risk to the program. Progeny of natural-origin females with ELISA levels greater than 0.12 may be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

WDFW genetic assessment of natural-origin Methow spring Chinook (Small et al. 2007) indicated that Twisp natural-origin spring Chinook can be distinguished, via genetic analysis, from non-Twisp spring Chinook with a high degree of certainty. The Wells HCP Hatchery Committee accepted that Twisp-origin fish could be genetically assigned with sufficient confidence and that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic/stock analysis will be obtained from adipose-present, non-CWT, non-ventral-clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam, and origins assigned based on genetic analysis. Natural-origin fish retained for broodstock will be PIT tagged (pelvic girdle) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to the WDFW genetics lab in Olympia Washington for genetic/stock analysis. Spring Chinook collected from Wells will be held until genetic analysis results are received then transferred to and retained at Methow Hatchery and spawned for each program depending on results of DNA analysis. Brood collection of NORs at Wells will be based upon assignment of Twisp NORs to the Twisp program and non-Twisp NORs being used to support Methow and Chewuch River releases. Spring Chinook collected at Methow Hatchery will be held at MFH until genetic analysis results are received and then handled accordingly.

The number of natural-origin Twisp and Methow Composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural-origin adults returning and the collection objective limiting extraction to no greater than 33% of the natural-origin spring Chinook return to the Methow Basin. Natural origin fish not assigning to the Twisp or Methow Composite will be released back into the Columbia River.

Weekly estimates of the passage of Wells Dam by natural-origin spring Chinook will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%. Hatchery origin adults trapped at the Winthrop NFH may be included, if needed, in the event of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2019 is estimated at 1,803 spring Chinook, including 1,018 hatchery and 785 natural origin spring Chinook (Table 1 and Table 2). In-season estimates of natural-origin spring Chinook will be adjusted proportional to the estimated returns to Wells Dam at weekly intervals and may result in adjustments to the broodstock collection targets presented in this document. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2019 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and biological assumptions listed in Appendix A.

The 2019 aggregate Methow spring Chinook broodstock collection will target up to 128 adult spring Chinook (18 Twisp, 110 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 7.9% of the CWT tagged hatchery adults and 22% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin spawning escapement to the Twisp, the 2018 Twisp origin broodstock collection will total 18 wild fish, representing 100% of the broodstock necessary to meet Twisp program production of 30,000 smolts. Methow Composite fish are expected to represent about 34% of the CWT tagged hatchery adults and 78% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin recruits, the 2019 aggregate Methow/Chewuch broodstock collection will total 110 natural-origin spring Chinook. Broodstock collected for the aggregate Methow conservation programs represents 100% of the broodstock necessary to meet the Methow programs production of 223,765 smolts. The Twisp River releases will be limited to releasing progeny of broodstock identified as wild Twisp and or known Twisp hatchery-origin fish, per ESA Permit 18925. The MetComp releases will include progeny of broodstock identified as wild non-Twisp origin (or known Methow Composite hatchery origin if needed to meet shortfalls in the production goal) fish. Age-3 males ("jacks") will not be collected for broodstock unless needed to meet effective population goals and minimize contribution of hatchery fish within the conservation program.

Table 1. Brood year 2014-2015 age class-at-return projection for wild spring Chinook above Wells Dam, 2019.

Brood Year	Smolt Estimate		Age-at-return							
			Twisp sub-basin				Methow sub-basin			
	Twisp[1]	Methow Basin[2]	Age-4	Age-5	Total	SAR[3]	Age-4	Age-5	Total	SAR[4]
2014	28,380	41,353	164	**25**	210	0.0074	707	**145**	906	0.0219
2015	22,738	26,491	**131**	20	168	0.0074	**453**	92	580	0.0219
Estimated 2019 Return			**131**	**25**	**156**		**453**	**145**	**598**	

[1] *Smolt estimate is based on sub-yearling and yearling emigration (Charlie Snow, personal communication).*
[2] *Estimated Methow Basin smolt emigration based on Twisp Basin smolt emigration, proportional redd deposition in the Twisp River and Twisp Basin smolt production estimate.*
[3] *Geometric mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*
[4] *Geometric mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*

Table 2. Brood year 2014-2016 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2019.

Stock	Projected Escapement											
	Origin								Total			
	Hatchery				Wild				Methow Basin			
	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total
MetComp	48	292	10	**350**	17	453	145	**615**	65	745	155	**965**
%Total				34.4%				78.3%				53.5%
Twisp	16	54	11	**81**	14	131	25	**170**	30	185	36	**251**
%Total				7.9%				21.7%				13.9%
Winthrop (MetComp)	71	503	13	**587**					71	503	13	**587**
%Total				57.7%								32.6%
Total	135	849	34	**1,018**	31	584	170	**785**	166	1,433	204	**1,803**

Table 3. Number of broodstock needed for the combined Methow spring Chinook conservation program production obligation of 223,765 smolts, collection location, and mating strategy.

By obligation	Production target	Number of Adults		Total		
		Hatchery	Wild			
Chelan PUD	60,516		17F/17M	**34**		
Douglas PUD	29,123		9F/9M	**18**		
Grant PUD	134,126		38F/38M	**76**		
Total	**223,765**		**64F/64/M**	**128**		
By program		Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**55F/55M**	**110**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**64F/64M**	**128**		

Trapping at Wells Dam will occur at the East and West ladder traps beginning on May 1, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through June 30, 2019 (collection quotas will be prioritized for the May 1-June 22 time frame). Spring Chinook broodstock collection and stock assessment sampling activities authorized through the 2019 Douglas PUD Hatchery M&E Implementation Plan will utilize a combination of trapping on the East and West ladders as per the detailed descriptions of the modified trapping operations for spring Chinook collection in Appendix D. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota). Collection goals will be developed by Wells M&E and DPUD staff to identify the most appropriate spatial and temporal approach to achieving the overall brood target. All natural origin spring Chinook collected at Wells Dam for broodstock will initially be held at Wells FH pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or be transferred to WNFH.

Collection of ad-clipped +CWT spring Chinook adults may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH 10j program

Trapping at the Twisp Weir for spring Chinook may begin May 1 or at such time as spring Chinook are observed passing Wells Dam and may continue through August 23. The trap may be operated up to seven days per week/16 hours per day (provided it is manned during active trapping).

However, trapping at the Methow Hatchery Outfall trap may continue beyond the Twisp Weir operations as needed to meet basin wide PNI/pHOS objectives. Hatchery-origin adults captured at the Methow Hatchery Outfall (surplus to the Methow Hatchery program) will be: 1) used for adult out-planting to increase natural production and secondarily, 2) transferred to the WNFH for incorporation into WNFH brood, or 3) removed as surplus as to meet ESA permit requirements of both facilities.

Steelhead

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations (Table 5). Broodstock for the conservation programs (USFWS and DPUD) is achieved via angling in the Methow Basin and trapping at the Twisp Weir (as needed), respectively. Broodstock for the Methow safety net program is achieved primarily through returns to WNFH (including hook and line-caught HOR steelhead) and surplus fish removed at Methow Hatchery and the Twisp Weir. Broodstock for the Columbia safety net is achieved primarily through adult returns to the Wells volunteer trap or secondarily through surplus adults collected at MFH and WNFH. Broodstock for the Okanogan conservation program (GPUD) is achieved via Omak weir, dip-netting and or box traps in tributaries to the Okanogan River and hook-and-line in the mainstem Okanogan and tributaries. Broodstock collected for the Okanogan safety net program (GPUD) is primarily collected from Omak Creek but also in the Okanogan River and tributaries to the Okanogan River via box traps, traditional dip-net methods and hook-and-line angling, and at Wells FH via the volunteer trap. Generally incubation/rearing occur for the DPUD conservation program, Methow safety net, Okanogan, and Columbia River releases at Wells Fish Hatchery (FH). Methow Hatchery may be used to temporarily hold broodstock that are ultimately transferred to Wells Hatchery or WNFH. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin summer steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Presently the HCP HC and Joint Fisheries Parties are continuing to work to develop, approve, and implement an alternative to past programmatic approaches to more fully coordinate the collective Methow sub-basin steelhead conservation programs as well as address concerns over potential Ryman-Laikre (RL) effects in the Twisp River watershed. Some elements of a preferred alternative (see Appendix H), are still being piloted for the 2020 brood. The HC parties have not approved a long-term plan for the Twisp program pending results of the 2018 and 2019 pilot years brood collection efforts. The broodstock collection protocols for the 2020 brood will remain the same as those described in the 2018 Broodstock Collection Protocols. If the alternative in Appendix H or other alternative is approved prior to implementation of the 2020 BY conservation programs, the 2019 Broodstock Collection Protocols will be updated to reflect the new direction.

Specific program brood sources are structured as follows:

Broodstock collection for the DPUD and GPUD summer steelhead programs is designed to meet program production goals while minimizing the probability of producing overages. The following broodstock collection logic provides a step-by-step process whereby DPUD, GPUD, and WNFH summer steelhead broodstock will be collected.

1. February 2020-April 2020: Hook-and Line collections in the Methow mainstem: target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release; 13 broodstock collected downstream of Twisp) and the WNFH (up to 200,000 release; up to110 broodstock collected throughout Methow mainstem). These natural origin fish are to be transported to WNFH, spawned collectively, and a portion of the progeny sufficient to meet the 24,000 release target will be transferred to Wells Hatchery as eyed eggs. By-catch of hatchery origin fish will be retained as broodstock for the WNFH program (Ad+CWT), the Methow Safety-Net (CWT only, Ad+CWT), and the Columbia Safety-Net (Ad only, Ad_CWT), as needed. Adults in excess of broodstock needs will be managed as surplus. Go to #2.

2. March-May 2020: Twisp Weir collection. Target sufficient natural origin summer steelhead for the Twisp Conservation component (13 adults; 24,000 release). Hatchery-origin fish to be removed at a rate to meet pHOS management target. CWT-only fish to be used as broodstock for the Methow Safety-Net up to 25% (approximately 14 broodstock). Additional CWT-only broodstock may be used in the Columbia Safety-Net. CWT+Ad may be used in the Columbia Safety-Net. Go to # 3.

3. March-May 2020: WNFH Volunteer Channel and Methow Hatchery Volunteer channel. Natural origin fish may be collected if present and included in the WNFH and Methow River collected component of the Twisp Conservation Program. Hatchery origin fish will be collected and used as broodstock in the WNFH program (Ad+CWT), Methow Safety-Net program (Ad+CWT), and the Columbia Safety-Net program (Ad+CWT, Ad only). Such fish may be used to augment the fish previously collected described in #s 1 and 2, above. Adults in excess of broodstock and escapement needs will be managed as surplus. Go to #4.

4. March-May 2020: Okanogan River Basin collections to target, up to 58 adult steelhead, consistent with provisions included in the CTCR Tribal Resource Management Plan (TRMP) BiOP. Go to #5.

5. March-May 2020: The Wells Volunteer Channel will be used to collect AD+CWT, Ad only, and CWT only hatchery origin adult summer steelhead to be used as backfill for Methow Safety-Net, Columbia Safety-Net, Okanogan Program, and WNFH program (if desired by USFWS) should any of these program lack sufficient broodstock for the collections described above. Adult hatchery origin steelhead in excess of broodstock needs will be surplused.

Twisp River – Conservation Releases

Due to the recent increased concern for inbreeding depression risk (Ryman-Laikre) for the Twisp program as a result of low N_e and other confounding issues, the design of the Twisp program is currently under review.

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan can be implemented.

The current plan (BY 2020) collects approximately 13 natural origin fish as broodstock from the Methow Mainstem (hook and line) and approximately 13 natural origin fish as broodstock from the Twisp River (weir).

Wells Hatchery – Methow River Release

The Wells Hatchery Methow River release (Methow safety net program) uses locally collected hatchery origin broodstock representative of the Twisp and WNFH conservation programs and as needed, the Methow safety-net program. Adults are collected in concert with adult management and broodstock collection (including hook-and-line) activities at the Twisp Weir, Methow Hatchery, and WNFH. As a backup strategy, hatchery origin broodstock may be collected from Wells Hatchery Volunteer Channel in spring 2020 if other broodstock collection measures fall short. Beginning with the 2018 release, fish will be truck planted at Effy Bridge (RKM 13) in the lower Methow.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use progeny returns from the Methow Safety-Net broodstock (described above). The remaining production for the Columbia Safety-Net may include hatchery origin broodstock collected via hook-and-line in the Methow River, Twisp Weir, adult returns to the Methow Hatchery and Winthrop NFH, and may be augmented with fish collected in spring 2020 from the Wells Volunteer channel if needed to fulfill the program. Surplus eggs and/or fry from the Columbia and Okanogan broodstock may be utilized for other programs in the upper Columbia. Fish are released to the Columbia River, immediately downstream of Wells Dam.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural-origin (NO) fish collected through hook-and-line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, WNFH hatchery-origin returns will be prioritized, followed by Methow safety-net hatchery returns. Transfer of adult and/or gametes/eggs between program will be carefully choreographed to ensure fish are being utilized in the most efficient and effective manner. Fish may be released throughout the Methow basin.

Okanogan River and Tributary Releases

The Okanogan River conservation program uses a combination of natural- and hatchery-origin adults collected in Omak Creek and elsewhere in the Okanogan Basin through CCT collection efforts. Surplus eggs and/or fry from the Okanogan River program broodstock may possibly be utilized for other programs in the upper Columbia or otherwise surplussed at the earliest time when overages are apparent.

Should the Okanogan Basin spring period collection fail to achieve sufficient broodstock to meet programmed production, steelhead will be collected from the Wells Hatchery volunteer ladder in the spring of 2020, sufficient to meet broodstock needs. Fish with positive CWT or PIT tag for Okanogan origin will be the priority to fill the shortfall in broodstock, followed by unknown hatchery origin fish.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2020 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
DPUD Conservation[2]	WNFH – 2S; Wells Hatchery 1S	Douglas PUD	Twisp River @ Buttermilk Bridge, Methow basin @ WNFH or other location as determined by the HCP-HC	48,000 (S_1)	Twisp Weir and Methow basin (angling)
Methow Safety-Net	Wells Hatchery	Douglas PUD	Effy Bridge – Lower Methow River	100,000	HxH: Twisp Weir (up to 25%) + WNFH Hatchery (75%) or WNFH 1st, MFH 2nd to make up balance
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Columbia River @ Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	Methow basin @ WNFH or other locations as determined by the JFP	Up to 200,000 (S_2)	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River and Spring Creek Weir.
Okanogan[1]	Wells Hatchery/ St. Mary's Pond	Grant PUD/CCT	Okanogan tributaries	100,000[1]	Okanogan Basin, Wells FH/Wells FH/Dam

[1] CCT received approval for the Okanogan steelhead HGMP as part of their Tribal Resource Management Plan in February, 2017. Omak Creek and Wells Fish Hatchery are no longer separate hatchery programs. Up to 58 broodstock (NOB or HOB) may be collected from throughout the Okanogan basin (or Wells Dam if necessary) to meet the 100k program.
[2] The DPUD Twisp conservation program is currently under re-development after detection of inbreeding depression risk. The HC and JFP have committed to developing an approved plan in sufficient time for implementation.

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 6), biological assumptions (Appendix A), and the probability that sufficient adult steelhead will return in 2019/2020 to meet production objectives absent a reliable preseason forecast at the present time.

For the 2020 brood steelhead programs operating above Wells Dam, a total of 334 adults (194 natural origin and up to 140 hatchery origin adults) are estimated to be needed to fulfill the respective mitigation obligations (Table 6). To support these obligations and to ensure sufficient backup adults are available in the event spring tributary based collection efforts fall short of targets, spring 2020 trapping at Wells Dam and/or Wells FH may be implemented to selectively retain sufficient adults to backfill shortfalls in spring collections (west [and east, as necessary] ladder and volunteer trap collection; Table 5). As a note, all potential broodstock will be scanned for PIT tags at collection and PIT tagged fish will be returned to the river to meet their monitoring objective. Any adult determined to have been part of the Yakama Nation's kelt reconditioning program will be released in the vicinity it was collected.

Twisp Conservation Program (DPUD)

The HC and JFP are working to redefine the scope and nature of the 2020 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan (the current draft plan be reviewed in Appendix H) can be implemented.

Methow Safety Net Program

Up to 14 surplus hatchery-origin Twisp-stock steelhead (to meet up to 25% of the 100K Methow Safety-Net release) will be targeted at collection locations including the Twisp Weir and moved as live adults to Wells Hatchery for spawning. No less than 40 hatchery adults will be targeted at WNFH and through angling efforts, and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). If collection via hook-and-line, at the Twisp Weir, and WNFH and MH traps/collection efforts are unsuccessful (Table 5) then broodstock will be trapped in the Wells Volunteer channel in spring 2020. Coordination between USFWS, DPUD, and WDFW staff will occur during the season to determine prioritization.

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will be targeted for retention through hook–and-line collection efforts in the Methow River (Table 6). In the event of a shortage, excess hatchery steelhead from the Twisp Weir and volunteer returns to the WNFH (including angle-caught fish) will be utilized as needed to augment WNFH broodstock. Should there be inadequate surplus steelhead from these sources, excess hatchery steelhead (presumed Methow Safety-Net origin) captured at the Methow Hatchery volunteer trap will be used to fulfill the program. Natural-Origin females will be live-spawned and reconditioned by YN.

Okanogan Conservation Program (GPUD/CCT)

Up to 58 adult steelhead will be targeted in the Okanogan Basin, including up to 100% natural-origin adults (dependent on run size and within the 33% natural origin extraction rate) (Table 5). Broodstock collected at Wells FH that are subsequently identified as Okanogan-origin will be transferred to the Okanogan program (as needed to meet program obligations). Due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5) further broodstock shortfalls for the Okanogan may be supplemented with broodstock collected in the spring of

2020 at the Wells Fish Hatchery Volunteer Ladder and/or Wells Dam east/west ladder traps to meet the production obligation.

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild			Hatchery	Wild
DPUD Columbia R. SN	86		Wells FH/Dam, Methow River, WNFH, Methow Hatchery, Twisp Weir	Wells Hatchery	86	
DPUD Methow R. SN	54		Twisp weir (14), Methow River, WNFH[3] (46)	Wells Hatchery/Dam	54	
DPUD Met. Conservation		26	Twisp Weir; Methow basin	NA		26
GPUD Okanogan R.	0-58[6]	0-58[7]	Omak Cr., Okanogan R. and tributaries,	Wells Hatchery/Dam[5]	0-58	(1st priority) 0-58
USFWS Methow R.		110	Methow R. WNFH[4]	Methow Hatchery	Up to 54[8]	110[8]
Total (PUD programs)	**140-198**	**26-84**			**140**	**26-84**
Total (All programs)	**140-198**	**136-194**			**140-252**	**136-194**

[1] Assumes a 1:1 sex ratio (see Table 6). Natural origin females will be live spawned and reconditioned.
[2] Primarily uses hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH. May include Methow safety net adults collected via angling, or adult returns to WNFH and Methow FH.
[3] May also include excess hatchery origin adults collected via angling and at Methow FH and the Twisp Weir.
[4] Spring collection of hatchery origin steelhead as needed to meet program for the Okanogan Program. Shortfall, if encountered, to be met with Wells Hatchery Volunteer Channel collection in spring.
[5] Dependent upon number of NOR broodstock collected in the Okanogan Basin, age structure and fecundity to achieve sufficient brood for a100k smolt program for the Okanogan.
[6] Depending upon NOR abundance and trapping efficiency.
[7] Broodstock composition for the WNFH conservation program is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2020 brood summer steelhead programs. Includes primary collection location(s) and mating strategy. *Broodstock totals do not include additional fish that may be collected at other locations as a backup for shortfalls from primary collection sources*.

Program	Production target/request	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
DPUD[1] Columbia R.	160,000	43F/43M		**86**	Wells FH/ Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	27F/27M		**54[4]**	Twisp Weir, MFH, WNFH, Wells FH/Dam	1:1
DPUD Methow Conservation	48,000		13F/13M	**26**	Twisp Weir/Methow River	2x2 Factorial
GPUD Okanogan R.[3]	100,000		29F/29M	**58[5]**	Okanogan R./Omak Creek	1:1/2x2[7]
USFWS Conservation[8]	200,000[8]		55F/55M	**110**	Methow River[6]	2X2 Factorial
Total[4]	**608,000**	**70F/70M**	**97F/97M**	**334**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow River release of HxH fish produced from either adults returning from the Winthrop conservation program, adults trapped at MFH, and/or surplus hatchery adults from the Twisp weir, or Wells FH/Dam.
[3]CCT intends to achieve greater than 0.5 pNOB, but the actual number will be dependent upon run size and trap efficiency, per the HGMP. Numbers of hatchery and wild males and females in this table should not be taken as the goal or limit for any collection effort, as it could be up to 100% pNOB or pHOB.
[4] Additional hatchery adults may be collected at Wells FH to augment shortfalls in collections for the Methow safety net.
[5] Additional hatchery origin adults may be collected during the spring of 2020 at Wells Dam/Wells FH to augment shortfalls in Okanogan Basin collection efforts.
[6] Collection priority: 1) hook and line, 2) adult returns to WNFH, 3) excess adult returns to Methow Hatchery.
[7] A 1:1 mating protocol will be used for all HxH/HxW crosses within the Okanogan. The Okanogan locally-adapted natural stock (WxW) will utilize a minimum 2x2 factorial mating to minimize potential negative effects associated with a small effective population size.
[8] Production is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Overall collection for the PUD programs will be 224 fish (Table 6) and limited to no more than 33% of the entire run and/or 33% of the natural origin return. Hatchery and natural origin collections will be consistent with the respective run-timing of hatchery and natural origin steelhead at Wells Dam, Omak Weir and the Twisp Weir. Trapping at the Wells Dam ladders may occur between 01 August, 2019 and 30 April, 2020, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. (Appendix D). The Twisp Weir operates from early March (dependent on river conditions) through the end of the steelhead spawning run (spring Chinook trapping takes over by June 1). Trapping occurs daily for broodstock collection and gene flow management.

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments may be made based on in-season monitoring and evaluation. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

Summer/fall Chinook

The summer/fall Chinook mitigation program in the Methow River utilizes adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 200,000 summer/fall Chinook smolts for acclimation and release from the Carlton Acclimation Facility.

The TAC 2019 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2014, 2015, and 2016 spawn escapement to tributaries above Wells Dam indicate sufficient summer Chinook will return past Wells Dam to achieve full broodstock collection for supplementation programs above Wells Dam. The following broodstock collection protocol for the Methow summer Chinook program was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives, and program assumptions (Appendix A).

For 2019, up to 124 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 62 females for the Methow summer Chinook program (Table 7). Collection will be proportional to return timing between 01 July and 15 September. Summer Chinook stock assessment will run concurrent with summer Chinook broodstock collection at the west ladder trap. Trapping may occur up to 3-days/week, 16 hours/day (48 cumulative hours per week). Age-3 males (“jacks”) will not be collected for broodstock unless needed to pair with females.

Should use of Wells Dam be needed to meet any shortfalls in Chief Joseph Hatchery broodstock for summer/fall Chinook programs, the CCT will notify the HCP-HC and Wells HCP Coordinating Committee/PRCC-HSC and coordinate with Douglas PUD, Grant PUD, and WDFW to facilitate additional broodstock collection effort. Summer Chinook broodstock collection efforts at Wells Dam, should they be required to meet CJH program objectives, will be conducted concurrent with broodstock collection efforts for the Methow summer Chinook program and or steelhead collection efforts for steelhead programs above Wells Dam.

If the probability of achieving the broodstock goal is reduced based on passage at the west ladder or actual natural-origin escapement levels, broodstock collections may be expanded to the east ladder trap and/or origin composition will be adjusted to meet the broodstock collection objective. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 7. Number of broodstock needed for Grant PUDs Methow summer Chinook production obligation of 200,000 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
Methow	200,000		62F/62M	**124**	Wells Dam	1:1
Total	**200,000**		**124**	**124**		

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Collection at the Wells FH volunteer channel will be used to collect the broodstock necessary for the Wells FH yearling (320,000) and sub-yearling (484,000) programs.

Because of CCT concerns about sufficient natural-origin fish reaching spawning grounds and to ensure sufficient NOR's being available to meet the CCT summer Chinook program, incorporation of natural-origin fish for the Wells program or programs with broodstock originating from the Wells volunteer channel, will be limited to fish collected in the Wells volunteer channel. The program includes up to 10% natural origin broodstock. The following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

DPUD will target 532 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs (Table 8). Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin July 1 and terminate by August 31. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not exceeding 10% representation of natural origin fish in the summer Chinook broodstock collection. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

For 2019, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Wells Fish Hatchery volunteer trap. The Chelan Falls Canal Trap (CFCT) was piloted from 2016 to 2018 to collect adult Chinook broodstock, but for various reasons the trapping season was truncated and the CFCT was unsuccessful, in meeting the broodstock requirements for the Chelan Falls program. Chelan PUDs assessment of the financial investment necessary to make the CFCT viable has determined it to be unfeasible at the present time.

While broodstocking efforts in 2019 will be prioritized at the Wells volunteer trap, Chelan PUD will evaluate the installation and operation of a temporary picket weir in the Chelan River habitat channel and utilizing the CCT to evaluate the feasibility of beach seining for adult Chinook in the Chelan tail race area. Specific details of these two efforts have yet to be finalized. However, if implemented and successful, adults collected will be incorporated into the Chelan Falls program and adult brood numbers from the Wells volunteer trap will be appropriately reduced.

If shortfalls in adult needs are expected and the number of females needed to meet program has not been reached by August 15th, the HCP HC will discuss whether broodstock collection may default to surplus summer Chinook collected from other HCP approved locations to make up the difference. The 2019 broodstock target for the Chelan Falls program is 390 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 8. Number of broodstock needed for the combined Chelan and Douglas PUD Columbia River below Wells summer Chinook production obligations of 1,380,000 smolts, collection location, and mating strategy. Also includes broodstock necessary for outside programs that rely on adult collection at Well Hatchery in 2019.

Program	Production target	Number of Adults[1]		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	96F/96M		**192**	Wells VC[2]	1:1
Wells 0+	484,000	170F/170M		**340**	Wells VC[2]	1:1
Chelan Falls 1+	576,000	195F/195M		**390**	Wells VC[2]	1:1
Total	**1,380,000**	**461F/461M**		**922**		

[1] The number of adults collected for these programs may indirectly incorporate natural origin fish; however, because they are volunteers, the number is likely to be less than 10% of the total.
[2] Wells Hatchery volunteer channel trap.

Wenatchee River Basin

In 2019 the Eastbank Fish Hatchery (FH) is expecting to early rear spring Chinook salmon for the Chiwawa River and Nason Creek acclimation facilities located on the Chiwawa River and Nason Creek. The program production level target for the Chiwawa program (Chelan PUD obligation) in 2019 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 72 natural origin spring Chinook (Table 10). The spring Chinook production obligation as currently described in the BiOp and Section 10 permit for Grant PUD in the Wenatchee Basin is 223,670 smolts (125,000 conservation and 98,670 safety net) and based upon the biological assumptions (Appendix A) will require a total broodstock collection of 136 adults (66 natural origin and 60 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2019 is estimated at 1,599 spring Chinook, including 1,209 hatchery and 390 natural origin spring

Chinook (does not include age-3 males; Table 9). In-season estimates of natural-origin spring Chinook to Tumwater Dam will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2019.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	238	27	**265**	70	8	**78**	350	40	**390**
Estimated hatchery return	905	30	**935**	265	9	**274**	1,170	39	**1,209**
Total	1,143	57	**1,200**	335	17	**352**	**1,520**	**79**	**1,599**

Table 10. Number of broodstock *needed* for the combined Wenatchee spring Chinook production obligation of 367,969 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
Chiwawa Conservation[4]	144,026	7/7M	31F/31M	**76**	Chiwawa Weir and Tumwater Dam[3]	2x2 factorial
Nason Conservation	125,000	8F/8M	26F/26M	**75[1]**	Tumwater Dam[3]	2x2 factorial
Nason Safety net	98,670	30F/30M[2]	0	**60**	Tumwater Dam	1:1
Total	**367,969**	**90**	**114**	**211[4]**		

[1] Includes ~10% additional NO fish for the Nason program to account for fish that may assign back to the White River spawning aggregate. No more than 52 NO fish will be retained for spawning.
[2] Chiwawa hatchery fish will only be collected to satisfy the Nason Cr. safety net program if in-season estimates of returning Nason conservation fish fall short of expectations.
[3] Collection of NO fish at Tumwater for the Chiwawa program will include previously PIT tagged adults (NO juveniles PIT tagged at the Chiwawa smolt trap) and/or excess NO adults/eggs/progeny originating from females with assignments >95% to the Chiwawa from the Nason conservation program.
[4] Total includes the 10% over-collection as part of the genetic assignment variance for the Nason conservation program.

Chiwawa River Conservation Program Broodstocking:

The 2019 pre-season forecast for NO adults back to the Chiwawa is well below the 2018 forecast (527 and 265 for 2018 and 2019 forecasts, respectively). It is under these circumstances that WDFW is proposing to maintain the number of bull trout encounters (and subsequent number of trappings days) to facilitate meeting the Chiwawa spring Chinook broodstock collection target as agreed to by the HCP HC. Consistent with the realized shortfall in NO broodstock in 2018, the 2019 operations plan seeks to maintain the number of bull trout encounters to about 93 (this theoretically increases the number of trapping days available from 15 to about 20). However, to minimize impacts to bull trout, operations will initially target the lower 15 day and 71 bull trout encounter levels. If additional NO brood collection is required operations may be extended to the 20 day and 93 bull trout encounter level. Should the higher level of trapping activity be required the USFWS will be notified in writing. Any further in-season modification of this plan would require concurrence on the part of the HC and the USFWS prior to implementation.

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 27 previously PIT-tagged NO spring Chinook from the Chiwawa River could be collected at TWD between June 1 and July 15, concurrent with Nason Creek brood stocking, adult management, RM&E, and the RRS Study.
- The balance adults needed to meet the Chiwawa Conservation program (up to ~76 total or ~38 females) would be collected at the Chiwawa Weir (HO adults will be collected at Tumwater Dam during the Nason broodstocking).

    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 15 cumulative trapping days and/or 71 bull trout encounters or after notifying the USFWS, 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.
    - Using the most recent 3-year redd count data (2014-2017; 2016 and 2018 survey data was not collected due to widlfires), the 10% threshold is 148 bull trout as determined by an average number of redds in the Chiwawa sub-basin of 739 (expands to 1,147 adults at a 1:1 sex ratio).
    - No more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using up to a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS.
    - To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program (either through trap inefficiency or to not exceed 33% NO extraction), HO adults (presently estimated at 19% [N=14] of the total broodstock requirement, however may be

adjusted up or down depending on the run) would be collected at TWD to make up the shortfall (see Table 10) between June 1 and July 15.

- For additional assurance and to help reduce effort at the Chiwawa Weir, during broodstock collection for the Nason conservation program, any excess adults not genotyping to the White River will be retained for the Nason program and an equivalent number of adults that have assignment probabilities >95% for Chiwawa, will be transferred to the Chiwawa program.
- Historic and in-season data for NO spring Chinook timing to the lower Chiwawa array from TWD will be used to determine optimal dates for collection.
- Any bull trout that are caught at the Chiwawa trap will be immediately removed and released at a site ~10KM upstream of the weir to prevent fallback/impingement and to mitigate for potential delay. Handling and transport will be conducted by WDFW hatchery staff.
- If a bull trout is killed during trapping, despite implementing conservation measures, trapping activities will cease and not continue until additional measures to minimize risks to bull trout can be discussed with the USFWS.

Table 11. PIT tagged natural origin adults to Tumwater Dam for the most recent 5-years (2014-2018) with conversion rates from Bonneville Dam.

	Detections at Bonneville Dam		Detections at Tumwater Dam			
Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
2016	8	34	8	1.000	24	0.706
2017	5	31	3	0.600	31	1.000
2018	1	27	1	1.000	26	0.963
Mean	5.8	40.0	3.8	0.687	27.6	0.755
Geomean	4.6	38.0	2.7	0.582	27.5	0.724

Nason Creek Conservation Program Broodstocking:

- Up to ~58 NO spring Chinook (to allow for up to 10 percent of White River NO fish estimated to be encountered at Tumwater Dam MSA; Table 10) would be collected at TWD between June 1 and July 15.
  - Only 52 NO adults (26 females) and 16 HO adults (8 females) will be retained to produce the 125K Nason Conservation program.
  - Collection of additional HO fish may occur in the event NO collection/retention falls short of expectation or would exceed 33% extraction.
  - Brood stock collection would run concurrent with adult management, RM&E, and the Spring Chinook Relative Reproductive Success Study. The GAPS microsatellite panel and existing GAPS plus WDFW spring Chinook Wenatchee

baseline will be used for genotyping and GSI analyses similar to methods used beginning in 2013.

- Decision Rules:
  - Any fish that assigns to the White River with greater than 90% surety will be released in the White River.
  - Unassigned fish (individuals that can't be assigned to the Wenatchee Population or Leavenworth NFH), will be released upstream of Tumwater Dam at the Alps or Swift Water rest stop.
  - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the highest assignment probabilities (>95%) to the Chiwawa will be incorporated into the Chiwawa conservation program if needed or otherwise returned to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- At the current run forecast, up to ~60 HO spring Chinook adults (from conservation program [1st priority] – identified by snout wire + body wire) would be targeted at TWD (Table 10) between June 1 and July 15, concurrent with NO brood stock collection, adult management, RM&E, and the Spring Chinook Relative Reproductive Success (RRS) Study to meet a 98,670 smolt release.

<u>Steelhead</u>

The steelhead mitigation program in the Wenatchee Basin uses broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 18583 provisions, broodstock collection will target adults necessary to meet a natural origin – conservation (WxW) oriented program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin and a hatchery origin (HxH) – safety net program. The conservation and safety net programs each make up approximately half of the 247,300 production obligation. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain a total of 136 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 70 hatchery origin adults will be targeted at Dryden Dam and if necessary Tumwater dam. The 66 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 14 November. Collection may also occur between 15 November and 5 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Only adipose present coded wire tagged hatchery fish (or previously PIT tagged WxW hatchery progeny) will be retained for the safety net program unless low returns require use of safety net adults (adipose clipped) to meet the production obligation. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and at Dryden Dam. In-season broodstock collection adjustments may be made based on this monitoring and evaluation.

To better ensure achieving the appropriate female equivalents for program production, the collection will include the use of ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinate adult steelhead collection in the mainstem Wenatchee River by hook and line. In addition to trapping and hook and line collection efforts, Tumwater and Dryden dams may be operated between February and early April the subsequent spring to supplement broodstock numbers if the fall trapping effort provides fewer than the required number of adults.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 12. Number of broodstock needed for the combined 2020 BY Wenatchee summer steelhead production obligation of 247,300 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wenatchee Conservation[1]	123,650	0	33F/33M	**66**	TWD[3]/Dryden LBT-RBT[4]	2x2 factorial
Wenatchee Safety net[2]	123,650	35F/35M	0	**70**	Dryden LBT-RBT[4] /TWD[4]	1:1
Total	**247,300**	**70**	**70**	**136**		

[1] Broodstock collection for the conservation program will occur primarily at Tumwater Dam and will only fall back to Dryden Dam trapping facilities if a shortfall is expected.
[2] Broodstock collection for the safety net program will occur primarily at the Dryden Dam trapping facilities to minimize activities at TWD that could increase unintended delays on non-target fish. Collection at Tumwater Dam will only occur if shortfalls in broodstock are expected at Dryden Dam.
[3] TWD=Tumwater Dam.
[4] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.

Summer/fall Chinook

Summer/fall Chinook mitigation programs in the Wenatchee River Basin utilize adult broodstock collections at Dryden and Tumwater dams, incubation/rearing at Eastbank Fish Hatchery (FH) and acclimation/release from the Dryden Acclimation Pond. The total production level target for BY 2019 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2019 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2014, 2015 and 2016 spawner escapement to the Wenatchee River indicate sufficient summer Chinook will likely return to the Wenatchee River to achieve full broodstock collection for the Wenatchee River summer Chinook supplementation program. Review of recent summer/fall Chinook run-timing past Dryden and Tumwater dams indicates that previous broodstock collection activities have omitted the early returning summer/fall Chinook, primarily due to limitations imposed by ESA Section 10 Permit 1347 to minimize impacts to listed spring Chinook. In an effort to incorporate broodstock that better represent the summer/fall Chinook run timing in the Wenatchee Basin, the broodstock collection will front-load the collection to account for the disproportionate collection timing. Approximately 43% of the summer/fall Chinook destined for the upper Basin (above Tumwater Dam) occurs prior to the end of the first week of July; therefore, the collection will provide 43% of the objective by the end of the first week of July. Weekly collection after the first week of July will be consistent with run timing of summer/fall Chinook during the remainder of the trapping period. With concurrence from NMFS, summer Chinook collections at Dryden Dam may begin up to one week earlier. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain up to 274 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 137 females (Table 13). To better ensure achieving the appropriate females for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock. Trapping at Dryden Dam may begin 24 June and terminate no later than 15 September and operate up to 7-days/week, 24-hours/day. Trapping at Tumwater Dam if needed may begin 15 July and terminate no later than 15 September and operate up to 48 hours per week for broodstock related activities.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 13. Number of broodstock needed for the combined 2019 BY Chelan and Grant PUD Wenatchee summer Chinook production obligations of 500,001 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Chelan PUD	318,185		87F/87M	**174**		
Grant PUD	181,816		50F/50M	**100**		
Total	**500,001**		**137F/137M**	**274**	Dryden LBT-RBT[1] /TWD[2]	1:1

[1] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.
[2] TWD=Tumwater Dam.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery (PRH) will generally begin in early September and continue through about mid-November. Juvenile release objectives specific to Grant PUD (5,599,504 sub-yearlings), and Federal (1,700,000 sub-yearlings at PRH + 3,500,000 smolts at Ringold Springs Hatchery – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE), mitigation commitments. Biological assumptions are detailed in Appendix A. For the Ringold Springs production, adult collection, holding, spawning and incubation occurs at PRH until the eyed-egg stage. Eyed eggs are transferred to Bonneville Hatchery until they are transferred for spring acclimation and release at Ringold Springs.

For 2019 NO adults will be targeted through hook-and-line angling efforts in the Hanford Reach and the OLAFT to increase the proportion of natural origin adults in the broodstock to meet integration of the hatchery program will also be incorporated into the program. It is estimated that approximately 600 adults may be collected through the hook-and-line efforts and 650 adults will be targeted from the OLAFT. Close coordination between broodstock collections at the volunteer channel, the OLAFT and through hook-and-line efforts in the Hanford Reach will need to occur so over collection is minimized. Fish surplus to production needs will be culled at the earliest possible life-stage (e.g, prior to ponding, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from hook-and-line caught broodstock will be prioritized for PRH programs (i.e. Hanford Reach angler caught fish will be, held in a separate pond from volunteer collected fish, spawned first each week, and to the extent possible segregated and reserved for the GPUD program).

Grant PUD staff will work closely with WDFW hatchery and M&E staff to maintain separation of gametes/progeny of angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,651 females will need to be collected to meet the 10,799,054 smolts required to meet the current three up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap, the OLAFT, and hook-and-line efforts on the Hanford Reach (Table 14).

To increase the probability of incorporating a higher percentage of NOR's from the volunteer channel, adipose present, non-CWT males and females will be prioritized for retention and males older than 3 will be prioritized. In addition, preliminary information suggests that the pNORs is higher in the later part of the trapping period than the earlier period. As data become available, the PRCC-HSC may choose, in-season, to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of broodstock necessary to backfill shortfalls.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), the Priest Rapids Hatchery volunteer channel trap, and the OLAFT.

2) Assumptions used to determine egg/adult needs is based upon current program performance metrics.

3) Broodstock retained from the volunteer channel will exclude to the degree possible, age-2 and 3 males (using length at age; i.e. retain males ≥ 75 cm) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and also decrease the probability of using hatchery origin fish in the broodstock that are skewed towards earlier ages at maturity. Age-3 fish may be retained for broodstock if in-season run estimates suggest a shortage may occur.

4) Adipose present, non-CWT males and females will be prioritized for broodstock from the volunteer channel collected broodstock unless a shortage is expected.

5) Broodstock collected by hook-and-line will exclude age-2 to minimize genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and to ensure the highest proportion of NOR's in the collection.

6) All gametes of fish spawned from hook-and-line broodstocking efforts will be incorporated into the PRH based programs.

7) All juveniles released from PRH will, at a minimum, have a unique otolith mark so that returning adults can be identified.

8) Natural origin broodstock collection at the volunteer trap will be prioritized for the GPUD program by collecting fish when the probability of encountering natural origin fish is highest and balancing run-time representation.

Table 14. Number of broodstock needed for the combined Grant PUD and ACOE fall Chinook production obligations of 10,799,504 sub-yearling smolts at Priest Rapids and Ringold Springs hatcheries, collection location, and mating strategy in 2019.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,427F/1,498M	**3,925**		
ACOE-PRH	1,700,000	737F/454M	**1,191**		
ACOE – Ringold[1]	3,500,000	1,534F/947M	**2,481**		
Total	**10,799,504**	**4,698F/2,899M**	**7,597**		

Collection location	Estimated number of adults: Hatchery	Estimated number of adults: Wild	Total		
Priest Rapids Hatchery	**3,838F/2,155**	**222F/132M**	**6,347**	PRH volunteer trap	1:2
OLAFT	**103F/51M**	**331F/165M**	**650**		1:2, 1:4
ABC[2,3]	**19F/36M**	**185F/360M**	**600**	Hanford Reach	1:2, 1:4

Total	**3,960F/2,242M** (6,202; 90.4%)	**738F/657M** (729; 9.6%)	**7,597**

[1] As of brood year 2009, Priest Rapids Hatchery is taking sufficient eggs to meet the 3,500,000 sub-yearling smolt release at Ringold-Meseberg Hatchery funded by the ACOE – late incubation of this program occurs at Bonneville.
[2] Estimated number of fall Chinook females and males to be acquired from the OLAFT in 2019. F/M ratios were derived through run at large data. Estimates of H/W were derived through otolith results.
[3] ABC fish are adults collected from hook and line collection efforts on the Hanford Reach. Estimates of F/M were derived through 2012-2014 spawn numbers. Estimates of H/W were derived through otolith results from 2013 -2017.

Appendix A

2019 Biological Assumptions and estimated adult, green egg, and eyed egg targets for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Table 1. 2019 Biological assumptions for UCR spring, summer, and fall Chinook and summer steelhead.

Program	Mean Values for 2013-2017: ELISAs H ≥ 0.12	ELISAs W ≥ 0.2	Fecundity H	Fecundity W	Prespawn Survival H M	Prespawn Survival H F	Prespawn Survival W M	Prespawn Survival W F	Mean Values 2011-2015 Brood[1] G-E-R Survival
Methow SPC	0.210	0.031	3,673	4,124	0.923	0.944	0.986	0.970	0.881
Chewuch SPC	0.210	0.031	3,673	4,124	0.923	0.944	0.986	0.970	0.881
Twisp SPC	0.300	0.027	3,781	3,914	1.000	1.000	1.000	1.000	0.910
Twisp SHD	[redacted]	[redacted]	[redacted]	5,006	[redacted]	[redacted]	1.000	1.000	0.751
Wells SHD	[redacted]	[redacted]	5,796	[redacted]	0.959	0.972	[redacted]	[redacted]	0.657
Okanogan Conservation	[redacted]	[redacted]	[redacted]	5,041	[redacted]	[redacted]	1.000	0.956	0.741
Okanogan Safety Net	[redacted]	[redacted]	5,203	[redacted]	0.959	0.972	[redacted]	[redacted]	0.657
Wells SUC 1+	0.023	0.000	3,948	4,613	0.976	0.984	[redacted]	[redacted]	0.882
Wells SUC 0+	0.023	0.000	3,948	4,613	0.979	0.984	[redacted]	[redacted]	0.753
Methow SUC	0.000	0.044	[redacted]	4,156	[redacted]	[redacted]	0.973	0.972	0.837
Chelan Falls 1+	0.027	[redacted]	3,827	[redacted]	0.963	0.947	[redacted]	[redacted]	0.837
Wenatchee SUC	0.000	0.010	[redacted]	4,484	[redacted]	[redacted]	0.963	0.959	0.856
Wenatchee SHD	[redacted]	[redacted]	5,378	5,708	0.996	0.946	0.954	0.939	0.708
Nason SPC	0.031	0.009	[redacted]	4,515	[redacted]	[redacted]	0.975	0.969	0.889
Chiwawa SPC	0.030	0.004	3,920	4,573	0.978	0.989	0.989	0.981	0.896
Priest Rapids FAC 0+	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.784
ACOE @PRH	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.784
ACOE @Ringold	[redacted]	[redacted]	3,737	[redacted]	0.810	0.788	[redacted]	[redacted]	0.775

[1] Green egg to release survival.

Table 2. Summary of UCR 2019BY Chinook and 2020BY steelhead, broodstock (H/W; M/F), green egg, eyed egg, and smolt release targets by program.

	Adults						
	Hatchery		Wild				
Program	Male	Female	Male	Female	Green egg target[1]	Eyed egg target[1]	Smolt release target
Spring Chinook							
Methow Spring Chinook			38	38	152,243	144,631	133,249
Chewuch Spring Chinook			17	17	68,690	65,256	60,516
Twisp Spring Chinook			9	9	33,882	31,442	30,000
Nason Spring Chinook (Conservation)	8	8	26	26	141,884	131,101	125,000
Nason Spring Chinook (Safety net)	30	30			114,423	105,727	98,670
Chiwawa Spring Chinook	7	7	31	31	161,389	153,158	144,026
Steelhead							
Twisp Steelhead			13	13	63,915	55,734	48,000
Wells Steelhead (MR release)	27	27			152,207	129,528	100,000
Wells Steelhead (CR release)	43	43			243,531	207,245	160,000
Okanogan Steelhead			29	29	134,953	117,679	100,000
Wenatchee Steelhead (Conservation)			33	33	174,647	131,160	123,650
Wenatchee Steelhead (Safety net)	35	35			175,949	132,138	123,650
Summer Chinook							
Wells Yearling Summer Chinook	96	96			371,853	346,195	320,000
Wells Sub-yearling Summer Chinook	169	169			657,894	624,341	484,000
Methow Summer Chinook			62	62	249,946	230,700	200,000
Chelan Falls Yearling Summer Chinook	195	195			707,268	640,078	576,000
Wenatchee Summer Chinook			137	137	590,013	543,992	500,001
Fall Chinook							
Priest Rapids Fall Chinook	1,083	2,113	415	314	7,142,807	6,399,955	5,599,504
ACOE @PRH Fall Chinook	455	737			2,168,367	1,942,857	1,700,000
ACOE @Ringold Fall Chinook	947	1,534			4,516,129	4,046,452	3,500,000

[1] Estimated value at time of inventory to meet 100% of the production obligation at release.

Appendix B

Projected Brood Year Juvenile Production Targets, Marking Methods, Release Locations, Release Size, Release Type

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2019	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2021	13-18	Forced
2019	Wells SUC 0+ (DPUD)	480,000	Ad + CWT	3K-5K PIT	Columbia R. at Wells Dam	2020	50	Forced
2019	Wells SUC 1+ (DPUD)	320,000	Ad + CWT	Up to 120,000 PIT	Columbia R. at Wells Dam	2021	10	Volitional
2019	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2021	13	Forced
2019	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	20,000 PIT	Wenatchee R. at DAF	2021	18	Volitional
2019	CJH SUS 1+	500,000	Ad + 100K CWT	5,000 PIT	CJH	2021	10	Volitional
2019	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2020	50	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2021	10	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT		Riverside Pond	2021	10	Volitional
2019	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2021	10	Volitional
2019	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2020	50	Forced
Spring Chinook								
2019	Methow SPC (PUD)	108,249	CWT only	5,000 PIT	Methow R. at MFH	2021	15	Volitional
2019	Methow SPC (PUD)	25,000	CWT only	7,000 PIT	Methow R. at GWP (YN)	2021	15	Volitional
2019	Methow SPC (PUD)	60,516	CWT only	5,000 PIT	Chewuch R. at CAF	2021	15	Volitional
2019	Twisp SPC (PUD)	30,000	CWT only	5,000 PIT	Twisp R. at TAF	2021	15	Volitional
2019	Methow SPC (USFWS)	400,000	Ad + CWT	20,000 PIT	Methow River at WNFH	2021	17	Forced (2-day)

2019	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond/Riverside	2021	15	Volitional
2019	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT	Columbia R. at CJH	2021	15	Forced
2019	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only/TBD[1]	10,000 PIT	Chiwawa River at CPD	2021	18	Short term volitional
2019	Nason Cr. SPC (GPUD) (conservation)	100,000	CWT body tag/TBD[1,13]	5,000 PIT	Nason Cr. at NAF	2021	18	Forced
2019	Nason Cr. SPC (GPUD) (safety net)	123,670	Ad + CWT	5,000 PIT	Nason Cr. at NAF	2021	18	Forced
Fall Chinook								
2019	Priest Rapids FAC 0+ (ACOE)	1.7M	Ad + Oto	Approximately 43,000 spread across the fish released from PRH	Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	600,000	Ad+CWT+ Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	600,000	CWT + Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	1M[2]	Ad + Oto		Columbia River at PRH	2020	50	Forced
2019	Priest Rapids FAC 0+ (GPUD)	3.4M	Oto only		Columbia River at PRH	2020	50	Forced
2019	Ringold Springs FAC 0+ (ACOE)	3.5M	Ad + 400K CWT		Columbia River at RSH	2020	50	Forced
Steelhead								
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	35,451	Ad + CWT (HxH) CWT only (WxW)	33,000 PIT	Nason Cr. direct release	2021	6	Direct Plant
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	70,582	Ad + CWT (HxH) CWT only (WxW)		Chiwawa R. direct release	2021	6	Direct Plant
2020	Wenatchee Mixed (HxH/WxW) (CPUD)	104,021	Ad + CWT (HxH) CWT only (WxW)		Upper Wenatchee R. direct release	2021	6	Direct Plant

2020	Wenatchee HxH (CPUD)	37,246	Ad + CWT		Lower Wenatchee R. direct release	2021	6	Direct Plant
2020	Twisp Conservation (DPUD)[11]	48,000	CWT only	5,000[7]	Twisp River at Buttermilk Bridge/TBD	2021	6	Direct Plant
2020	Wells HxH (DPUD)	100,000	Ad only	5,000 PIT	Methow River at Effy Bridge	2021	6	Direct Plant
2020	Wells HxH (DPUD)	160,000	Ad only	5,000 PIT	Columbia R. at Wells Dam	2021	6	Volitional
2020	MetComp WxW (USFWS)	Up to 200,000	Ad + CWT	20,000 PIT	Methow R. at WNFH and other locations TBD	2022[12]	4-6	(WNFH) other locations TBD
2020	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K [6]	Ad /CWT snout	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2021	5-8	Volitional capture Wells; truck planted in Salmon Creek, Similkameen R., and possibly other tributaries, TBD by fall of 2020.
2020	Okanogan WxW (CCT/GPUD)	Up to 100K [6]	Body and snout CWT[8]	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2021	5-8	Volitional from St. Mary's pond. The numbers going to Omak Creek and other tributaries will be determined by fall of 2020.

[1] WDFW would like to have a JFP discussion on an alternate tag (internal) for progeny of hatchery adults incorporated into the conservation program such that progeny of the wild parents can be prioritized. As such the minimum mark is identified with a TBD on an additional alternate mark.
[2] Externally marking of this group is presently funded by WDFW. Marking of this 1M fish is contingent on *US v. Oregon* Policy Committee approval for 2019.
[3] Presently all CWT's are applied to the snout.
[4] The Okanogan SPC program derives its juveniles from a 200K transfer of Methow SPC from WNFH as part of a reintroduction effort. Fish are released into the Okanogan Basin.
[5] The Chief Joe Hatchery SPC program presently receives surplus adults from the Leavenworth NFH as needed. Juveniles are released on station from CJH.
[6] Total Okanogan release not to exceed 100K + 10%.
[7] DPUD will tag 2,500 of the Twisp Only S1's and 2,500 of the Methow S1's. USFWS will tag 2,500 of the Methow S2's for release into the Twisp and 2,500 of the Methow S2's, will accompany the DPUD Methow S1's for an off station release.
[8] The Okanogan steelhead HGMP and NOAA's BiOp for the TRMP state that WxW progeny will receive a unique internal tag (CWT or PIT) and/or receive an alternative fin clip. At this time, CCT does not intend to use an alternative fin clip until/unless a high proportion of the released fish have WxW parents and there is an acceptable survival risk/benefit of the alternative fin clip.
[9] Total PIT tag release in the Okanogan 20,000
[10] Beginning with the 2017 brood, adult returns from the Nason conservation program will be utilized to meet the Nason safety net program and will receive a supplemental body tag (blank wire in the dorsal sinus) in addition to the adipose clip.
[11] With the recent detection of potential inbreeding depression effects in the Twisp conservation program, parties are continuing to develop a long term plan for the program. Once developed and agreed to, this table will be updated to reflect any changes.
[12] Winthrop NFH steelhead program produces 2-year (S2) smolts.
[13] For the 2020 brood, CWT placement will shift from the base of adipose fin to the dorsal sinus to evaluate if the adipose tagging location is responsible for spinal deformities and elevated mortality.

Appendix C

Return Year Adult Management Plans

At a gross scale, adult management plans will include all actions that _may_ be taken within the current run year to address surplus hatchery fish (if any). At the time of submission for this document, spring Chinook will probably be the only group where a reasonable pre-season forecast may be available to lay out what the expected surplus is, how many can be expected to be removed through each action, etc. Preseason forecasts for steelhead will be available in September.

Wenatchee Spring Chinook

Pre-season estimates for age-4 and age-5 adults project a total of 1,599 (390 natural origin [24.4%] and 1,209 hatchery origin [75.6%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 1,143 Chiwawa and 335 Nason spring Chinook are to reach Tumwater Dam in 2019, of which about 343 (22.1%) and 1,209 fish (77.9%) are expected to be natural and hatchery origin spring Chinook, respectively. The balance of about 47 natural origin spring Chinook expected back are destined to the remaining spawning aggregates (Table 1). In-season assessment of the magnitude and origin composition of the spring Chinook return above Tumwater Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18118 and 18121.

Table 1. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2019.

	Chiwawa Basin[1]			Nason Cr. Basin[1]			Wenatchee Basin to Tumwater Dam[2]		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	238	27	**265**	70	8	**78**	350	40	**390**
Estimated hatchery return	905	30	**935**	265	9	**274**	1,170	39	**1,209**
Total	1,143	57	**1,200**	335	17	**352**	**1,520**	**79**	**1,599**

[1] Reflects NOR estimates to Tumwater Dam and has not been adjusted for pre-spawn mortality.
[2] Wenatchee Basin to Tumwater Dam total includes NORs to the White, Little Wenatchee, and Chiwawa rivers and Nason Creek.

Absent broodstock, conservation fisheries, or adult removal at Tumwater Dam (TWD), the expected number of age-4 and age-5 Hatchery Origin Returns (HOR) for the upper Wenatchee River Basin as a whole is estimated to be approximately 3.1 times the expected number of Natural Origin Returns (HORs; 3.5 times the number of NOR's in the Chiwawa River and in Nason Creek). The combined HO and NO returns will represent about 1.3 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 2). The combined HO and NO returns will represent about 70.4% of the number of adults needed to meet the interim Nason run escapement to TWD of 500 fish indicating a disproportionate number of hatchery origin spring Chinook may be on the spawning grounds in the fall of 2018 (Table 3).

Additional Adult Management

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Wenatchee Spring Chinook BiOp (2013; 2105) and Permits #18118, #18129 and #18121. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

2019 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks), and unknown hatchery origin adults (ad-/cwt-) during broodstock collection, run composition assessment, and the RSS. No additional adult removal is expected according to current models, Table 2. The return will be managed for escapement only unless actuals return are higher than the current forecast. In addition, approximately 90 HO and 114 NO adults will be removed between TWD and the Chiwawa Weir and retained for broodstock to support meeting the combined Grant and Chelan PUD Wenatchee spring Chinook obligation.

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2019.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	146	636	87	331	0	**418**
Males[4]	119	299	64	145	0	**209**
Sub-total	265	935	151	476	0	**627**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.52**
Expected pHOS						**0.76**

[1] Wild broodstock of 62 wild NO fish (38 females/38 males) for the Chiwawa conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 14 fish (7 females/7 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 418 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Run escapement and spawning escapement of Nason Creek hatchery and natural origin fish to Tumwater Dam and Nason Creek in 2018.

	To Tumwater Dam		To Nason Creek		Adults surplused at TWD[3]	Total Nason spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	43	186	53	97	0	**150**
Males[4]	35	88	41	43	0	**84**
Sub-total	78	274	94	140	0	**234**
Pre-spawn survival[6]			0.80	0.55		
Expected PNI						**0.56**
Expected pHOS						**0.60**

[1] Wild broodstock of 52 wild NO fish (26 females/26 males) for the Nason conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 76 fish (38 females/38 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 150 redds in Nason Creek under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Methow Spring Chinook

Pre-season estimates project a total of 1,803 (785 natural origin [43.5%] and 1,018 hatchery origin [56.5%]) spring Chinook back to the Methow Basin. Of the 1,018 hatchery returns, about 431 are estimated to be from the conservation program with the balance of 587 from the WNFH safety net program (Table 5).

Table 5. Brood year 2014-2016 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2019.

	Projected Escapement											
	Origin								**Total**			
	Hatchery				**Wild**				**Methow Basin**			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	48	292	10	**350**	17	453	145	**615**	65	745	155	**965**
%Total				34.4%				78.3%				53.5%
Twisp	16	54	11	**81**	14	131	25	**170**	30	185	36	**251**
%Total				7.9%				21.7%				13.9%
Winthrop (MetComp)	71	503	13	**587**					71	503	13	**587**
%Total				57.7%								32.6%
Total	135	849	34	**1,018**	31	584	170	**785**	166	1,433	204	**1,803**

Based on the current forecast, adult management to control MFH escapement, beyond removal of age-3 hatchery males during the course of broodstock collection and M&E, will not likely be needed. Active trapping and operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH) will likely be needed to retain WNFH hatchery adults, and collect returning MFH adults for potential translocation into the spawning grounds.

Presently hatchery fish from MH are prioritized to: a) contribute to the supplementation of the natural populations (up to either the escapement objectives or PNI/pHOS goal), b) make up shortfalls in natural-origin brood for the MH conservation program, and c) to support the 400K safety-net program at WNFH. As such both hatcheries will operate volunteer hatchery ladders to support removal of excess safety-net and conservation fish (when needed). MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH and conservation needs) to WNFH to support the safety-net program, to support removal of excess safety-net and conservation fish, or retain adults to facilitate testing translocation of conservation fish to under-seeded spawning areas as approved by the HCP HC and PRCC HSC. The translocation of conservation program adults may be prioritized over their use as broodstock for the safety net program as long as both programs can meet full production and gene flow (pHOS/PNI) terms and conditions on the spawning grounds. The intention of adult translocation is to increase natural production which is the primary function of the Methow Hatchery. Any implementation of adult translocation as a strategy to increase the abundance of spawners in the natural environment will require the review and refinement (if necessary) of the approved 2017 Out-planting plan for implementation in 2019. Implementation of a Return Year 2019 Out-planting Plan should be supported by updated escapement estimates and outlines the targeted number, gender, out-planting location, and evaluation criteria. It is expected that the information provided in the 2019 BCP will serve as the starting point for development of the out-planting plan.

Specific actions are as follows:

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Methow Spring Chinook BiOp (2017) and Permits #18925, #18927 and #20533. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

Twisp River Spring Chinook: spring Chinook in the Twisp River will be managed separately from the rest of the basin.

a. Adipose-clipped fish encountered at the Twisp Weir will be removed (putative WNFH returns or strays from outside of the basin).
b. Age-3 hatchery males will be removed and euthanized or transported to WNFH for surplusing unless there is a broodstock shortage – in that case age-3 males may be used as brood on a very limited basis (up to 2 Age-3 fish may be used if necessary, but up to one is preferred, only of necessary).
c. Adult management will be performed to maintain pHOS $\leq$0.50. pNOB will be >0.50 and may be allowed to fluctuate between 0.50 and 1.0 in order to achieve a pHOS $\leq$0.50.

d. Wild fish will be collected as broodstock – up to ~18 individuals, but not to exceed 33% of the wild run. Hatchery fish may be collected as broodstock, dependent on collection success of wild fish and provided that Twisp-program pNOB may not be less than 0.50.
e. The Twisp Weir will be fished for the duration of the broodstock collection, only, in 2019. Adult management activities will be incidental to broodstock collection. Once broodstock collection is completed, the weir will be opened to fish passage to limit delay/trapping effects on bull trout. During broodstock collection, the weir will be fished from 6:00 AM to 9:00 PM on a daily basis. Deviation from this schedule may be implemented based on the run size and catch efficiency for broodstock.

Methow River (MFH and WNFH) and Chewuch River Spring Chinook (MetComp):

a. Stock assessment will be performed at Wells Dam during the spring Chinook broodstock collection. This information on stock, hatchery:wild, and male:female composition in conjunction with fish counts at Wells Dam will be used to adjust in-season adult management targets.
b. MetComp returns will be managed by removing volunteers at WNFH and Methow Hatchery using the outfall traps at these facilities.
    i. All hatchery-origin age-3 males will be removed
        1. Gender identified by ultrasound.
    ii. The Methow FH and Winthrop NFH volunteer traps will be fished continuously (24 h per day/7 d per week) throughout the run and fish removed at least once daily (depending on specific facility limitations), or as often as needed when fish are present. Adjustments to the operation of the trapping facilities will be made based upon capture/extraction rates as well as bull trout encounters and take limitations.
    iii. Trapping may cease at Methow Hatchery if:
        1. Removal of MFH and WNFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season, and/or through the development of an approved Out-planting plan), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    iv. Trapping may cease at Winthrop NFH if:
        1. Removal of WNFH and MFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season, and/or through the development of an approved Out-planting plan), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    v. All adipose clipped returns encountered at WNFH and MFH volunteer traps will be removed.

1. Returns to WNFH will be retained at WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.
2. Returns to MFH will be transferred to WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.

vi. Conservation program returns may also be transported to specific reaches of the Methow and/or Chewuch Rivers (or other locations as determined by the HC/HSC) to meet the minimum spawning escapement objective or to experimentally augment spawner distribution (such an action will require an approved study or implementation plan by the HCP HC and PRCC HSC, and be permissible under current ESA permits).

Based on the preseason forecast for wild and hatchery spring Chinook to the Methow Basin, once NO broodstock requirements are fulfilled and accounting for an estimated prespawn mortality for NO fish of 50% (42% for HO fish), there will be approximately 329 NO spawners. Based upon the sliding PNI scale for NO run sizes >300 fish, the initial goal for 2019 will be to manage for a minimum spawning escapement of 548 spawners; to achieve this, based on the current forecast, the collection and translocation of hatchery fish will likely be needed (Table 6). This will require an approved out-planting plan for 2019 (using the approved 2017 plan as a starting point) that balances the current and out-year effects to PNI with the need to supplement natural production. Further, the 400K WNFH (in addition to the 200K 10j program) safety net program would need to utilize WNFH returning adults for some or all of its broodstock. Up to 100 % of the MFH HO returns collected at the outfalls would be translocated to the spawning grounds, any MFH HO returns retained may be used for broodstock for the WNFH safety net program to meet PNI requirements. It is expected that in the course of developing an out-planting plan for 2019, the parties will utilize the information provided in Table 6 as well as develop modeling scenarios to anticipate how various out-planting and broodstock collection strategies may impact natural production and PNI (using the multi-pop PNI calculation) in the current and out years.

Table 6. Calculated targets and projected adult management expectations for Methow spring Chinook in 2019 based on current run forecast.

Wild Spawning Escapement[1]		pNOB[2]	pHOS	PNI [3]	Hatchery Spawners[1,4]	Hatchery surplus[4]	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawning escapement
Twisp	76	0.96	0.29	0.77	31	0 MH		0	107
Methow/Chewuch	253	0.89	0.34	0.72	132	56 WNFH[5]	472 (316 WH+156 WH)	0	441
Total	329	0.93	0.33	0.74	163	56	472 (316 WH+156 WH)	0	548

[1] Adjusted for prespawn mortality.
[2] pNOB of conservation program only averaged for BY14, 15, and 16. pNOB target for BY19 is 1.0 for both programs.
[3] Because of the uncertainty around run forecasts, PNI was provisionally estimated using the PNI=pNOB/(pNOB+pHOS) equation.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value already considers hatchery adults needed to meet WNFH and Okanogan 10(j) production components.
5 If the estimated 56 surplus WNFH are allowed (or assumed) to be on the spawning grounds, PNI would drop to 0.67.

In-season assessment of the abundance and origin composition of the spring Chinook return above Wells Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18925, 18927, and 20533.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may occur at the Twisp Weir to meet an overall pHOS = 0.25 with 0.20 allocated to the Twisp Conservation program returns (the exception to this would be if a higher pHOS is still needed to wrap up the remaining time series on the Relative Reproductive Success Study as approved),the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, during broodstock collection efforts (including angling), or in combination with a conservation fishery, consistent with ESA authorizations.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations, consistent with ESA authorizations.

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin should the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT) occur, removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Wenatchee tributary weir operations, consistent with ESA authorizations.

Adult management plans, if needed, will be finalized then and appended to this document.

Priest Rapids Fall Chinook

The Joint Fisheries Parties have an elevated interest in ensuring any surplus adults back to Priest Rapids Hatchery are made available to back fill anticipated shortfalls in other Columbia River fall Chinook programs given the low 2019 return forecast. As no specific action plan has yet been discussed or developed by the parties, this space is reserved for those details to be inserted at a later date.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for Tumwater Dam is summarized in Table 1):

1) **Real-time monitoring and trap operations:** The PIT tag antennae arrays at the entrance (low and high water entrances; A4 and A5) and at weir 18 (A1) within the Tumwater Dam ladder will be monitored by WDFW and Chelan PUD throughout all trapping activities described in this plan. Detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at the ladder entrances and last detection weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish detected at the ladder entrance. If the median passage time is greater than 48 hours, trapping will cease and fish will be allowed to exit via the ladder (i.e., bypass the trap). If trapping has been stopped, PIT tag passage monitoring will continue and trapping will resume if and when the median passage time is less than 24 hours. In summary, real-time PIT tag monitoring will occur both when the trap is operational and when fish are bypassed. This will provide an opportunity to evaluate trapping effects versus baseline passage rates through the ladder for future operations.

2) **Enhanced effort for Tumwater trapping operations from June 1 and July 15**: The Tumwater trap will be operated in an active-manned trapping condition (the ladder bypass will not be used however, fish may still ascend the denil [steep pass] unimpeded). The trap will be checked a minimum of 1x per day. More frequent trap checks will be made as fish numbers increase. Between June 16 and July 15 the Tumwater trap will be actively manned 24 hours/day 7 days/week utilizing two- three person crews (two people will sample fish and the third will maintain operation of the steep pass so that it will not be closed to passage). This represents an additional person to keep the denil operating constantly. If during this period staff are not available (due to logistical, funding, or other issues) to keep the denil operating continuously, the trap will be opened to allow for nighttime passage (this is in addition to passage required under a detected delay event).

3) **Enhanced effort and limited Tumwater trapping operations from July 16 to August 31**: The trap will be operated 3 days/week for up to 16 hours/day (not to exceed 48 hours per week) to support broodstock collection activities for summer Chinook and sockeye run composition sampling (CRITFC) and sockeye spawner escapement PIT tagging. Video enumeration and full passage will occur when trapping is not occurring.

4) **Planned Tumwater trapping operations from September 1 until mid-December:** To facilitate lamprey passage and meet coho and steelhead broodstocking and steelhead adult management needs, the trap is being proposed to operate up to 16 hours per day from 6AM to 10PM 7days/week manned or unmanned active trapping. The trap will be open for lamprey passage between the hours of 10PM and 6AM. During this time period

bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will be implemented with video enumeration when opened.

5) **Operations at Tumwater from mid-December until about mid-February:** During this period the trapping facility is not operated due to having been winterized. Only video enumeration and full passage are available during this period.

6) **Planned Tumwater trapping operations from mid-February through May:** The trap may return to a 24 hours/7days/week manned or unmanned active trapping for adult steelhead management and/or broodstock collection as needed. Beginning on or about May 1, limited spring Chinook broodstocking, run comp sampling, etc. may also occur. For this trapping period, real-time monitoring will continue to be implemented.

7) **Limitation in staffing or other unforeseen problems:** If WDFW staff are not available to operate the trapping facility (according to this plan) for any reason, then full passage will be allowed (fish will be allowed to bypass the trap and exit the ladder directly), until staff are able to return.

8) **Unforeseen scenarios and in season observations**: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and Chelan PUD will alert the Hatchery Committee and work cooperatively with the Services to determine whether changes are needed to further minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the Services.

Table 1. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and reproductive success activities anticipated to be conducted at Tumwater Dam in 2019. Blue denotes steelhead, brown spring Chinook, orange sockeye, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD pHOS mgt[1]		15 Feb				15 June			1 Sep			15 Dec
Su. SHD BS collection[2]									1 Sep		15 Nov	
Su. SHD Spawner Esc. tagging[3]		15 Feb				15 June			1 Sep			15 Dec
Spring Chinook RSS[4]					1 May		15 Jul					
Sp Chinook run comp[5]					1 May		15 Jul					
Sp Chinook pHOS mgt[6]					1 May		15 Jul					
Sp Chin stray mgt[7]					1 May		15 Jul					
Sp Chin BS collection					1 May		15 Jul					
Sockeye run comp[8]							15 Jul	15 Aug				
Sockeye spawner esc tagging[9]							15 Jul	15 Aug				
Su. Chin BS collection[10]							1 Jul		15 Sep			
Coho BS collection[11]									1 Sep		30 Nov	

[1] Adult management of the 2019 brood will end in June 2019. However it is anticipated that adult management will occur for the 2020 brood (if needed) beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at Tumwater Dam for other species.

[2] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[3] SHD spawner composition tagging at Tumwater Dam will run concurrent with SHD adult management and other (broodstock) activities at Tumwater Dam.
[4] The spring Chinook RSS will run from 1 May through about 15 July or at such time or at such time the sockeye return develops at Tumwater Dam.
[5] Spring Chinook run composition sampling will run concurrent with the RSS.
[6] Spring Chinook pHOS management will end in July consistent with the arrival of the sockeye return and run concurrent with RSS activities.
[7] Removal of unknown hatchery origin spring Chinook strays at Tumwater Dam will run concurrent with the RSS.
[8] Sockeye run composition sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for run composition sampling will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[9] Sockeye spawner escapement sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for spawner escapement tagging will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[10] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Tumwater Dam for summer Chinook broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[11] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Tumwater Dam for Coho broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Dryden Dam

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the right and left bank Dryden Dam traps is summarized in Table 2):

The Dryden Dam left and right bank trapping facilities will operate up to 7 days per week, 24 hours per day beginning June 24 and continue until as late as November 15. Both traps, if operated, will do so on concurrent days and will be checked and cleared every 24 hours, or sooner if it appears that run contribution to the facilities exceeds reasonable limits for adult holding.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 2. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Dryden Dam trapping facilities in 2019. Blue denotes steelhead, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Left Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul				15 Nov	
Su. SHD spawner esc. Tagging[2]							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection									1 Sep		30 Nov	
Right Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul					
Su. SHD spawner esc. Tagging2							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[4]									1 Sep		30Nov	

[1] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities. In the event steelhead brood cannot be met by Nov 14 and the YN coho program does not need to operate the trap(s), steelhead brood collection may continue independently through Dec 5.
[2] SHD spawner composition tagging at Dryden Dam will run concurrent with other (broodstock or M&E) activities at Dryden Dam.
[3] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Dryden Dam for summer Chinook broodstock will follow an up to 7d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Dryden Dam for Coho broodstock will follow an up to 7d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 5 of each year but typically ceases by the end of November.

Chiwawa Weir

For 2019, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the Chiwawa Weir is summarized in Table 3):

Weir operations will be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.

Table 3. Summary of broodstock collection activities anticipated to be conducted at the Chiwawa Weir in 2019. Brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sp Chin BS collection						1 June		15 Aug				

Wells Dam Ladder and Hatchery Volunteer Traps

For 2019, WDFW and Douglas PUD propose the following plan (activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps are summarized in Table 4):

1). **East Ladder Trap:**

The East ladder trap will only be operated as needed to meet broodstock collection objectives and other management activities if they cannot be adequately fulfilled through the West ladder and Wells FH volunteer trap operations or if the use of either the West ladder or volunteer traps is precluded for some reason.

If the East ladder trap is used, it may begin as early as May 1 and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week and will run concurrent with any trapping activities occurring at the West ladder trap. The first exception to the above is that for spring Chinook between May 1 and June 20, the trap may operate a maximum of 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the West ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the East ladder trap may be operated, concurrent with the West ladder trap, 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment. Their request for trapping in 2019 did not specify trapping details other than timing (late June through early August), but their preference in past years has been to use the East ladder.

If daily river temperatures meet or exceed 21º C (69.8º F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

2). **West Ladder Trap:**

The West ladder may begin as early as May 1 for spring Chinook broodstock collection and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week. The first exception to the above is that for spring Chinook between

May 1 and June 20, the trap may operate under a maximum 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the East ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the West ladder trap may be operated 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment and may use the west ladder; however, their preference in past years has been to use the East ladder. CRITFC has proposed trapping from late June through early August.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

3). **Wells FH Volunteer Trap:** The Wells FH volunteer trap may begin as early as July 1 for summer Chinook broodstock collection and operate through mid-June of the following year for steelhead broodstock collection and adult management if needed. The trap may operate up to seven days per week/24 hours per day to facilitate broodstock collection and adult management actions.

If water temperatures in the trapping facility meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Wells Dam in 2019. Blue = steelhead, brown = spring Chinook, pink = summer Chinook, orange = sockeye, and green = Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
East/West Ladders												
Su. SHD BS collection[1]									1 Sep		15 Nov	
Su. SHD run comp.									1 Sep		15 Nov	
Su. SHD Spawner Esc. Tagging[2]									1 Sep		15 Nov	
Sp Chinook BS collection					1 May	30 Jun						
Sp Chinook run comp					1 May		15 Jul					
Sockeye SA [4]tagging[4]						2525 June		1717 Aug				
Su. Chin BS [3]collection[3]							1 Jul		15 Sep			

Coho BS collection[5]			15 Sep	15 Nov
Wells Volunteer Trap				
Su. SHD BS collection[1]			1 Sep	15 Nov
SHDBS/pHOS mgt.[6]	15 Feb	15 June	1 Sep	15 Dec
Su. Chin BS collection[7]			1 Jul	15 Sep
Su. Chin Surplussing			1 Jul	30 Oct

[1] Summer steelhead broodstock collection will be prioritized at West ladder and volunteer traps. However if broodstock objectives cannot be met at either of those two locations then trapping may occur at the East ladder concurrent with other activities.
[2] SHD spawner composition tagging at Wells Dam will run concurrent with other (broodstock or M&E) activities at Wells Dam.
[3] Summer Chinook broodstock collection for the Methow (Carlton) program will be prioritized at the West ladder trap. However if broodstock objectives cannot be met at the West ladder then trapping may occur at the East ladder. Trapping at the west and/or East ladders for summer Chinook broodstock will follow an up to 3d/week 16hr/day (48 cumulative hours) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] CRITFC trapping of sockeye for stock assessment and tagging typically begins the last week of June and extends through the third week of August, following an up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW spring or summer Chinook and steelhead broodstock collection and stock assessment trapping, preferring to trap on the East ladder.
[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock prior to September 27, will follow up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW steelhead broodstock collection and stock assessment trapping; from September 27 through October 9, an up to 5d/week 9hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities, and 7 days per week/16 hours per day beginning October 10. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2019 brood will end in June 2019. However it is anticipated that adult management will occur for the 2020 brood beginning 1 September 2019 or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.
[7] Summer Chinook broodstock collection for the Wells Hatchery programs will be prioritized at the Wells Hatchery volunteer trap. Trapping at the volunteer channel may occur up to 7 days per week, 24 hours per day and may include broodstock collection and/or adult management.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2019, WDFW and Douglas PUD propose the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Methow Hatchery Volunteer Trap

The Methow Hatchery volunteer trap may be operated for spring Chinook as early as May 1 through August 31 for broodstock collection and gene flow management. The trap may be operated from approximately March 1 through June 1 for steelhead broodstock collection and gene flow management. In all cases, the trap may be operated 24 hours a day, seven days a week. The trap will be checked at least once every 24 hours, but will be checked two or more times a day when fish are abundant. Trap operations will be adjusted if bull trout captures approach ESA take limits. Trapping operations will be halted prior to exceeding ESA take levels for any ESA listed species.

If daily river temperatures meet or exceed 21^{o} C (69.8^{o} F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Twisp Weir

1) **General Weir Operating Parameters:**
    a. Weir fished from ice out in late February/early March through mid-August.
    b. Steelhead trapping occurs from late February/early March through June 1.
    c. Spring Chinook Trapping occurs from June 1 until broodstock and adult management targets are achieved (usually prior to mid-August).
    d. The height of the weir panels is hydraulically controlled and panels are set at the water surface level when the weir is fishing to allow downstream migrating steelhead, spring Chinook, and bull trout to safely and effectively pass the weir.
    e. Weir is tended by DPUD or WDFW personnel whenever the trap is operated. WDFW is contracted by Douglas PUD under the HCP Monitoring and Evaluation Plan to monitor the trap.
    f. Operation of the weir under the ESA is currently authorized by Section 10 Permits 18925 and 1395 (1395 permit extended by NMFS on September 20, 2013).
    g. Real-time monitoring and trap operations: Throughout all trapping activities described in this plan, PIT tag interrogation locations WEL and WEA (Wells Dam), WEH (Wells Hatchery), LMR (Lower Methow River) and TWR (Twisp River) will be monitored by WDFW and DCPUD staff for detections of previously PIT tagged steelhead, spring Chinook, and bull trout. Detections at Wells Dam are nearly 100% efficient. However, detections at LMR and TWR during the higher flows, particularly when spring Chinook and bull trout are migrating, may be less than 20% efficient (comparing fall downstream movements to upstream movements). Data will be examined on a yearly basis to determine if there are peak periods when bull trout are most likely to pass the weir.
    h. When the weir is not fishing, the weir panels will be lowered to the stream bottom, or the traps will be opened to passage, or both. If only the weir panels are lowered the entrances to the traps will be closed.
    i. Limitation in staffing or other unforeseen problems: If staff are not available to staff the trapping facility (according to this plan) for any reason, or the trap will not be checked within 24 hours, then full passage will be allowed by lowering the weir panels or opening the traps or both, dependent on flow conditions until staff are able to return.
    j. Unforeseen scenarios and in-season observations: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and the District will alert the National Marine Fisheries Service, HCP Hatchery Committee, and/or the USFWS, as appropriate, and work cooperatively with these parties to minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the USFWS.
    k. Trapping effort monitoring: Trapping effort in the form of daily trap operation time will be recorded by trap operators. Trapping effort will be used in subsequent years to refine this plan.

l. Nocturnal vs diurnal use: Species composition during trapping hours will be recorded to document times of day when various species are trapped.
m. Trapping will be suspended prior to exceeding the take limits specified by USFWS for bull trout and by NMFS for summer steelhead and spring Chinook.
n. Broodstock collection target numbers are established annually prior to trapping based on predicted age composition, fecundity, and survival of broodstock and rearing in-hatchery.
o. This Plan does not limit other ESA Permit (1395 and 18925, Wells Bull Trout Biological Opinion) conditions that also apply under this plan.

2) Late February/Early March through June 1 Operations:

a. Weir begins fishing in late February or early March as environmental conditions allow.
b. The weir will be fished constantly during this time to trap steelhead, as conditions allow. The weir will be tended by WDFW personnel at least once daily, but twice daily or more when fish are present. An attempt will be made to capture all adult steelhead during this time period:
   i. Steelhead are trapped during this period for Twisp River broodstock collection for the Douglas PUD Twisp Steelhead Conservation Program (N~12-26).
   ii. Steelhead are trapped for population census data collection and for a relative reproductive success study of hatchery and wild steelhead required of Douglas PUD under the Wells HCP.
   iii. Steelhead are trapped to control the relative abundance of hatchery and wild steelhead adults upstream of Twisp Weir. Steelhead removed via adult management may be used as broodstock for other Douglas PUD and WNFH programs.
c. Bull trout have not been observed or trapped at the Twisp Weir prior to June 5^{th}.
d. No more than 118 adult and 50 sub-adult bull trout (also includes 19 juveniles) handled in the entire trapping season. Trapping would be suspended with one lethal take of any size bull trout.
e. High flows that may occur during the steelhead trapping season can significantly limit the efficiency of the weir or prevent fishing the weir. In these cases, the weir panels are lowered or over-topped by the water and the traps are opened for passage. During such flow episodes that prevent trapping, the weir and trap boxes are fully passable to all species.

3) June 1 through August Operations:

a. The weir will be fished selectively during this time period to trap spring Chinook broodstock. Normally the weir will be fished daily from 6:00 AM until 9:00 PM, but overnight trapping may be used if greater trapping effort is needed to collect spring Chinook broodstock. When the weir is not fishing, the weir panels will be lowered and/or the traps will be opened to allow passage.
b. Trapping effort will be based on meeting the spring Chinook broodstock collection target for adult spring Chinook of natural origin. In-season information derived from sampling and counts at Wells Dam and PIT tag detections at in-river

arrays will inform trapping operations in order to target spring Chinook while reducing effort when spring Chinook are not likely to be available.

c. Trapping will not necessarily occur every day or for 24 consecutive hours per day, dependent on efficiency of trapping operation in obtaining broodstock. Fine-scale scheduling of trap operations will be determined on a day-to-day basis.

d. No more than 118 adult and 50 sub-adult bull trout (also includes 19 juveniles) handled in the entire trapping season. Trapping would be suspended with one lethal take of any size bull trout.

e. Trapping will be suspended when the broodstock target is met. When the weir is not fishing the traps will be opened to allow passage and the weir panels will be lowered. The traps will be removed from the river in mid- to late August.

f. High flows significantly limit the efficiency of the weir or prevent fishing the weir entirely. In these cases, the weir panels are lowered and the traps are opened for passage. During high flow episodes that prevent trapping the weir is fully passable to all species.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Methow Hatchery and the Twisp Weir in 2019. Blue denotes steelhead and brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Methow Hatchery[1]												
SHD pHOS mgt.			1 Mar			15 Jun			1 Sep		15 Nov	
Sp. Chinook BS collection					1 May			30 Aug				
Sp. Chinook pHOS mgt.[2]					1 May			30 Aug				
Twisp Weir[3]												
Steelhead RSS			1 Mar		30 May							
Su. SHD BS collection			1 Mar		30 May							
SHD pHOS mgt.			1 Mar		30 May							
Sp. Chinook BS collection						1 June		15 Aug				
Sp. Chinook pHOS mgt.						1 June		22 Aug				

[1] Specific details on how operation of the Methow Hatchery volunteer trap will work for SHD adult management are still being worked out at this time.

[2] Adult management for spring Chinook at the Methow Hatchery volunteer trap will run concurrent with broodstock collection.

[3] Specific details on how operation of the Twisp Weir will work for 2019 to include the steelhead RSS, broodstock collection, and adult management and spring Chinook broodstock collection and adult management is still being worked out at this time.

Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT)

Table 5. Summary of broodstock collection, VSP monitoring, and/or run composition sampling activities anticipated to be conducted at the Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT) in 2019. Blue denotes steelhead, purple fall Chinook, and orange sockeye. All users of the OLAFT must have a signed Facility Use Agreement with GPUD.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chinook Run Comp.[2]									1 Sep		15 Nov	
Sockeye BS Collection[3]						22 Jun	10 Jul					

[1] Steelhead VSP monitoring, if it occurs in 2019, will target up to 15% of the annual return over Priest Rapids Dam. Presently that requires operation of the OLAFT up to 3 days/ week, 8 hours per day. The trap is opened to passage each night.
[2] Fall Chinook run composition runs concurrent with SHD VSP monitoring.
[3] Sockeye broodstock collection to support YN reintroduction efforts in the Yakima is based upon abundance based sliding scale. Depending on the strength of the return and allowable allocation, the trap may be operated up to 5 days per week, 8 hours per day beginning about 22 June and running through about 10 July. The trap is opened to passage each night.

Appendix E

Columbia River TAC Forecast

Table 1. 2018 Columbia River at mouth salmon returns – actual and forecast.

		2018 Forecast	**2018 Actual**	**2019 Forecast**
Spring Chinook		**248,520**	**176,642**	**157,500**
Willamette River		53,820	37,441	40,200
Sandy River		5,400	4,733	5,500
Select Areas**		12,300	9,887	8,200
Cowlitz River		5,150	4,000†	1,300
Kalama River		1,450	2,300†	1,400
Lewis River		3,700	3,200†	1,600
Lower River Total		**81,820**	**61,561**	**58,200**
Wind River**		5,300	3,109	n/a
Drano Lake/Little White Salmon River**		10,200	7,352	n/a
Hood River**		2,500	2,026	2,300
*Hood River wild***		*120*	--	--
Klickitat River**		1,990	667	n/a
Yakima River**		7,000	3,155	3,000
Umatilla River**		6,300	3,257	n/a
***Mid-Columbia total** (by subtraction)*		***39,200***	***34,641***	***40,000***
Upper Columbia (total)		20,100	12,844	11,200
Upper Columbia wild		*3,400*	*1,977*	*2,100*
Snake River Spring/Summer (total)***		107,400	67,596	48,100
*Snake River wild****		*18,500*	*11,339*	*8,200*
Upriver Total		**166,700**	**115,081**	**99,300**
Summer Chinook	**Upper Columbia**	**67,300**	**42,120**	**35,900**
Sockeye	**Total Sockeye**	**99,000**	**210,915**	**94,400**
Wenatchee		25,700	--	18,300
Okanogan		72,600	--	74,500
Yakima		50	--	1,300
Deschutes		50	--	100
Snake River		600	297	200

*Components may not sum to totals shown since individual forecasts are not available for all upriver spring Chinook tributaries. Wild components are included in the stock total.

**Return to tributary mouth.

***2018 return is based on standard TAC run reconstruction methodology.

†2018 returns to the Cowlitz, Kalama, and Lewis rivers are to the tributary mouth and are not directly comparable to the forecasts. These values will be updated when estimates for return to the Columbia River mouth are available.

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The Final 2018 Chelan Hatchery Monitoring and Evaluation Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Douglas PUD
The Final 2018 DCPUD ME Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Grant PUD

2018 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin and Methow Summer Chinook Salmon
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/2016%20GPUD%20Hatchery%20ME%20Implementation%20Plan%20for%20the%20Wenatchee%20Basin_FINAL.pdf?Web=1

2018 Priest Rapids Hatchery Implementation Plan
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/PRH%20ME%202016-17%20Implementation%20plan%20final.pdf?Web=1

Appendix G

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Hatchery Production Management Plan

The following management plan is intended to provide life-stage-appropriate management options for Upper Columbia River (UCR) PUD salmon and steelhead mitigation programs. Consistent, significant over-production or under-production risks the PUD's not meeting the production objectives required by FERC and overages in excess of 110% of program release goals violates the terms and conditions set forth for the implementation of programs under ESA and poses potentially significant ecological risks to natural origin salmon communities.

Under RCW 77.95.210 (Appendix A) as established by House Bill 1286, the Washington Department of Fish and Wildlife has limited latitude in disposing of salmon and steelhead eggs/fry/fish. While this RCW speaks more specifically to the sale of fish and/or eggs, WDFW takes a broader application of this statute to include any surplus fish and/or eggs irrespective of being sold or transferred.

We propose implementing specific measures during the different life-history stages to both improve the accuracy of production levels and make adjustments if over-production occurs. These measures include (1) Improved Fecundity Estimates, (2) Adult Collection Adjustments, (3) Within-Hatchery Program Adjustments, and (4) Culling at the earliest life-stage.

<u>Improved Fecundity Estimates</u>

A) Develop broodstock collection protocols based upon the most recent 5-year mean in-hatchery performance values for female to spawn, fecundity, green egg to eye, and green egg to release.
B) Use portable ultrasound units to confirm gender of broodstock collected (broodstock collection protocols assume a 1:1 male-to-female ratio). Ultrasonography, when used by properly trained staff will ensure the 1:1 assumption is met (or that the female equivalents needed to meet production objective are collected). Spawning matrices can be developed such that if broodstock for any given program are male limited, sufficient gametes are available to spawn with the females.

<u>Adult Collection Adjustments</u>

C) Make in-season adjustments to adult collections based upon a fecundity-at-length regression model for each population/program and origin composition need (hatchery/wild). This method is intended to make in-season allowances for the age structure of the return (i.e. age-5 fish are larger and therefore more fecund than age-4 fish), but will also make allowances for age-4 fish that experienced more growth through better ocean conditions compared to an age-5 fish that reared in poorer ocean conditions.

<u>Within-Hatchery Program Adjustments</u>

D) At the eyed egg inventory (first trued inventory), after adjustments have been made for culling to meet BKD management objectives, the over production will be managed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:

- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon funding recovery board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Governmental hatcheries in Washington, Oregon, and Idaho; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

E) At tagging (second inventory correction) fish will be tagged up to 110% of production level at that life stage. If the balance of the population combined with the tagged population amounts to more than 110% of the total release number allowed by Section 10 permits then the excess will be distributed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:

- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon recovery funding board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Transfer to another resource manager program such as CCT, YN, or USFWS program;
- Governmental hatcheries in Washington, Oregon, and Idaho;
- Placement of fish into a resident fishery (lake) zone, provided disease risks are within acceptable guidelines; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

F) In the event that a production overage occurs after the above actions have been implemented or considered, and deemed non-viable for fish health reasons in accordance with agency aquaculture disease control regulations (i.e. either a pathogen is detected in a population that may pose jeopardy to the remaining population or other programs if retained or could introduce a pathogen to a watershed where it had not previously been detected) then culling of those fish may be considered.

All, provisions, distributions, or transfers shall be consistent with the department's egg transfer and aquaculture disease control regulations as now existing or hereafter amended. Prior to department determination that eggs of a salmon stock are surplus and available for sale, the department shall assess the productivity of each watershed that is suitable for receiving eggs.

Species/Program Specific Juvenile Surplussing Protocols:

Surplus UCR Juvenile Steelhead Management

Above Wells Programs:

In the event excess HxH juveniles are produced from over-collection efforts to support the Methow Safety-Net and /or Okanogan programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Progeny transferred to the Columbia Safety-Net program provided fish health and/or marking requirements for the program can be met.

2. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met and provided basin wide pHOS/PNI allow for a decrease in program pNOB.

3. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

4. Out-planted to landlocked lakes within Okanogan County and/or Colville Reservation provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

5. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from any of the conservation programs occurs, the priority will be to incorporate those progeny either into an available conservation program (if a shortfall exists) or into the closest safety net program (in this case it would be the Methow safety net [MSN]). Excess safety net fish from the MSN will then be managed in accordance with the guidelines above.

Wenatchee Summer Steelhead:

In the event excess HxH juveniles are produced resulting from higher than expected in-hatchery survival, fecundities, etc.), the parties agree that distribution of juveniles will follow the following priority matrix:

1. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

2. Out-planted to landlocked lakes within Chelan, Douglas, or Grant counties provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

3. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from the conservation program occurs, the priority will be to incorporate those progeny into the closest safety net program Excess safety net fish will then be managed in accordance with the guidelines above.

Surplus Upper Columbia Juvenile Spring Chinook Management

Methow Sub-basin

In the event excess juveniles are produced from Methow Sub-basin spring Chinook programs, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess WxW progeny from the Methow conservation program(s) may be used to support shortfalls in the WNFH safety net program provided fish health and/or marking requirements for the program can be met.

2. Excess progeny from HO broodstock which *may* be collected to support the aggregate DPUD/GPUD/CPUD production obligation may be used to support any potential shortfall in the WNFH safety net program provided fish health and/or marking requirements for the program can be met.

3. In the event no other option exists within the Methow Sub-basin, excess hatchery progeny originating from the aggregate PUD production obligation, may be used to support the CCT 10(j) spring Chinook program in the Okanogan Sub-basin provided fish health and/or marking requirements can be met.

4. In the event no other option exists for excess hatchery progeny within the Methow Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

5. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Wenatchee Sub-basin

In the event excess juveniles are produced from Wenatchee Sub-basin spring Chinook programs (excluding Leavenworth), the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess progeny from the Chiwawa conservation program may be used to support shortfalls in the Nason conservation program provided fish health and/or marking requirements for the program can be met.

2. Excess progeny from the Nason conservation program may be used to support the Chiwawa conservation program provided they are progeny from females with assignment probabilities >95%. Additionally, it will require that fish health and/or marking requirements for the program can be met.

3. In the event excess NO production from the Nason program is not needed to or cannot support the Chiwawa (for reasons of fish health, marking, or ability to identify assignment probability), they will be incorporated into the Nason safety net program and prioritized over HxH progeny.

4. Excess progeny from the HO contingency broodstock collected for the Chiwawa program may be used to support any potential shortfall in the Nason safety net program provided fish health and/or marking requirements for the program can be met.

5. In the event no other option exists for excess hatchery progeny within the Wenatchee Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

6. In the event a surplus is identified, WDFW and the appropriate Hatchery Committee(s) will be notified via email no later than two weeks prior to fish needing to be moved off station or to another program. This is to ensure adequate and appropriate logistics can be coordinated between affected parties.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Appendix H

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Alternative Plan for 2019 BY and beyond, for Methow Sub-basin Conservation Steelhead Programs

Introduction

The objective of this draft plan is to provide a thumbnail approach for mitigating genetic concerns specifically in the Twisp Conservation program, and describe our alternative for future implementation (2018 and beyond) for Methow Subbasin conservation steelhead programs (Twisp and Winthrop NFH). Direction herein is general with seasonal/run-specific technical details to be worked out annually between operators and formalized through broodstock collection protocols and steelhead-specific management plans. Our intent for this memo is to serve as a vehicle for the Hatchery Committee to approve this direction by vote. While this plan is being presented as a preferred course of action by the parties, approval (and further refinement of a long term plan) is contingent upon successful broodstock collection of the 2018 brood. No modifications to program size or release numbers are proposed – only modification of brood stocking methodology, rearing/release strategies and parentage.

Genetic analysis of returning adult steelhead at the Twisp River weir as part of the Relative Reproductive Success Study, indicated that relatedness among the returning hatchery origin adults was high (T. Seamons, WDFW Genetics Lab, pers. comm.). This is not surprising given the small program size (Table 1), and may result in a reduction in genetic diversity and N_e, consistent with effects described in Ryman and Laikre (1991), hereafter "Ryman-Laikre" or "RL" effects.

In response to concerns about minimizing the potential long term risks/effects associated with RL, the HCP-HC and co-managers are looking to adopt a strategy to address potential (or increased) RL effects in the Twisp population as well as having a more integrated approach to steelhead conservation programs in the Methow sub-basin. Mitigating actions were selected with goals to increase genetic diversity, reduce risk of inbreeding on the spawning grounds, and increase N_e. Actions includes release of age-2 (S2) WNFH conservation program juveniles into the Twisp River and compositing a portion of the Twisp and WNFH conservation program broodstock (while retaining a small Twisp WxW (S1) release. Specifically, returning spawners will originate from a greater number of less-related parents compared to the resulting return if these actions are not undertaken.

From the alternatives discussed by a small work group, a hybrid approach (hereafter referred to as alterative 3) between a couple alternatives was developed (and is preferred) that aims to retain Twisp genetics within the Twisp basin but includes incorporation of non-Twisp conservation program genetics.

Alternative 3 was developed based on the desire to protect any remaining or developing Twisp genetic stock structure while balancing and mitigating for genetic concerns by managing N_e and potential spawner relatedness concerns. The major point by which Alt. 3 differs from other alternatives discussed is that a small Twisp x Twisp broodstock would continue to be operated instead of full compositing. No overall changes to current production and release levels would occur. Approximately six Twisp x Twisp (NOR) crosses would produce approximately 24K smolts for release back to the Twisp River. Annual Twisp releases would also include a 24K co-release of S2 smolts from the WNFH conservation program, allowing for unrelated returning adults to provide an increased level of genetic diversity into the Twisp to combat low N_e and reduce risk of inbreeding. This strategy would also provide an evaluation opportunity where potential Twisp stock performance could be evaluated against WNFH conservation program smolts, providing management guidance for continued future direction.

Implementation details for Alternative 3 follow:

Broodstock Collection

- Combined broodstock collection (joint DPUD, WDFW, USFWS, and YN effort)
    - Collection occurs throughout the Methow River, including below-Twisp River angling, Twisp Weir, and WNFH/MFH hatchery infrastructure
    - Broodstock Targets
        - Approximately 6-8* pairs NORs collected at Twisp Weir (half of Twisp program)
        - Approximately 61-65* NOR pairs (WNFH program plus half of Twisp program) collected throughout the Methow River via angling
        - As a contingency for under-collection of broodstock sufficient to fulfil the two components of Twisp-release production, broodstock collection at Twisp Weir could be increased to the traditional collection target of 13 pairs, as needed.
        - *Flexibility required in targets for variation in escapement, fecundity, inclusion of hatchery-origin brood (as per BiOp), etc.
    - All broodstock transferred to WNFH for holding and spawning
        - DPUD may collect up to 37 pairs of conservation program returns (Ad+CWT and CWT-only) at Wells Dam and/or via angling consistent with conservation program efforts and direct-transfer to Wells Hatchery for use in safety-net program
    - Data management for broodstock collection and spawning at WNFH will be primary responsibility of USFWS MCFWCO (all data would be shared with WDFW and DPUD to allow completion of HCP-HC related reports):
        - All broodstock uniquely PIT-tagged upon capture/transfer for assignment on spawn days
        - PIT data tied to collection date/location, mark, DNA samples
        - USFWS will provide standardized effort collection information to all angling participants
    - Adult management will continue to be a large part of broodstock collection efforts
        - Guided by terms and conditions for minimum escapement, pNOB, and mitigation requirements in BiOp
        - Supported generally (i.e. without run-specific details) in annual broodstock collection protocols (e.g. Tonseth 2017)

        - Supported specifically (i.e. includes run-specific details) by annual FMEP and targets/goals established by small Methow Steelhead Working Group

Spawning

- All conservation program spawning will occur at WNFH
    - Spawning will be 2x2 factorial crosses
    - Half of Twisp program will be Twisp weir collected NOR x Twisp weir collected NOR as feasible. Individuals PIT-tagged as juveniles in the Twisp will be treated the same.
    - WNFH program and remaining half of Twisp program will be Methow Subbasin NOR x NOR as feasible
    - All NOR females will be live-spawned & transferred to YN Kelt Program
    - USFWS MCFWCO will collect and provide all spawning biological and cross data to WDFW M&E staff.

Gamete Management & Smolt Release

- Maintain 48K total smolt release in Twisp River
    - 24K will be known-Twisp NOR x NOR spawned at WNFH but sent to Wells for S1 rearing
    - 24K will be representative cross-section of WNFH component, reared as S2 smolts at WNFH
    - All releases will be direct smolt plants at Buttermilk Bridge (RKm 21)
- Maintain 100K-200K total conservation program smolt release to Methow Sub-basin outside Twisp
    - 24K cross-section of WNFH population will be transferred to Wells Hatchery for S1 rearing for WNFH on-station or alternative release sites in Methow Subbasin.
    - 24K cross-section of WNFH population will be reared as S2 on-station as paired release for 24K S1 group (above) for potential alternative release strategies, as per above. Any alternative release strategies will guided by JFP and consider need for gradual implementation and patience in awaiting environmental response to management changes.
    - Remaining 52-152K of WNFH population will be reared as S2 smolts for on-station release.

Table 1. Methow Subbasin steelhead hatchery programs under Alternative 3.

Program	Rearing Hatchery	Funding entity	Release site	Release goal	Broodstock	Genetic crosses	Age at release
Methow Subbasin Conservation	WNFH	Reclamation	Methow R. @ WNFH	52-152K[1]	60-65	WxW	2
			Methow Subbasin[2]	24,000			2
	Wells	DPUD		24,000			1
	Wells	DPUD		24,000	6-8	WxW	1

Twisp Conservation	WNFH	Reclamation	Twisp R. @ Buttermilk Br	24,000	6-8	WxW	2
Methow Safety-net	Wells	DPUD	Methow R.[3]	100,000	68[2]	HxH	1
Total				348,000			

[1]WNFH program subject to pNOB/production sliding scale in BiOp.
[2]Initially Methow R. at WNFH but may include alternative offsite release strategies subject to JFP and HCP- HC guidance and BiOp terms and conditions. Would be paired S1 and S2 release.
[3]Methow Safety-net program released in Methow River at Lower Burma Bridge.

Discussion

Alternative 3 was proposed by the working group as it appears to provide the best compromise while also including measures to address the Spatial Structure and Diversity VSPs, by attempting to maintain (or allow) development of local stock structure in the Twisp Watershed. In addition, Alternative 3 provides a higher probability of finding an effective conservation hatchery strategy for the Twisp River, and elsewhere in the Methow Subbasin because it uses three conservation hatchery strategies: 1) local WxW Twisp Program, 2) Methow Composite S1 program, and 3) Methow Composite S2 program.

Table 2. Illustration of out-year effects of 2017 actions and proposed Alternative 3 on Twisp River spawning ground age/program composition.

Spawn/ Escapement Yr.	Age/Program composition of spawners (HOR only) on spawning grounds - Twisp Watershed only		
	Status Quo - S1 smolt supplementation only (all fish are Twisp Program only)	Additional spawners resulting from 2017-only, single-year Alt. mgmt. (juvenile release & brood compositing)	Spawner composition resulting from 2017 actions plus implementation of Alt. 3
2014	BY'10 1.2, BY'11 1.1	N/A	N/A
2015	BY'11 1.2, BY'12 1.1	N/A	N/A
2016	BY'12 1.2, BY'13 1.1	N/A	N/A
2017	BY'13 1.2, BY'14 1.1	N/A	N/A
2018	BY'14 1.2, BY'15 1.1	N/A	N/A
2019	BY'15 1.2, BY'16 1.1	BY'15 2.1 (WNFH)	BY'15 2.1 (WNFH)
2020	BY'16 1.2	BY'15 2.2 (WNFH), BY'17 1.1 (Met[1])	BY'15 2.2 & BY'16 2.1 (WNFH), BY'17 1.1 (Met+Twisp[1])
2021	*BY'18 1.1*[2]	BY'17 1.2 (Met[1])	BY'16 2.2 (WNFH) BY'17 2.1, BY'18 1.1 (Met+Twisp[1])
2022	*BY'18 1.2, BY'19 1.1*[2]	N/A	BY'17 2.2, BY'18 1.2 & 2.1, BY'19 1.1 (Met+Twisp[1])
2023	*BY'19 1.2, BY'20 1.1*[2]	N/A	BY'18 2.2, BY'19 1.2 & 2.1, BY'20 1.1 (Met+Twisp[1])
2024	*BY'20 1.2, BY'21 1.1*[2]	N/A	BY'19 2.2, BY'20 1.2 & 2.1, BY'21 1.1 (Met+Twisp[1])

[1]Combined Methow Subbasin Conservation Programs (yearlings raised at Wells Hatchery, 2-year smolts raised at WNFH).
[2]No BY'17 Twisp Program was developed; brood were composited. This column displays return composition if status quo were to return in 2018.

Appendix I

2019 Brood Program Specific Rearing and Release Plans

Unless specifically detailed below, rearing and release protocols will follow the number, date, and location identified in Appendix B. In addition, all releases will prioritize nighttime or necessary, late afternoon release timing to reduce potential predation related impacts. Release timing will also take advantage of increasing flows and turbidity to further provide improved post release survival advantages.

Methow Summer Chinook (Carlton Acclimation Facility):

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - The summer Chinook salmon acclimated at the Carlton Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Methow River flows are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempt's will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in the Methow River are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Methow River flows are not satisfactory due to insufficient snow pack.

Nason Creek spring Chinook (Nason Acclimation Facility):

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - Spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Nason Creek flows/conditions are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in Nason Creek are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Nason Creek flows are not satisfactory due to insufficient snow pack.

Wenatchee Summer Steelhead

Final Memorandum

Date: March 12, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

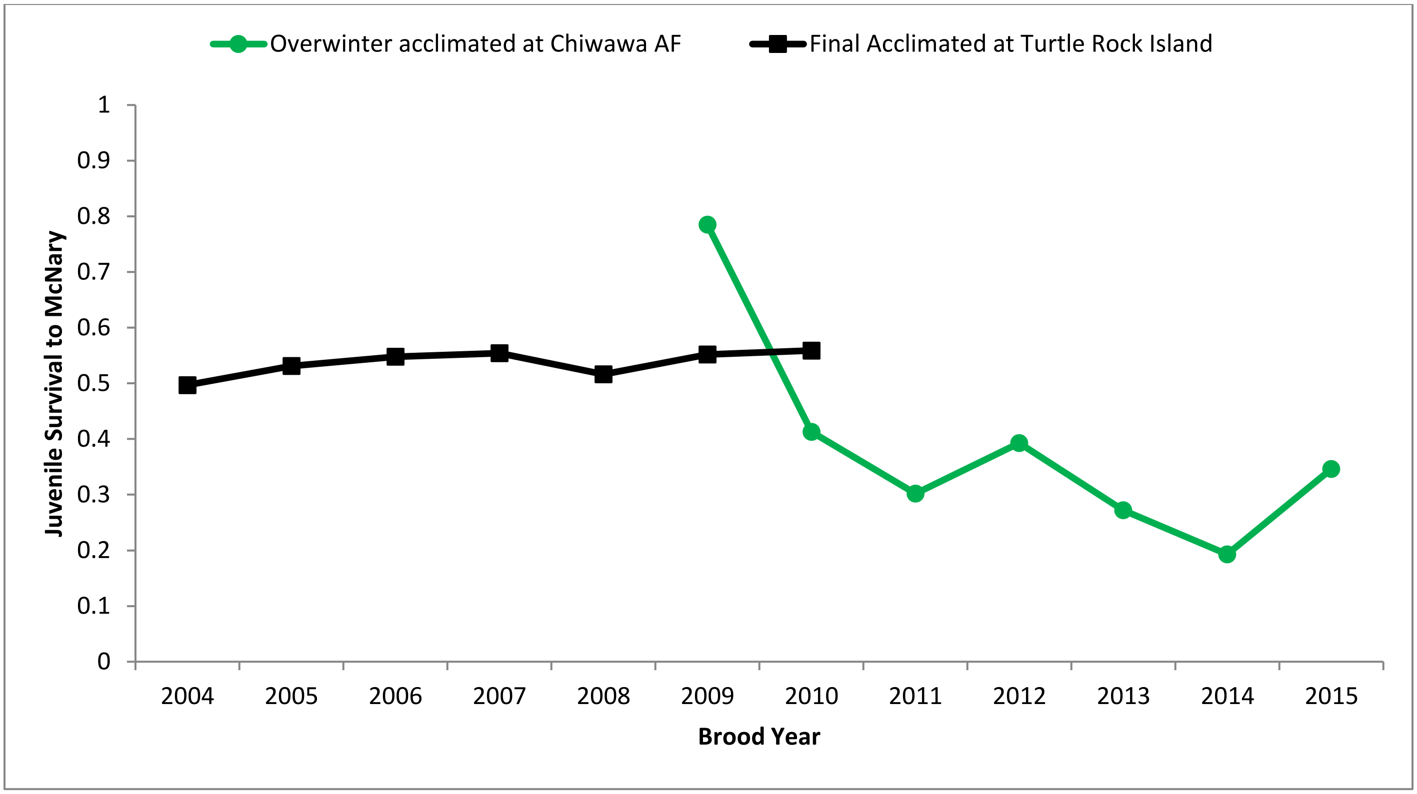

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

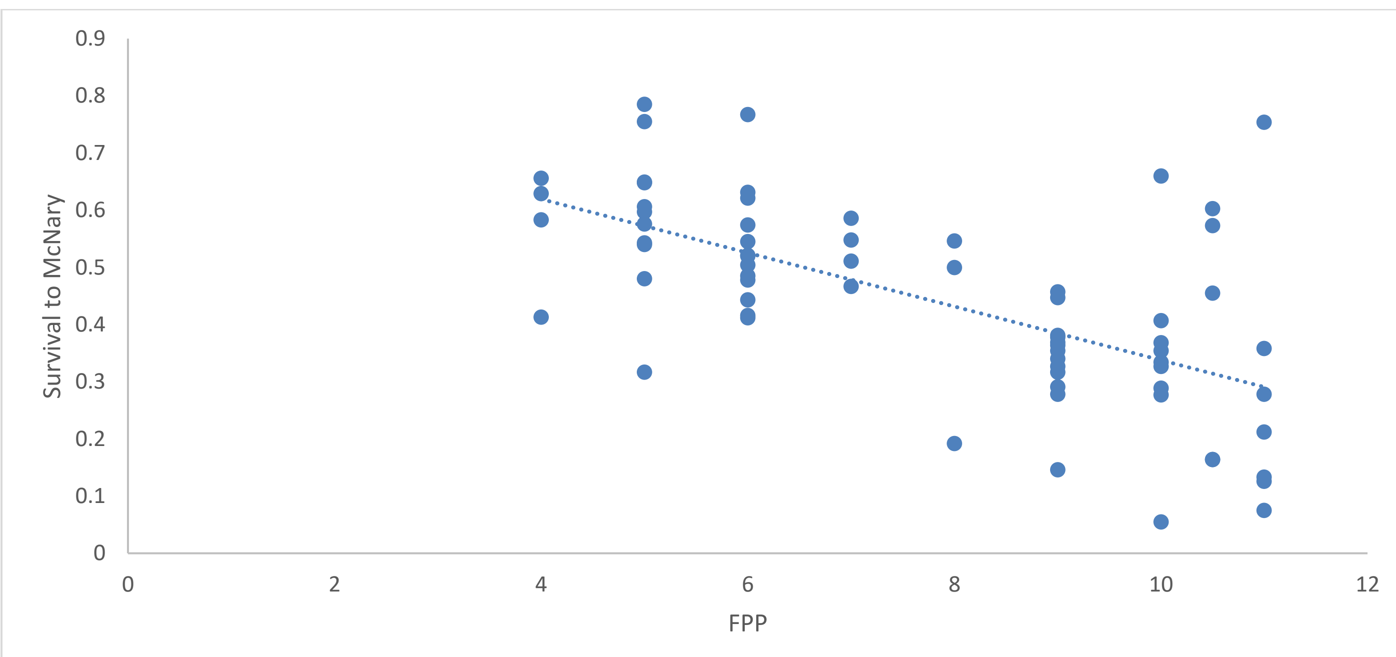

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

<u>2018-2020 Release Strategy Objectives</u>

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.
- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

<u>Methods</u>

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish ((statistical power $1-\beta = 0.80$; $\alpha = 0.10$, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	Brood Origin	Treatment	Estimated # PIT-tagged	Treatment PIT release size
RCY2	HxH	Size	5,500 small	11,000 Small Mixed
RCY2	WxW	Size	5,500 small	
RCY2	HxH	Size	5,500 medium	11,000 Medium Mixed
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8th. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location on the same day to the Chiwawa River (Table 2).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	Origin[1]	Estimated Number Released[2]	Estimated # PIT-tagged	Destination	rkm
RCY2	Mixed	58,067	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.
[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.
  Which release location should be utilized? All PIT-tags released in Chiwawa River well upstream from the detection array (RK 11.4).
- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
  - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

Input on post-release sampling to conduct GSI sampling and assessment of smolt index? See "Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program" March 12, 2018, Rock Island and Rocky Reach HCPs HCs notes.

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Appendix J

2018-2020 Brood year Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs.

Background: Hatchery broodstock disease profiles observed in some programs operating out of the Eastbank FH complex in 2017 (as well as other hatchery programs throughout the Columbia River Basin) resulted in higher than expected prespawn mortality and/or BKD ELISA results which required (under the terms and conditions of the Section 10 permits) culling eggs/fish at a higher rate than anticipated which put several programs considerably below the respective production targets. The inability to determine whether the deviation in performance in 2017 was the result of eliminating prophylactic antibiotic injection practices, as was historically conducted, or was related to environmental conditions (or a combination of both) has prompted WDFW to develop and implement a fish health treatment plan (adult broodstock only) beginning with the 2018 brood and running for at least three (3) consecutive brood years.

The overall goals are to primarily ensure integrated and/or recovery programs make the most efficient use of natural origin broodstock to avoid mining as well as maximize natural origin spawners while minimizing handling/unnecessary activities on broodstock. In addition where practical, we (WDFW) would like to see the use of antibiotics and other therapeutics reduced or eliminated over time. Having a controlled approach to evaluating the use of prophylactic treatments in these programs will allow the operators/managers to determine which programs may benefit from prophylactic treatments and which programs may be able to shift away from this practice, all of which is designed to reduce overall handling and associated effects as much as possible.

Methods: To minimize handling events, injections will be scheduled to occur either at collection or during sorting (such as during genetic sorting that occurs for the Nason spring Chinook program). Only females will be injected, in the intraperitoneal cavity (IP) with Draxin for BKD and if necessary, long acting Oxytetracycline for gram negative bacteria (i.e., *Columnaris*). Generally, injections will be prioritized for natural origin females as the control and hatchery origin females as the treatment for the spring Chinook programs. A slightly different approach will be used for each of the summer Chinook programs. All females receiving the injections will be considered the control given that this was the standard hatchery practice by which current disease result data sets and decisions are built on. All females will be PIT tagged at time of collection or injection to facilitate tracking of individual females (and possibly their progeny).

The results will be evaluated annually to determine if modifications to the current plan are necessary.

Program Specific Plans For 2019 Brood year:

Methow (Carlton/MEOK) Summer Chinook:

1) Collected at Wells Dam
2) 62 NO females are targeted for collection in 2019 with every other female will be injected at collection.
    a. Since the Twisp M&E staff are conducting run comp and broodstock collection activities at the Wells Dam East/West ladders, it makes sense for them to inject while the fish are sedated.

Chelan Falls Summer Chinook:

1) Collected at Well Hatchery Volunteer Trap
2) If injections cannot be accommodated at time of collection at Well Hatchery, adults collected over the course of a week will be placed at the head of the adult pond. At the end of the week, females will be PIT tagged and every other female will be injected then placed over the net and not handled again until spawning.
3) 195 HO females are targeted for collection and up to 97 will be injected.
4) Disease management may vary somewhat depending upon the determination of the pathogen in play (i.e., *Columnaris* may play a larger role than BKD which require different approaches).

Wenatchee Summer Chinook:

1) Collected at Dryden dams or Tumwater Dam.
2) No injections planned at this time. The Wenatchee summer Chinook program was the only EB program in 2017 which did not see a negative deviation in disease/prespawn mortality outcomes from the predicted so the 2019 plan is to stay consistent with the 2018 approach of no injections. If during the three year period, it appears the Wenatchee summer Chinook may benefit by evaluation of injection versus non-injection then we will make plans to accommodate that evaluation.
3) 137 NO females are targeted for collection and will not be injected.

Chiwawa Spring Chinook:

1) Collected at Tumwater Dam
    a. All previously PIT tagged Chiwawa NOR's collected will be combined with Nason Spring Chinook weekly collections at Eastbank.
    b. All Chiwawa NO females collected at Tumwater Dam will be injected during genetic sorting of the Nason Fish.
    c. HO females collected at Tumwater will not be injected.
2) Collected at Chiwawa Weir

a. All female NO females collected at the weir will be injected at the time of collection.

3) 32 NO females are targeted for collection between the two locations and will be injected.
4) 4 HO females targeted for retention as part of the production shortfall backup, collected at Tumwater Dam will not be injected.

Nason Spring Chinook:

1) Collected at Tumwater Dam.
2) 26 NO females are targeted for retention and will be injected during genetic sorting.

37 HO females are targeted for retention. HO females will not be injected.

Appendix K

MID-COLUMBIA COHO BROODSTOCK

COLLECTION PROTOCOLS 2019

Yakama Nation

Fisheries Resource Management

Mid-Columbia Field Office

7051 Hwy. 97

Peshastin, Washington 98847

The Yakama Nation Fisheries Resource Management's (YN FRM) 2019 broodstock collection protocols for coho (*Oncorhynchus kisutch*) were developed to meet upper Columbia (Methow and Wenatchee basins) annual smolt release goals for 2021, as per the Mid-Columbia Coho Reintroduction Program's (MCCRP) Master Plan (YN 2017). Additionally, this document identifies the applicable operational planning to achieve adult collection goals and associated broodstock spawning conventions herein.

BROODSTOCK COLLECTION GOALS

Brood Year (BY) 2019 coho smolt production goals are 1,000,000 fish for release in the Wenatchee River basin and 1,000,000 fish for the Methow River basin.

Adult coho returning to the Wenatchee River basin will be collected at Tumwater Dam, Dryden Dam, Leavenworth National Fish Hatchery (LNFH), and/or Priest Rapids Dam (PRD); in order of collection priority. The program strives to achieve at least 50% of adult collections from Tumwater Dam with the remainder coming from Dryden Dam, LNFH and/or PRD. Coho collections from Tumwater Dam are important to encourage stock adaptation so that returning adults can reach key, upstream habitats within the upper basin. Based upon a phased approach, the Wenatchee program currently in Broodstock Development Phase II (BDPII; YN 2017). However, collecting sufficient female broodstock from Tumwater Dam has presented a challenge and identified the need for a contingency plan. The ratio of female to male coho navigating Tumwater Canyon to Tumwater Dam has been tilted heavily toward males. Due to this occurrence, the BDPII completion goal for the Wenatchee Basin has transitioned to collecting 50% of our female broodstock from Tumwater Dam for a three year period

In the Methow River basin, returning adults will be collected from Douglas County Public Utility District's (DCPUD) Wells Dam facilities (i.e., east and west ladders and Wells Fish Hatchery (FH) volitional channel), Winthrop National Fish Hatchery (Winthrop NFH), and Methow Fish Hatchery (Methow FH); in order of priority. Although project releases from Wells FH were concluded in 2013, some returning adults may be collected as volitional swim-ins to the facility's holding pond concurrent with summer Chinook and steelhead trapping efforts. The program will rely on Wells Dam facilities as primary collection locations to ensure a representative sample of returning adults from all in-basin release locations, as well as provide sufficient numbers of broodstock required for continued development of the Natural Production Implementation Phase (NPIP; YN, 2017) in 2021. In-basin collections will continue to include Winthrop NFH and Methow FH adult weir on a supplementary basis, as swim-ins to these facilities remain a key component in broodstock development. While coho have not been released from Methow FH, an adult weir will be used to collect returning adults since both hatcheries' surface water withdrawals come from a common, upstream diversion on the mainstem Methow River (Foghorn Irrigation Diversion). Broodstock collection goals for both Wenatchee and Methow programs are calculated from measured, mean survival rates that include pre-spawn adult mortality, average female fecundity, green egg survival, and hatch rates observed during past brood years.

In the Wenatchee River basin, collection of up to 1,264 adult coho will be necessary to release 1,000,000 smolts. **Table 1** illustrates the program's anticipated release, survival, and collection goals for brood year 2019**.** Throughout the program's history, adult coho sex ratios collected at Tumwater Dam have been tilted heavily towards males. If necessary, the likely disproportionate number of adult males may be reconciled by collecting additional adult females at alternative in-basin collection sites (i.e. - Dryden Dam or LNFH ladder).

Table 1. 2019 YN Wenatchee River Basin Program Release Target, Mean Survival, and Broodstock Collection Goal

Program target smolts	Survival green egg to eyed [1]	Survival eyed egg to release[2]	Green eggs required	Average eggs per female[3]	Adult pre-spawn mortality[4]	Viable females required	Total female collection	Total adult collection goal [5]
1,000,000	87.4%	83.5%	1,370,258	2,778	6.5%	494	527	1,264

1. Due to unusual elevated mortality observed at the eyed egg stage in BY2014 & 2015, survival is based on an 9 yr. mean eyed egg rate for 2007- 2018 brood years, excluding 2014 & 2015.

2. Observed 7 yr. mean eyed to release survival rate includes 2008 to 2012 brood years, 2014 & 2015. 2013 was excluded as a large number of eggs were transferred to the Methow Basin. 2016 was excluded due to significant overwinter rearing predation at Leavenworth NFH. 2017 & 2018 percentages are yet to be determined.

3. Observed 12 yr. mean fecundity for 2007-2018 brood years.

4. Observed 12 yr. mean pre-spawn mortality observed in 2007-2018 adult brood years.

5. Based on observed, mean male-to-female ratio (57.3%M: 41.7%F) for 2008-2018 brood years.

In the Methow River basin, a maximum of 1,054 adult coho will be necessary to release 1,000,000 smolts. Anticipated release, survival, and collection goals for brood year 2019 are presented in **Table 2**. Throughout Broodstock Development Phase II (BDP II; YN 2017), Methow River basin collection goals were calculated as number of adult coho needed if broodstock were collected from Wells Dam and as swim-ins to Winthrop NFH and Methow FH to accomplish broodstock development goals as outlined in the Mid-Columbia Coho Master Plan (YN, 2017). After completion of BDP II in 2013, a programmatic transition was made to prioritize Wells Dam facilities to ensure collected adults were representative of all in-basin release locations. Since Wells Dam facilities will provide the primary brood source throughout the NPIP phases of the program, collection goals for 2019 are based on data collected at these facilities.

Table 2. 2019 YN Methow River Basin Program Release Target, Mean Survival, and Broodstock Collection Goal

Program target smolts released	Survival green egg to eyed [1]	Survival eyed egg to release[2]	Green eggs required	Average eggs per female [3]	Adult pre-spawn mortality[4]	Viable females required	Total female collection goal	Total adult collection goal [5]
1,000,000	84.6%	85.9%	1,376,057	2,728	4.4%	504	527	1,054

1. Observed 12 yr. mean eyed-egg rate for 2007- 2018 brood years.

2. Observed 10 yr. mean eyed to release survival rate for 2007-2016 brood years.

3. Observed 12 yr. mean fecundity for 2007-2018 brood years.

4. Observed 12 yr. mean pre-spawn mortality observed in BY 2007-2018 adults.

5. Observed 12 yr. mean male-to-female ratio for Wells Dam facilities (46.5%M: 53.5%F) for 2007-2018 broods. Total collection goal is based on a 1 M: 1 F ratio.

BROODSTOCK COLLECTION PROTOCOLS

Wenatchee River Basin

Past protocols focused on broodstock development in the sense of maximizing genetic diversity; attempting to collect a representative sample of returning adult coho from throughout the run. Based on information collected from 2000 to 2018, the first returning adult coho traditionally arrive at Dryden Dam during the second week of September. The run typically continues through the last week of November, with peak migration ordinarily occurring mid to late October. Migration timing over Tumwater Dam is characteristically one week later than observed at Dryden Dam. Beginning with brood year 2017, an effort to retain and distinctly floy tag first arriving fish at Dryden Dam has been instituted. Based on the strengthened ability of female coho to reach the Tumwater Dam in September versus October, a shift in prioritizing adults appearing early in the run has been set in place. Attaching the capture date specific tags allows a focus on mating as many early arriving pairs as possible at spawning. The long term result is anticipated to expand the annual number of adult coho arriving early in the run, thus increasing the number of adult female coho capable of ascending Tumwater Dam during optimal flow conditions.

Bi-weekly broodstock collection goals have been established for both Tumwater and Dryden dams and are illustrated in **Table 3.** Collection goals target a minimum of 50% of the broodstock from Tumwater Dam (YN 2017). Bi-weekly goals are intended to serve as a guide for collection from throughout the run but may be adjusted to ensure the newly implemented broodstock arrival time prioritization needs and adult accessibility are optimized. If during any week the broodstock collection goals are not met, the deficit will be carried over to the following week until the collection total is reconciled. Adults collected from PRD or LNFH will be assimilated into the combined weekly goal. A minimum of one male will be collected for each female to adhere to spawning protocols.

Table 3. 2019 Wenatchee River Basin Coho Broodstock Collection Goals

Calendar Week	**9/1**	**9/8**	**9/15**	**9/22**	**9/29**	**10/6**	**10/13**	**10/20**	**10/27**	**11/3**	**11/10**	**11/17**	**TOTAL**
Dryden Dam	1	5	14	47	52	90	131	124	107	39	18	4	632
Tumwater Dam	0	1	10	38	67	100	165	125	90	29	6	1	632
TOTALS	1	6	24	85	119	190	296	249	197	68	24	5	1,264

Between September 1 and November 2 of this year, broodstock collection at Dryden Dam will occur daily and in coordination with Washington Department of Fish and Wildlife's (WDFW) evaluation and monitoring staff and Eastbank Fish Hatchery (Eastbank FH) hatchery personnel, as it characteristically occurs concurrently with steelhead broodstock collection. YN will provide a minimum of two people each day to assist in operations and collection at Dryden Dam adult fish trapping facilities. Between November 3 and November 16, YN personnel ordinarily operate the trapping facility independently but will communicate with Eastbank FH, WDFW, and Chelan County Public Utility District (CCPUD) personnel regarding collections, trap maintenance, and operations. If YN staff foresees broodstock collection goals (through trapping efforts at Tumwater and Dryden dams) will not be met, adult coho may be collected at the LNFH adult ladder to prevent a deficit. Tumwater Dam operations will be coordinated with Eastbank FH personnel and/or WDFW evaluation crews and occur concurrently with WDFW steelhead brood collections.

Methow River Basin

Prior to 2005, coho broodstock collections for the Methow River program were solely conducted at Winthrop NFH; however, few coho completed this long migration and successful returnees were typically males. In 2005, the primary collection site shifted towards Wells Dam in an effort to intercept more returning Methow Basin coho and increase female collections in the process. Broodstock Development Phase I (BDP I) was initiated in 2006 and focused on eliminating the reliance on lower Columbia stocks and transitioning to a local broodstock. During BDP I, program adults began to demonstrate the ability to return in sufficient numbers to meet collection goals from both in-basin release locations (i.e., Winthrop NFH on-station raceways and back-channel pond) and Wells FH. By 2009, average contribution of swim-ins (Winthrop NFH and Methow FH combined) into the Methow broodstock had exceeded 50% (*avg.* = 52.7%) and were a predominant portion of the program. In 2010, the program transitioned to BDP II and swim-ins to these facilities were prioritized as the primary brood source, with collections at Wells Dam facilities providing supplementary adults. Broodstock Development Phase II was accomplished in 2013 for the Methow Program and a shift back to prioritizing collections at Wells Dam facilities was made in 2014. Collections in 2019 are intended to provide sufficient broodstock required for the continued development of NPIP in 2021, and will require incorporation of adults from all established, in-basin release locations. Since no in-basin collection locations currently exist (i.e., tributary collection weirs) that would provide for a representative sample of returning adults in-basin, Wells Dam facilities would provide those means. Adult collections will continue to occur at Winthrop NFH and Methow FH collection weir on an auxiliary basis, as swim-ins to these facilities will continue to be a key element to broodstock development.

At Wells Dam, proposed trapping operations would occur on the east and west ladders according to the following schedule (National Marine Fisheries Service (NMFS), 2017; Consultation Number WCR-2015-3778):

1) Sept 1- Sept 26: 3 days/week and 16 hrs/day
2) Sept 27-Oct 9: 5 days/week and 9 hrs/day
3) Oct 10- Dec 7: 7days/week and16 hrs/day

Trapping operations will be coordinated with WDFW and DCPUD and to maximize coinciding operations with WDFW evaluations and Wells FH summer steelhead and summer Chinook collections. If during this timeframe, WDFW/Wells FH is not operating one or both of the traps, YN personnel would assume full operations of both facilities and actively operate traps with all non-target fish being documented and passed upstream while minimizing handling. When operating the west ladder trap, coho salmon will be diverted directly from the ladder into the holding facility at Wells FH. Removal of coho from the temporary holding area, to include volitional swim-ins, will be coordinated with DCPUD/Wells FH personnel. YN staff will continue to transport collected adults at a minimum of three times per week with holding criteria to not exceed 150 coho at one time. During east ladder operations, trapped coho would be placed directly into a transport tank. All coho transported from Wells Dam facilities will have a unique mark to differentiate them at spawning from volunteer swim-ins at Winthrop NFH and Methow FH adult weir.

Supplemental collections at Winthrop NFH and Methow FH could, if required, occur up to seven days per week (24 hours/day) between September 1 and December 7 at both facilities (NMFS, 2017). Adults collected from Methow FH collection weir would be transported to Winthrop NFH for holding and spawning. All trapping operations at Methow FH will be coordinated with DCPUD.

Methow River basin weekly broodstock collection goals for 2019 are illustrated in **Table 4**. If during any week broodstock collection goals are not met, the deficit will carry over to subsequent weeks until collection totals are reconciled. Weekly trapping goals are intended to serve as a guide to ensure collection from throughout the run but may be adjusted mid-season to ensure that the total collection goal is met. Collection goals are expressed in numbers of adult coho needed if broodstock are solely collected from Wells Dam facilities. A minimum of one male will be collected for each female to adhere to spawning protocols.

Table 4. 2019 Methow River Basin Coho Collection Goals

Calendar Week	9/1	9/8	9/15	9/22	9/29	10/6	10/13	10/20	10/27	11/3	11/10	11/17	TOTAL
Wells Dam	3	21	81	181	237	209	179	98	36	8	1	0	1,054

REFERENCES

Yakama Nation Fisheries Resource Management (YN FRM). 2017. Mid-Columbia Coho Restoration Master Plan. Prepared for Northwest Power and Conservation Council.

NMFS (National Marine Fisheries Service). 2017. Endangered Species Act (ESA) Section 7(a) (2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Mid-Columbia Coho Salmon Restoration Program: Operation and Construction. Consultation Number: WCR-2015-3778)

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Appendix P
Broodstock Collection Protocols
Discussion Topics for 2020

Topic	Discussion Lead	Meeting Date for Discussion
Review of the Broodstock Collection Protocols to identify major revisions needed and assign co-authors	Tracy Hillman	September
Elemental signature analysis could differentiate natural-origin Okanogan spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection at Wells Dam for Methow Fish Hatchery programs	Kirk Truscott	
Sizing of upper Columbia River conservation programs**	All	TBD—Based on prespawn survival (currently working on Nason Spring Ch)
Use of age-3 males in broodstock Use of alternative mating strategies	Greg Mackey	Sept
Establishing ranges around broodstock collection targets	Greg	Sept-Oct
Source for Chiwawa spring Chinook salmon broodstock	Catherine	Oct
Outplanting surplus Methow Composite Spring Chinook Salmon Adults**	Mike	Sept-Oct
Request for HCP surplus adults for research or other requests	All	Sept-Feb
Revised Broodstock Collection Protocols Development Timeline SOA	Mike Tonseth	

**Programs in part independent of BSP.

Appendix Q
Chelan PUD 2020 Hatchery M&E Implementation Plan

Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2020 – FINAL

Prepared by:

Catherine Willard

August
2019

1. INTRODUCTION

The Habitat Conservation Plan (HCP) specifies that a monitoring and evaluation plan will be developed for the hatchery program. The approach to monitoring the hatchery programs was guided by the "*Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update*" (Hillman et al. 2017).

The purpose of this document is to define the tasks associated with the approved scope of work to implement Chelan PUD's (CPUD's) hatchery monitoring and evaluation (M&E) plan for 2020. Additionally, monitoring and evaluation activities for Lake Wenatchee sockeye in 2020 are included in this document. As monitoring tasks are completed in 2019 and are evaluated for their efficacy, methodologies to accomplish the tasks defined in the 2020 Implementation Plan may be modified [with Habitat Conservation Plan's Hatchery Committee (HCP-HC) approval].

The work described in this plan has Endangered Species Act (ESA) coverage provided by NMFS Section 10(a)(1)(A) permits 18121 and 18583, Section 10(a)(1)(B) permit 1347, and Section 7 USFWS 2017 Biological Opinion for the Wenatchee River Spring Hatchery Programs. All activities conducted under this Implementation Plan shall adhere to all terms and conditions as specified in the referenced permits and Biological Opinion. These permits allow for changes to monitoring or research protocols with the caveat that such modifications are approved by NMFS prior to implementing those changes. Terms and conditions relevant to monitoring and evaluating the hatchery programs have been used to inform the various measurements below and associated scopes of work with entities performing the work. A report summarizing compliance with the terms and conditions set forth under the above-references permits is required for submittal to NMFS; a copy of this completed report will be provided to the HCP HC.

The Implementation Plan includes all four components of the hatchery M&E Program including: (1) aquaculture monitoring; (2) juvenile monitoring; (3) adult monitoring; and (4) data, analysis and reporting. Under each component are study design elements that will be used to inform the overarching program components. Figure 1 illustrates the relationship of the components and study design elements used to address each component. Table 1 depicts which study design element is being performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017. For Lake Wenatchee sockeye salmon, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP) and is described in Section 6.0.

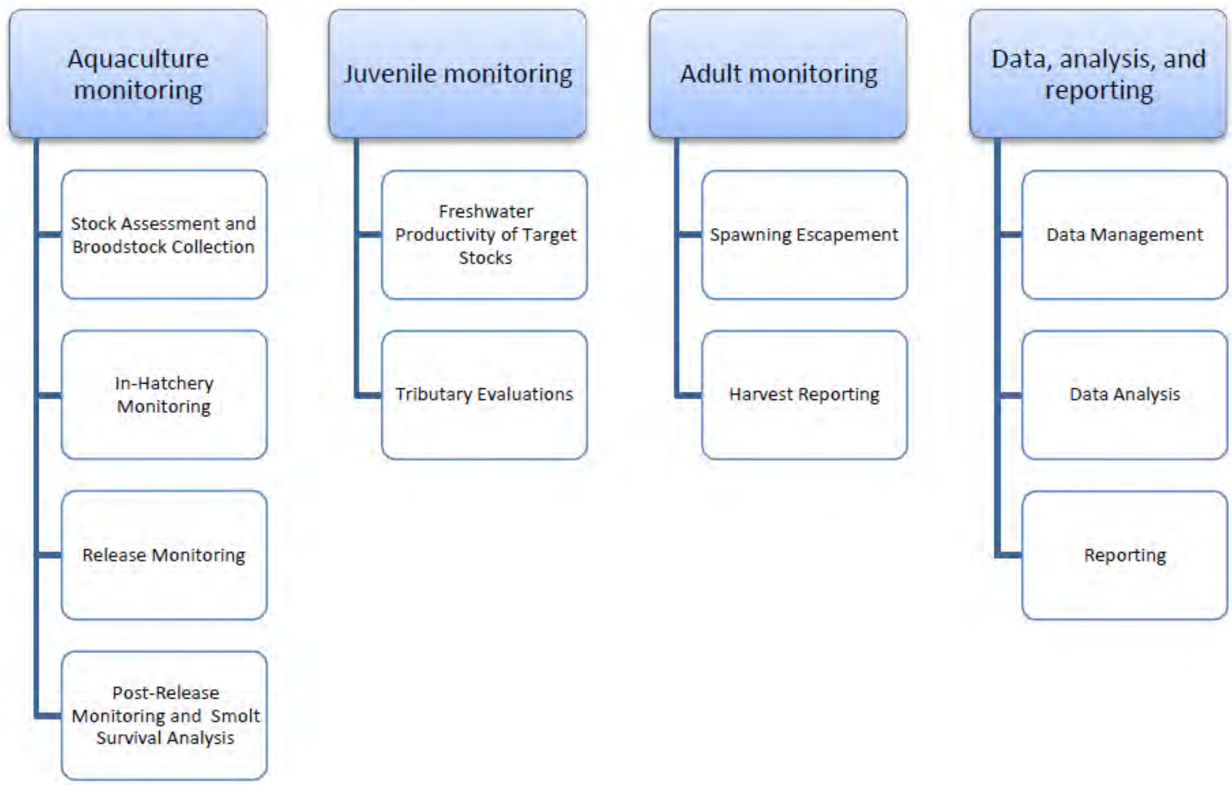

Figure 1. The four components of the hatchery monitoring and evaluation program and the study design elements within each component.

Table 1. Study design elements performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017.

Monitoring and evaluation component	Objectives[1]	Study Design Elements	Chiwawa spring Chinook	Wenatchee summer Chinook	Methow spring Chinook[4]	Chelan Falls summer Chinook[5]	Wenatchee Steelhead
Aquaculture Monitoring	3,5,8	Stock assessment and broodstock collection	WDFW	WDFW	WDFW DPUD	WDFW	WDFW
	5, 8	In-hatchery monitoring	WDFW CPUD[2]	WDFW CPUD[2]	DPUD Biomark[3]	WDFW CPUD[2]	WDFW CPUD[2]
	9	Release monitoring	CPUD	CPUD	DPUD	CPUD	CPUD
	9	Post-release monitoring and smolt survival analysis	BioAnalysts	BioAnalysts	WDFW	BioAnalysts	BioAnalysts
Juvenile monitoring	2	Freshwater productivity of stocks	WDFW	WDFW	WDFW	NA	WDFW
		Tributary evaluations	WDFW	WDFW	WDFW	NA	WDFW
Adult monitoring	1,2,3,4,5,6, 8,10	Spawning escapement	CPUD	WDFW	WDFW	BioAnalysts	WDFW BioAnalysts
	8	Harvest reporting	WDFW	WDFW	WDFW	WDFW	WDFW
Data, analysis, and reporting	All	Data management	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Data analysis	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Reporting	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts

[1] Monitoring questions relative to Objective 7 will be analyzed in the 2020 Comprehensive Report.
[2] CPUD crews will PIT tag in-hatchery fish.
[3] Biomark will PIT tag in-hatchery fish.
[4] In 2020, monitoring and evaluation for the Methow spring Chinook program is described in "Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs".
[5] Because the Chelan summer Chinook program is primarily an augmentation program, monitoring and evaluation efforts focus on straying, release characteristics, and harvest.

2. AQUACULTURE MONITORING

The aquaculture monitoring component is comprised of two basic elements: (1) stock assessment and broodstock collection at adult trapping locations and (2) in-hatchery monitoring including spawning, rearing, and release of juveniles. Data collected during these elements primarily support monitoring questions 5.1.1, 5.2.1, 8.1.1, 8.2.1, 8.3.1, 8.3.2, 8.4.1, 9.1.1, 9.2.1, 9.3.1 and 9.4.1, but also contribute data to monitoring questions 3.2.1, and 3.2.2 (Hillman et al. 2017). Table 2 below provides a summary of the variables to be measured in 2020 under the aquaculture monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

Table 2. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the aquaculture monitoring component.

Objectives	**Measured Variables** *(Applicable Study Component(s))*
<u>Objective 3:</u> Determine if the hatchery adult-to adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of broodstock used by brood year (hatchery and naturally produced fish) (*Broodstock Collection and Stock Assessment*)
<u>Objective 5:</u> Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Ages of hatchery and naturally produced fish sampled via PIT tags or stock assessment monitoring (*Broodstock Collection and Stock Assessment*) • Time (Julian date) of ripeness of hatchery and natural origin steelhead captured for broodstock (*Broodstock Collection and Stock Assessment*)
<u>Objective 8:</u> Determine if hatchery programs have caused changes in phenotypic characteristics of the natural populations.	• Size (length), gender, and total/salt age of broodstock (*Broodstock Collection and Stock Assessment*) • Assess age of fish (*Broodstock Collection and Stock Assessment*) • Length, weight, and age (covariate) of hatchery and natural-origin broodstock after eggs have been removed (*Broodstock Collection and Stock Assessment*) • Number and weight of eggs (*Broodstock Collection and Stock Assessment*)
<u>Objective 9:</u> Determine if hatchery fish were released at the programmed size and number.	• Fork length and weights of random samples of hatchery juveniles at release (*Release Monitoring*) • Monthly individual lengths and weights of random samples of hatchery juveniles (*In-Hatchery Monitoring*) • Numbers of smolts released from the hatchery (*Release Monitoring*)

2.1 Broodstock Collection and Stock Assessment

Broodstock collection and stock assessment for Wenatchee summer steelhead, Wenatchee summer Chinook, Methow spring Chinook, Chelan Falls summer Chinook, and Chiwawa River spring Chinook, hatchery programs will, in most instances, occur concurrent to and consistent with the 2020 Broodstock Collection Protocol approved annually by the HCP-HC and relevant permits. Data collection during broodstock collection will be consistent with Hillman et al. 2017. Several biological parameters will be measured during broodstock collection at adult collection sites. Those parameters included the date and start and stop time of trapping; number of ea collected for broodstock; origin, size, and sex of trapped fish; age from scale analysis; and pre-spawn mortality. For each species, trap efficiency, extraction rate, and trap operation effectiveness will be estimated following procedures in Hillman et al. (2017). In addition, a representative sample of most species trapped but not taken for broodstock were sampled for origin, sex, age, and size (stock assessment).

2.2 In-Hatchery Monitoring

The in-hatchery monitoring component will begin when adult fish are collected and retained for broodstock and ends when juvenile fish are released. Methods for monitoring hatchery activities are described in Hillman et al. (2017). Biological information will be collected from all spawned adult fish including age at maturity, length at maturity, spawn time, and fecundity of females. In addition, all fish will be checked for tags and females were sampled for pathogens. Throughout the rearing period in the hatchery, fish will be sampled for growth, health, and survival. Each month, lengths and weights will be collected from a sample of fish and rearing density indices will be calculated. In addition, fish will be examined monthly for health problems following standard fish health monitoring practices for hatcheries. Various life-stage survivals will be estimated for each hatchery stock.

Fish Marking

All of Chelan PUD's hatchery fish will be coded-wire tagged (CWT) and externally marked or marked as otherwise agreed to by the HCP HC. A comprehensive marking strategy will be developed by the HCP-HC and included in the annual Broodstock Collection Protocols (Table 3). The identification of these hatchery-produced fish is needed for a suite of adult metrics and may be used for adult management and/or fisheries as contemplated by the co-managers.

Using methods described in Keller and Murauskas (2012), hatchery fish will be PIT-tagged approximately two to four weeks before the fish are transferred to acclimation ponds or in the spring prior to release. Numbers of hatchery fish to be PIT-tagged per program is described in the annual Broodstock Collection Protocol (Table 3). Additional PIT-tagging may occur for program specific studies/comparisons as approved by the HCP-HC. The data collected from the PIT-tags will assist in release monitoring, migration timing, juvenile survival, and smolt-to-adult survival. For all fish marking, quality control check will be performed during and immediately following tagging and prior to release.

Table 3. Chelan PUD's hatchery program release goals and recommended number of fish PIT tagged.

Brood Year	Production Group	Program Size	Marks/Tags	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2018	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2021	13	Forced
2018	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	20,000 PIT	Wenatchee R. at DAF	2021	18	Volitional
Spring Chinook								
2018	Methow SPC (PUD)	60,516	CWT only	5,000 PIT	Chewuch R. at CAF	2021	15	Volitional
2018	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only	10,000 PIT	Chiwawa River at CPD	2021	18	Short term volitional
Steelhead								
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	35,451	Ad + CWT (HxH) CWT only (WxW)	0	Nason Cr. direct release	2021	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	70,582	Ad + CWT (HxH) CWT only (WxW)	33,000 PIT	Chiwawa R. direct release	2021	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	104,021	Ad + CWT (HxH) CWT only (WxW)	0	Upper Wenatchee R. direct release	2021	6	Direct Plant

2.3 Release Monitoring

Hatchery fish will be released during smoltification in the spring, typically between 15 April and 1 June. Whenever possible, the exact release dates will coincide with environmental conditions that promote a rapid emigration that minimizes both the potential negative ecological interactions of hatchery fish with naturally produced fish and predation on hatchery fish by avian or other predators. The default release method will incorporate a volitional approach, as approved by the HCP HC, unless it can be demonstrated other approaches are better. The monitoring data collected for each stock are described below.

Chiwawa and Methow Spring Chinook

Pre-release sampling data will be conducted consistent with Hillman et al. 2017 including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan (Hillman et al. 2017). PIT tag monitoring of spring Chinook released in the Chiwawa River will occur during the release period (April). Juvenile Chinook will pass through two 92-cm diameter PIT-tag antennas connected to Allflex 310 readers and Quantitative Sampling Technologies (QST) QuBE data logger. The release location and type (i.e., volitional, forced, or trucked) are recorded for each observation file created and uploaded to the PTAGIS database maintained by the Pacific States Marine Fisheries Commission after each year of release. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

Wenatchee Summer Steelhead

Pre-release sampling will be conducted consistent with Hillman et al. 20017, including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. The release methodology will follow the HCP-HC approved 2018 Steelhead Release Plan (Appendix B). The number of fish in each truckload will be estimated using volumetric displacement. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

Wenatchee and Chelan Falls Summer Chinook

Pre-release sampling will be conducted consistent with Hillman et al. 2017, including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. PIT-tag monitoring will occur consistent with other Chinook stocks (i.e., Chiwawa Spring Chinook). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

2.4 Post-Release Monitoring and Survival Analysis

Data will be collected during rearing, acclimation, release, and the emigration period that may prove valuable in explaining variability in adult survival (Hillman et al. 2017). Rearing densities have been reported to influence the survival of hatchery fish (Martin and Wertheimer 1989; Banks 1994) and may also be linked to disease prevalence during rearing (Banks 1994; Ogut and Reno 2004). Acclimation of hatchery fish before release has been found to increase survival and reduce stray rates when the duration of the acclimation period is sufficient (Clarke et al. 2010, 2012; Rosenberger et al. 2013). These metrics (i.e., rearing density and acclimation period) will be collected annually to determine their influence on fish survival.

PIT-tagged groups of hatchery fish will be used to estimate survival during their emigration. Variation in survival during the emigration period may also inform observed adult survival rates. Survival during emigration and travel will be estimated using interrogation or release files and the standard Cormack-Jolly-Seber (CJS) estimator. CJS estimates are termed apparent survival estimates because it is unknown whether fish suffered mortality (e.g., size or time of release) or simply failed to emigrate (i.e., residualized or were precocial males). In the latter case, the proportion of PIT-tagged fish detected in the Methow sub-basin, Wenatchee or Columbia rivers after the emigration period is complete may explain variation in smolt survival rates. The post-release performance of PIT-tag groups will be estimated and monitored annually, consistent with methods in Hillman et al. 2017. Additionally, precocity of hatchery releases will be evaluated by examining the proportion of PIT tag releases detected in adult fish ladders and tributaries within the same year as release.

3. JUVENILE MONITORING

Data collected during these elements primarily support monitoring questions 2.1.1 and 2.2.1. and the monitoring objectives described in Table 4 (Hillman et al. 2017). Table 4 below provides a summary of the variables to be measured in 2020 under the juvenile monitoring component and what objective the measure supports. The text that follows in this section further describes the activities.

Table 4. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the juvenile monitoring component.

Objective	Measured Variables *(Applicable Study Component(s))*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of juveniles (smolts and emigrants) (*Freshwater Productivity of Supplemented Stocks*)

3.1 Freshwater productivity of Supplemented Stocks

Steelhead, Spring Chinook, and Summer Chinook

The freshwater productivity of supplemented stocks in the Wenatchee sub-basin will be monitored using smolt traps in the Chiwawa River and the lower Wenatchee River consistent with historical trapping efforts. Additionally, a derived analytical method which uses PIT-tag mark-recapture data will be utilized that reduces bias and increases precision by including estimates of emigration during the winter non-trapping periods. Up to 3,000 parr will be PIT tagged in the Chiwawa River in the fall, based on the spatial distribution and abundance estimated during parr snorkel surveys, to generate estimates of migration during the non-trapping periods. A random sample of a minimum of 10 percent of fish per remote site will be held in a live box for 24 hours to evaluate tag loss and delayed mortality. Using PIT tagged parr detections at the lower Chiwawa PIT array during the non-trapping period, the total number of PIT-tagged parr that emigrated will be estimated, and then expanded by the tag rate. Overwinter mortality of PIT-tagged parr is assumed to be the same as non-PIT-tagged parr. Overwinter survival estimates of Chiwawa River parr will be derived by estimating survival to the lower Wenatchee PIT tag array and analyses with the TribPit Survival software program and/or estimating survival of fall parr and spring smolts to McNary. PIT-tag mark-recapture trials conducted during the trapping period in the fall will also be used to estimate detection probabilities of the PIT-tag array at a given discharge level. Abundance and variance will be estimated using the same methods as those used in the smolt trap estimate. The estimated abundance and variance from each method and time period (trapping and non-trapping periods) will be summed to estimate a total production estimate. Under the proposed methodology, unbiased estimates of abundance during the entire migration period will be generated with relatively high precision (PSE < 15%), which is consistent with NOAA Fisheries' recommendations (Crawford and Rumsey 2011). Historical estimates will be revised using the new estimation techniques.

4. ADULT MONITORING

The adult monitoring component is comprised of two basic elements: (1) estimating spawning escapement and (2) harvest monitoring. Data collected during these elements primarily support monitoring questions 1.1.1, 1.2.1, 2.1.1, 2.2.1, 3.2.1, 3.2.2, 4.1.1, 5.1.1, 5.2.1, 5.3.1, 5.3.2, 6.3.1, but also contribute data to monitoring questions 6.1.1, 6.2.1, 8.1.1, 8.2.1, 8.4.1, 10.1.1, 10.1.2, 10.1.3 and 10.1.4. Table 5 below provides a summary of the variables to be measured in 2020 under the adult monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

Table 5. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the adult monitoring component.

Objective	Measured Variables *(Applicable Study Component(s))*
Objective 1: Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish taken for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the Columbia) *(Harvest Reporting)*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of hatchery and naturally produced fish on the spawning grounds (*Spawning Escapement Estimates*) • Number of redds *(Spawning Escapement Estimates)*
Objective 3: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish harvested *(Harvest Reporting)*
Objective 4: Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)*
Objective 5: Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Time (Julian date) of hatchery and naturally produced salmon carcasses or marked steelhead detected on spawning grounds within defined reaches *(Spawning Escapement Estimates)* • Time (Julian date) of arrival at mainstem projects and within tributaries (e.g., traps, PIT arrays) with

Objective	Measured Variables *(Applicable Study Component(s))*
	the intent to identify biologically significant differences *(Spawning Escapement Estimates)* • Location (GPS coordinates) of female salmon carcasses observed on spawning grounds *(Spawning Escapement Estimates)*
Objective 6: Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	• Number of hatchery fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery fish taken in fishery (*Harvest Reporting*) • Locations of live and dead strays (used to tease out overshoot) *(Spawning Escapement Estimates)* • Number of hatchery carcasses (PIT-tagged and/or CWT) found in non-target and target spawning areas or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas (stray data into the Entiat sub-basin will be obtained from USFWS Fisheries Resource Office-Leavenworth) *(Spawning Escapement Estimates)*
Objective 7: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.	• Allele frequency • Linkage disequilibrium • Genetic distance between subpopulations and populations • Effective spawning population

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	• Total and salt (ocean) age and gender of hatchery and naturally produced salmon carcasses collected on spawning grounds *(Spawning Escapement Estimates)* • Whenever possible, age at maturity and sex ratio will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling or ultrasound on live fish) *(Spawning Escapement Estimates)* • Assess age of fish, including harvested fish *(Spawning Escapement Estimates and Harvest Reporting)*
Objective 10: Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations.	• Numbers of hatchery fish taken in harvest *(Harvest Reporting)* • Numbers of natural-origin fish taken in harvest *(Harvest Reporting)*

4.1 Spawning Escapement Estimates

Chelan Summer/Fall Chinook

Chinook spawning ground surveys will be conducted in the Chelan River and (see Appendix A for survey reaches). Spawning ground surveys will be conducted via foot or raft beginning late September and continuing until spawning has ended (usually mid-November). Frequency of surveys will vary depending on method.

Summer Chinook carcass surveys will be conducted in the Chelan River beginning in September and ending in November consistent with methods described in Hillman et al. 2017. A representative sample (i.e., 20%) of spawners as determined by spawner abundance and distribution (typically 100% of the carcasses encountered in the Chelan River) will be sampled. Biological data will include collection of scale samples for age analysis, length measurements (POH and FKL), gender, egg voidance, and a check for tags or marks. DNA samples (five-hole punches from operculum) will be collected as needed to address different objectives. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), stray rates, and genetics. All carcass surveys will be conducted within the historical reaches.

Wenatchee Steelhead

The number of BY 2020 hatchery and naturally produced steelhead returning to the Wenatchee sub- basin will be estimated using a PIT tag mark recapture model. The estimated spawner abundance for the Wenatchee steelhead population will be a combination of PIT tag-based tributary and redd-based mainstem Wenatchee River estimates. Steelhead redd counts will be conducted weekly in all major spawning areas in the mainstem Wenatchee River (see Appendix A for survey reaches); minor spawning areas in the mainstem Wenatchee River will be surveyed once, based on the spawn timing in adjacent major spawning areas, to estimate redd abundance at peak spawning. The estimated total number of redds in the Wenatchee River mainstem will be expanded by the sex ratio of the population to estimate spawner abundance. Spawner abundance in tributaries of the Wenatchee River will be estimated using a PIT tag mark recapture model (Truscott et al. 2018).

Chiwawa Spring Chinook

Chiwawa spring Chinook spawning escapement will be estimated based on the total number of redds found in each tributary (Murdoch et al. 2010) using methods described inHillman et al. 2017. Weekly redd and carcass surveys will be conducted simultaneously from the first week of August through September (see Appendix A
for survey reaches). Redd-based estimates assume that each female constructs one redd, which WDFW has found to be appropriate for this population (Murdoch et al. 2009). The total number of redds in each reach will be estimated using methods described in Millar et al. (2012) and using the observer efficiency model currently under development by WDFW. Redd counts will be expanded and the number of hatchery and naturally produced fish will be estimated using methods in Murdoch et al. (2010). Carcasses encountered during surveys will be sampled according to methods outlined in Murdoch and Peven (2005). All CWTs (i.e., snout or adipose) from carcasses will be read and the data entered into the Regional Mark Processing Center database within one year of collection.

Additionally, all redds and female carcasses will be geo-referenced using hand-held GPS devices. Carcass recovery bias has been detected in the Chiwawa spring Chinook population (Murdoch et al. 2010) and if not corrected will bias estimates of hatchery and naturally produced fish on the spawning grounds. While it may be appropriate to correct for carcass recovery bias for some monitoring questions (e.g., 2.2), when comparisons to reference populations are made in monitoring questions 1.1.and 1.2, carcass bias will not be corrected because other monitoring programs have not corrected for a similar bias.

Wenatchee Summer Chinook

Wenatchee summer Chinook spawning ground counts will begin the first week in September and continue through the end of spawning in November (see Appendix A for survey reaches). Total census redd counts will be conducted by foot or raft depending on stream size, flow, and density of spawners within the stream reach (see Appendix A for survey reaches). All stream reaches will be surveyed once per week. Redd data will be collected using methods described in Hillman et al. 2017 . Salmon carcass data collected during spawning ground surveys will be consistent with Hillman et al. 2017. All CWTs (i.e., snout or adipose) from carcasses will be sent to the WDFW lab in Olympia. The CWT lab will extract and read CWTs and submit all required information to RMIS within one year of collection.

4.2 Harvest Reporting

In years when the expected hatchery adult returns are in excess of the levels needed to meet the hatchery program goals (i.e., broodstock and/or escapement), surplus fish may be available for harvest. Harvesting or removal of surplus hatchery fish may have benefits to the natural populations by reducing potential negative ecological and genetic impacts (e.g., density dependent effects, loss of fitness, and loss of genetic variation). The contribution of hatchery fish to fisheries will be monitored using CWT recoveries on a brood-year basis supporting Objective 10.

To obtain the necessary data to determine if the harvest rates are meeting objectives, a statistically valid creel program will be designed and implemented for all sport and/or conservation fisheries in the Upper Columbia River to estimate harvest of hatchery fish from both Chelan and Grant County PUD funded hatchery programs Hillman et al. 2017. Information collected during creel surveys are an integral component to calculating the HRR (Objective 3), particularly given most CWT recoveries for PUD mitigation programs occur in the Upper Columbia River and its tributaries, with the exception of summer Chinook where most CWT recoveries occur in ocean fisheries. Because of considerable time lags in reporting of CWT’s to the Regional Marking Information System (RMIS) database, it requires an ongoing query of recovery data until the number of estimated fish does not change.

5. DATA MANAGEMENT, ANALYSIS, AND REPORTING

5.1 Data Management

A Microsoft Access database maintained by WDFW will contain all the monitoring data collected for hatchery evaluations. The database will contain and manage all data associated with aquaculture monitoring, juvenile monitoring, and adult monitoring.

All data entered into the database are evaluated for quality control and quality assurance by WDFW. Quality control checks using analyses such as modified Z-scores, boxplots, and the Generalized Extreme Studentized Deviate Procedure (Iglewicz and Hoaglin 1993) will be conducted for all data entry. In the event outliers are identified, discussion will occur on whether identified outliers are true data points or transcription errors. This process ensures that the data used to test statistical hypotheses are correct and accurate.

5.2 Data Analysis

The analyses proposed are consistent with the Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update (Hillman et al. 2017). Each of the objectives will be addressed using the appropriate statistical tests, as well as graphic analyses that convey relevant information.

5.3 Reporting

An annual M&E report will be generated following the completion of each calendar year and will be available for HCP-HC review by June 1 of the following year. Additionally, monthly progress reports will be made available to the HCP-HC.

6. Lake Wenatchee Sockeye Salmon

The Chelan PUD will conduct monitoring and evaluation (M&E) activities to track key population attributes related to Lake Wenatchee sockeye salmon in 2020 (Table 6). In the absence of a sockeye hatchery program, M&E activities are no longer rooted in the context of evaluating the effects of sockeye salmon supplementation, but instead focus directly on the performance of the natural population, which is a unique departure from historic monitoring obligations. Broadly, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP): abundance, productivity, spatial structure and diversity (McElhaney et al. 2000). The data collected may also have utility in future hatchery compensation recalculation efforts.

Chelan PUD is conducting these M&E activities to support commitments made under the 2011 hatchery recalculation effort, which also included a steelhead production commitment for a sockeye species swap (SOA 2011). This section of the implementation plan describes the specific commitments by juvenile and adult life history stages.

6.1 Juvenile Monitoring

Chelan PUD will conduct or fund activities to monitor and evaluate the temporal distribution and age/size of out-migrating smolts, and estimate smolt production (Table 6). Smolt production will be estimated from data collected at the lower Wenatchee smolt trap and via back calculations based on collected adult return data (i.e., age-at-return estimates, SARs, and adult escapement to the tributaries). Collectively, these activities include: (1) funding of the lower Wenatchee River smolt trap concurrent with efforts aimed at evaluating Chelan PUD funded supplemented populations in the Wenatchee River sub-basin; (2) tagging up to 5,000 PIT tags for natural-origin juveniles encountered during smolt trapping activities and collecting scale samples at this location; and (3) estimating adult escapement estimates to the tributaries, and collection of adult return data at Tumwater (see the *Adult Monitoring* section for details) to back-calculate smolt production.

The monitoring data obtained will provide a useful set of tools for evaluating the performance of natural origin sockeye salmon within the sub-basin and downstream and also support the evaluation of VSP parameters [e.g., outmigration timing and size (diversity); and PIT tagging juveniles for SAR estimates (productivity)].

6.2 Adult Monitoring

Several M&E activities associated with adult returns of Lake Wenatchee sockeye salmon will be conducted and/or funded by Chelan PUD (Table 6). These efforts include (1) continuation of accurate adult counts at Rock Island, Rocky Reach, and Tumwater dams; (2) sampling of scales for age distribution, sex ratio determination, and returns of PIT-tagged adults at Tumwater Dam; (3) reach-specific conversion estimates between Rock Island Dam and spawning grounds in the White and Little Wenatchee rivers (i.e., Rock Island to Tumwater Dam to spawning tributaries); and (4) providing between 250 to 1,000 PIT tags to estimate adult spawning escapement in the Little Wenatchee and White rivers utilizing PIT tags and mark-recapture techniques (the software program Sample Size 2.0.7, developed by the University of Washington School of Aquatic and Fisheries Science (P. Westhagen, J. Lady, and J. Skalski) was used to determine the minimum number of tags required (i.e., 250) to estimate adult sockeye escapement at a +/- 7 percent confidence interval). Chelan PUD will adjust the number of PIT-tagged individuals in order to maintain precision in estimates at the lowest rate of interference to migrating populations, if it is warranted due to annual changes in escapement and detection probabilities. In an effort to PIT tag the run at large, adults will be PIT tagged at Tumwater consistent with the Tumwater Operations Protocol, daily throughout the run.

Collectively, these data will provide reliable metrics of adult returns and spawning escapement (abundance), recruits-per-spawner (productivity), distribution of spawners among tributaries (spatial structure), and run-timing and age structure for adult immigrants (diversity).

Table 6. Chelan PUD's Lake Wenatchee sockeye salmon monitoring and evaluation activities.

Life History Stage	M&E Activity	Entity Performing the Activity	Related analysis	VSP parameter addressed
Juvenile	Concurrent operation of the lower Wenatchee smolt trap to collect juvenile outmigration data	WDFW	Generate distribution of outmigration timing, estimate smolt production and determine average smolt size.	Diversity and productivity
Juvenile	PIT tagging smolts at lower Wenatchee smolt trap (up to 5,000 fish annually) and collecting/aging scale samples	WDFW	Estimate smolt-to-adult returns.	Productivity
Juvenile	Develop adult return based smolt production estimates	WDFW	Use collected data (i.e., adult age-at-return data, SARs, adult escapement to the tributaries) to back-calculate smolt production.	Productivity
Adult	Rock Island and Rocky Reach Dam adult counts	CPUD	Initial spawner abundance (Okanogan stock separation)	Abundance and spatial structure
Adult	PIT tag subsample (250 adults) of returning adults at Tumwater Dam to support mark-recapture evaluation	WDFW	Calculate spawner abundance and relative distribution among ~~in~~ tributaries	Abundance and spatial structure
Adult	Collect and age scales[1] and determine sex via ultrasound from returning adults at Tumwater Dam	WDFW	Estimate age-at-return, sex ratio, and relative productivity of contributing spawner cohorts	Productivity and diversity
Adult	Tumwater Dam adult counts	WDFW	Estimate potential spawner abundance (pre-Lake-Wenatchee harvest), potential productivity (recruits/spawner), and run timing distribution	Abundance and diversity
Adult	Operate PIT detection arrays on Little Wenatchee and White River	WDFW	Calculate spawner abundance (post-Lake Wenatchee harvest and other mortality), actual productivity (recruits/spawner), and entry-to-spawning-habitat timing distribution, and spatial spawner distribution among tributaries	Abundance, productivity, spatial structure, and diversity
All	Data management, analysis, and reporting	BioAnalysts CPUD	------	NA

[1] Scales would be collected concurrently from adults that are PIT tagged at Tumwater Dam.

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Appendix A

Designated survey reaches for Methow subbasin summer Chinook spawning ground surveys.

River	Reach	Code	RM
Methow	Mouth to Methow Bridge	M1	0.0-14.78
	Methow Bridge to Carlton Bridge	M2	14.78-27.17
	Carlton Bridge to Twisp Bridge	M3	27.17-39.55
	Twisp Bridge to MVID	M4	39.55-44.85
	MVID to Winthrop Bridge	M5	44.85-49.80
	Winthrop Bridge to Hatchery Dam	M6	49.80-51.55

Designated survey reaches for Wenatchee River basin summer Chinook spawning grounds surveys. Asterisks denotes reaches where redd observer efficiency will be assessed.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Bridge	54.20-53.58
	Bridge to Swamp *	53.58-52.66
	Swamp to Chiwawa River	52.66-48.39
W9	Chiwawa River to Schugart Flats	48.39-47.93
	Schugart Flats to Old Plain Bridge	47.93-46.21
	Old Plain Bridge to RR Bridge	46.21-41.91
	RR Bridge to RR Tunnel	41.91-39.28
	RR Tunnel to Swing Pool *	39.28-36.67
	Swing Pool to Tumwater Br	36.67-35.55
W8	Tumwater Br to Swiftwater Campground *	35.55-33.50
	Swiftwater Campground to Unimproved Campground	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Penstock Br	30.91-28.66
	Penstock Br to Icicle Road Br *	28.66-26.43
W6	Icicle Road Br to Icicle Mouth	26.43-25.61
	Icicle Mouth to Boat Takeout *	25.61-24.49
	Boat Takeout to Leavenworth Br	24.49-23.90
W5	Leavenworth Br to Irrigation Flume *	23.90-22.77
	Irrigation Flume to Peshastin Br	22.77-20.00
W4	Peshastin Br to Dryden Dam *	20.00-17.76
W3	Dryden Dam to Williams Canyon	17.76-15.54
	Williams Canyon to Upper Cashmere Br	15.54-10.22
	Upper Cashmere Br to Lower Cashmere Br	10.22-9.49
W2	Lower Cashmere Br to Old Monitor Br *	9.49-7.12
	Old Monitor Br to Sleepy Hollow Br	7.12-3.27
W1	Sleepy Hollow Br to River Bend *	3.27-1.73
	River Bend to Siphon	1.73-1.29
	Siphon to Mouth	1.29-0.45

Designated survey reaches for Wenatchee Basin spring Chinook spawning grounds surveys.

Reach Code	Reach Section	River Mile
Chiwawa River and Tributaries (Rock and Chikamin)		
C7	Buck Cr to Phelps Cr	36.39-33.46
C6	Phelps Cr (Trinity) to Maple Cr Br	33.46-29.64
C5	Maple Cr Br to Atkinson Flats	29.64-26.59
C4	Atkinson Flats to Schaefer Cr	26.59-24.24
C3	Schaefer Cr to Rock Cr Campground	24.24-22.97
R1 - Rock	Mouth to Chiwawa River Road Bridge	0.00-1.05
C2	Rock Cr Campground to Grouse Cr	22.97-12.27
K1 - Chikamin	Mouth to Chiwawa River Road Bridge	0.00-0.68
C1	Grouse Cr to Mouth	12.27-0.00
Nason Creek		
N4	White Pine Creek to Lower R.R. Bridge	16.09-13.68
N3	Lower R.R. Bridge to Hwy 2 Bridge	13.68-9.13
N2	Hwy 2 Bridge to Kahler Cr	9.13-4.46
N1	Kahler Cr to Mouth	4.46-0.00
White River and Tributaries (Panther and Napeaqua)		
H4	Falls to Grasshopper Meadows	21.16-19.78
T1 - Panther	Boulder field to Mouth	0.43-0.00
H3	Grasshopper Meadows to Napeaqua River	19.78-17.59
Q1 - Napeaqua	Take out to Mouth	0.91-0.00
H2	Napeequa River to Sears Cr Bridge	17.59-11.97
H1	Sears Cr Bridge to Mouth	11.97-0.00
Little Wenatchee River		
L3	Rainy Cr to Lost Cr	10.78-6.74
L2	Lost Cr to Old Fish Weir	6.74-2.13
L1	Old Fish Weir to Mouth	2.13-0.00
Upper Wenatchee River		
W10	Lake Wenatchee to Chiwawa River	54.20-48.39
Chiwaukum Creek		
U1	Metal bridge to Mouth	1.0 – 0.0
Icicle River		
I1	Hatchery to Mouth	3.02-0.00
Peshastin Creek and Tributaries (Ingalls Creek)		
D1 - Ingalls	Trailhead to mouth	0.64-0.00
P2	Ingalls Creek to Camas Cr	9.14-5.63
P1	Camas Cr to Mouth	5.63-0.00

Designated survey reaches for Wenatchee River basin steelhead spawning grounds surveys. Asterisks denote index reaches. Spawning escapements in tributaries will be estimates using PIT-tag arrays.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Chiwawa River*	54.20-48.39
W9	Chiwawa River to Tumwater Bridge*	48.39-35.55
W8	Tumwater Br to Swiftwater Campground	35.55-33.50
	Swiftwater Campground to Unimproved Campground*	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Icicle Road Bridge	30.91-26.43
W6	Icicle Road Br to Leavenworth boat ramp*	26.43-24.49
	Boat Takeout to Leavenworth Bridge	24.49-23.90
W5	Leavenworth Bridge to Peshastin Bridge	23.90-20.00
W4	Peshastin Bridge to Dryden Dam	20.00-17.76
W3	Dryden Dam to Lower Cashmere Bridge	17.76-9.49
W2	Lower Cashmere Bridge to Sleepy Hollow Bridge *	9.49-3.27
W1	Sleepy Hollow Bridge to Mouth	3.27-0.45

Tributary	River mile of PIT tag array
Mission Creek	0.54
Peshastin Creek	1.91
Chumstick Creek	0.31
Icicle River	0.26
Chiwaukum Creek	0.24
Chiwawa River	0.58
Nason Creek	0.52
Little Wenatchee River	1.74
White River	1.65

Appendix B

Final Memorandum

Date: March 12, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of

2017. A special condition of this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

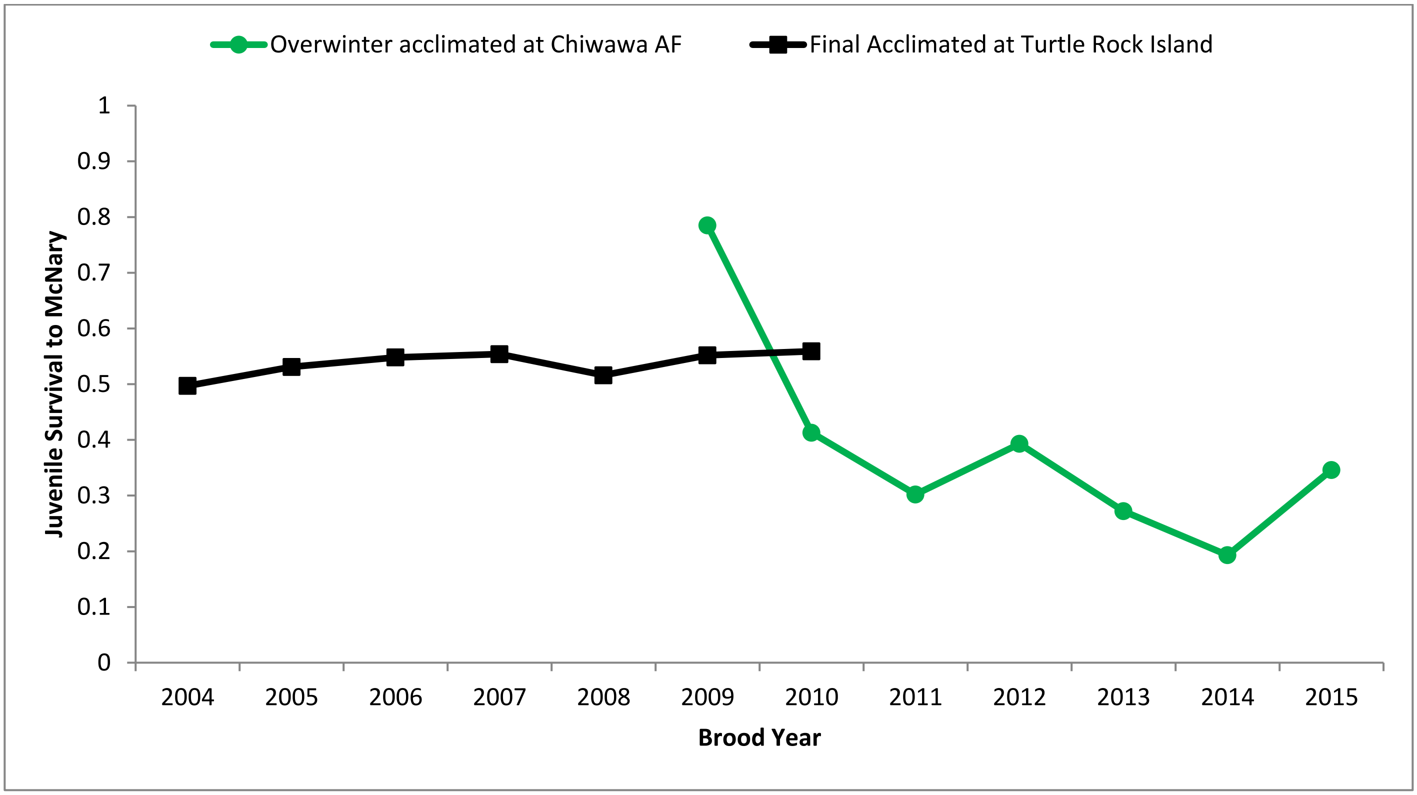

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

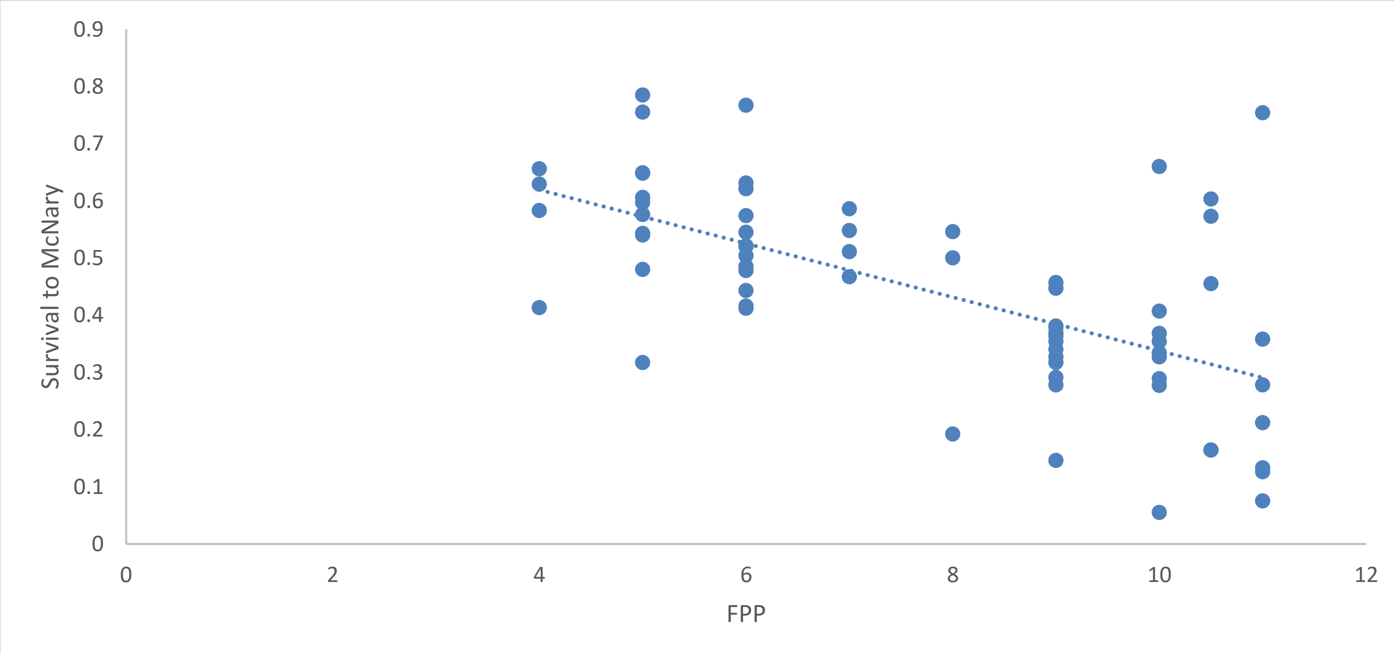

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

<u>2018-2020 Release Strategy Objectives</u>

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).

- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).

- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.

- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

Methods

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish ((statistical power $1-\beta$ = 0.80; α = 0.10, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	**Brood Origin**	**Treatment**	**Estimated # PIT-tagged**	**Treatment PIT release size**
RCY2	HxH	Size	5,500 small	11,000 Small Mixed
RCY2	WxW	Size	5,500 small	
RCY2	HxH	Size	5,500 medium	11,000 Medium Mixed
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8th. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location on the same day to the Chiwawa River (Table 2).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	**Origin[1]**	**Estimated Number Released[2]**	**Estimated # PIT-tagged**	**Destination**	**rkm**
RCY2	Mixed	58,067	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.

[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.

Which release location should be utilized? All PIT-tags released in Chiwawa River well upstream from the detection array (RK 11.4).

- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
    - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

Input on post-release sampling to conduct GSI sampling and assessment of smolt index? See "Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program" March 12, 2018, Rock Island and Rocky Reach HCPs HCs notes.

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Appendix R
Monitoring and Evaluation Plan for PUD Hatchery Programs: 2019 Update

MONITORING AND EVALUATION PLAN FOR PUD HATCHERY PROGRAMS

2019 UPDATE

December 18, 2019

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Citation: Hillman, T., T. Kahler, G. Mackey, Andrew Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard. 2017. Monitoring and evaluation plan for PUD hatchery programs: 2017 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

TABLE OF CONTENTS

LIST OF APPENDICES

SECTION 1: INTRODUCTION

This document is an update of the monitoring and evaluation (M&E) plan of the salmon and steelhead hatchery programs funded by Douglas, Chelan, and Grant County Public Utility Districts (PUDs). Programmatic changes, evaluation of data collection methods, and M&E results from the past several years, along with shifting management paradigms affect M&E needs, all of which have occurred under advancing fish culture and monitoring techniques. As required by the programs, this document is a result of a five-year review intended to expand on and coalesce previous M&E documents (BAMP 1998; Cates et al. 2005; Murdoch and Peven 2005; Hays et al. 2006; Pearsons and Langshaw 2009a, 2009b; Hillman et al. 2013) with inclusion of new information.

Fishery management agencies developed the following general goal statements for hatchery programs, which were adopted by the HCPs Hatchery Committees and PRCC Hatchery Sub-Committee (hereafter, Hatchery Committees):

1. Support the recovery of ESA-listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.
2. Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when spawning escapement is sufficient to support harvest.
3. Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural tributary spawning populations.

Following the development of Hatchery and Genetic Management Plans (HGMPs), artificial supplementation programs are now characterized into three categories. The first type, integrated conservation programs, are intended to support or restore natural populations. These programs focus on increasing the natural production of targeted fish populations. A fundamental assumption of this strategy is that hatchery fish returning to the spawning grounds are reproductively similar to naturally produced fish. The second type, safety-net programs, are extensions of conservation programs, but are intended to function as reserve capacity for conservation programs in years of low returns. The safety-net provides a demographic and genetic reserve for the natural population. That is, in years of abundant returns they function like segregated programs, and in low return years they can be managed as conservation programs. Lastly harvest augmentation programs are intended to increase harvest opportunities while limiting interactions with wild-origin counterparts.

Monitoring is needed to determine if the hatchery programs are meeting the intended management objectives of conservation, safety-net, or harvest augmentation programs. Objectives for hatchery programs are generally grouped into three categories of performance indicators:

1. In-Hatchery: Is the program meeting the hatchery production objectives?
2. In-Nature: How do fish from the program perform after release?
    a. Conservation Program:

- How does the program affect target population abundance and productivity?
- How does the program affect target population long-term fitness?

b. Safety-Net Program:
- How does the program affect target population long-term fitness?

c. Harvest Augmentation Program:
- Does the program provide harvest opportunities?

3. Risk Assessment: Does the program pose risks to other populations?

Objectives in this plan have been organized in a hierarchy where productivity indicators are the primary metrics used to assess if conservation and safety-net program goals have been met; harvest rates and effects on non-targeted populations are used for harvest programs. In cases where productivity indicators are not available or results are equivocal, monitoring indicators may be used to help evaluate the performance of the program. Evaluations of monitoring indicators may not provide sufficiently powerful conclusions on which to base management actions, although they may provide insight as to why a productivity indicator did or did not meet the program goal. Therefore, the relationship between hatchery programs and indicators can be viewed in a chain-of-causation: management actions within the hatchery programs affect the status of monitoring indicators, which in turn influence productivity indicators (Figure 1).

Figure 1. Relationship of indicators to the assessment of supplementation programs. Management actions affect monitoring indicators, which influence productivity indicators. Monitoring indicators may be used to hypothesize the magnitude of influence on productivity.

The primary goal of a conservation program is to contribute to the rebuilding and recovery of naturally reproducing populations within their native habitat. In this plan, natural replacement rates (NRR), recruitment of naturally-produced fish (NOR), and juvenile productivity (juveniles per redd) are important indicators for assessing the success of supplementation. These indicators are difficult to measure precisely and are quite variable in space and time. Therefore, monitoring indicators can be evaluated to help assess if productivity was related to the hatchery programs or other factors (Table 1).

Table 1. Program objectives, indicators, and goals for conservation hatchery programs including productivity and monitoring indicators (also applies to safety-net programs when used to support a conservation program).

	Objective	Indicator	Target	Program goals: Rebuild natural populations	Program goals: Maintain genetic diversity	Program goals: Opportunity for harvest
Productivity indicators	Determine if the program has increased the number of naturally spawning adults	Abundance of natural spawners	Increase	✓		✓
		Adult productivity (NRR)	No decrease	✓		
	Determine if the proportion of hatchery fish affects freshwater productivity	Residuals vs. pHOS	No relationship	✓		
		Juveniles per redd vs. pHOS	No relationship	✓		
Monitoring indicators	Determine if run timing and distribution meets objectives	Migration timing	No difference	✓	✓	
		Spawn timing[1]	No difference	✓	✓	
		Redd distribution[2]	No difference	✓	✓	
	Determine if program has affected genetic diversity and population structure	Allele frequency (hatchery vs. wild)	No difference		✓	
		Genetic distance between populations	No difference		✓	
		Effective population size	Increase		✓	
		Age and size at maturity	No difference		✓	
	Determine if hatchery survival meets expectations	HRR	HRR > NRR	✓		
		HRR	HRR ≥ Goal[3]	✓		
	Determine if recipient stray rate of hatchery fish is acceptable	Out of basin	≤ 5%	✓	✓	
		Within basin	≤ 10%	✓	✓	
	Determine if hatchery fish were released at program targets	Size and number	= Target[4]	✓		
	Provide harvest opportunities when appropriate	Harvest	Escapement goals			✓

[1] Hatchery and natural-origin fish should spawn at the same time across the range of elevations within the spawning distribution of each stock.

[2] Hatchery and natural-origin fish should spawn in the same locations. Exceptions are the Carlton and Dryden Summer Chinook programs (see Appendix 4).

[3] HRR targets are identified in Appendix 2.

[4] Number and size targets are identified in Table 3 and Appendix 5.

A flow of information following sequential, logical steps will be employed to evaluate supplementation programs, consistent with the indicators described in Table 1. For example, a hatchery program, at a minimum, must be able to produce more adults per spawner than would occur in the natural environment. Should the program fail this test, hatchery operations should be evaluated to determine if improvements can correct the problem. If a program successfully replaces the required number of adults, it is then evaluated against a reference population or condition, if available, to determine if it has increased the overall number of naturally spawning fish (including both hatchery- and natural-origin adults), increased the number of natural-origin spawners, and to test if productivity of the natural population has changed. When these goals are met, the program is considered successful. When these goals are not met, monitoring indicators may infer why the program is not achieving its goals

If suitable reference populations are not available, other comparisons can be used to help evaluate treatment responses. Evaluation of programs may pursue the following approaches:

- Comparison to reference population(s) that do not contain pre-treatment data.
- Before treatment and after treatment comparisons.
- Comparison to standard(s).
- Comparison to other suitable reference conditions.

Methodologies for selecting reference streams, analyzing data from treatment and reference stream comparisons, and other comparisons are presented in Hillman et al. (2012) (see Appendix 6).

The primary goals of a safety-net program are to provide demographic and genetic reserves for a population that is supplemented by a conservation program (Table 2). Harvest and adult management may be used to control escapement of spawners when appropriate. Monitoring focuses on estimating the number of fish that escape to spawn naturally and stray rates and in-hatchery performance evaluation.

Table 2. Program objectives, indicators, and goals for segregated harvest augmentation hatchery programs including monitoring indicators.

				Program goals		
	Objective	**Indicator**	**Target**	**Rebuild natural populations**	**Maintain genetic diversity**	**Opportunity for harvest**
Monitoring indicators	Determine if hatchery survival meets expectations	HRR	HRR > NRR			✓
		HRR	HRR ≥ Goal[1]			✓
	Determine if stray rate of hatchery fish is acceptable	Out of basin	≤ 5%		✓	
		Within basin	≤ 10%		✓	
	Determine if hatchery fish were released at program targets	Size and number	= Target[2]			✓
	Provide harvest opportunities when appropriate	Harvest	When greater than escapement goals			✓

[1] HRR targets are identified in Appendix 2.

[2] Number and size targets are identified in Table 3 and Appendix 5.

The primary goal of a harvest augmentation program is to increase harvest opportunities, while segregating adults from natural spawning populations. In this plan, harvest opportunity, survival rates, and stray rates are important indicators for assessing the success of harvest augmentation. These indicators are more readily quantified compared to productivity indicators (Table 2). A flow of information will be employed to evaluate harvest augmentation programs. Since harvest augmentation programs are typically segregated, monitoring indicators will be used to determine the success of a program.

Both monitoring and productivity indicators will be used to evaluate the success of hatchery programs. In the event that the statistical power of tests that involve productivity indicators is insufficient to inform sound management decisions, some of the monitoring indicators may be used to guide management. Figure 2 show the categories of indicators associated with each component of monitoring.

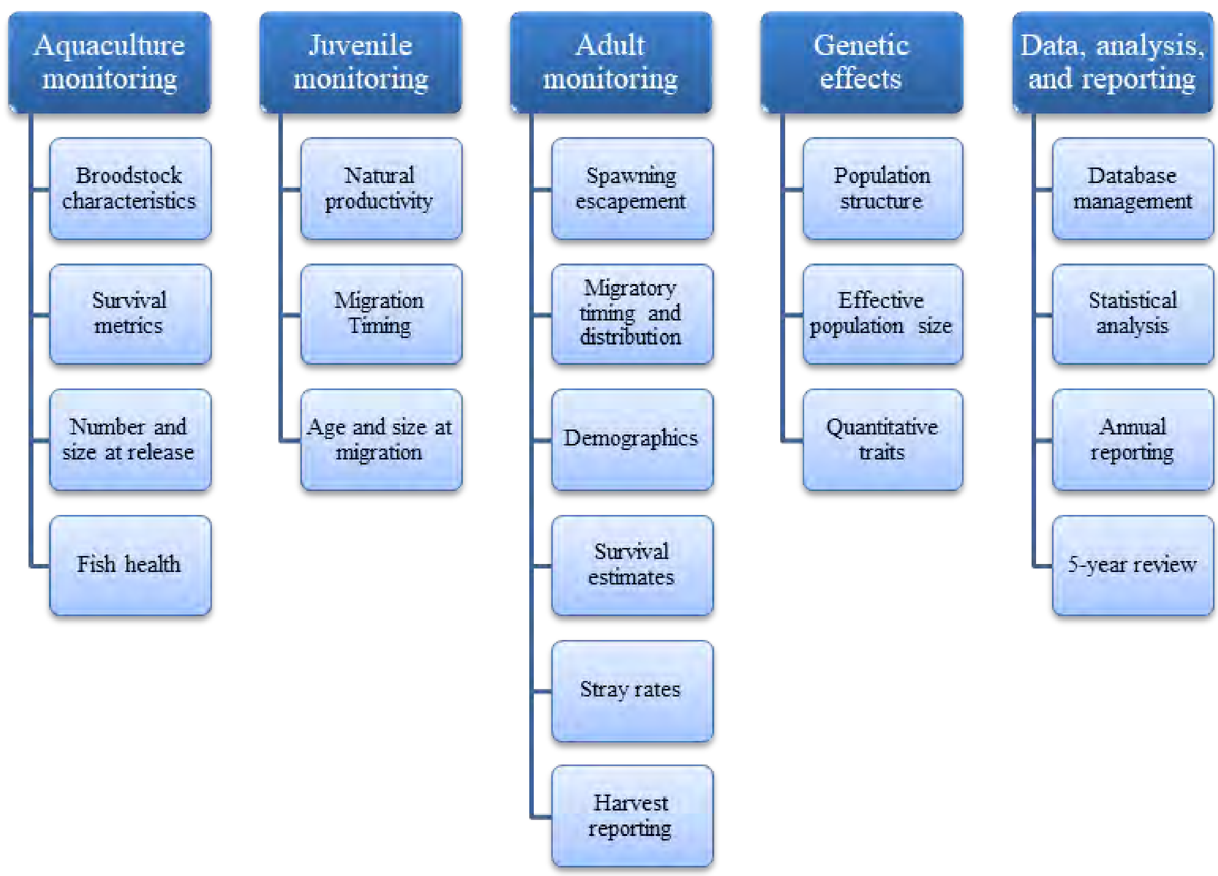

Figure 2. Overview of Monitoring and Evaluation Plan Categories and Components (not including regional objectives).

The overarching goals of conservation, safety-net, and harvest augmentation programs, as described above, are shown in detail in Figure 3. The flow chart (Figure 3) shows the relationship of overarching program goals, the strategies used to meet the goals, the monitoring and evaluation objectives used to evaluate the strategies and determine if goals are being met, and the adaptive management cycle associated with the programs (see Tables 1 and 2 for the indicators under each objective). The logic depicted in this flow chart shall be used to assess M&E results and apply those results to management decisions. Table 3 presents the current hatchery programs releasing fish in the Upper Columbia Basin.

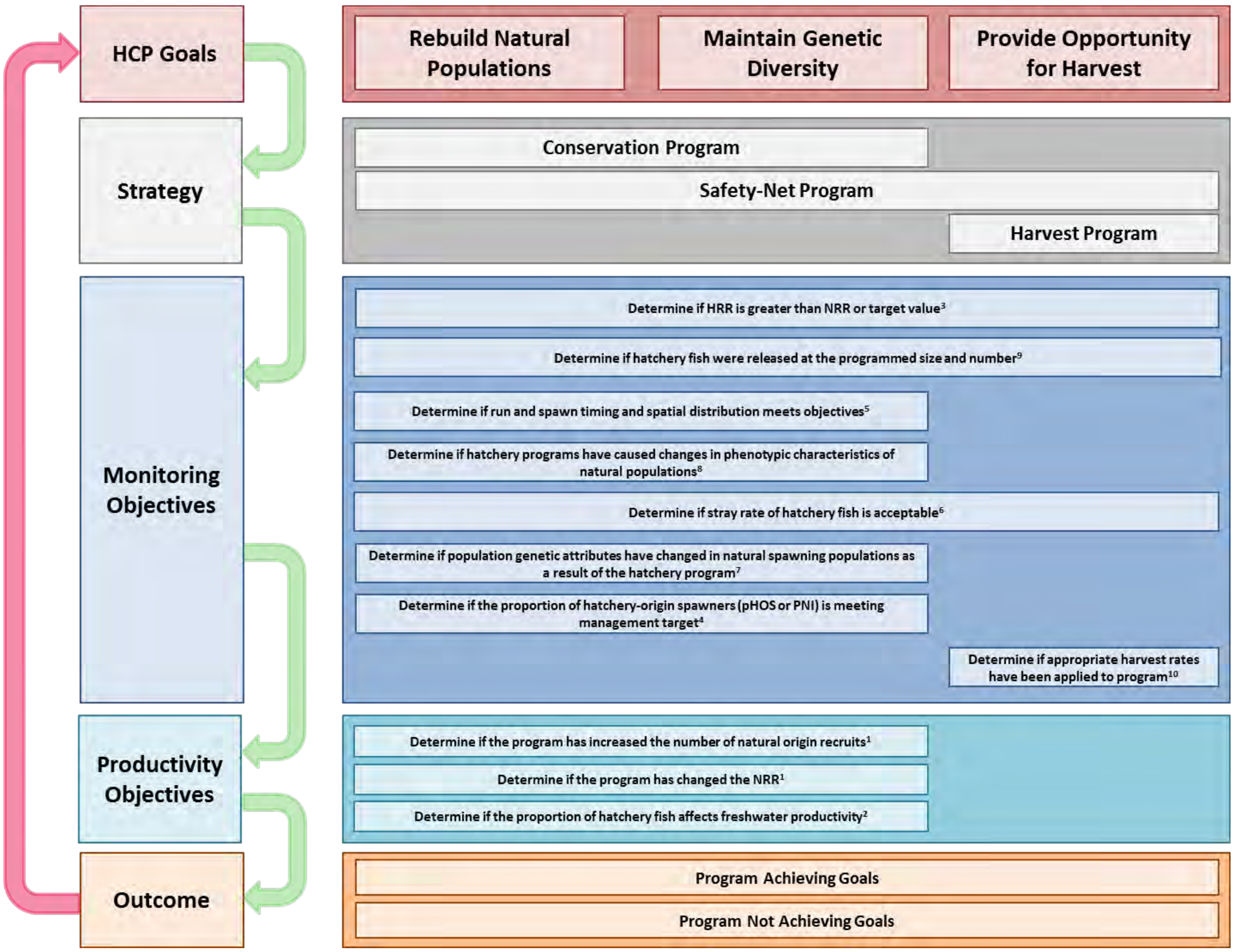

Figure 3. Adaptive management flow chart depicting HCP goals, associated strategies to meet the goals, the monitoring and evaluation objectives (indicated in superscript), and the adaptive management feedback cycle. The strategies, objectives, and outcomes are aligned vertically under the corresponding goals.

Table 3. Hatchery programs in the mid-Columbia River Basin, 2012. Funding entities included Douglas PUD (D), Chelan PUD (C), Grant PUD (G), Bonneville Power Administration (B), Bureau of Reclamation (O), and Army Corps of Engineers (A) and are listed in order of contribution. Total artificial production targets in the mid-Columbia River exceeds 20 million juveniles annually.

Program	Species	Basin	Purpose	Funding Entity	Production
Methow[5]	Spring Chinook [1]	Methow	NNI/Conservation	G, C, D	223,765
Chief Joseph[7]	Spring Chinook	Okanogan	Reintroduction/Harvest	B, G, C, D	900,000
Chiwawa[5]	Spring Chinook [1]	Wenatchee	NNI/Conservation	C	144,026
Nason[5]	Spring Chinook [1]	Wenatchee	NNI/Conservation	G	223,670
Winthrop[7]	Spring Chinook [2]	Methow	Safety-Net	O	400,000
Leavenworth	Spring Chinook [2]	Wenatchee	Harvest	O	1,200,000
Wells[5]	Steelhead [1]	Columbia	Inundation/Safety-Net	D	160,000
Winthrop[7]	Steelhead [1]	Methow	Conservation	O	100,000-200,000
Wells[5]	Steelhead [1]	Methow	Inundation/Safety-Net	D	100,000
Wells/Omak[5, 6]	Steelhead [1]	Okanogan	NNI/Conservation	G	100,000
Wells[5]	Steelhead [1]	Twisp	Inundation/Conservation	D	40,000
Wells[5]	Steelhead [1]	Twisp	NNI/Conservation	D	8,000
Chiwawa[5]	Steelhead [1]	Wenatchee	NNI/Conservation	C	22,000
Chiwawa[5]	Steelhead [1]	Wenatchee	Inundation/Harvest	C	165,000
Chiwawa[5]	Steelhead [1]	Wenatchee	Species trade	C	60,300
Ringold	Steelhead [9]	Columbia	Harvest	Mitchell Act	180,000
Wells[5]	Summer Chinook [2, 3]	Columbia	Inundation/Harvest	D	484,000
Chief Joseph[7]	Summer Chinook [3]	Okanogan	NNI/Cons./Harvest	B, C, D	700,000
Chelan Falls[5]	Summer Chinook [2]	Chelan	Inundation/Harvest	C	400,000
Chelan Falls[5]	Summer Chinook [2]	Chelan	NNI/Conservation	C	176,000
Wells[5]	Summer Chinook [2]	Columbia	Inundation/Harvest	D	320,000
Entiat	Summer Chinook	Entiat	Harvest	O	400,000
Carlton[5]	Summer Chinook	Methow	NNI/Conservation	G	200,000
Chief Joseph[7]	Summer Chinook	Okanogan	NNI/Cons./Harvest	B, G, C, D	1,300,000
Dryden[5]	Summer Chinook	Wenatchee	NNI/Conservation	C, G	500,000
Priest[5]	Fall Chinook[3]	Columbia	Inundation/Harvest	G	5,000,000
Priest[5]	Fall Chinook[3]	Columbia	NNI/Harvest	G	325,543
Priest[5]	Fall Chinook[4]	Columbia	Fry loss/Harvest	G	273,961
Priest[5, 7]	Fall Chinook[3]	Columbia	Harvest	A	1,700,000
Ringold[7]	Fall Chinook[3]	Columbia	Harvest	A	3,500,000
Yakama Nation	Coho	Wenatchee	Reintroduction/Harvest	B, G, C, D	1,000,000
Yakama Nation[8]	Coho	Methow	Reintroduction/Harvest	B, G, C, D	500,000
Skaha	Sockeye	Okanogan	Reintroduction/Harvest	C, G	≤ 5 M eggs

[1] Species listed under the Endangered Species Act.
[2] Segregated program.
[3] Sub-yearling production.
[4] Fry production.
[5] Program covered by this M&E Plan.
[6] Program also partially covered by CCT M&E Plan.
[7] Program affects PUD-funded programs covered by this plan.
[8] Planned to increase to 1,000,000.
[9] Part of the Mitchell Act suite of mitigation programs under the FCRPS BiOp.

SECTION 2: ADULT PRODUCTIVITY

2.1 Natural Replacement Rates of Supplemented Populations[1]

Objective 1: **Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.**

At the core of a conservation program is the objective of increasing the number of spawning adults (i.e., the combined number of naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural-origin recruits (NOR). In order for the natural population to remain stable or to increase, the Natural Replacement Rate (NRR), or the ratio of NORs to the parent spawning population, must be at a level where parents are being replaced by their offspring as spawners in the next generation. It is possible to affect an increase in natural-origin spawners through supplementation with a stable or decreasing NRR. However, if the NRR is below replacement (NRR<1.0), termination of the supplementation program will result in a declining natural population should that state of NRR persist. The proportion of the hatchery-origin spawners (pHOS) that will increase natural production without creating adverse effects to the genetic diversity or reproductive success rate of the natural population is unknown, and may be dependent on how individual hatchery programs are operated, as well as available spawning and rearing habitat. Some programs restrict pHOS to reduce the risk to the natural population with the intent of optimizing productivity, concomitantly reducing the overall number of spawners. All other objectives of the M&E Plan either directly support this objective or seek to minimize negative effects of the conservation programs on non-target stocks of concern.

Differences in carrying capacities of supplemented and non-supplemented streams can confound the analysis of the effects of supplementation on total number of spawners returning to the streams. For example, if the supplemented population is at carrying capacity and the non-supplemented population is not, the total number of spawners returning to the non-supplemented population may show an increasing trend over time, while the supplemented population would show no increasing trend. To avoid concluding that the supplementation program has no effect or perhaps a negative effect on total spawners, density corrections should be included in the analyses. Hypotheses that may require density corrections are noted under each monitoring question. Appendix 1 describes methods for estimating carrying capacities.

Monitoring Questions:

Q1.1.1 Has the supplementation program changed the adult productivity (NRRs) of the supplemented populations?[2]

Target Species/Populations:

---

[1] Supplementation programs may include a safety-net component.

[2] Because adult productivity is affected by the abundance of the population (i.e., productivity decreases with increasing abundance), the goal of supplementation is to increase or maintain productivity, but not decrease it.

- Q1.1.1 applies to all conservation and safety-net stocks.

Statistical Hypotheses 1.1.1[3]:

- $Ho_{1.1.1.1}$: Slope in NRRs before supplementation ≤ slope in NRRs after supplementation.
- $Ho_{1.1.1.2}$: Differences in slopes in NRRs between supplemented and reference populations before supplementation ≤ differences in slopes in NRRs between supplemented and reference populations after supplementation.
- $Ho_{1.1.1.3}$: Mean NRRs before supplementation ≤ mean NRRs after supplementation.
- $Ho_{1.1.1.4}$: Mean ratio scores in NRRs before supplementation ≤ Mean ratio scores in NRRs during supplementation.
- $Ho_{1.1.1.5}$: Mean ratio scores in NRRs (adjusted for density dependence) before supplementation ≤ Mean ratio scores in NRRs (adjusted for density dependence) during supplementation. [This hypothesis adjusts NRRs for density-dependent effects (see Hillman et al. 2012 for details; Appendix 6).]
- $Ho_{1.1.1.6}$: There is no association between the proportion of hatchery-origin spawners (pHOS) and the residuals from the smooth hockey stick stock-recruitment curve; rho = 0. [If there is a significant negative association between pHOS and the residuals, then hatchery fish may be reducing the productivity of the wild population.]

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds
- Number of naturally produced fish harvested

Derived Variables:

- Number of naturally produced recruits by brood year for both naturally produced parents and hatchery parents (≥age-3).
- NRRs (calculated as NORs/spawner).
- Stock-recruit models, parameters, and residuals.
- Includes ratio scores of NRRs (requires reference population[s]).
- Includes calculation of ratios NORs (requires reference population).
- Appendix 1: Spawning escapement and carrying capacity information (as applicable)

Spatial/Temporal Scale:

- Calculated annually based on brood year.
- Time series.

Possible Statistical Analysis:

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3 Quality and quantity of data will determine which hypotheses are evaluated. See Hillman et al. 2012 (Appendix 6) for details.

- These analyses shall be performed every 5-years. Use graphic analyses, trend analyses, t-tests, Aspin-Welch tests, and randomization tests to evaluate the statistical hypotheses (see Hillman et al. 2012; Appendix 6). The specific analysis used will depend on the availability of reference conditions.
- Correlation analysis will examine associations between hatchery adult composition and NRRs.
- On a five-year period, correlate productivity with extraneous factors such as ocean productivity indices.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.

2.2 Natural-Origin Recruits of Supplemented Populations

Monitoring Questions:

Q1.2.1: Has the supplementation program changed the abundance of NORs within the supplemented population?

Target Species/Populations:

- Q1.2.1 applies to all supplemented or safety net stocks.

Statistical Hypotheses 1.2.1[4]:

- $Ho_{1.2.1.1}$: Slope in NORs[5] before supplementation ≥ slope in NORs after supplementation.
- $Ho_{1.2.1.2}$: Differences in slopes in NORs between supplemented and reference populations before supplementation ≥ differences in slopes in NORs between supplemented and reference populations after supplementation.
- $Ho_{1.2.1.3}$: Mean NORs before supplementation ≥ mean NORs after supplementation.
- $Ho_{1.2.1.4}$: Mean ratio scores in NORs before supplementation ≥ Mean ratio scores in NORs during supplementation.
- $Ho_{1.2.1.5}$: Mean ratio scores in NORs/Maximum Recruitment before supplementation ≥ Mean ratio scores in NORs/Maximum Recruitment during supplementation. [This hypothesis adjusts NORs for the capacity of the habitat; it tests the fraction of the habitat saturated with NORs (see Hillman et al. 2012 for details).]
- $Ho_{1.2.1.6}$: There is no association between the proportion of hatchery-origin spawners (pHOS) and NORs; rho = 0. [If there is a significant negative association between

4 Quality and quantity of data will determine which hypotheses are evaluated. See Hillman et al. 2012 (Appendix 7) for details.

5 "Slope in NORS" refers to abundance of NORs across time (years).

pHOS and NORs, then hatchery fish may be reducing the reproductive success of the wild population.]

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Number of hatchery and naturally produced fish taken for broodstock.
- Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the Columbia).

Derived Variables:

- NORs (number of naturally produced recruits (total recruits) by brood year for both naturally produced parents and hatchery parents [≥age-3]).
- Stock-recruit models, parameters, and residuals.
- Includes ratio scores of NORs (requires reference population[s]).
- Estimates of carrying capacity (see Appendix 1).

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- These analyses shall be performed every 5-years. Use graphic analyses, trend analyses, t-tests, Aspin-Welch tests, and randomization tests to evaluate the statistical hypotheses (see Hillman et al. 2012). The specific analysis used will depend on the availability of reference conditions.
- Correlation analysis will examine associations between hatchery adult composition and NORs.
- On a five-year period, correlate NORs with extraneous factors such as ocean productivity indices.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.

SECTION 3: JUVENILE PRODUCTIVITY

3.1 Freshwater Juvenile Productivity

<u>Objective 2</u>: **Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.**

Out-of-basin effects (e.g., smolt passage through the hydro system, harvest, and ocean productivity, etc.) influence the survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRRs and HRRs) and may mask in-basin effects (e.g., habitat quality, density-dependent mortality, and differential reproductive success of hatchery and naturally produced fish). Therefore, an estimate of freshwater productivity may help inform the performance of hatchery and natural-origin spawners.

The objective of estimating freshwater productivity in the Upper Columbia ESU/DPS is to estimate the survival from egg to a critical juvenile life stage(s) of target stocks. Smolt or juvenile production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that consider all effects.

Differences in the current carrying capacities of supplemented and non-supplemented streams can confound the effects of supplementation on numbers of juveniles per redd. For example, if the supplemented population is at or above carrying capacity and the non-supplemented population is not, numbers of juveniles per redd in the non-supplemented population may be significantly greater than the number of juveniles per redd in the supplemented population. In addition, pHOS may be correlated with overall spawner abundance. In these cases, it is difficult or impossible to separate density-dependent effects from the influence of pHOS on freshwater productivity. To avoid concluding that the supplementation program has no effect or perhaps a negative effect on juveniles per redd, the capacity of the habitats must be included in the analyses. The Supplementary Hypotheses presented below are designed to address the confounding effects of different densities on the analyses.

Monitoring Questions:

Q2.1.1: Has the supplementation program changed the number of juveniles (smolts, parr, and/or emigrants) per redd within the supplemented population?

Q2.2.1: Does the number of juveniles per redd decrease as the proportion of hatchery spawners increases?[6]

Target Species/Populations:

- Both Q2.1.1 and Q2.2.1 apply to all conservation stocks.

Statistical Hypotheses for 2.1.1[7]:

[6] Information is needed to estimate the effects of density dependence on these questions. Consider spatial distribution of redds.

[7] Quality and quantity of data will determine which hypotheses are evaluated. See Hillman et al. (2012) for details.

- $Ho_{2.1.1.1}$: Slope in juveniles/redd before supplementation ≤ slope in juveniles/redd after supplementation.
- $Ho_{2.1.1.2}$: Differences in slopes in juveniles/redd between supplemented and reference populations before supplementation ≤ differences in slopes in juveniles/redd between supplemented and reference populations after supplementation.
- $Ho_{2.1.1.3}$: Mean juveniles/redd before supplementation ≤ mean juveniles/redd after supplementation.
- $Ho_{2.1.1.4}$: Mean ratio scores in juveniles/redd before supplementation ≤ Mean ratio scores in juveniles/redd during supplementation.
- $Ho_{2.1.1.5}$: Mean ratio scores in juveniles/redd (adjusted for density dependence) before supplementation ≤ Mean ratio scores in juveniles/redd (adjusted for density dependence) during supplementation. [This hypothesis adjusts juveniles/redd for density-dependent effects (see Hillman et al. 2012 for details; Appendix 6).]
- $Ho_{2.1.1.6}$: There is no association between the proportion of hatchery-origin spawners (pHOS) and the residuals from the smooth hockey stick stock-recruitment curve; rho = 0. [If there is a significant negative association between pHOS and the residuals, then hatchery fish may be reducing the productivity of the wild population.]

Statistical Hypotheses for 2.2.1:

- $Ho_{2.2.1.1}$: There is no association between the proportion of hatchery-origin spawners (pHOS) and the residuals from the smooth hockey stick stock-recruitment curve; rho = 0. [If there is a significant negative association between pHOS and the residuals, then hatchery fish may be reducing the productivity of the wild population.]
- $Ho_{2.2.1.2}$: The slope between proportion of hatchery spawners and juveniles/redd is ≥ 0.

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Numbers of redds.
- Number of juveniles (smolts, parr [where appropriate], and emigrants).

Derived Variables:

- Number of juveniles per spawner.
- Number of juveniles per redd.
- Carrying capacity (see Appendix 1).

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- These analyses shall be performed every five-years. Use graphic analyses, trend analyses, t-tests, Aspin-Welch tests, and randomization tests to evaluate the statistical hypotheses (see Hillman et al. 2012; Appendix 6). The specific analysis used will depend on the availability of reference conditions.
- Correlation analysis will examine associations between hatchery adult composition and juveniles/redd.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.

SECTION 4: NATURAL ENVIRONMENT MONITORING INDICATORS

4.1 Hatchery Replacement Rates (HRRs)

Objective 3: **Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.**

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish, then the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and agreed upon target values (see Appendix 2), comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved.

Monitoring Questions:

Q3.2.1: Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the adult-to-adult survival rate (NRR) of naturally produced fish?

Q3.2.2: Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the Target Value identified in Appendix 2[8]?

Target Species/Populations:

- Q3.2.1 applies to all conservation stocks.
- Q3.2.2 applies to all stocks.

Statistical Hypothesis 3.2.1:

- $Ho_{3.2.1.1}$: $HRR_{\text{Year x}} \geq NRR_{\text{Year x}}$

Statistical Hypothesis 3.2.2:

- $Ho_{3.2.2.1}$: HRR ≥ Target Value identified in Appendix 2

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Number of hatchery and naturally produced fish harvested.
- Number of hatchery and naturally produced fish collected for broodstock.
- Number of broodstock used by brood year (hatchery and naturally produced fish).

Derived Variables:

- Number of hatchery and naturally produced adults by brood year (≥age-3).

[8] Target values may be adjusted by the hatchery committees.

- HRR (number of returning adults per brood year/broodstock)
- NRR (from Objective 1)
- Appendix 2: HRR targets identified in Appendix 2

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- For Q3.2.1 use graphic analysis and paired-sample quantile tests to compare HRR to NRR
- For Q3.2.2 use graphic analysis and one-sample quantile tests to compare HRR to the target value.
- On a five-year period, correlate HRRs with extraneous factors such as ocean productivity indices.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

4.2 Proportion of Hatchery-Origin Spawners (pHOS or PNI)

<u>Objective 4</u>: **Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.**

Certain hatchery programs have pHOS or PNI targets, while other do not. HGMPs and permits inform the selection of targets, which are identified in Appendix 3.

Monitoring Questions:

Q4.1.1: Is the estimated proportion of hatchery-origin spawners (pHOS) less than or equal to the management target, and/or, is the estimated Percent Natural Influence (PNI) greater than or equal to the management target identified in Appendix 3?

Target Species/Populations:

- Q4.1.1 applies to all conservation and safety-net stocks that have a defined pHOS or PNI target or sliding scale (see Appendix 3).

Statistical Hypothesis 4.1.1:

- $Ho_{4.1.1.1}$: pHOS > target value or $PNI_{\text{Supplemented population}}$ < target value identified in Appendix 3

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds

Derived Variables:

- pHOS or PNI
- Appendix 3: PNI and pHOS targets and sliding scales identified in Appendix 3

Spatial/Temporal Scale:

- Calculate annually.
- Analyzed as time series.

Possible Statistical Analysis:

- Use graphic analysis and summary statistics to compare pHOS or PNI to the target value in Appendix 3.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.

4.3 Run Timing, Spawn Timing, and Spawning Distribution

Objective 5: **Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.**

Strategies for conservation programs typically intend that hatchery and natural-origin fish spawn together and in similar locations. However, in some cases, strategies may differ from this paradigm (e.g., summer Chinook salmon in the Wenatchee and Methow rivers; see Appendix 4). Phenotypic plasticity or selection resulting from the hatchery environment (i.e., domestication) may affect run (migration) timing, spawn timing, and spawning distribution. If conservation programs do not adequately represent the genetic diversity of the natural population, and if phenotypic traits in supplementation fish related to fitness deviate from the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate and/or spawn at different times or are spatially segregated from natural-origin fish may be subject to reduced fitness. Hatchery adults that spawn at different times or locations than natural-origin fish would be reproductively isolated from the natural population. The extent of such isolation, ranging from no isolation to substantial isolation, may be exploited for management purposes in some cases.

Migration Timing

Monitoring Questions:

Q5.1.1: Is the migration timing of hatchery and natural-origin fish from the same age class similar?

Target Species/Populations:

- Q5.1.1 applies to all conservation stocks.

Statistical Hypotheses 5.1.1:

- $Ho_{5.1.1.1}$: Migration timing $_{\text{Hatchery Age X}}$ = Migration timing $_{\text{Naturally produced Age X}}$

- $Ho_{5.1.1.2}$: The cumulative frequency of migration timing of hatchery-origin fish = the cumulative frequency of migration timing of natural-origin fish.
- $Ho_{5.1.1.3}$: The 10th percentile, 50th percentile (mode), 90th percentile, and mean migration timing of hatchery-origin fish = the 10th percentile, 50th percentile (median), 90th percentile, and mean migration timing of natural-origin fish.

Measured Variables:

- Ages of hatchery and natural-origin fish sampled via PIT tags or stock assessment monitoring.
- Time (Julian date) of arrival at mainstem projects and within tributaries (e.g., traps, PIT arrays) with the intent to identify biologically significant differences.

Derived Variables:

- Mean Julian date for a given age class.

Spatial/Temporal Scale:

- Calculate annually based on return year and age class.
- Time series.

Possible Statistical Analysis:

- Use graphic analyses (cumulative frequency polygons), paired t-tests, Aspin-Welch tests, and randomization tests.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Spawn Timing

Monitoring Questions:

Q5.2.1: Is the timing of spawning similar for conservation hatchery and natural-origin fish?

Target Species/Populations:

- Q5.2.1: Applies to all semelparous species and populations supplemented by conservation programs. Steelhead can only be assessed for natural spawning in situations where hatchery and natural-origin fish can be appropriately marked and detected.

Statistical Hypotheses 5.2.1:

- $Ho_{5.2.1.1}$: The cumulative frequency of spawn timing of hatchery-origin fish = the cumulative frequency of spawn timing of natural-origin fish.
- $Ho_{5.2.1.2}$: The 10th percentile, 50th percentile (mode), 90th percentile, and mean spawn timing of hatchery-origin fish = the 10th percentile, 50th percentile (mode), 90th percentile, and mean spawn timing of natural-origin fish.

- $Ho_{5.2.1.3}$: The relationship between elevation and spawn timing of hatchery-origin fish = the relationship between elevation and spawn timing of natural-origin fish.

Measured Variables:

- Time (Julian date) and elevation (m) of hatchery and natural-origin salmon carcasses or marked steelhead detected on spawning grounds within defined reaches.
- Time (Julian date) of ripeness of hatchery and natural-origin steelhead captured for broodstock.

Derived Variables:

- Mean Julian date.

Spatial/Temporal Scale:

- Calculate annually based on return year.
- Time series.

Possible Statistical Analysis:

- Use graphic analyses (cumulative frequency polygons), paired t-tests, Aspin-Welch tests, and randomization tests.
- Use graphic analyses, ANCOVA, and/or regression analysis to assess relationships between elevation and spawn timing.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Spatial Distribution of Redds

Monitoring Questions:

Q5.3.1: Is the distribution of redds similar for conservation hatchery and natural-origin fish?

Q5.3.2: Is the distribution of redds similar to defined management targets (see Appendix 4)?

Target Species/Populations:

- Q5.3.1 applies to all conservation program stocks.
- Q5.3.2 applies only to conservation program stocks with specific spawning distribution targets (Carlton and Dryden summer Chinook programs; Appendix 4).

Statistical Hypothesis 5.3.1:

- $Ho_{5.3.1.1}$: The distribution of hatchery-origin redds (hatchery females) = the distribution of natural-origin redds (natural-origin females).

Statistical Hypothesis 5.3.2:

- $Ho_{5.3.2.1}$: The distribution of hatchery-origin redds (hatchery females) = the target distribution identified in Appendix 4.

Measured Variables:

- Location (GPS coordinate) of female salmon carcasses observed on spawning grounds. The distribution of hatchery and naturally produced steelhead redds may be evaluated if marking or tagging efforts provide reasonable results.

Derived Variables:

- Location of female salmon carcass at the historic reach scale and at the 0.1 km scale.
- Calculate percent overlap in distribution across available spawning habitat or historical reaches.
- Appendix 4: Management targets for spatial distribution of spawners or redds (as applicable).

Spatial/Temporal Scale:

- Calculate annually based on return year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and Yates' Chi-square analysis for both Q5.3.1 and Q5.3.2.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

4.4 Stray Rates

Objective 6: Determine if the recipient stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.

Maintaining locally adapted traits among independent fish populations requires that returning hatchery fish have a high rate of site fidelity to the target population or stream. Hatchery practices (e.g., imprinting on water sources at key life history stages, release methodology, release location, age at return, broodstock used, spawner density, spawning habitat quality and access, and environmental conditions) are the main variables thought to affect stray rates. Regardless of the magnitude of homing of adult returns, if adult hatchery fish do not contribute to the natural population, the program will not meet the basic condition of a supplementation program.

Independent populations are populations that are genetically differentiated from other populations. In some cases, genetic differentiation may be assumed based on phenotypic traits or geographic isolation when molecular genetics analyses are not available. When populations are not independent, straying among them does not pose a risk of genetic homogenization. In addition, stray rates of hatchery-origin fish cannot be expected to be lower than for natural-origin fish. When estimates of stray rates for natural-origin fish are available and if they exceed the 5% among population stray rate or 10% within population stray rate thresholds identified in this plan, analysis and interpretation of stray rates must take into account the concept that hatchery programs may be held to unattainable standards based on the natural stray rate. Current criteria established by the ICBTRT (2005) and the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (2007) indicate that fish that do stray to other non-target populations should not comprise greater than 5% of the non-target spawning population. Likewise, fish that stray into non-target spawning areas within an independent population should not comprise greater than 10% of the non-target spawning aggregate (see Tables 6.1 and 6.2).

This plan identifies three stray rate metrics; brood-year stray rate, among population return-year stray rate, and within population return-year stray rate. The return-year stray rates have specific targets that are from the ICBTRT (2005) and Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (2007), and are linked to extinction risk. That is, hatchery strays from other populations cannot make up more than 5% of the spawning escapement within a non-target, recipient population. In addition, hatchery strays from other spawning aggregations within a population (e.g., Chiwawa spring Chinook) cannot make up more than 10% of the spawning escapement within a non-target, recipient spawning aggregate (e.g., White River). Brood-year stray rate, on the other hand, is not discussed in the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (2007) or ICBTRT (2005) and therefore has no specific target. Nevertheless, it is important to track brood-year stray rates to determine if hatchery operations affect the homing and straying of specific brood years. These data support the return-year stray metrics and are used to inform possible changes in genetic variation among stocks.

Brood-Year Stray Rates

Monitoring Questions:

Q6.1.1: What is the brood-year stray rate of hatchery fish?

Target Species/Populations:

- Q6.1.1 applies to all hatchery stocks.

Statistical Hypothesis 6.1.1:

- $Ho_{6.1.1.1}$: None.

Measured Variables:

- Number of hatchery carcasses found in non-target and target spawning areas or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas.
- Number of hatchery fish collected for broodstock.
- Number of hatchery fish taken in fishery.
- Locations of live and dead strays (used to tease out overshoot).

Derived Variables:

- Total number of hatchery carcasses and take in fishery estimated from expansion analysis.
- Percent of the total brood return that strays.

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphical analysis to track brood-year stray rates over time.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.

Among-Population Return-Year Stray Rates

Monitoring Questions:

Q6.2.1: Do hatchery strays make up less than 5% of the spawning escapement within their non-target independent populations?

Target Species/Populations:

- Q6.2.1 applies to all hatchery stocks.

Statistical Hypothesis 6.2.1:

- $Ho_{6.2.1.1}$: Stray hatchery fish make up ≥ 5% of the spawning escapement (based on run year) within other independent populations [9]

Measured Variables:

- Number of hatchery carcasses (PIT-tagged steelhead) found in non-target and target spawning areas or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas.

Derived Variables:

- Total number of hatchery salmon carcasses (PIT-tagged steelhead, spawners counted at weirs) estimated from expansion analysis.
- Percent of the non-target population that is made up of hatchery strays.

Spatial/Temporal Scale:

- Calculate annually based on return year.
- Time series.

Possible Statistical Analysis:

[9] This stray rate is suggested based on a literature review and recommendations by the ICBTRT (2005) and is identified in the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (2007). It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the HCP HC and PRCC HSC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

- Use graphical analysis and one-sample quantile tests to compare the estimated stray rate with the target (5%) stray rate.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Within-Population Return-Year Stray Rates

Monitoring Questions:

Q6.3.1: Do hatchery strays make up less than 10% of the spawning aggregate within non-target spawning areas within the target population?

Target Species/Populations:

- Q6.3.1 applies to all hatchery stocks.

Statistical Hypothesis 6.3.1:

- $Ho_{6.3.1}$: Stray hatchery fish make up ≥ 10% of spawning escapement (based on run year) within non-target spawning areas within the target population

Measured Variables:

- Number of hatchery carcasses (possibly PIT-tagged steelhead) found in non-target and target spawning aggregates or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas.

Derived Variables:

- Total number of hatchery salmon carcasses (possibly PIT-tagged steelhead or spawners counted at weirs) estimated from expansion analysis.
- Percent of the non-target spawning aggregate that is made up of hatchery strays.

Spatial/Temporal Scale:

- Calculate annually based on return year.
- Time series.

Possible Statistical Analysis:

- Use graphical analysis and one-sample quantile tests to compare the estimated stray rate with the target (10%) stray rate.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

4.5 Population Genetics

Objective 7: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the conservation and safety-net hatchery programs and assess genetic changes of hatchery-origin returns.

The genetic component of the M&E Plan specifically addresses the potential for changes in genetic diversity in natural populations as a result of safety-net and conservation hatchery programs. The long-term fitness of populations is assumed to be related to maintaining the genetic diversity of natural populations. However, hatchery programs select a subset of individuals from the population to pass on genetic material to the next generation. This is often a relatively small number of individuals that produce a large number of offspring and can result in changes in allele frequencies and reductions of effective population size. Therefore, it is important to monitor the genetic status of the natural populations to determine if there are signs of changes in genetic distance among populations, changes in allele frequencies, linkage disequilibrium, and to estimate effective population size. Assessing the genetic effects of the hatchery program on natural populations does not require annual sampling but does require regular sampling at generational time scales. Additionally, genetic status of hatchery-origin returns should be monitored to further evaluate potential genetic risks to the natural population. Beginning with brood years 2017 and 2018 (and then at subsequent ten year intervals), testing statistical hypotheses associated with genetic components (Hypotheses 7.1.1, 7.2.1, 7.3.1, and 7.4.1) will be conducted with natural-origin baseline samples (the earliest genetic samples available for each program), natural-origin contemporary samples, and hatchery-origin contemporary samples.

Alternatively, genetic divergence between the hatchery-origin population and natural-origin population is expected with segregated programs. Monitoring of genetic risks associated with utilizing multi-generations of hatchery-origin broodstock is important. Beginning with brood years 2017 and 2018 (and then at subsequent ten-year intervals), testing statistical hypotheses associated with genetic components (Hypotheses 7.1.2 and 7.2.2) will be conducted with hatchery-origin baseline samples (the earliest genetic samples available for each program) and hatchery-origin contemporary samples.

An alternative analysis to statistical hypotheses testing is equivalence testing, which requires determination of biologically relevant effects. To date, biologically relevant effects for measured differences in genetic metrics have not been determined; when they are determined, equivalence testing will also be conducted.

Allele Frequency

Monitoring Questions:

Q7.1.1: Is the contemporary allele frequency of natural-origin fish and hatchery-origin fish similar to the baseline allele frequency of natural-origin fish over time?

Q7.1.2: Is the contemporary allele frequency of hatchery-origin broodstock similar to the baseline allele frequency of hatchery-origin broodstock over time?

Target Species/Populations:

- Q7.1.1 Applies to all conservation and safety net programs. .

- Q7.1.2 Applies to all segregated programs.

Statistical Hypotheses 7.1.1 and 7.1.2:

- $Ho_{7.1.1.1}$: Allele frequency natural-origin$_{t=baseline}$ = Allele frequency natural-origin$_{t=contemporary}$ = Allele frequency hatchery-origin$_{t=contemporary}$
- $Ha_{7.1.1.1}$: Allele frequency natural-origin$_{t=baseline}$ ≠ Allele frequency natural-origin$_{t=contemporary}$ ≠ Allele frequency hatchery-origin$_{t=contemporary}$
- $Ho_{7.1.1.2}$: Allele frequency hatchery-origin$_{t=baseline}$ = Allele frequency hatchery-origin$_{t=contemporary}$
- $Ha_{7.1.1.2}$: Allele frequency hatchery-origin$_{t=baseline}$ ≠ Allele frequency hatchery-origin$_{t=contemporary}$

Measured Variables:

- SNP genotypes

Derived Variables:

- Allele frequency

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing contemporary samples to baseline samples, and then at a ten-year frequency.
- Compare conservation and safety-net program samples within subpopulations (when applicable), populations, and the upper Columbia.

Possible Statistical Analysis:

- Population differentiation tests, analysis of molecular variance (AMOVA), relative genetic distances, or suitable equivalence tests.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Linkage Disequilibrium

Monitoring Questions:

Q7.2.1.: Is contemporary linkage disequilibrium (LD) of natural-origin and hatchery-origin fish similar to the baseline LD of natural-origin fish over time?

Q7.2.2.: Is contemporary linkage disequilibrium (LD) of hatchery-origin broodstock similar to the baseline LD of hatchery-origin broodstock over time?

Target Species/Populations:

- Q7.2.1 Applies to all safety-net and conservation programs.

- Q7.2.2 Applies to all segregated programs.

Statistical Hypotheses 7.2.1 and 7.2.2:

- $Ho_{7.2.1.1}$: LD natural-origin$_{t=baseline}$=LD natural-origin$_{t=contemporary}$ = LD hatchery-origint=contemporary
- $Ha_{7.2.1.1}$: LD natural-origin$_{t=baseline}$ ≠ LD natural-origin$_{t=contemporary}$ ≠ LD hatchery-origin$_{t=contemporary}$
- $Ho_{7.2.1.2}$: LD hatchery-origin$_{t=baseline}$ = LD hatchery-origin$_{t=contemporary}$
- $Ha_{7.2.1.2}$: LD hatchery-origin$_{t=baseline}$ ≠ LD hatchery-origin$_{t=contemporary}$

Measured Variables:

- SNP genotypes

Derived Variables:

- Pairwise by locus tests of LD
- Counts or percentages of pairwise tests with statistically significant LD before and after correction for multiple tests

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing contemporary samples to baseline samples, and then at a ten year frequency.
- Compare conservation and safety-net program samples within subpopulations (when applicable), populations, and the upper Columbia.

Possible Statistical Analysis:

- Probability testing for pairwise by locus LD, Chi-squared tests, Wilcoxon signed rank test, or suitable equivalence tests.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Genetic Distance Between Subpopulations and Populations

Monitoring Questions:

Q7.3.1: Does the genetic distance among supplemented subpopulations (where applicable) and populations remain the same over time?

Target Species/Populations:

- Q7.3.1 applies to all safety-net and conservation programs.

Statistical Hypothesis 7.3.1:

- $Ho_{7.3.1.1}$: Genetic distance between sub-populations$_{Year\ t=contemporary}$ = Genetic distance between subpopulations$_{Year\ t=baseline}$

- $Ho_{7.3.1.1}$: Genetic distance between $populations_{Year\ t=contemporary} \neq$ Genetic distance between $populations_{Year\ t=baseline}$

Measured Variables:

- SNP genotypes

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Analyze comparing contemporary samples to baseline samples.
- Compare samples between sub-populations (where applicable) and populations.

Possible Statistical Analysis:

- Population differentiation tests, AMOVA, relative genetic distances, or suitable equivalence tests.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Effective Spawning Population

Monitoring Questions:

Q7.4.1: Is the ratio of effective population size (N_e) to spawning population size (N) constant or increasing over time?

Target Species/Populations:

- Q7.4.1 applies to all programs.

Statistical Hypothesis 3.3:

- $Ho_{7.4.1.1}$: $(N_e/N)_{t=contemporary} \geq (N_e/N)_{t=baseline}$ for each population.
- $Ha_{7.4.1.1}$: $(N_e/N)_{t=contemporary} < (N_e/N)_{t=baseline}$ for each population.

Measured Variables:

- SNP genotypes and estimates of N

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Compare contemporary samples to baseline samples.

Possible Statistical Analysis:

- Statistics to calculate effective population size (e.g., harmonic means), Wilcoxon signed rank tests, or suitable equivalence tests.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

4.6 Phenotypic Traits

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components.[10] Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location, and stray rates) is addressed under Objective 5. Objective 8 assess the potential effects of domestication, including size at maturity, age at maturity, sex ratio, and fecundity. Age and size at maturity shall be assessed for both fish arriving in the Columbia system, and those recovered on the spawning grounds. Size (or age) selective mortality during migration through the Columbia system, such as through fisheries, could alter the age and size of fish on the spawning grounds.

Age at Maturity

Monitoring Questions:

Q8.1.1: Is the age at maturity of hatchery and natural-origin fish similar at the time they enter the Columbia River and when they spawn?

Target Species/Populations:

- Q8.1.1 applies to all conservation program stocks.

Statistical Hypotheses 8.1.1:

- $Ho_{8.1.1.1}$: Age at Maturity $_{\text{Hatchery produced spawners Gender X}}$ = Age at Maturity $_{\text{Naturally produced spawners Gender X}}$
- $Ho_{8.1.1.2}$: Age at Maturity $_{\text{All hatchery produced adults Gender X}}$ = Age at Maturity $_{\text{All naturally produced adults Gender X}}$

Measured Variables:

- Total and salt (ocean) age of hatchery and natural-origin salmon carcasses collected on spawning grounds.
- Total and salt age of broodstock.
- Total and salt age of fish at stock assessment locations (e.g., Dryden, Tumwater, Wells, Priest Rapids).

[10] These metrics are difficult to measure, and phenotypic expression of these traits may be all we can measure and evaluate.

- Whenever possible, age at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).
- Assess age of fish, including harvested fish.

Derived Variables:

- Total age and saltwater age
- Age of fish entering the Columbia River.

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and Yates' Chi-square.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Size at Maturity

Monitoring Questions:

Q8.2.1: Is the size (length) at maturity of a given age and sex of hatchery fish similar to the size at maturity of a given age and sex of natural-origin fish?

Target Species/Populations:

- Q8.2.1 applies to all conservation and safety-net stocks.

Statistical Hypothesis 8.2.1:

- $Ho_{8.2.1.1}$: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$
- $Ho_{8.2.1.2}$: Size (length) at Maturity $_{\text{All hatchery adults Gender X}}$ = Size (length) at Maturity $_{\text{All naturally produced adults Gender X}}$

Measured Variables:

- Size (length), age, and gender of hatchery and natural-origin salmon carcasses collected on spawning grounds.
- Size (length), age, and gender of broodstock.
- Size (length), age, and gender of fish at stock assessment locations (e.g., Priest Rapids, Dryden, Tumwater, Wells, Twisp Weir).

- Whenever possible, size at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).

Derived Variables:

- Total age and saltwater age

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and three-way ANOVA by origin, gender, and age

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Fecundity at Size[11]

Monitoring Questions:

Q8.3.1: Is the fecundity vs. size relationship of hatchery and natural-origin fish similar?

Q8.3.2: Is the gonadal mass vs. size relationship of hatchery and natural-origin fish similar?

Target Species/Populations:

- Both Q8.3.1 and Q8.3.2 apply to all conservation stocks using both natural- and hatchery-origin broodstock.

Statistical Hypothesis 8.3.1:

- $Ho_{8.3.1.1}$: Slope of Fecundity vs. Size $_{Hatchery}$ = Slope of Fecundity vs. Size $_{Naturally\ produced}$

Statistical Hypothesis 8.3.2:

- $Ho_{8.3.2.1}$: Gonadal Mass vs. Size $_{Hatchery}$ = Gonadal Mass vs. Size $_{Naturally\ produced}$

Measured Variables:

- Length, weight, and age (covariate) of hatchery and natural-origin broodstock after eggs have been removed.
- Number and weight of eggs

Derived Variables:

- Total age and saltwater age.

[11] May not apply to all programs.

- Mean weight per egg.

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis, regression, t-test, and ANCOVA.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Sex Ratio

Monitoring Questions:

Q8.4.1: Is the sex ratio of hatchery and natural-origin fish similar?

Target Species/Populations:

- Q8.4.1 applies to all conservation stocks.

Statistical Hypothesis 8.4.1:

- $Ho_{8.4.1.1}$: Sex Ratio $_{\text{Hatchery}}$ = Sex Ratio $_{\text{Naturally produced}}$

Measured Variables:

- Age and sex of hatchery and natural-origin salmon carcasses collected on spawning grounds or sampled at dams or weirs.
- Whenever possible sex ratio will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling or ultrasound on live fish).

Derived Variables:

- Ratio of sexes based on brood year returns

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and Yates'Chi-square.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

SECTION 5: HATCHERY ENVIRONMENT MONITORING INDICATORS

5.1 Release Targets

Objective 9: Determine if hatchery fish were released at the programmed size and number.

The HCP outlines the number and size of fish that are to be released to meet NNI and inundation compensation levels. The size of the fish at release may be altered according to an adaptive management process in the Hatchery Committee(s), and the number of fish can be altered by survival study results and adjustment of hatchery production for population dynamics. Size of fish at release can affect survival, sex ratios, age at return, stray rate, and fecundity. In addition, the variation in size at release may affect performance of the fish.

The coefficient of variation (CV) will be evaluated to ascertain if program performance is related to variation in size at release. Note also that variation in a population is a natural condition and striving to control this variation could result in directional or stabilizing artificial selection that could have unforeseen long-term consequences. Attaining uniform or multi-modal growth in a hatchery environment may not be adaptive for fitness in the wild. Therefore, pursuit of a CV target should be seen as an informative exercise, but is not in itself indicative of success or failure of a hatchery program. Furthermore, growth regimes may prove to be important in affecting adult returns and age structure. Although many factors can influence both the size and number of fish released, past hatchery cultural experience with these stocks should assist in meeting program production levels. Appendix 5 presents the target size at release and CVs for the programs. These targets shall be assessed annually to ensure they are optimized to inform management decisions.

Size at Release of Hatchery Fish

Monitoring Questions:

Q9.1.1: Is the size (fish per pound; fpp) of hatchery fish released equal to the program goal identified in Appendix 5?

Target Species/Populations:

- Q9.1.1 applies to all hatchery stocks.

Statistical Hypothesis 9.1.1:

- $Ho_{9.1.1.1}$: Hatchery fish $_{\text{fpp at release}}$ = Programmed $_{\text{fpp at release}}$ (see Appendix 5)

Measured Variables:

- Fork length and weights of random samples of hatchery juveniles at release.

Derived Variables:

- Mean length (FL), mean weight, and fish per pound
- Appendix 5: Rearing targets

Spatial/Temporal Scale:

- Calculate annually.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and descriptive statistics to compare the estimated fpp of hatchery fish at time of release with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.

Coefficient of Variation (CV) of Hatchery Fish Released

Monitoring Questions:

Q9.2.1: Is the CV of hatchery fish released equal to the program target identified in Appendix 5?

Target Species/Populations:

- Q9.2.1 applies to all hatchery stocks.

Statistical Hypothesis 9.2.1:

- $Ho_{9.2.1.1}$: Hatchery fish $CV_{\text{at release}}$ = Programmed CV in Appendix 5

Measured Variables:

- Length and weights of random samples of hatchery smolts.

Derived Variables:

- Coefficient of Variation: $cv = (1 + 1/4n) \times (s/x)$ (where s = standard deviation, x = estimated mean, n = sample size)
- Appendix 5: Rearing targets

Spatial/Temporal Scale:

- Calculate annually.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and descriptive statistics to compare the estimated CV of size of hatchery fish released with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.

Condition Factor (K) of Hatchery Fish Released

Monitoring Questions:

Q9.3.1: Is the K of hatchery fish released equal to the program target identified in Appendix 5?

Target Species/Populations:

- Q9.3.1 applies to all hatchery stocks.

Statistical Hypothesis 9.3.1:

- $Ho_{9.3.1.1}$: Hatchery fish $K_{\text{at release}}$ = Programmed K identified in Appendix 5

Measured Variables:

- Monthly individual lengths and weights of random samples of hatchery juveniles.

Derived Variables:

- Condition Factor: $K = W/L^3 \times 10^5$

Spatial/Temporal Scale:

- Calculate annually.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and descriptive statistics to compare the estimated K of released hatchery fish with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Number of Hatchery Fish Released

Monitoring Questions:

Q9.4.1: Is the number of hatchery fish released equal to the program goal identified in Appendix 5?

Target Species/Populations:

- Q9.4.1 applies to all hatchery stocks.

Statistical Hypothesis 9.4.1:

- $Ho_{9.4.1.1}$: Hatchery Fish Number = Programmed Number identified in Appendix 5

Measured Variables:

- Numbers of smolts released from the hatchery.

Derived Variables:

- Appendix 5: Rearing targets

Spatial/Temporal Scale:

- Calculate annually.

- Time series.

Possible Statistical Analysis:

- Use graphic analysis and one-sample quantile tests to compare the estimated number of hatchery fish released with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

SECTION 6: HARVEST MONITORING INDICATORS

6.1 Harvest Rates

<u>Objective 10</u>: **Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations.**

Harvest will be applied to different types of programs in an effort to achieve the management objectives of those programs. Programs designed to augment harvest should routinely contribute to harvest at a rate that greatly reduces the incidence of straying to natural spawning grounds, but also allows the program to be sustained. Safety-net programs may be harvested as part of an adult management strategy to minimize excessive escapement of hatchery-origin fish to spawning grounds. Similarly, conservation programs may undergo harvest to manage returning adults, but the emphasis for these programs should be to achieve escapement goals. In all cases, harvest effort should not have the unintended consequence of removing excessive numbers of conservation or natural-origin fish. In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or brood stock requirements), surplus fish may be available for harvest. The M&E Plan specifically addresses harvest and harvest opportunities upstream of Priest Rapids Dam. Harvest or removal of surplus hatchery fish from the spawning grounds may assist in reducing potential adverse ecological and genetic impacts to natural populations (e.g., loss of genetic variation within and between populations, loss of fitness, reduced effective population size, and density-dependent effects).

Monitoring Questions:

Q10.1.1: Conservation Programs: Is the harvest on conservation hatchery fish at an appropriate level to manage natural spawning of conservation hatchery fish but low enough to sustain the hatchery program?

Q10.1.2: Safety-Net Programs: Is the harvest on conservation hatchery fish at an appropriate level to manage natural spawning of safety-net hatchery fish but low enough to sustain the hatchery program?

Q10.1.3: Is the harvest on hatchery fish produced from harvest-augmentation programs high enough to manage natural spawning but low enough to sustain the hatchery program?

Q10.1.4: Is the escapement of fish from conservation and safety-net programs in excess of broodstock and natural production[12] needs to provide opportunities for terminal harvest?

Target Species/Populations:

- Q10.1.1 applies to conservation programs.
- Q10.1.2 applies to safety-net programs.

[12] The current best estimates of carrying capacity (maximum recruits) will be used, as available.

- Q10.1.3 applies harvest augmentation programs.
- Q10.1.4 applies to conservation and safety-net programs.

Statistical Hypothesis 10.1.1:

- $Ho_{10.1.1.1}$: Harvest rate ≤ Maximum level to meet program goals

Statistical Hypothesis 10.1.2:

- $Ho_{10.1.2.1}$: Harvest rate ≤ Maximum level to meet program goals

Statistical Hypothesis 10.1.3:

- $Ho_{10.1.3.1}$: Escapement ≤ Maximum level to meet supplementation goals

Statistical Hypothesis 10.1.4:

- $Ho_{10.1.4.1}$: Harvest rate ≤ Maximum level to meet program goals

Measured Variables:

- Numbers of hatchery fish taken in harvest.
- Numbers of natural-origin fish taken in harvest.

Derived Variables:

- Total harvest by fishery estimated from expansion analysis.

Spatial/Temporal Scale:

- Calculated annually.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and one-sample quantile tests to compare the estimated harvest of hatchery fish with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

SECTION 7: REGIONAL OBJECTIVES

Hatchery programs have the potential to increase diseases that typically occur at low levels in the natural environment (Objective 9). In addition, hatchery fish can reduce the abundance, size, or distribution of non-target taxa through ecological interactions (Objective 10). In this section, we address incidence of disease and non-target taxa of concern.

7.1 Incidence of Disease

Objective 11: Determine if the incidence of disease has increased in the natural and hatchery populations.

The hatchery environment has the potential to amplify diseases that are typically found at low levels in the natural environment. Amplification could occur within the hatchery population (i.e., vertical and horizontal transmission) or indirectly from the hatchery effluent or commingling between infected and non-infected fish (i.e., horizontal transmission). Potential impacts to natural populations have not been extensively studied, but should be considered for programs in which the hatchery fish are expected to commingle with natural fish. This is particularly important for supplementation type programs. Specifically, the causative agent of bacterial kidney disease (BKD), *Renibacterium salmoninarum* (Rs), could be monitored at selected acclimation ponds, both in the water and fish, in which the risk and potential for transmission from the hatchery is highest. Although it is technologically possible to measure the amount of Rs in water or Rs DNA in smolts and adults non-lethally sampled, the biological meaning of these data are uncertain. Currently, the only metric available for M & E purposes is measuring the antigen level from kidney/spleen samples (i.e., ELISA, PCR). When available, non-lethal sampling may replace or be used in concert with lethal sampling.

Implementation of this objective will be conducted in a coordinated approach within the hatchery and natural environment. BKD management within the hatchery population (e.g., broodstock or juveniles) has the potential to reduce the prevalence of disease through various actions (e.g., culling or reduced rearing densities). BKD management must also take into account and support other relevant objectives of the M & E program (e.g., Hatchery Return Rate [HRR], number of smolts released). Hence, the goal of BKD management is to decrease the prevalence of disease and maintain hatchery production objectives (i.e., number and HRR).

As previously discussed, disease transmission from hatchery to naturally produced fish may occur at various life stages and locations. Of these, horizontal transmission from hatchery effluent, vertical transmission on the spawning grounds, and horizontal transmission in the migration corridor have been identified as disease interactions that could be examined under this objective, although others may also be relevant. Experimental designs addressing this objective may require technology not yet available, although in some instances samples may be collected, but not analyzed until a link can be established between bacteria levels in samples and disease prevalence.

Developing a complete set of questions and hypotheses statements for this objective may not be practical at this time, because there is currently no BKD Management Plan. However, while developing experimental designs for this objective, it may be feasible to incorporate both hatchery and natural environment monitoring under a single study design. Integration of the different aspects of the objective would likely result in a more robust approach into understanding the effectiveness of disease management strategies.

Proposed Tasks:

T1: Assemble fish health data for fish used as brood (e.g., ELISA results).

T2: Conduct data exploration exercise to identify potential relationships between pathogen profiles and likely causative variables (e.g., rearing conditions and management actions).

T3: Develop hypotheses for potential testing to meet objective.

7.2 Non-Target Taxa of Concern (NTTOC)

<u>Objective 12</u>: Determine if the release of hatchery fish affects non-target taxa of concern (NTTOC) within acceptable limits.

Hatchery programs have the potential to affect non-target taxa through various types of interactions (e.g., competition and predation). These interactions can reduce the distribution, size, and abundance of non-target species. The non-target taxa of concern (NTTOC) ecological risk assessment was developed as a regional objective that would addressed ecological interactions on non-target taxa.

In 2008, the Wells HCP, Rocky Reach HCP, Rock Island HCP Hatchery Committees, and the Priest Rapids Hatchery Sub-Committee agreed to an approach to evaluate the potential effects of hatchery programs on NTTOC. The committees originally planned to convene a panel of experts to conduct a preliminary evaluation of the potential effects of Plan supplemented species on NTTOC. At the 15 October 2008 Hatchery Committees meeting, the members agreed to convene an expert panel to conduct a preliminary evaluation of potential effects of supplemented Plan Species on non-target taxa using an approach similar to that used in the Yakima Basin (Pearsons and Hopley 1999; Ham and Pearsons, 2001). The Committees agreed to convene the panel in spring or early summer 2009, and focus this initial effort on HCP Plan Species and the two non-Plan Species, westslope cutthroat trout and lamprey. The Committees identified species interactions, containment objectives for non-target species, and fisheries professionals who possessed the expertise to contribute as panel members. The Committees directed the Hatchery Evaluation Technical Team (HETT) to pursue assessment of the hatchery programs potential effects on NTTOC.

The HETT evaluated methods to conduct a risk assessment on NTTOC, and proposed using a combined modeling and a Delphi panel approach, whereby the modeling results would be compared and correlated with the Delphi panel results. The HETT identified the PCD Risk 1 model (Busack et al., 2005; Pearsons and Busack, 2012) to conduct the modeling evaluation. The PCD Risk 1 model is a data intensive, individual-based stochastic model. The HETT determined that the assembled data to be used as inputs for the PCD Risk 1 model would also serve to provide expert panelists the necessary data for them to conduct risk assessments. Hence, the HETT embarked on an extensive effort to gather, organize, and extract the required data from existing datasets, literature, and biologists familiar with the programs and/or particular NTTOC. Ultimately, the input data were assembled in a relational database that allowed the data to be output in user-friendly formats for modeling or Delphi panel use. The database also served to hold the modeling results, which could be extracted and summarized as needed. Following the modeling work, the Committees decided not to assemble the expert panel, because the panel would not be able to evaluate adequately the very large number of possible interactions.

A report titled *Ecological Risk Assessment of Upper-Columbia Hatchery Programs on Non-Target Taxa of Concern* was drafted in 2013 and finalized in 2014, which included the modeling results to date. The results in the report represent a very extensive effort to model the risk of all the upper Columbia hatchery programs for the identified NTTOC for which data and model runs were available. Should new information become available, the Committees agreed to assess the suitability of the data as it relates to conducting future NTTOC evaluations as a regional objective.

SECTION 8: ADAPTIVE MANAGEMENT

One of the challenges of evaluating PUD hatchery programs is that hatchery programs are modified resulting in hatchery treatments that are uneven throughout the duration of the hatchery program. Modifications occur as a result of recalculating hatchery release numbers every 10 years and also through adaptive management. To solve this evaluation challenge, we propose to conduct two scales of analysis. First, the entire duration of the program will be analyzed using the entire data set. This evaluation will analyze whether the overall adaptively managed program achieved objectives. Second, where appropriate, analyses will be compared across periods or programs to determine if major program changes have resulted in hypothesized changes to key response variables. We acknowledged that partitioning data into shorter periods will likely result in reduced statistical power so only the biggest changes will be evaluated. In the future, the hatchery committees will develop a table or figure that identifies major program changes in fish culture or M&E.

In the past, hatchery programs have been evaluated at the hatchery program scale (e.g., Nason Creek, Carlton summer Chinook). In some cases, it may be worthwhile to evaluate supplementation programs at different spatial scales. For example, the Nason Creek spring Chinook salmon program can be evaluated at the scale of Nason Creek, the combined effects of spring Chinook hatchery programs in the Wenatchee basin at the Wenatchee basin scale, and then all of the spring Chinook programs in the upper Columbia at the upper Columbia basin scale.

Comparisons of supplemented populations (treatments) to in-basin reference populations are the best way to evaluate whether treatments have caused changes to variables such as natural-origin recruits or productivity. Many suitable out-of-basin references are available (see Appendix 6), but these references do not control for unique factors that may be happening in the upper Columbia or areas outside the upper Columbia. For example, large fires that occur in the Upper Columbia may not occur at similar times in areas outside of this area. Candidate in-basin reference populations are not ideal for spring Chinook salmon because they are small and are above a lake (e.g., Little Wenatchee River) or they have had a long history of hatchery stocking (e.g., Entiat River). Every population of upper Columbia summer and fall Chinook is supplemented so in-basin references are not currently available. Without a suitable number of in-basin reference populations that are similar in size and distribution to treated populations, it will be difficult to unambiguously assess hatchery effects on certain variables. Although not ideal, the only way to increase in-basin reference comparisons is to strategically reduce the number of places where hatchery fish are released such as was done for the Entiat River.

Previous stocking history will lessen the value of reference populations; however, they can still be of value. For instance, the Committees can still test whether NORs are increased under supplementation compared to periods when other populations are not supplemented (i.e., a reverse BACI analysis).

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SECTION 10: GLOSSARY

Adult-to-Adult survival (Ratio)	The number of parent broodstock relative to the number of returning adults.
Age at maturity	The age of fish at the time of spawning (hatchery or naturally).
Augmentation	A hatchery strategy where fish are released for the sole purpose of providing harvest opportunities.
Broodstock	Adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.
Donor population	The source population for supplementation programs before hatchery fish spawned naturally.
Effective population size (Ne)	The number of reproducing individuals in an ideal population (i.e., Ne = N) that would lose genetic variation due to genetic drift or inbreeding at the same rate as the number of reproducing adults in the real population under consideration (Hallerman 2003).
ESA	Endangered Species Act passed in 1973. The ESA-listed species refers to fish species added to the ESA list of endangered or threatened species and are covered by the ESA.
Expected value	The number of smolts or adults derived from survival rates agreed to in the Biological Assessment and Management Plan (BAMP 1998).
Extraction rate	The proportion of the spawning population collected for broodstock.
Genetic diversity	All the genetic variation within a species of interest, including both within and between population components.
Genetic stock structure	A type of assortative mating, in which the gene pool of a species is composed of a group of subpopulations, or stocks, that mate panmictically within themselves.
Genetic variation	All the variation due to different alleles and genes in an individual, population, or species.
HCP	Habitat Conservation Plan is a plan that enables an individual or organization to obtain a Section 10 Permit which outlines what will be done to "minimize and mitigate" the impact of the permitted take on a listed species.

HCP-HC	Habitat Conservation Plan Hatchery Committee is the committee that directs actions under the hatchery program section of the HCP's for Chelan and Douglas PUDs.
HRR	Hatchery Replacement Rate is the ratio of the number of returning hatchery adults relative to the number of adults taken as broodstock, both hatchery and naturally produced fish (i.e., adult-to-adult replacement rate).
Long-term fitness	Long-term fitness is the ability of a population to self-perpetuate over successive generation.
Naturally produced	Progeny of fish that spawned in the natural environment, regardless of the origin of the parents.
Mean Ratio	The ratio between a treatment and control population, with the mean taken across a time period, such as years. Used in analysis in Before-After-Control-Impact studies.
Ne	Effective population size.
Non-target taxa of concern (NTTOC)	Species, stocks, or components of a stock with high value (e.g., stewardship or utilization) that may suffer negative effects because of a hatchery program.
NRR	Natural replacement rate is the ratio of the number of returning naturally produced adults relative to the number of adults that naturally spawned, both hatchery and naturally produced.
NTTOC	Non-target taxa of concern.
pHOS	Proportion of Hatchery Origin Spawners.
PNI	Proportionate Natural Influence.
pNOB	Proportion of Natural Origin Broodstock.
PRCC HSC	Priest Rapids Coordinating Committee Hatchery Subcommittee.
Productivity	The capacity in which juvenile fish or adults can be produced.
Reference population	A population in which no directed artificial propagation is currently directed, although may have occurred in the past. Reference populations are used to monitor the natural variability in survival rates and out of basin impacts on survival.
Smolt-to-adult survival rate (SAR)	Smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population.
Segregated	A type of hatchery program in which returning adults are spatially or temporally isolated from other populations.

Size at maturity	The length or weight of a fish at a point in time during the year in which spawning will occur.
Smolts per redd	The total number of smolts produced from a stream divided by the total number of redds from which they were produced.
SNP or single-nucleotide polymorphism	A single-nucleotide polymorphism is a variation in a single nucleotide that occurs at a specific position in the genome, where each variation is present to some appreciable degree within a population.
Spawning Escapement	The number of adult fish that survive to spawn.
Stray rate	The rate at which fish spawn outside of natal rivers or the stream in which they were released.
Supplementation	A hatchery strategy where the main purpose is to increase the relative abundance of natural spawning fish without reducing the long-term fitness of the population.
Target population	A specific population in which management actions are directed (e.g., artificial propagation, harvest, or conservation).

APPENDIX 1: ESTIMATION OF CARRYING CAPACITY

In the ecological literature, carrying capacity is often defined as the maximum population size that can be supported indefinitely by the environment (Cain et al. 2014). Said another way, carrying capacity is the maximum number or biomass of a species that a given habitat can support. This maximal environment load is often referred to as "habitat capacity" and is identified with the letter "C." In contrast, the carrying capacity parameter "K" in population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the Ricker model) defines a maximum equilibrium population size. Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. Maximum equilibrium population size is often referred to as "population capacity." The two capacities (habitat capacity and population capacity) are related but not identical and therefore should not be confused. Habitat capacity will usually be greater than population capacity.

Estimation of carrying capacity is important because hatchery managers use it to inform supplementation programs, harvest managers use it to set appropriate harvest and escapement levels, modelers use it in life-cycle models to predict the effects of different recovery scenarios, and restoration practitioners use it to guide restoration actions. The purpose of this paper is to describe methods that can be used to estimate carrying capacity for stocks within the Upper Columbia River basin. We apply these methods to Wenatchee and Chiwawa River spring Chinook salmon.[13] Data used in this exercise are shown in Tables 1 and 2 and come from Hillman et al. (2017). We begin by identifying simple methods used to detect density dependence. We then describe the use of population models to estimate population capacity. We also discuss the use of habitat models and quantile regression to estimate habitat capacity. We end by comparing results of different methods and offering recommendations for estimating carrying capacity.

Table 1. Numbers of redds, adult spawners (estimated from redd surveys), eggs (estimated as the number of redds times average brood-year fecundity), summer parr (estimated using snorkel surveys), and yearling smolts (estimates using a rotary screw trap) by brood year for spring Chinook salmon in the Chiwawa River watershed. Smolts represent the number of yearling Chinook produced entirely within the Chiwawa River watershed. Date are from Hillman et al. (2017). NS = not sampled.

Brood year	Numbers of Chiwawa spring Chinook				
	Redds	Spawners	Eggs	Parr	Smolts
1991	104	242	478,400	45,483	42525
1992	302	676	1,570,098	79,113	39723
1993	106	233	556,394	55,056	8662
1994	82	184	485,686	55,241	16472
1995	13	33	66,248	5,815	3830

[13] Technically, Wenatchee River spring Chinook are one population. Chiwawa River spring Chinook are a subgroup of the Wenatchee spring Chinook population.

Brood year	Numbers of Chiwawa spring Chinook				
	Redds	Spawners	Eggs	Parr	Smolts
1996	23	58	106,835	16,066	15475
1997	82	182	374,740	68,415	28,334
1998	41	91	218,325	41,629	23,068
1999	34	94	166,090	NS	10,661
2000	128	346	642,944	114,617	40,831
2001	1,078	1,725	4,984,672	134,874	86,482
2002	345	707	1,605,630	91,278	90,948
2003	111	270	648,684	45,177	16,755
2004	241	851	1,156,559	49,631	72,080
2005	332	599	1,436,564	79,902	69,064
2006	297	529	1,284,228	60,752	45,050
2007	283	1,296	1,256,803	82,351	25,809
2008	689	1,158	3,163,888	106,705	35,023
2009	421	1,347	1,925,233	128,220	30,959
2010	502	1,094	2,165,628	141,510	47,511
2011	492	2,032	2,157,420	103,940	37,185
2012	880	1,478	3,716,240	149,563	34,334
2013	714	1,378	3,367,224	121,240	39,396
2014	485	999	1,961,825	111,224	37,170
2015	543	967	2,631,921	140,172	

Table 2. Numbers of redds, adult spawners (estimated from redd surveys), eggs (estimated as the number of redds times average brood-year fecundity), and yearling smolts (estimates using a rotary screw trap) by brood year for spring Chinook salmon in the Wenatchee River basin. Smolts represent the number of yearling Chinook produced entirely within the Wenatchee River basin. Date are from Hillman et al. (2017). NS = not sampled.

Brood year	Numbers of Wenatchee spring Chinook			
	Redds	Spawners	Eggs	Smolts*
2000	350	830	1,758,050	76,643
2001	2,109	3,217	8,674,624	243,516
2002	1,139	1,965	5,300,906	165,116
2003	323	673	1,887,612	70,738
2004	574	1,686	2,663,445	55,619
2005	830	1,484	3,587,083	302,116
2006	588	1,000	2,542,512	85,558
2007	466	2,035	2,069,506	60,219
2008	1,411	2,278	6,479,312	82,137
2009	733	2,299	NS	NS

Brood year	Numbers of Wenatchee spring Chinook			
	Redds	Spawners	Eggs	Smolts*
2010	968	1,921	NS	NS
2011	872	3,139	3,823,720	89,917
2012	1,704	2,720	7,195,992	67,973
2013	1,159	2,133	5,512,204	58,595
2014	885	1,600	3,894,000	36,752

* From 2000-2010 the smolt trap operated near the Town of Monitor; from 2013 to present the trap operated near the Town of Cashmere.

Evidence of Density Dependence

To calculate population capacity, the size of the population or stock must be influenced to a large degree by density-dependent factors. That is, population growth is affected by mechanisms whose effectiveness increases as population size increases. As population density increases, factors such as competition, predation, and disease (and parasites) cause birth rates to decrease, death rates to increase, and dispersal to increase. When densities decrease, the opposite occurs; birth rates increase and death and emigration rates decrease. In general, when the density of the population becomes high enough, density-dependent factors decrease population size because food or space are in short supply (Chapman 1966). In the ecological literature, this is referred to as "population regulation."

A simple way to determine if density-dependent factors regulate population size is to plot population growth rate (or appropriate surrogate) against population size. If population regulation is occurring, the relationship between population size and population growth rate decreases exponentially (decreases linearly if data are log-transformed). Surrogates for population growth rate include survival rates, natality (birth rates), productivity, recruits, individual growth rates, and movement. Figure 1 shows the relationship between productivity (parr/spawner and smolts/spawner) and spawning escapement for Wenatchee River and Chiwawa River spring Chinook. One could use redd counts as a surrogate for spawning abundance. Because most female spring Chinook construct only one redd (Murdoch et al. 2009), redd counts reflect the number of female spawners in the population. In this report, we use number of spawners (spawning escapement) because most management decisions are based on spawning escapement.

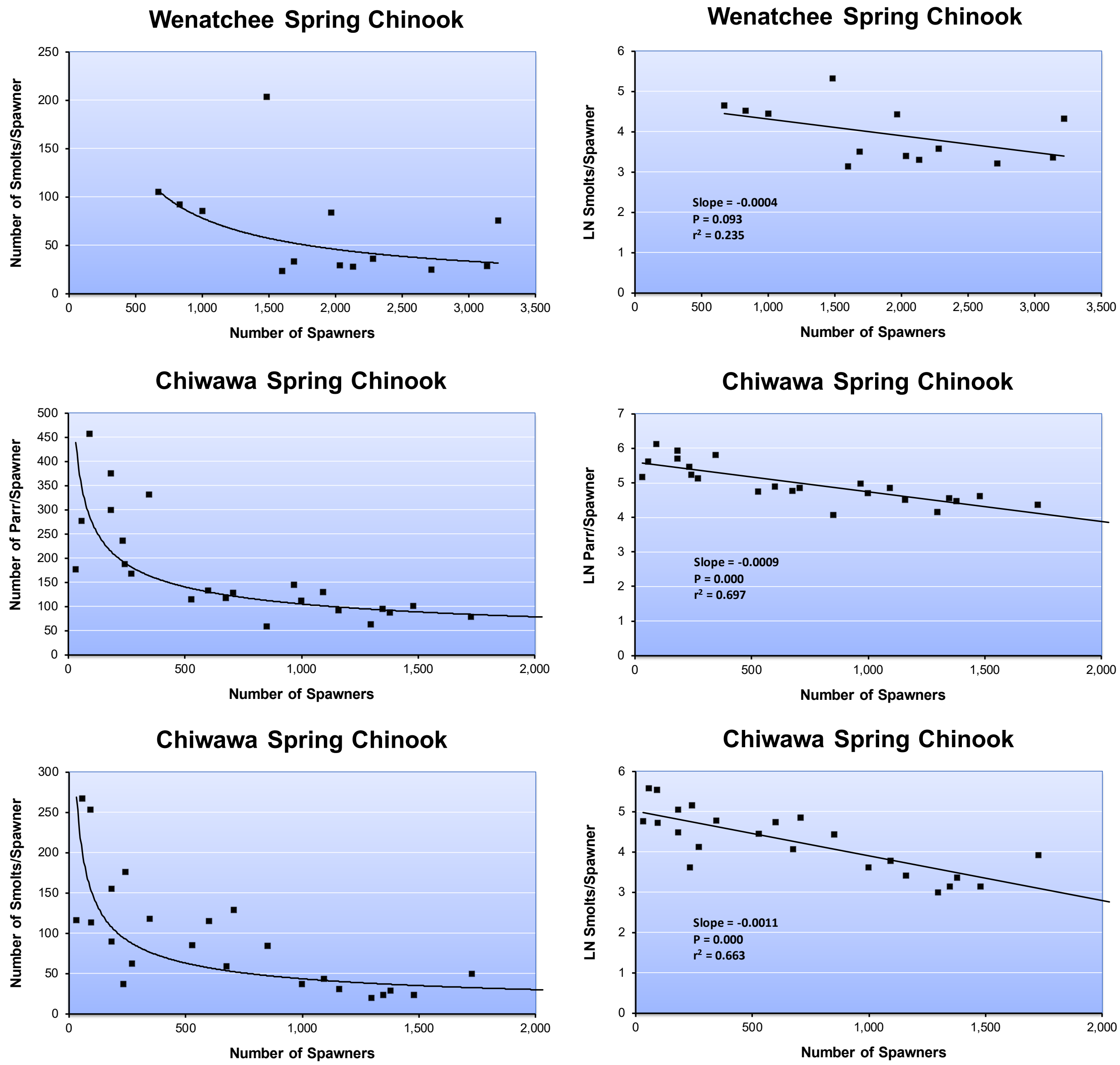

Figure 1. Relationship between spawner abundance and smolts/spawner for Wenatchee spring Chinook (top figures), spawner abundance and parr/spawner for Chiwawa spring Chinook (middle figures), and spawner abundance and smolts/spawner for Chiwawa spring Chinook (bottom figures). Figures on the right show natural log transformed productivity data.

The negative relationship between spawner abundance and juvenile productivity indicates the presence of density dependence in Chiwawa spring Chinook. Although there is a hint of density dependence in the Wenatchee River productivity data, the relationship was not significant statistically. This in part may be related to changes in sampling over the 13-year period. The negative relationship was significant for both summer parr and yearling smolts in the Chiwawa River watershed. We caution, however, that there may be a bias in the simple regression analysis presented in the figures. That is, the dependent (productivity) and independent (abundance) variables are not independent and this can produce a negative bias in regression estimates of slope. Nevertheless, the decline in juvenile productivity with increasing spawner abundance indicates the presence of density dependence. Given the presence of density dependence, we should be able to estimate population capacity.

Estimating Carrying Capacity

Several different methods can be used to estimate population capacity. For example, time series analyses, including the logistic or Gompertz functions, or stock-recruitment models can be used to estimate population capacity. Common stock-recruitment models include Ricker, Beverton-Holt, and smooth hockey stick models. These models incorporate environmental variability and can be used to estimate the size of the spawning population needed to produce the maximum number of recruits. Habitat capacity, on the other hand, can be estimated using fish-habitat models. In general, these models estimate habitat capacity as the product of habitat area and fish/habitat relationships. These range from simple models such as percent habitat saturation models to more complex models including habitat suitability, quantile regression forest models, dynamic food-web models, and bioenergetic or net rate of energy intake models. In this report, we explore the use of stock-recruitment models to estimate population capacity. We apply quantile regression to stock-recruitment models to estimate habitat capacity and compare those results to a habitat model, the quantile regression forest model.

Population Capacity

To estimate population capacity, we evaluated the fit of three different stock-recruitment models to Chiwawa and Wenatchee River spring Chinook data: Ricker, Beverton-Holt, and smooth hockey stick models. In using these models, we assume:

- *Density-dependent mortality*—For some time period before recruitment, the brood instantaneous mortality rate is proportional to the number of parent spawners (Ricker 1954).
- *Lognormal variation*—At any particular spawning stock size, the variation in recruitment is log-normally distributed about its average, and acts multiplicatively (Quinn and Deriso 1999).
- *Measurement error*—Error in spawning stock size estimates (measurement error) is small relative to the range of spawning stock sizes observed (Hilborn and Walters 1992). Variation in realized recruitment at any particular spawning stock size (process error) dominates recruitment measurement error.
- *Stationarity*—The average stock-recruitment relationship is constant over time (Hilborn and Walters 1992). That is, environmental conditions randomly affect survival independent of stock size or time.

In general, the methods we used to fit the models to the data followed those outlined in Hilborn and Walters (1992) and Froese (2008). The Ricker model, which assumes that the number of recruits increases to a maximum and then declines as the number of spawners increases, takes the form:

$$\boldsymbol{E(R) = \alpha S e^{-\beta S}}$$

where E(R) is the expected recruitment, S is spawner abundance, α is the number of recruits per spawner at low spawning levels, and β describes how quickly the recruits per spawner drop as the number of spawners increases. We estimated population capacity (K) as:

$$K = \left(\frac{\alpha}{\beta}\right) e^{-1}$$

and the number of spawners (SP) needed to produce the maximum number of recruits as:

$$SP = \frac{1}{\beta}$$

The Beverton-Holt model assumes that the number of recruits increases constantly toward an asymptote as the number of spawners increases. After the asymptote is reached, the number of recruits neither increases nor decreases. The asymptote represents the maximum number of recruits the system can support (i.e., population capacity for the system; K). The Beverton-Holt curve takes the form:

$$E(R) = \frac{(\alpha S)}{(\beta + S)}$$

where E(R) and S are as above, α is the maximum number of recruits produced (i.e., α = K), and β is the number of spawners needed to produce (on average) recruits equal to one-half the maximum number of recruits. The number of spawners needed to produce the maximum number of recruits is ∞ in the Beverton-Holt model.

Like the Beverton-Holt model, the smooth hockey stick model assumes that the number of recruits increases toward an asymptote (population capacity; K) as the number of spawners increases. After the carrying capacity is reached, the number of recruits neither increases nor decreases. The carrying capacity represents the maximum equilibrium number of recruits the system can support. This curve takes the form (Froese 2008):

$$E(R) = R_\infty\left(1 - e^{-\left(\frac{\alpha}{R_\infty}\right)S}\right)$$

where E(R) and S are as above, α is the slope at the origin of the spawner-recruitment curve, and R_∞ is the carrying capacity of recruits (i.e., $R_\infty = K$). There is no direct estimate of SP in the smooth hockey stick model. Therefore, we estimated SP as the number of spawners needed to produce 0.95(K).

We used non-linear regression to fit the three models to spawner-recruitment data. Before fitting the models, we transformed recruitment data using natural logs. We estimated bias and uncertainty measures (95% CI) for the model parameters using bootstrap procedures, which assumed that the {R, S} sample represented or approximated the population. The number of bootstrap samples was 3,000. We computed and stored the non-linear regression results for each bootstrap sample. We then calculated the bootstrap 95% CI by arranging the 3,000 bootstrap parameter values in sorted order and selected the 2.5 and 97.5 percentiles from the list.

We used Akaike's Information Criterion for small sample size (AIC_c) to determine which model(s) best explained the relationship between spawners and recruitment in the supplemented and reference populations. AIC_c was estimated as:

$$AIC_c = -2log\left(£(\theta|data)\right) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)$$

where *log(£(θ|data))* is the maximum likelihood estimate, *K* is the number of estimable parameters (structural parameters plus the residual variance parameter), and *n* is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate *log(£(θ|data))*, which was calculated as $log(\sigma^2)$, where σ^2 = residual sum of squares divided by the sample size ($\sigma^2 = RSS/n$). AIC_c assessed model fit in relation to model complexity (number of parameters). The model with the smallest AIC_c value represented the "best approximating" model within the model set. Remaining models were ranked relative to the best model using AIC_c difference scores (ΔAIC_c), Akaike weights (w_i), and evidence ratios. Models with ΔAIC_c values less than 2 indicated that there is substantial support for these models as being the best-fitting models within the set (Burnham and Anderson 2002). Models with values greater than 2 had less support. Akaike weights are probabilities estimating the strength of the evidence supporting a particular model as being the best model within the model set. Models with small w_i values are less plausible as competing models (Burnham and Anderson 2002). If no single model could be specified as the best model, a "best subset" of competing models was identified using (1) AIC_c differences to indicate the level of empirical support each model had as being the best model, (2) evidence ratios based on Akaike weights to indicate the relative probability that any model is the best model, and (3) coefficients of determination (R^2) assessing the explanatory power of each model.

Chiwawa River Spring Chinook Parr

We successfully fit the three stock-recruitment curves to the Chiwawa spring Chinook parr data (Figure 2).

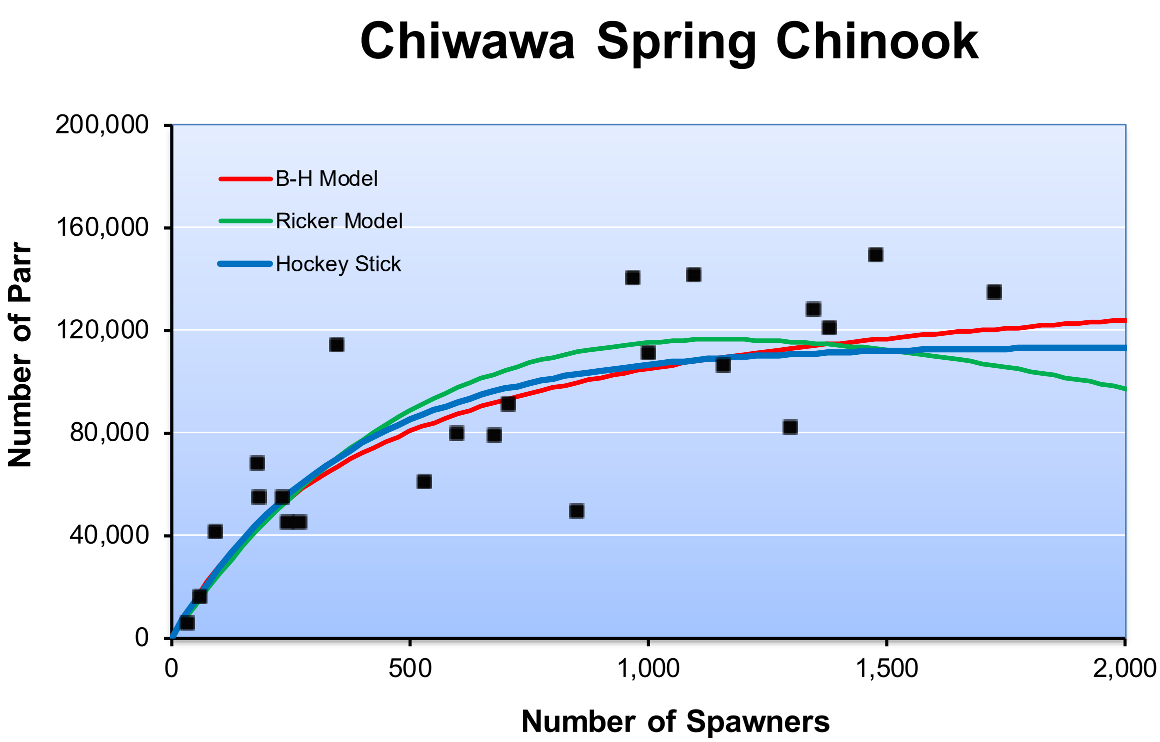

Figure 2. Relationship between numbers of spring Chinook parr and numbers of spawners in the Chiwawa River watershed, 1992-2016 (no sampling occurred in 2000). Figure shows the fit of the Beverton-Holt, Ricker, and smooth hockey stick models to the data.

For summer parr, the use of AIC_c indicated that the Beverton-Holt model best approximated the information in the productivity data. The estimated structural parameters for this model were:

$$Parr = \frac{(150{,}902 \times Spawners)}{(438 + Spawners)}$$

where the bootstrap estimated standard errors for the two parameters were 21,142 and 145, respectively. The adjusted $R^2 = 0.812$.

The second-best model was the smooth hockey stick model, which was 0.245 AIC_c units from the best model. The estimated parameters for this model were:

$$LN(Parr) = 11.6 + LN\left(1 - e^{-\left(\frac{312.9}{113{,}801}\right)Spawners}\right)$$

where the bootstrap estimated standard errors of the two parameters were 0.097 and 57.578, respectively, and the $R^2 = 0.810$.

The AIC_c difference scores, Akaike weights, and evidence ratios indicated that there was substantial support for both the Beverton-Holt and smooth hockey stick models. There was less support for the Ricker model, which was > 2 AIC_c units from the best models. This was further supported by the fact that, relative to the best models, the Ricker model had an evidence ratio greater than 3.

Depending on the stock-recruitment model used, population capacity ranged from 113,801 to 150,902 parr (Table 3). The Beverton-Holt model estimated the highest capacity, while the smooth hockey stick model estimated the lowest. The number of spawners needed to produce the population capacity of parr ranged from 1,089 to 1,163 (Table 3).

Table 3. Estimates of Beverton-Holt, smooth hockey stick, and Ricker model parameters, parr capacity (K), parr productivity (parr per spawner), and the number of spawners needed to produce the maximum number of parr for Chiwawa River spring Chinook.

Model	Parameter		Population capacity (K)	Intrinsic productivity	Spawners
	A	B			
Beverton-Holt	150,902.145	437.655	150,902	345	∞
Smooth Hockey Stick	11.642	312.913	113,801	313	1,089
Ricker	272.696	0.0009	116,650	273	1,163

It is important to note that the population capacity estimates are based on the number of parr counted in the Chiwawa River watershed during August. There are spring Chinook fry and parr that move out of the Chiwawa River watershed during spring and early summer (Hillman et al. 2017). It is unknown if these fish leave because of density-dependent pressures, they are flushed out during high flows, it is a life-history characteristic, or a combination of these. Regardless of the mechanism or reason, some of these fish may survive and rear in the Wenatchee or Columbia rivers. These emigrants are not included in the capacity estimates shown in Table 3.

The capacity estimates for spring Chinook parr apply only to the Chiwawa River watershed, a watershed within the Wenatchee River basin. Estimating parr capacity for the entire Wenatchee River basin using stock-recruitment models is difficult because there is no long-term time series of parr data for the entire basin. However, we can extrapolate parr capacity estimates from the

Chiwawa River watershed to the entire Wenatchee River basin using intrinsic potential (IP). Multiplying the parr capacity per intrinsic potential within the Chiwawa River watershed by the total intrinsic potential within the Wenatchee River basin yields an estimate of parr capacity for the Wenatchee River basin (Table 4). The Interior Columbia Basin Technical Recovery Team estimated IP based on wetted width, valley width (confinement), and gradient (see Cooney and Holzer 2006). They used sedimentation and temperature to refine IP for each 200-m long reach. We used the total stream area (km^2) weighted by intrinsic potential and temperature limited to extrapolate parr capacity to the entire Wenatchee River basin.

Table 4. Estimates of Wenatchee River basin parr capacity based on intrinsic potential (IP). The amount of IP within the Chiwawa River watershed is 0.481 km^2; the total amount of IP within the Wenatchee River basin is 1.798 km^2.

Model	Chiwawa parr capacity	Chiwawa parr/IP	Wenatchee parr capacity
Beverton-Holt	150,902	313,726	564,079
Smooth Hockey Stick	113,801	236,593	425,395
Ricker	116,650	242,516	436,043

Using this simple method, we estimate the Wenatchee River basin supports about 425,395-564,079 parr depending on which model is used. An important assumption of this simple method is that each unit of IP supports the same number of parr. This is clearly not true given that the quality of habitat within each unit of IP can vary greatly. That is, one unit of IP may contain more habitat structure (e.g., wood and cover) than another unit of IP. Importantly, the ratio of parr to IP comes from the Chiwawa River watershed, which contains some of the highest quality habitat within the Wenatchee River basin. Therefore, the estimated total parr capacity for the entire Wenatchee River basin is likely biased high. If habitat conditions throughout the Wenatchee River basin are enhanced to conditions similar to those in the Chiwawa River watershed, we may expect parr abundance to approach those estimated with this simple method.

Chiwawa River Spring Chinook Smolts

We successfully fit the three stock-recruitment curves to the Chiwawa spring Chinook smolt data (Figure 3). This information allows us to better understand the quality and quantity of overwintering habitat in the Chiwawa River basin.

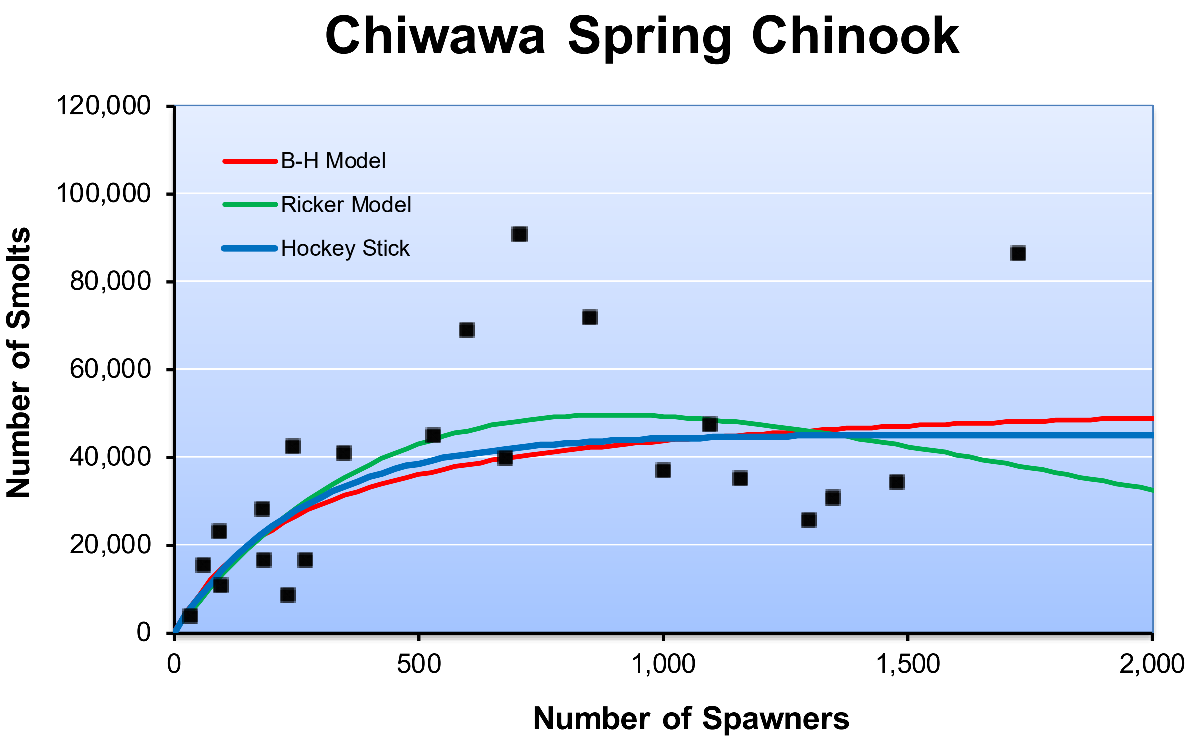

Figure 3. Relationship between numbers of spring Chinook smolts and numbers of spawners in the Chiwawa River watershed, 1992-2015. Figure shows the fit of the Beverton-Holt, Ricker, and smooth hockey stick models to the data.

For yearling smolts produced entirely within the Chiwawa River watershed, the use of AIC_c indicated that the smooth hockey stick model best approximated the information in the productivity data. The estimated structural parameters for this model were:

$$LN(Smolts) = 10.7 + LN\left(1 - e^{-\left(\frac{174.1}{45{,}161}\right)Spawners}\right)$$

where the bootstrap estimated standard errors for the two parameters were 0.13 and 41.29, respectively. The adjusted $R^2 = 0.569$.

The second-best model was the Ricker model, which was 0.234 AIC_c units from the best model. The estimated parameters for this model were:

$$Smolts = 149.45 \times Spawners(e^{-0.00111 \times Spawners})$$

where the bootstrap estimated standard errors of the two parameters were 26.23 and 0.00018, respectively, and the $R^2 = 0.573$.

The third-best model was the Beverton-Holt model, which was 0.725 AIC_c units from the best model. The estimated parameters for this model were:

$$Smolts = \frac{(55{,}702 \times Spawners)}{(273 + Spawners)}$$

where the bootstrap estimated standard errors of the two parameters were 10,421.9 and 123.0, respectively, and the R^2 = 0.560.

The AIC_c difference scores, Akaike weights, and evidence ratios indicated that there was substantial support for all three models. Relative to the best model, the other two models had evidence ratios less than 1.5.

Depending on the stock-recruitment model used, population capacity ranged from 45,161 to 55,702 smolts (Table 5). The Beverton-Holt model estimated the highest capacity, while the smooth hockey stick model estimated the lowest. The number of spawners needed to produce the population capacity of smolts ranged from 777 to 901 (Table 5).

Table 5. Estimates of Beverton-Holt, smooth hockey stick, and Ricker model parameters, smolt capacity (K), smolt productivity (smolts per spawner), and the number of spawners needed to produce the maximum number of smolts for Chiwawa River spring Chinook.

Model	Parameter		Population capacity (K)	Intrinsic productivity	Spawners
	A	B			
Smooth hockey stick	10.718	174.077	45,161	174	777
Ricker	149.452	0.00111	49,532	149	901
Beverton-Holt	55,702.281	273.910	55,702	203	∞

It is important to note that the population capacity estimates are based on the number of smolts produced entirely within the Chiwawa River watershed. As noted earlier, there are spring Chinook fry and parr that move out of the Chiwawa River watershed during spring, early summer, and fall (Hillman et al. 2017). Fall emigration is common and occurs even when densities of juveniles are very low, indicating that fall emigration is a life-history characteristic. Regardless of why the fish emigrate as fry and parr, some of these fish survive and rear in the Wenatchee or Columbia rivers. Some survive to smolt (unpublished WDFW data), but are not included in the smolt capacity estimates shown in Table 5.

As with parr, the capacity estimates for spring Chinook smolts apply only to the Chiwawa River watershed. As before, we can extrapolate smolt capacity estimates from the Chiwawa River watershed to the entire Wenatchee River basin using intrinsic potential (IP). In this case, we multiply the smolt capacity per intrinsic potential within the Chiwawa River watershed by the total intrinsic potential within the Wenatchee River basin. This yields an estimate of smolt capacity for the Wenatchee River basin (Table 6).

Table 6. Estimates of Wenatchee River basin smolt capacity based on intrinsic potential (IP). The amount of IP within the Chiwawa River watershed is 0.481 km^2; the total amount of IP within the Wenatchee River basin is 1.798 km^2.

Model	Chiwawa smolt capacity	Chiwawa smolts/IP	Wenatchee smolt capacity
Beverton-Holt	55,702	115,805	208,218
Smooth Hockey Stick	45,161	93,891	168,816
Ricker	49,532	102,976	185,152

Using this simple method, we estimate the population capacity for the Wenatchee River basin at 168,816-208,218 smolts depending on which model is used. Based on smolt trapping in the lower Wenatchee River over a 13-year period, total smolt abundance has ranged from 36,752 to 302,116 smolts (average = 107,300 smolts) (Table 2).[14] Thus, recent (2000-2014) smolt production appears to be below capacity estimates for most years but higher in some years.

An important assumption of this simple method is that each unit of IP supports the same number of smolts. As we noted earlier, this is not the case given that the quality of habitat within each unit of IP can vary greatly. Nevertheless, the ratio of smolts to IP comes from the Chiwawa River watershed, which contains some of the highest quality habitat within the Wenatchee River basin. Therefore, the estimated total smolt capacity for the entire Wenatchee River basin is likely biased high. If habitat conditions throughout the Wenatchee River basin are enhanced to conditions similar to those in the Chiwawa River watershed, we may expect smolt abundance to approach those estimated with this simple method.

Wenatchee River Spring Chinook Smolts

Rather than extrapolate results from the Chiwawa River watershed to the entire Wenatchee River basin, we can fit stock-recruitment models to the smolt data collected in the lower Wenatchee River and estimate population capacity directly from the population models. We successfully fit the three stock-recruitment curves to the Chiwawa spring Chinook smolt data; although, the models explained little of the variation in the stock-recruitment data ($R^2 < 0.05$) (Figure 3).

[14] It is important to point out that the trapping location has changed over time. During the period 2000-2008 and 2011-2012, the trap was located near the Town of Monitor. During the period 2013-present, the trap was located near the Town of Cashmere.

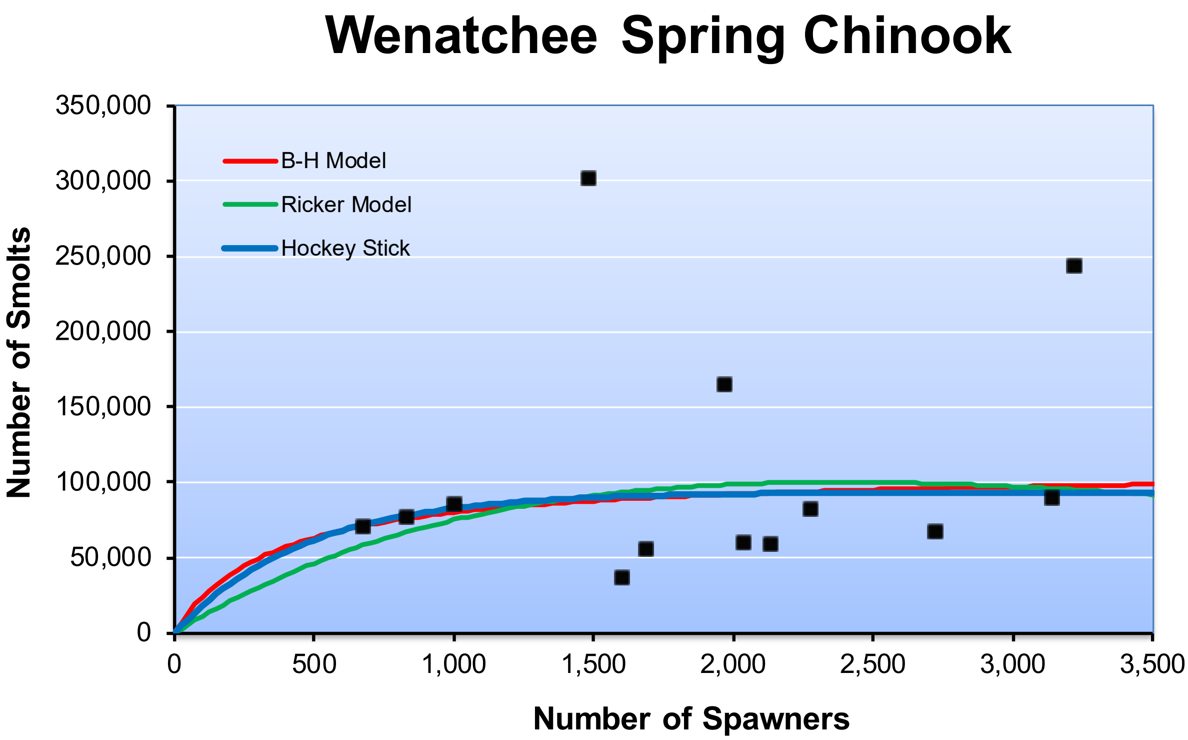

Figure 4. Relationship between numbers of spring Chinook smolts and numbers of spawners in the Wenatchee River basin, 2000-2014 (no data were collected in 2009 or 2010). Figure shows the fit of the Beverton-Holt, Ricker, and smooth hockey stick models to the data.

For yearling smolts produced within the Wenatchee River basin, the use of AIC_c indicated that the Beverton-Holt model best approximated the information in the productivity data. The estimated structural parameters for this model were:

$$Smolts = \frac{(108{,}696 \times Spawners)}{(359 + Spawners)}$$

where the bootstrap estimated standard errors for the two parameters were 49,948 and 836, respectively. The adjusted $R^2 = 0.026$.

The second-best model was the smooth hockey stick model, which was 0.112 AIC_c units from the best model. The estimated parameters for this model were:

$$LN(Smolts) = 11.4 + LN\left(1 - e^{-\left(\frac{20.72}{93{,}560}\right)Spawners}\right)$$

where the bootstrap estimated standard errors of the two parameters were 30.74 and 225.43, respectively, and the $R^2 = 0.017$.

The third-best model was the Ricker model, which was 0.0.808 AIC_c units from the best model. The estimated parameters for this model were:

$$Smolts = 114.10 \times Spawners(\mathrm{e}^{-0.00042 \times Spawners})$$

where the bootstrap estimated standard errors of the two parameters were 56.16 and 0.00021, respectively, and the $R^2 = 0.001$.

The AIC_c difference scores, Akaike weights, and evidence ratios indicated that there was substantial support for all three models. Relative to the best model, the other two models had evidence ratios less than 2.0.

Depending on the stock-recruitment model used, population capacity for the Wenatchee River basin ranged from 93,560 to 108,696 smolts (Table 7). The Beverton-Holt model estimated the highest capacity, while the smooth hockey stick model estimated the lowest. The number of spawners needed to produce the population capacity of smolts ranged from 1,389-2,381 (Table 7).

Table 7. Estimates of Beverton-Holt, smooth hockey stick, and Ricker model parameters, smolt capacity (K), smolt productivity (smolts per spawner), and the number of spawners needed to produce the maximum number of smolts for Wenatchee River spring Chinook.

Model	Parameter		Population capacity (K)	Intrinsic productivity	Spawners
	A	B			
Smooth hockey stick	11.446	201.724	93,560	202	1,389
Ricker	114.104	0.00042	99,944	114	2,381
Beverton-Holt	108,696.009	358.616	108,696	303	∞

The population capacity estimates reported here are based on the number of smolts produced within the Wenatchee River basin. It is likely that some juvenile spring Chinook rear in the Columbia River and survive to smolt. Those fish are not included in these estimates of capacity.

Habitat Capacity

Habitat capacity can be estimated using fish-habitat models and creative modeling of stock-recruitment data. As we noted earlier, there are several different fish-habitat models that can be used to estimate habitat capacity. In this paper, we explore the use of two different methods, quantile regression applied to stock-recruitment functions and the Quantile Regression Random Forest model. The former relies on simple stock and recruitment data, while the latter requires estimates of habitat quality and quantity, and functional relationships between maximum fish density and habitat conditions.

Quantile Regression Analysis of Stock-Recruitment Data

To estimate population capacity, we used non-linear regression techniques to fit stock-recruitment functions to the data. These techniques approximate the conditional mean of the recruitment data given the range of stock sizes. As such, the functions (curves) estimated from the analyses lie near the center of the distribution of data resulting in data points above and below the curve. Although this technique is useful for estimating population capacity, it is not appropriate for estimating habitat capacity. The fact that there are actual recruitment data above the estimated population capacity indicates that habitat capacity must be greater than the population capacity, or that measurement error is high. The former explanation is more likely than the latter.

One way to possibly estimate habitat capacity with stock-recruitment data is to fit stock-recruitment functions to the juvenile spring Chinook data using quantile regression techniques. Quantile regression estimates quantiles of the recruitment data given the range of stock sizes. Thus, we can use quantile regression to fit a stock-recruitment function to, say, the upper 90% or 95% of the recruitment distribution. In other words, we fit a stock-recruitment function to the upper limits of the recruitment data given the range of stock sizes. In this case, the resulting stock-recruitment curve is above most of the recruitment data and therefore few data points lie above the curve. Calculation of capacity from these functions should more closely represent habitat capacity, provided there is an adequate range of stock sizes. Quantile regression gives results similar to those obtained from calculating reference intervals (RI).

In this exercise, we calculated the upper 90% RI for the Beverton-Holt and Ricker functions. We assume the 90% RI will closely represent the habitat capacity for juvenile spring Chinook. We calculated the 90% RI only for the Beverton-Holt and Ricker models, because these functions can be transformed into linear function (see Hilborn and Walters 1992). RIs are easier to calculate on linear functions than non-linear functions. We were unable to transform the smooth hockey stick model into a linear function and therefore we did not calculate RIs for this function.

Chiwawa River Spring Chinook Parr—We calculated 90% RIs for Chiwawa Chinook parr data for both the Ricker and Beverton-Holt models (Figure 5). The estimated parameters for the 90% RI for the Ricker model were:

$$\log\left(\frac{Parr}{Spawners}\right) = 6.152 - \frac{6.152}{5{,}984.436}(Spawners)$$

This resulted in an estimated habitat capacity of 168,071 parr, which is about 1.4 times greater than the population capacity estimated with the Ricker model.

The estimated parameters for the 90% RI for the Beverton-Holt model were:

$$\frac{Spawners}{Parr} = \frac{196.91}{181{,}818} + \frac{1}{181{,}818}(Spawners)$$

This function resulted in an estimated habitat capacity of 181,818 parr, which was about 1.2 times greater than the population capacity estimated with the Beverton-Holt model.

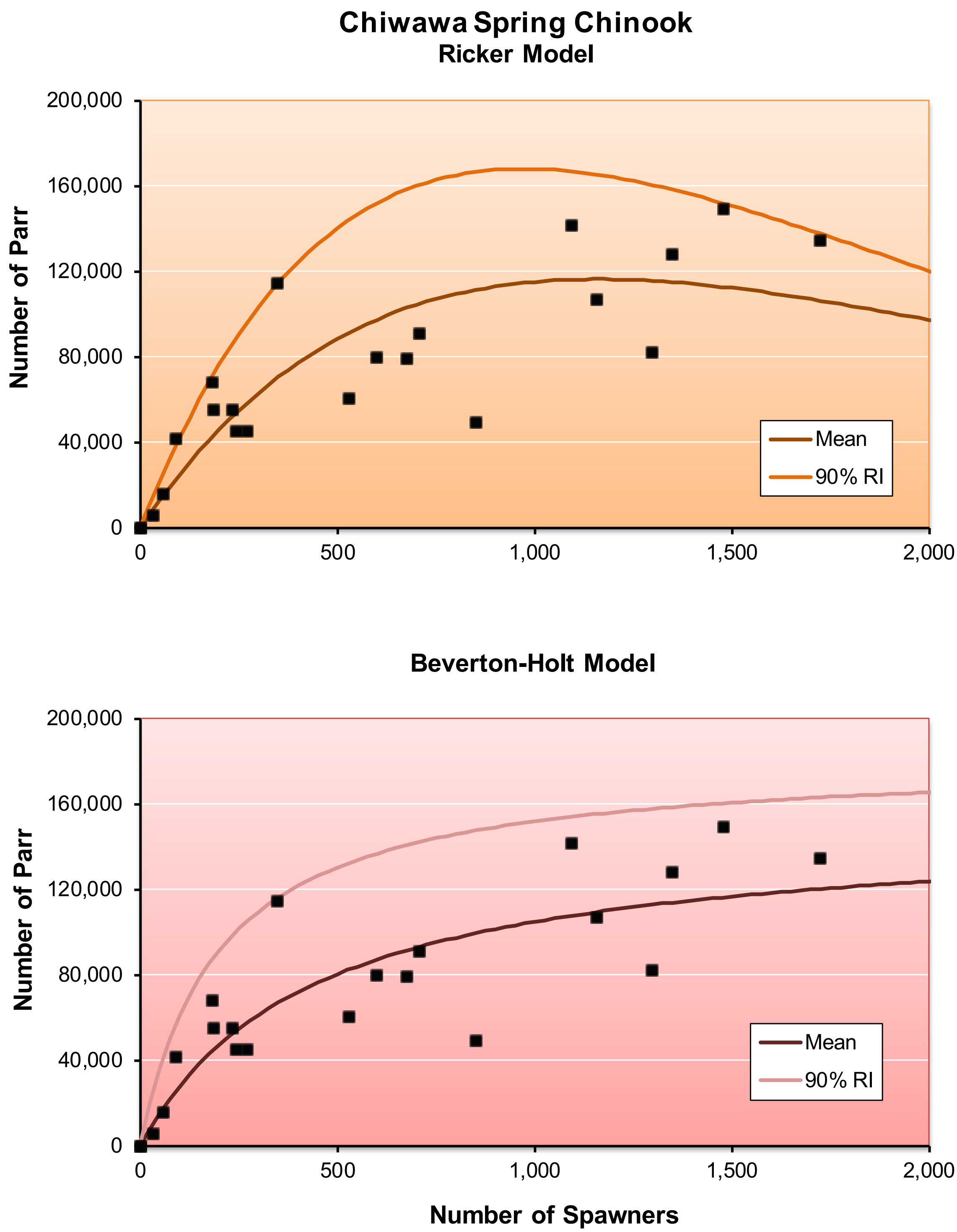

Figure 5. Relationship between numbers of spring Chinook parr and numbers of spawners in the Chiwawa River watershed, 1992-2016. Upper figure shows the fit of the Ricker model and its 90% reference interval to the data; lower figure shows the fit of the Beverton-Holt model and its 90% reference interval.

If we extrapolate the habitat capacity estimates for Chiwawa spring Chinook parr to the entire Wenatchee River basin (using the IP method described earlier), we estimate the habitat capacity for the Wenatchee River basin to be 628,256 parr from the Ricker model and 679,645 parr from the Beverton-Holt model.

Chiwawa River Spring Chinook Smolts—As with parr, we calculated 90% RIs for Chiwawa Chinook smolt data for both the Ricker and Beverton-Holt models (Figure 6). The estimated parameters for the 90% RI for the Ricker model were:

$$\log\left(\frac{Smolts}{Spawners}\right) = 5.687 - \frac{5.687}{4{,}687.964}(Spawners)$$

This resulted in an estimated habitat capacity of 89,425 smolts, which is about 1.8 times greater than the population capacity estimated with the Ricker model.

The estimated parameters for the 90% RI for the Beverton-Holt model were:

$$\frac{Spawners}{Smolts} = \frac{102.129}{64{,}516} + \frac{1}{64{,}516}(Spawners)$$

This function resulted in an estimated habitat capacity of 64,516 smolts, which was about 1.2 times greater than the population capacity estimated with the Beverton-Holt model.

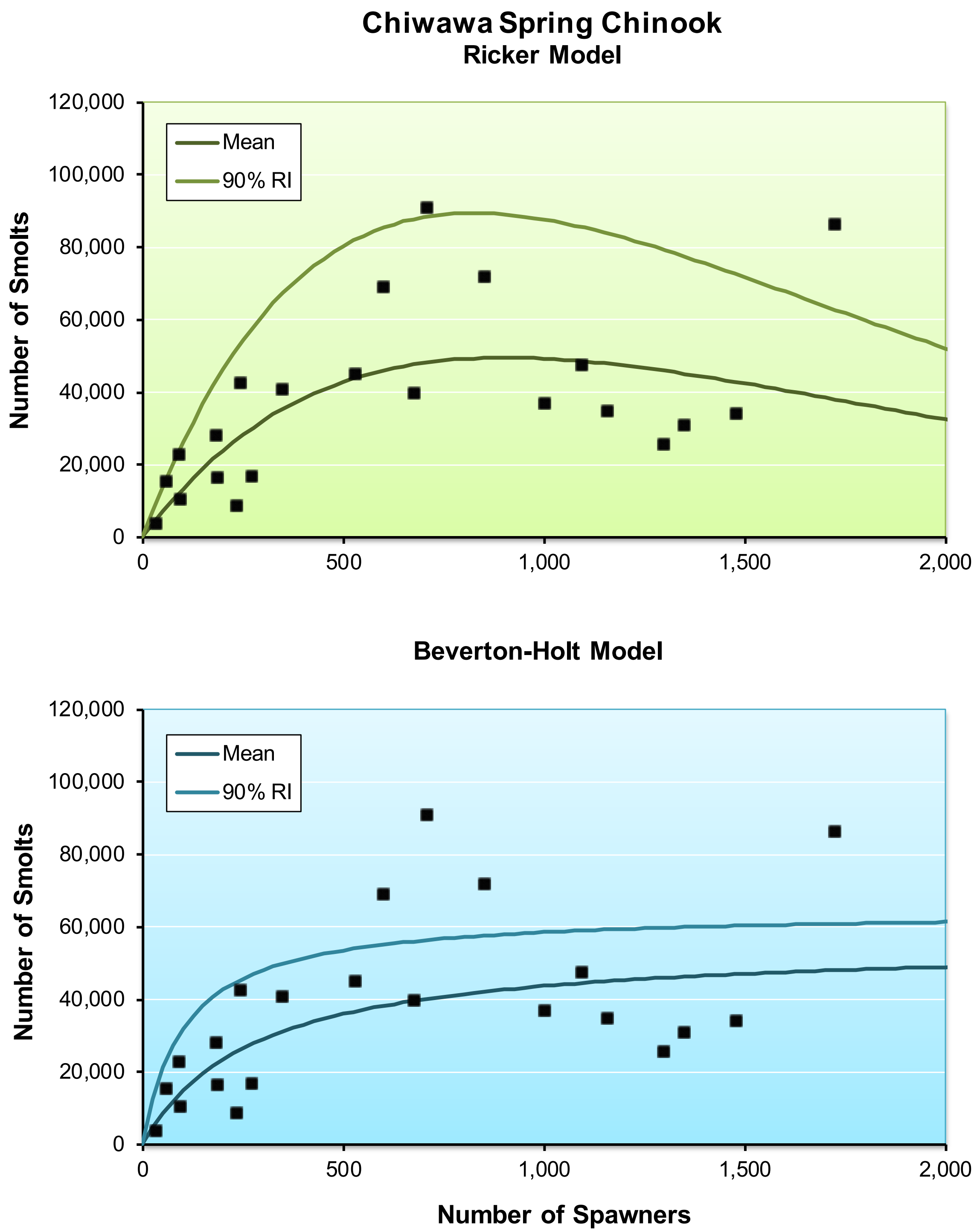

Figure 6. Relationship between numbers of spring Chinook smolts and numbers of spawners in the Chiwawa River watershed, 1992-2015. Upper figure shows the fit of the Ricker model and its 90% reference interval to the data; lower figure shows the fit of the Beverton-Holt model and its 90% reference interval.

If we extrapolate the habitat capacity estimates for Chiwawa spring Chinook smolts to the entire Wenatchee River basin (using the IP method described earlier), we estimate the habitat capacity for the Wenatchee River basin to be 334,276 smolts based on the Ricker model and 241,164 smolts from the Beverton-Holt model.

<u>*Wenatchee River Spring Chinook Smolts*</u>—We calculated 90% RIs for Wenatchee River Chinook smolt data for both the Ricker and Beverton-Holt models (Figure 7). The estimated parameters for the 90% RI for the Ricker model were:

$$\log\left(\frac{Smolts}{Spawners}\right) = 5.320 - \frac{5.320}{16{,}642.420}(Spawners)$$

This resulted in an estimated habitat capacity of 235,131 smolts, which is about 2.4 times greater than the population capacity estimated with the Ricker model.

The estimated parameters for the 90% RI for the Beverton-Holt model were:

$$\frac{Spawners}{Smolts} = \frac{357.593}{186{,}567} + \frac{1}{186{,}567}(Spawners)$$

This function resulted in an estimated habitat capacity of 186,567 smolts, which was about 1.7 times greater than the population capacity estimated with the Beverton-Holt model.

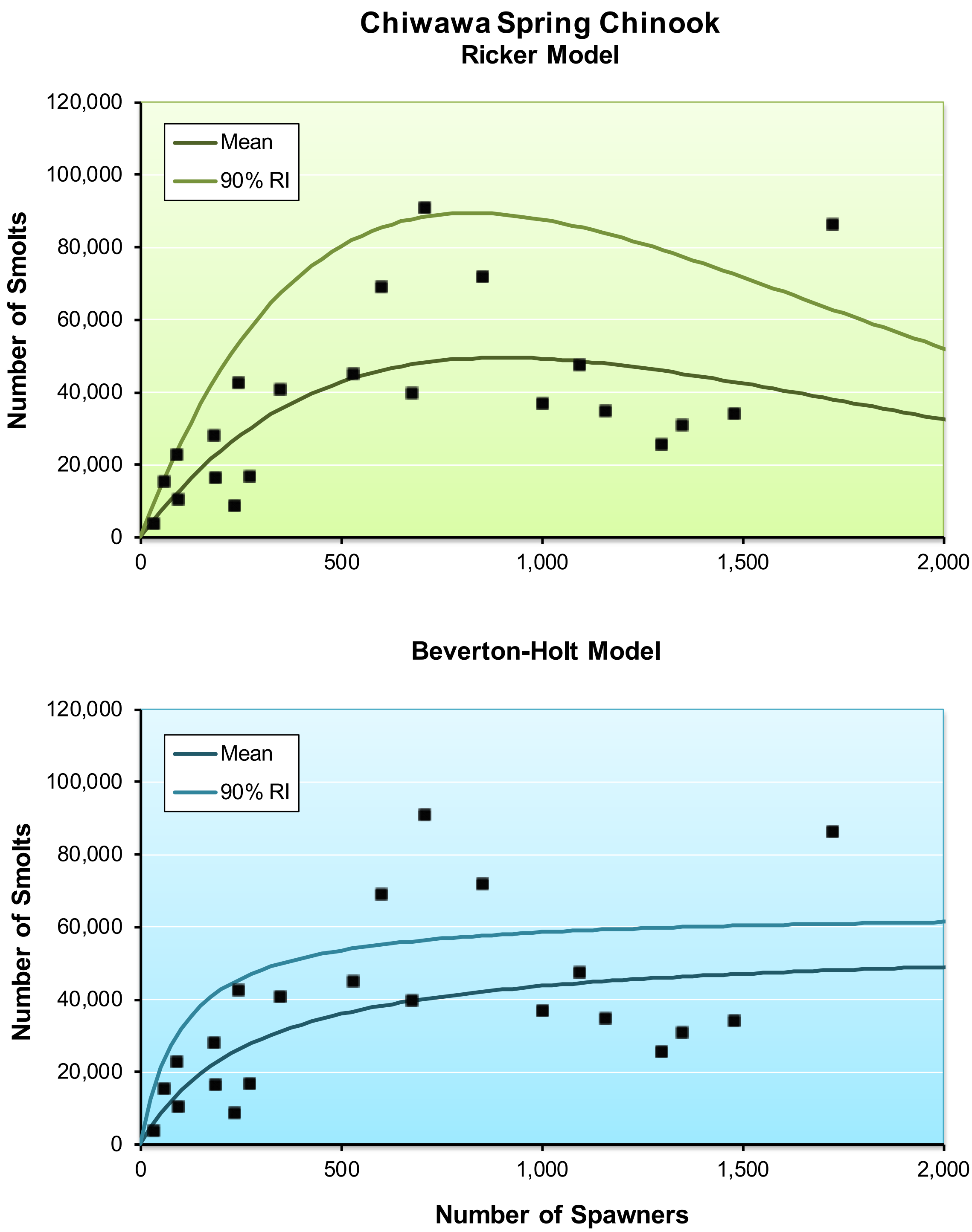

Figure 7. Relationship between numbers of spring Chinook smolts and numbers of spawners in the Wenatchee River basin, 2000-2015 (no data were collected in 2009 or 2010). Upper figure shows the fit of the Ricker model and its 90% reference interval to the data; lower figure shows the fit of the Beverton-Holt model and its 90% reference interval.

Quantile Regression Random Forest Model

Researchers with the Integrated Status and Effectiveness Monitoring Program (ISEMP) developed a model that estimates Chinook parr habitat capacity based on fish-habitat relationships (ISEMP/CHaMP 2015). Based on extensive sampling throughout the Columbia River basin, these researchers developed relationships between maximum densities of Chinook parr (summer estimates) and various habitat variables. Quantile regression forest (QRF) models use these relationships to estimate carrying capacities for juvenile Chinook. Very simply, QRF analysis develops non-linear relationships between fish density and different habitat variables. In this case, however, QRF analysis predicts the 90% quantile of fish density rather than the mean or median density. The researchers assume that the 90% quantile represents habitat capacity. This is important because the numbers of fish counted in some field sampling sites may not have been at maximum capacity. That is, it is likely that not all sites sampled were fully "seeded" with Chinook salmon. Thus, using the mean or median (50% quantile) would not represent habitat capacity, but some level below habitat capacity.

Researchers fit the QRF model to parr density data and 12 habitat variables that were collected from 227 sites within the distribution of Chinook throughout the Columbia River basin (within CHaMP/ISEMP watersheds). These variables were selected to represent a variety of types of habitat variables (e.g., substrate, riparian, complexity, temperature, etc.), contain the most "fish information," and be as uncorrelated as possible (ISEMP/CHaMP 2015). The 12 habitat variables and their relative importance are shown in Figure 8.

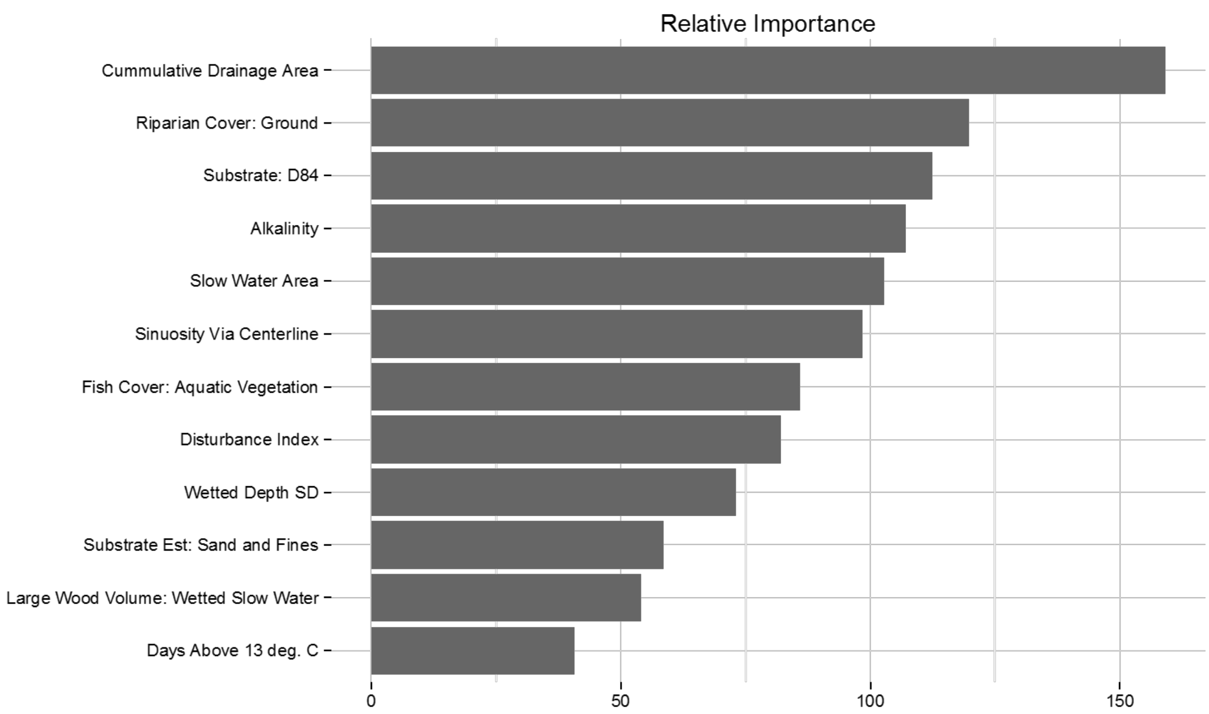

Figure 8. Relative importance of habitat variables included in juvenile Chinook salmon quantile regression forest models (Figure is from ISEMP/CHaMP 2015).

As a way of testing the model, ISEMP researchers used their QRF model to estimate Chinook parr capacities in different watersheds, including the Chiwawa River watershed, and compared their estimates to those generated from fish population data using stock-recruitment modeling. Figure 9 shows the relationship between the QRF model results and population model results for the Chiwawa River watershed. The red curve was generated using the QRF model and the blue curve was generated using the Beverton-Holt model. At the time of this analysis, the Beverton-Holt model was fit to 21 years of parr data, not the 24 years of data used in the analyses above.

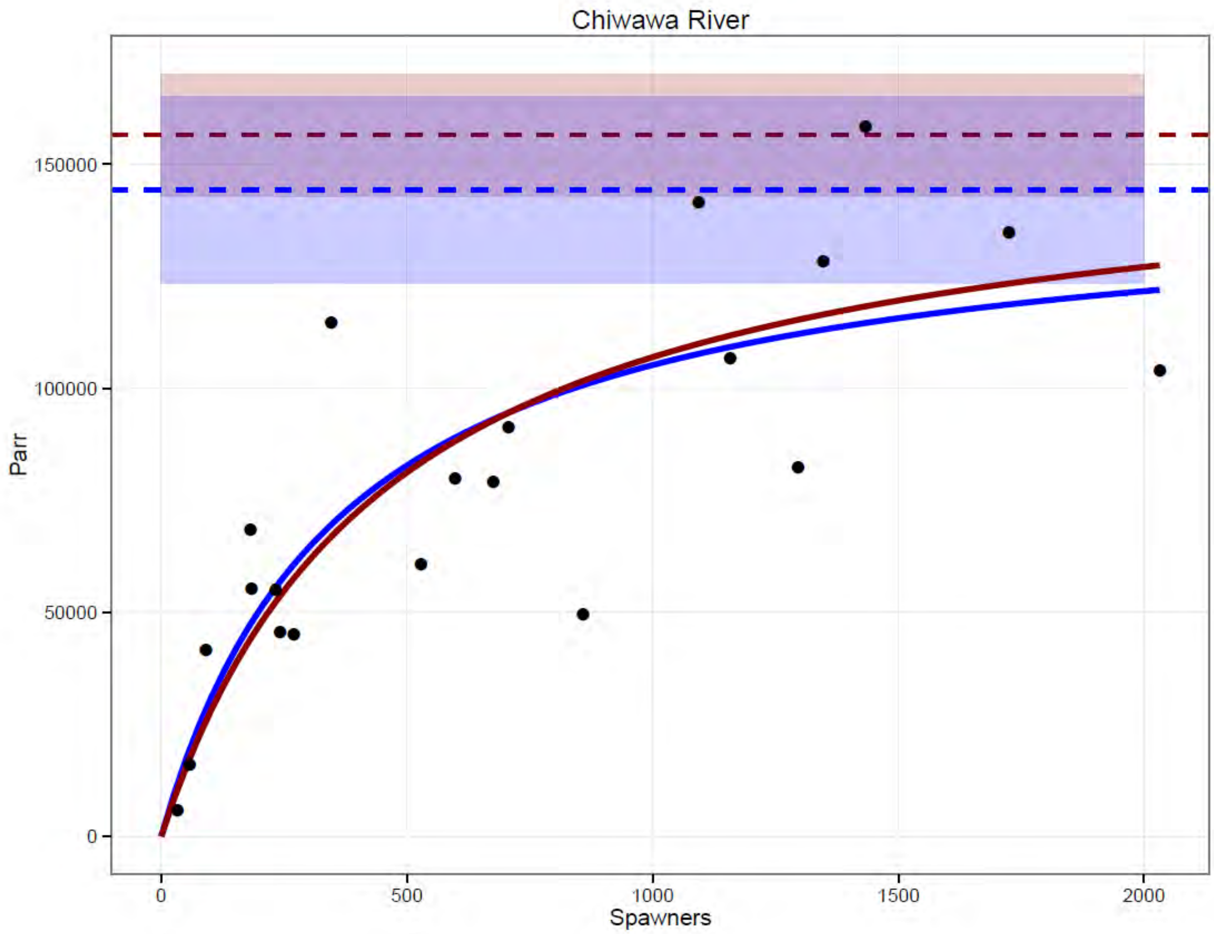

Figure 9. Comparison of productivity curves for Chiwawa spring Chinook parr generated from the QRF model (red line) and Beverton-Holt model (blue line). Dashed horizontal lines represent carrying capacity estimates. Shading about the capacity estimates represent the 95% confidence bounds. Figure is from ISEMP/CHaMP (2015).

The comparison shows that although the curves are very similar, the carrying capacity estimates (dashed horizontal lines) differed, with the habitat capacity generated from the QRF model being larger than the population capacity generated from the population data. That is, the QRF model estimated a habitat capacity of about 164,000 spring Chinook parr, while the population model estimated a population capacity of about 145,000 parr. Including more recent parr data in the Beverton-Holt model indicates that the population capacity estimate is about 151,000 parr for the Chiwawa River watershed. The 90% RI for the Beverton-Holt model estimated a habitat capacity of about 182,000, which is 1.1 times greater than the estimate from the QRF model. Note that the 90% RI for the Ricker model estimated a habitat capacity of about 168,000, which is close to the QRF model estimate.

Comparing Results

We estimated capacities for both spring Chinook parr and smolts for the Chiwawa River watershed and the entire Wenatchee River basin using different analytical tools. In this section, we compare the results from the different approaches.

Parr Capacity

Depending on the population model used, population capacity estimates for the Chiwawa River watershed ranged from 113,801 to 150,902 parr (Table 8). Not surprisingly, the Beverton-Holt model generally predicts the highest capacity estimates, while the smooth hockey stick model predicts the lowest. As expected, the population capacity estimates for Chiwawa parr were less than the habitat capacity estimates for parr. Habitat capacity estimates were about 1.2 to 1.5 times greater than the population capacity estimates (Table 8). Importantly, the fish-habitat model (QRF model) calculated a habitat capacity estimate that was close to that estimated from calculating 90% RI for the population models. Extrapolating Chiwawa capacity estimates to the entire Wenatchee River basin resulted in population capacities of 425,395 to 564,079 parr and habitat capacity estimates of 613,040 to 679,645 parr (Table 8).

Table 8. Comparison of spring Chinook parr capacity estimates for the Chiwawa River watershed and the Wenatchee River basin. Population capacities were estimated directly from the stock-recruitment functions; habitat capacities were estimated by calculating 90% reference intervals (using quantile regression; QR) for the stock-recruitment models and using a fish-habitat model (Quantile Regression Forest Model; QRF). Capacities for the Wenatchee River basin were estimated by extrapolating Chiwawa capacities using intrinsic potential.

Capacity type	Model	Chiwawa parr capacity	Wenatchee parr capacity
Population capacity	Beverton-Holt	150,902	564,079
	Smooth Hockey Stick	113,801	425,395
	Ricker	116,650	436,043
Habitat capacity	QR Beverton-Holt	181,818	679,645
	QR Ricker	168,071	628,256
	QRF Model	164,000	613,040

The number of spawners needed to achieve parr capacity also varied depending on the population model used (Table 9). For the Chiwawa River watershed, maximum spawners needed to achieve population capacity for parr ranged from 1,089 to 1,163 adults. Extrapolating Chiwawa results to the entire Wenatchee River basin resulted in maximum spawner estimates of 4,070 to 4,347 adults. We were able to estimate habitat capacity only with the Ricker model (Table 9). Using quantile regression to calculate the 90% RI for the Ricker model resulted in a maximum spawner abundance of 973 adults, which is less than the number needed to achieve population capacity. This is because the 90% RI for the Ricker function estimates a higher intrinsic productivity, which shifts the "hump" of the curve to the left resulting in a higher capacity estimate but a lower maximum spawner estimate (see Figure 5).

Table 9. Comparison of the number of spawners needed to achieve parr capacities in the Chiwawa River watershed and the Wenatchee River basin. For the Chiwawa River watershed, maximum spawners were estimated directly from the stock-recruitment functions. Maximum spawners for the entire Wenatchee River basin were estimated as the product of the extrapolated parr numbers times the ratio of maximum spawners to parr capacity for Chiwawa spring Chinook. Because of the nature of the Beverton-Holt model, no maximum spawners can be calculated from that model.

Capacity type	Model	Spawners need to achieve parr capacity	
		Chiwawa	Wenatchee
Population capacity	Smooth Hockey Stick	1,089	4,070
	Ricker	1,163	4,347
Habitat capacity	QR Ricker	973	3,636

Smolt Capacity

As with parr estimates, population capacity estimates for smolts varied depending on the population model used. For Chiwawa spring Chinook smolts, population capacities ranged from 45,161 to 55,702 smolts, with the smooth hockey stick providing the lowest estimate and the Beverton-Holt model providing the highest (Table 10). The population capacity estimates were about 55 to 86% of the habitat capacity estimates. Extrapolating Chiwawa capacity estimates to the entire Wenatchee River basin resulted in population capacities of 168,816 to 208,218 smolts and habitat capacity estimates of 241,164 to 334,276 smolts (Table 10). These were greater than those estimated using smolt and spawner data for the entire Wenatchee River basin. Fitting population models to smolt and spawner data for the entire basin resulted in population capacities of 93,560 to 108,696 smolts and habitat capacities of 186,567 to 235,131 smolts (Table 10).

Table 10. Comparison of spring Chinook smolt capacity estimates for the Chiwawa River watershed and the Wenatchee River basin. Population capacities were estimated directly from the stock-recruitment functions; habitat capacities were estimated by calculating 90% reference intervals (using quantile regression; QR) for the stock-recruitment models. Capacities for the Wenatchee River basin were estimated by extrapolating Chiwawa capacities using intrinsic potential and by fitting population models to the smolt and spawner data for the entire basin.

Capacity type	Model	Chiwawa smolt capacity	Wenatchee smolt capacity	
			Chiwawa extrapolation	Wenatchee data
Population capacity	Beverton-Holt	55,702	208,218	108,696
	Smooth Hockey Stick	45,161	168,816	93,560
	Ricker	49,532	185,152	99,944
Habitat capacity	QR Beverton-Holt	64,516	241,164	186,567
	QR Ricker	89,425	334,276	235,131

The number of spawners needed to achieve smolt capacity varied depending on the population model used (Table 11). For the Chiwawa River watershed, maximum spawners needed to achieve population capacity for smolts ranged from 777 to 901 adults. Note that the maximum number of adults needed to achieve population capacity for smolts is less than those needed to achieve population capacity for parr. Extrapolating Chiwawa results to the entire Wenatchee River basin resulted in maximum spawner estimates of 2,904 to 3,368 adults. These estimates are considerably higher than those estimated from fitting population models to Wenatchee River basin data. The latter estimated maximum spawners ranging from 1,389 to 2,381 adults. We were able to estimate habitat capacity only with the Ricker model (Table 11). Using quantile regression to calculate the 90% RI for the Ricker model resulted in a maximum spawner abundance of 824 adults for the Chiwawa River watershed and 3,129 adults for the entire Wenatchee River basin. Extrapolating Chiwawa results to the entire Wenatchee River basin resulted in a maximum spawner estimate of 3,080, which is close to the estimate generated by fitting the model to Wenatchee River basin data.

Table 11. Comparison of the number of spawners needed to achieve smolt capacities in the Chiwawa River watershed and the Wenatchee River basin. Maximum spawners were estimated directly from the stock-recruitment functions. Maximum spawners for the entire Wenatchee River basin were also estimated as the product of the extrapolated smolt numbers times the ratio of maximum spawners to smolt capacity for Chiwawa spring Chinook. Because of the nature of the Beverton-Holt model, no maximum spawners can be calculated from that model.

Capacity type	Model	Spawners need to achieve smolt capacity		
		Chiwawa	Wenatchee	
			Chiwawa extrapolation	Wenatchee data
Population capacity	Smooth Hockey Stick	777	2,904	1,389
	Ricker	901	3,368	2,381
Habitat capacity	QR Ricker	824	3,080	3,129

As an additional exercise, we calculated smolt capacities and maximum spawners generated from fitting population models to smolt and spawner data in the Chiwawa River, Nason Creek, and White River watersheds, and compared the sum of those estimates to the Wenatchee River basin estimates. Only the Ricker model could be fit to the White River and Nason Creek data (see Hillman et al. 2017). Estimated population capacities from the Ricker model were 49,532 smolts in the Chiwawa, 4,412 smolts in Nason Creek, and 4,659 smolts in the White River, resulting in a cumulative population capacity of 58,603 smolts (1,550 spawners are needed to achieve this cumulative smolt capacity). The cumulative population capacity estimate is nearly 60% of the total population capacity calculated from fitting the Ricker model to the entire Wenatchee River basin data. If these estimates are correct, this means that about 40% of the current Wenatchee River basin smolt capacity is outside the Chiwawa River, Nason Creek, and White River watersheds. Hillman et al. (2017) report that over the period 1989 to 2016, on average, 76% of spring Chinook spawning occurs in the three watersheds. Thus, a large percentage of smolt capacity is generated outside the major spawning areas. We believe this highlights the importance of the mainstem Wenatchee River as a rearing area for juvenile spring Chinook.

Recommendations

Based on the simple analyses conducted in this report, we offer the following recommendations:

1. Where sufficient stock and recruitment data are available, and the data have sufficient contrast, then use population (stock-recruitment) modeling as the primary method to calculate population capacity and the number of spawners needed to produce the maximum number of recruits under current or average habitat conditions. Select the best fitting stock-recruitment model based upon AIC_c, unless other factors suggest otherwise, such as evidence for a biological mechanism. A biological mechanism supporting a Ricker function, for example, would be that there is a stock-dependent effect on the mortality of eggs and juveniles (i.e., mortality is proportional to the initial cohort size). When AIC_c values are not appreciably different, then select the model that is most useful (e.g., Ricker and smooth hockey stick models are easier to work with than the Beverton-Holt model).
2. Adult-to-adult data are the most relevant because they account for all life stages and delayed effects in freshwater (e.g., small size at migration), but they are also the most variable (i.e., low R^2). Therefore, adult-to-juvenile data (e.g., parr, yearling smolts, total migrants) are likely the most useful for determining freshwater population capacity. Where data are available, pre-spawn adult to spawning adult survival can also be assessed using population models to evaluate density dependence and pre-spawn adult capacity.
3. The population models used to estimate population capacity should also be used in reference streams so one can make comparisons of carrying capacities and density-corrected productivities. Unless there are good reasons for selecting a different juvenile life-stage, the default should be to use yearling smolts because they represent the capacity of the tributaries to produce yearlings and it is also a clear identification and quantification of a migrant life-stage.
4. In the absence of fish-habitat models, quantile regression can be used to estimate habitat capacity by calculating reference intervals for the population models. The percentage of the reference interval should be set using the error in the estimation of the recruits and the level of desire to exclude anomalous data. For example, if the 95% confidence interval is approximately 10% of the recruitment estimate, then the reference interval should be set at 90% (e.g., RI = 100% - C.I.%).
5. Where sufficiency conditions in (1) are not met, use habitat-based expansion of density at capacity for the most ecologically similar population. For example, use Twisp capacity estimates for habitat-based expansions in the Methow. The habitat expansion metric should be "total stream area weighted by intrinsic potential and temperature limited," unless there are good reasons for a different expansion. The primary idea is to exclude areas that are known to not produce fish because of passage, temperature, or other limitations.
6. Capacity estimates should be described within the context of the information that was used to derive estimates. For example, spawner distribution of hatchery-origin fish could influence estimates of capacity if they are within poor habitat. However, the capacity estimates do reflect the historic and current hatchery practices. It is unknown how the capacity estimates would change if a different hatchery program that produced different spawning distributions was to be implemented. However, if those data do become available, then capacity estimates can be revised. Similarly, significant enhancements (e.g.,

improved passage) or degradations (e.g., fire) in habitat can also change capacity and can be incorporated into future estimates of capacity.

7. Regardless of the method used to estimate capacity, always describe the limitations of the data and assumptions of the models. Note where assumptions are violated and how these violations could affect the results of the analysis.

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APPENDIX 2: HATCHERY REPLACEMENT RATES

Based on ideas developed by the HETT, in February 2016, the HCP Hatchery Committees and PRCC Hatchery Subcommittee agreed to the following rules and HRR targets:

1. Use the estimated 40% HRR Target during 5-year statistical evaluation periods.
2. Use varying degrees of action depending on the numbers of years that annual HRR deviates from Target.
    a. Green Light (below Target for ≤ 2 years).
    b. Red Light (below Target for > 2 years).
3. Each program will have its own HRR target with the following exceptions.
    a. Nason Creek spring Chinook will use the Chiwawa Target (there are currently no data to calculate a target for Nason Creek spring Chinook).
    b. Methow and Chewuch spring Chinook will use the greater of their two Targets (they are MetComp stock and evaluated similarly).

Table 1. Release numbers and 5-year hatchery replacement rates (HRR) targets for Upper Columbia River Hatchery Programs.

Species	Owner	Program (Hatchery)	Basin (Purpose)	Smolts released[1]	5-Year HRR[2]
Steelhead	CPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	123,650	6.9
Steelhead	CPUD	Eastbank (Chiwawa)	Wenatchee (Safety Net)	123,650	6.9
Steelhead	DPUD	Wells (Wells)	Columbia (Safety Net)	160,000	26.5
Steelhead	DPUD	Wells (Wells)	Methow (Safety Net)	100,000	26.5
Steelhead	DPUD	Wells (Wells)	Twisp (Conservation)	48,000	26.5
Steelhead	GPUD	Wells (Omak)	Okanogan (Conservation)	100,000	7.3 [3]
SUM Chinook	CPUD	Eastbank (Chelan Falls)	Chelan (Conservation)	176,000	5.7
SUM Chinook	CPUD	Eastbank (Chelan Falls)	Chelan (Harvest)	400,000	5.7
SUM Chinook	CPUD, GPUD	Eastbank (Dryden)	Wenatchee (Conservation)	500,000	5.7
SUM Chinook	DPUD	Wells (Wells)	Columbia (Harvest)	320,000	3.0
SUM Chinook	GPUD	Eastbank (Carlton)	Methow (Conservation)	200,000	3.0
SUM Chinook	CCT	Chief Joseph	Okanogan (Harvest)	1,100,000	8.6
SPR Chinook	CPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	144,026	6.7
SPR Chinook	CPUD, DPUD, GPUD	Wells (Methow)	Methow (Conservation)	193,765	3.8
SPR Chinook	DPUD, GPUD	Wells (Twisp)	Methow (Conservation)	30,000	2.7
SPR Chinook	GPUD	Eastbank (Nason)	Wenatchee (Conservation)	223,670	6.7

[1] Release goal established by HCPs and adjusted by HC.
[2] Derived from Annual Reports.
[3] Harvest not included.

APPENDIX 3: PNI and pHOS Targets and Sliding Scales

Select CPUD, DPUD, and GPUD funded hatchery mitigation programs have PNI management targets, while others do not. Table 1 summarizes management strategies by species and population. Detailed information can be found in the sections that follow. Descriptions provided in the following sections are taken directly from HGMPs and/or issued and draft permits.

Table 1. Summary of management strategies by species and population.

Species	Population	Management Strategy	Comments
Spring Chinook	Wenatchee	Sliding Scale of PNI management	Details can be found in Section 2.0
	Methow	Two—population sliding scale PNI management	Details can be found in Section 3.0
	Okanogan	None Currently	Details can be found in Section 4.0
Steelhead	Wenatchee	Two-zone management.	Details can be found in 5.0
	Methow	In-development	Details forthcoming; Section 6.0
	Okanogan	None Currently	Details can be found in Section 7.0
Summer Chinook	Wenatchee	None Currently	Details can be found in Section 9.0
	Methow	None Currently	Details can be found in Section 10.0
	Okanogan	0.67; pHOS 0.30	Details can be found in Section 11.0
	Upper Columbia River (Wells and Chelan Falls)	None Currently	Details can be found in Section 12.0
Fall Chinook	Hanford Reach	0.67	Details can be found in Section 13.0

2.0 Wenatchee Spring Chinook

Wenatchee spring Chinook will be managed according to the sliding scale identified in the Wenatchee Spring Chinook Management Plan (2010) and Permit Numbers 18118 and 18121. The sliding scale is based upon the estimated number of natural origin spring Chinook over Tumwater Dam. As more information becomes available the sliding scale may be adjusted as a result of gaining a better understanding of the pre-spawn mortality rate and carrying capacity.

Table 2. Sliding scale of PNI goals based on natural origin spring Chinook run size expected to the Wenatchee River basin. Percentiles are based on adult returns observed between 1999 and 2008.

Percentile	NOR Run Size				PNI
	Chiwawa	Nason Creek	White	Wenatchee River (above TWD)	
>75th	>372	>350	>87	>910	≥ 0.80
50% - 75%	278-372	259-349	68-86	631-909	≥ 0.67
25% - 50%	209-277	176-258	41-67	525-630	≥ 0.50
10%-25%	176-208	80-175	20-40	400-524	≥ 0.40

<10th	<175	<80	<20	<400	Any PNI

3.0 Methow/ Chewuch Spring Chinook

The following sliding scale (Table 3) is presented in the April 14, 2016 draft Methow Hatchery Spring Chinook Section 10-Draft. It is anticipated that no further changes will be made to the sliding scale prior to issuance of the final permits.

Table 3. PUD PNI sliding scale calculations for a range of natural run sizes.

Natural Origin Returns	PUD pHOS	WNFH pHOS	PUD pNOB	2-Pop PNI	PUD PNI (equation)
<300	Ensure minimum of 500 total spawners				
300	0.40	0.2	0.75	0.67	0.67
500	0.40	0.2	0.80	0.68	0.76
900	0.30	0.15	1.00	0.78	0.80
1500	0.25	0.1	1.00	0.8	0.80
2000	0.25	0.1	1.00	0.8	0.80
2500	0.25	0.1	1.00	0.8	0.80

4.0 Okanogan Spring Chinook

The Okanogan spring Chinook program is a re-introduction effort implemented as a non-essential experimental population under ESA Section 10j to re-introduce spring Chinook into the Okanogan River. As a non-essential experimental population targeting re-introduction and establishment of a local population of spring Chinook, the Okanogan spring Chinook program will not conduct adult management actions to reduce the proportion of 10j hatchery fish on the spawning grounds or conduct broodstocking efforts in the Okanogan for a 10-year period (2014 – 2023), as such, no PNI or pHOS objectives have been identified for this program in this 10-year period.

CJH Program segregated production released into the mainstem Columbia River are non-listed Leavenworth stock released reared/acclimated/released at CJH. Although no PNI or pHOS targets are identified for the Okanogan 10j population, minimizing strays from the CJH segregated spring Chinook program is a program objective, as such, returning segregated program fish will be subject to directed harvest and aggressive adult surplusing at CJH to minimize straying to the Okanogan River Basin as well as other extant upper Columbia River spring Chinook populations. Stray targets for the segregated program are 5% or less stray rate (i.e. spawning contribution to other upper Columbia River spring Chinook populations).

5.0 Wenatchee Steelhead

Interim escapement goal for Wenatchee River steelhead will be 1,500 spawners with an additional goal of attaining an average PNI of 0.67 for the Wenatchee River basin population as a whole. To achieve the stated goal, the Wenatchee steelhead program will use a two-zone management approach wherein the upper basin (above TWD) will be managed for recovery using an integrated recovery program, a separate spawning escapement goal, and a PNI standard to achieve the overall basin goal of an average PNI over time of 0.67 (Table 4). Areas below TWD will be managed to minimize hatchery supplementation with a pHOS goal of < 0.10.

Steelhead returning upstream of TWD will be managed as an integrated recovery program with a pNOB goal of 1.0. The above TWD escapement goal will be 1,094 spawners. Working within this framework, pNOB will be maximized above TWD while pHOS will be minimized.

Table 4. Wenatchee steelhead two-zone management and PNI targets.

Location	Run Escapement Goal	pNOB Conservation Program	pNOB Safety Net Program	pHOS	PNI
Above TWD	1,094	1.0	0.0	Varies	Varies
Below TWD	406	N/A	N/A	< 0.10	< 0.67
Basin Total	1,500	N/A	N/A	Minimal	Average = 0.67

6.0 Methow Steelhead

Methow steelhead PNI targets are currently in development.

7.0 Okanogan Steelhead

Current program has no PNI goal. CTCR submitted an Okanogan steelhead HGMP to NOAA Fisheries on February 4, 2014. Within the HGMP provisions were included to allow a greater collection of natural-origin broodstock and multiple adult management strategies to address over-escapement of hatchery-origin steelhead to the spawning grounds. The HGMP also identified a near-term (1-4 years) and a long-term PNI objectives of 0.50 and > 0.67, respectively. Once NOAA has completed the consultation and issued a new permit, providing the opportunity to increase the proportion of natural-origin fish in the broodstock and additional adult management strategies, the program will adopt the PNI objectives and this Appendix can be amended accordingly.

8.0 Wells Columbia Mainstem Safety-net Steelhead

The Safety-Net Mainstem Columbia component released below Wells Dam will be managed primarily at the Wells Hatchery volunteer channel. The objective of the adult management of the Safety-Net Mainstem Columbia component is to prevent runs of this component from moving into natural spawning areas. This will be accomplished through in-river harvest and removal of volunteers at the Wells Hatchery outfall. There are no PNI goals for this component.

9.0 Wenatchee Summer Chinook

No PNI goals are established.

10.0 Methow Summer Chinook

No PNI goals are established.

11.0 Okanogan Summer Chinook

Okanogan summer/fall Chinook will be managed to achieve a 5-year rolling average PNI of 0.67 and pHOS of 0.30. Strategies to achieve that PNI target include up to 100% pNOB, aggressive removal of hatchery-origin Chinook in selective fisheries, at the Okanogan weir, and during surplusing at CJH ladder. Reduction in the number of juveniles released in the Okanogan River Basin (integrated program) is also a management option, should adult management actions be unable to control the proportion of hatchery fish on the spawning grounds to achieve that PNI target.

CJH segregated summer/fall Chinook program rears/acclimates/releases smolts into the mainstem Columbia River at CJH. Broodstock are 100% hatchery-origin, as such no PNI target for this production component. Stray rate (i.e. contribution to upper Columbia summer/fall Chinook populations) is 5% or less. Adult management on returning adults from the segregated program include fisheries, removal at the Okanogan weir, and removal at the CJH ladder.

12.0 Upper Columbia Summer Chinook (Chelan Falls and Wells)

No PNI goals are established. Chelan Falls and Wells FH summer Chinook programs are segregated harvest programs designed to provide opportunity for harvest. Adult returns are not intended to spawn naturally; therefore, there is no escapement goal for natural spawning areas. Adult returns will be managed to meet program objectives. Chelan Falls and Wells Hatchery summer Chinook are available for harvest in the ocean and Columbia River commercial, tribal, and recreational fisheries.

13.0 Priest Rapids Fall Chinook

The Hanford Reach fall Chinook population is intentionally supplemented by Grant PUD at the Priest Rapids Hatchery and the ACOE at the Priest Rapids and Ringold Springs hatcheries. Managers desire to achieve a population level PNI that includes all hatchery programs of ≥0.67. Grant PUD and the HSC do not have control over operation or expansion of the ACOE program and therefore will strive to operate the Priest Rapids Hatchery fall Chinook program in a way that does its fair share of achieving a population level PNI of 0.67.

APPENDIX 4: SPATIAL DISTRIBUTION OF SPAWNERS OR REDDS

Strategies for conservation programs typically intend that hatchery and naturally produced fish spawn together and in similar locations. However, in some cases, strategies may differ from this paradigm. In Table 1, conservation programs that have a spatial distribution management plan that deviates from similar to the natural spawning spatial distributions are presented. Otherwise, conservation programs are intended to have a spawning distribution similar to the natural origin spawning spatial distributions, as described by M&E Objective 5.3.

Table 1. Management targets for the spatial distribution of hatchery-origin redds for conservation programs that deviate from Objective 5.3.

Program	Target	Rational	Source
Carlton Summer Chinook	The observed spawning distribution of hatchery origin Methow summer Chinook from 2005-2010 represents the base-line spawner distribution for evaluating the performance of the hatchery program (i.e., M&E plan check-ins). It is acknowledged that this distribution is lower in the River than the spawning distribution of natural origin summer Chinook salmon.	Based upon an assessment of summer Chinook and ESA-listed spring Chinook abundance and spawner distribution, it was determined that an increase in summer Chinook spawning abundance in the upper most range of natural origin summer Chinook distribution or potentially above the current range may pose an unknown and potentially adverse impact to ESA listed spring Chinook. Due to the concern for spring Chinook, the HSC has endorsed an acclimation site in the Methow Basin that is lower in the basin than may be required to attain exact replication of natural and hatchery origin summer Chinook spawner distribution.	SOA 2011-02 Priest Rapids Coordinating Committee Hatchery Subcommittee Statement of Agreement on Monitoring & Evaluation (M&E) Objective for Spawning Distribution of Hatchery-Origin Summer Chinook
Dryden Summer Chinook	The observed spawning distribution of hatchery origin Wenatchee summer Chinook from 2008-2013 (previous 5 years to the current M&E check-in cycle) represents the base-line spawner distribution for evaluating the performance of the hatchery program (i.e., M&E plan check-ins).	The primary site endorsed by the HSC for Grant PUD overwinter acclimation of summer Chinook is the Dryden Pond, and is the current acclimation and release site for the existing summer Chinook supplementation program funded and owned by Chelan PUD. Because current data indicates that spawning distribution of hatchery summer Chinook from the existing program is lower in the Wenatchee River than natural origin spawners, expectations are that acclimation of Grant PUD's summer Chinook at Dryden Pond would continue to return hatchery origin summer Chinook that result in different spawning distributions for hatchery and natural summer Chinook.	Adapted from SOA 2011-02 Priest Rapids Coordinating Committee Hatchery Subcommittee Statement of Agreement on Monitoring & Evaluation (M&E) Objective for Spawning Distribution of Hatchery-Origin Summer Chinook

APPENDIX 5: WITHIN HATCHERY REARING TARGETS

Rearing Targets for Upper Columbia River Hatchery Programs. K-factor or fork length targets will be determined based on data from the pending "Five-Year Report."

Table 1. Numbers, fish per pound (fpp), coefficient of variation (CV), and condition factor (K) targets at release of Upper Columbia River Hatchery Programs.

Hatchery	Species	Life Stage	Basin	Release number	FPP	CV	K-factor
Methow	Spring Chinook	Yearling	Methow	193,765[1]	15	<10	TBD
Methow	Spring Chinook	Yearling	Twisp	30,000	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Columbia	700,000	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Okanogan	200,000	15	<10	TBD
Chiwawa	Spring Chinook	Yearling	Wenatchee	144,026	18	<10	TBD
Nason	Spring Chinook	Yearling	Wenatchee	223,670[3]	18-24	<10	TBD
Winthrop	Spring Chinook	Yearling	Methow	400,000	17	<10	TBD
Leavenworth	Spring Chinook	Yearling	Wenatchee	1.2 M	17	<10	TBD
Wells	Steelhead	Yearling	Columbia	160,000	6	<10	TBD
Wells	Steelhead	Yearling	Methow	100,000	6	<10	TBD
Wells	Steelhead	Yearling	Twisp	48,000	6	<10	TBD
Wells	Steelhead	Yearling	Omak	~100,000[4]	5-8	<10	TBD
Wells	Steelhead	Yearling	Okanogan	~100,000[4]	5-8	<10	TBD
Winthrop	Steelhead	Two year	Methow	200,000	4-6	<10	TBD
Chiwawa	Steelhead	Yearling	Wenatchee	247,300[5]	6	9.0	TBD
Wells	Summer Chinook	Subyearling	Columbia	480,000	50[6]	<7	TBD
Wells	Summer Chinook	Yearling	Columbia	320,000	10	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Columbia	400,000	50	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Okanogan	300,000	50	<7	TBD
Chelan Falls	Summer Chinook	Yearling	Chelan	576,000	13	9.0	TBD
Entiat	Summer Chinook	Yearling	Entiat	400,000	17	<10	TBD
Carlton	Summer Chinook	Yearling	Methow	200,000	13-17	<12	TBD
Chief Joseph	Summer Chinook	Yearling	Columbia	500,000	10	<7	TBD
Chief Joseph	Summer Chinook	Yearling	Okanogan	799,998[7]	10	<7	TBD
Dryden	Summer Chinook	Yearling	Wenatchee	500,001	18	9.0	TBD
Priest	Fall Chinook	Subyearling	Columbia	7.3 M[8]	50	<10	TBD
Ringold	Fall Chinook	Subyearling	Columbia	3.5 M	50	<10	TBD

[1] The total release includes the release of 108,249 into the Methow River at the Methow Fish Hatchery, 25,000 into the Methow River at the Goat Wall site, and 60,516 into the Chewuch River at the Chewuch Acclimation Facility.

[2] These fish come from Winthrop National Fish Hatchery (MetComp) eyed eggs.

[3] The total release includes 125,000 conservation fish and 98,670 safety net fish.

[4] The combined Okanogan and Omak steelhead release number is 100,000.

[5] The total release includes 66,771 fish into Nason Creek, 53,170 into the Chiwawa River, 102,359 into the Wenatchee River, and 25,000 into Blackbird Pond.

[6] The Wells subyearling Chinook are not reared to achieve a specific size target. The fish are released on a date to optimize survival and are grown to the largest size possible before release.

[7] The total release is divided equally among the Omak, Riverside, and Similkameen Acclimation Ponds.

[8] The total release consists of 5.6 m fall Chinook for the Grant PUD program and 1.7 M fall Chinook for the Army Corps of Engineers program.

APPENDIX 6: IDENTIFYING AND ANALYZING REFERENCE POPULATIONS

An important goal of supplementation is to increase spawning abundance and natural-origin recruitment of the supplemented population, and not reduce the productivity of the supplemented population. Indeed, a successful supplementation program must increase spawning abundance and natural-origin recruitment to levels above those that would have occurred without supplementation. There are several methods that can be used to test the effects of supplementation programs on these population metrics. One important method is to compare the performance of population metrics (e.g., spawning abundance, natural-origin recruitment, and productivity) in the supplemented population to those in un-supplemented (reference) populations. By comparing supplemented populations to reference populations, one can determine if the supplementation programs benefit, harm, or have no effect on the supplemented populations. These comparisons, however, are only valid if the performance of the reference populations is similar to the performance of the supplemented population prior to the period of supplementation. If the performance of the two populations differs significantly before any supplementation occurs, then any results from comparing the two populations after supplementation will be suspect. It is therefore important to select reference populations that are as similar as possible to the supplemented populations.

One of the goals of the Conceptual Approach to Monitoring and Evaluating the Chelan County PUD Hatchery Programs (Murdoch and Peven 2005) is to use reference populations to analyze the potential effects of hatchery supplementation programs on natural-origin salmon and steelhead spawner abundance and productivity[15]. Murdoch and Peven (2005) identified specific objectives to evaluate the performance of the program. For example, Objective 1 determines if the supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population (supplemented population) relative to a reference population. Objective 7 determines if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (e.g., number of juveniles per redd) of supplemented streams when compared to reference streams. The relevant questions tested under each objective are as follows:

Objective 1:

- Is the annual change in the number of natural-origin recruits produced from the supplemented populations greater than or equal to the annual change in natural-origin recruits in an un-supplemented population?
- Is the change in natural replacement rates within the supplemented population greater than or equal to the change in natural replacement rates in an un-supplemented population?

Objective 7:

[15] Productivity is defined as adult recruits per spawner, where recruits are the number of adults produced from a given brood year (i.e., spawners plus adults harvested).

- Is the change in numbers of juveniles (smolts, parr, or emigrants) per redd in the supplemented population greater than or equal to that in an un-supplemented population?[16]

In this paper, we describe methods used to identify suitable reference streams and statistical techniques that can be used to compare reference populations with supplemented populations. Although we apply the methods described in this paper to Chiwawa spring Chinook salmon (hereafter referred to as Chinook), the methods should also apply to steelhead and other supplemented salmon stocks in the Upper Columbia Basin.

Identification of Reference Populations

Reference populations are an important component of an effectiveness monitoring design because they provide the standard by which treatment conditions are compared (ISRP and ISAB 2005; Murdoch and Peven 2005; Galbreath et al. 2008). Selecting appropriate reference areas and maintaining them over long periods of time is needed to establish the effectiveness of supplementation programs.

We developed a three-step process for identifying suitable reference populations (Figure 1). Each step serves as a filter. That is, potential reference populations are evaluated based on specific criteria under each step. Populations that pass through each step are considered suitable reference populations for a specific supplemented population.

[16] In this paper, we only address adult recruits, not juvenile recruits. This is because we were unable to find suitable reference populations for analysis of juveniles. However, the methods described in this paper would also apply to juveniles.

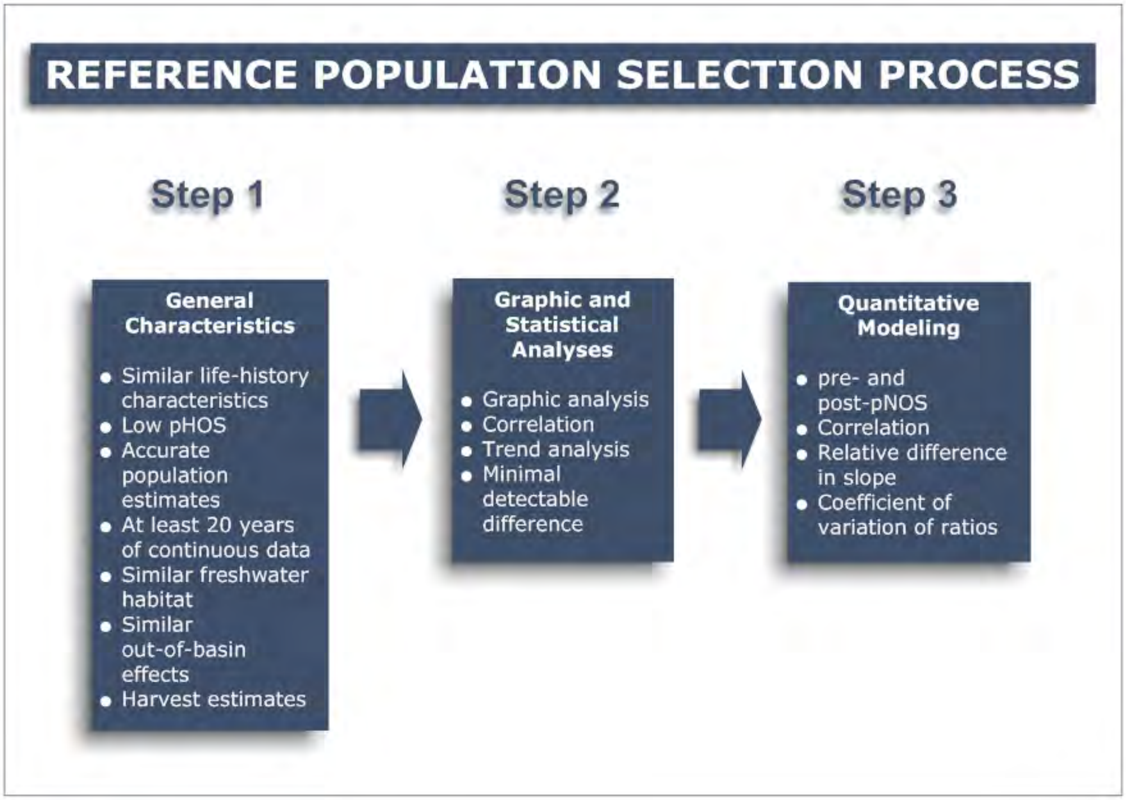

Figure 1. Criteria evaluated during each step in the process of identifying suitable reference populations.

Step 1: General Characteristics

Under step 1, potential reference populations are evaluated based on several general criteria. When compared to the supplemented population, potential reference populations should have:

- Similar life-history characteristics (e.g., run timing, migration characteristics, etc.).
- No or few hatchery fish in the reference area (pHOS < 10%).
- Accurate abundance estimates.
- Long time series of natural-origin abundance and productivity estimates (at least 20 years of continuous data).
- Similar trends in freshwater habitat.
- Similar out-of-basin effects (i.e., similar migration and ocean survivals).
- Harvest estimates for adjusting escapement estimates.

We used these criteria to begin the process of selecting suitable reference populations for the Chiwawa spring Chinook program. We began by identifying stream-type Chinook populations within the Columbia Basin. Galbreath et al. (2008; their Table 1) identified stream-type Chinook populations within the Columbia River Basin that may serve as suitable reference populations for hatchery programs. Supplementing their work with data from the NOAA Fisheries Salmon Population Summary Database, we identified 18 candidate stream-type Chinook populations that may serve as reference populations for the Chiwawa supplementation program (Table 1).

Table 1. Populations of stream-type Chinook salmon and their comparison to Chiwawa spring Chinook.

Population	Similar life-history	No or few hatchery fish	Accurate abundance estimates	Long time series (at least 20 years)	Similar freshwater habitat impairments	Similar out-of-basin effects	Comments
Deschutes River	Yes	Yes	Yes	Yes	No	No	
John Day mainstem	Yes	Yes	Yes	Yes	No	No	
Middle Fk John Day	Yes	Yes	Yes	Yes	No	No	
North Fk John Day	Yes	Yes	Yes	Yes	No	No	
Granite Creek	Yes	Yes	Yes	Yes	No	No	
Wenaha River	Yes	No	Yes	Yes	Yes	No	Hatchery strays (>10%)
Minam River	Yes	No	Yes	Yes	Yes	No	Hatchery strays (>10%)
Slate Creek	Yes	Yes	Yes	No	No	No	
Secesh River	Yes	Yes	Yes	Yes	Yes	No	
Middle Fk Salmon River	Yes	Yes	Yes	No	No	No	Fair productivity est.
Big Creek	Yes	Yes	Yes	Yes	No	No	
Camas Creek	Yes	Yes	Yes	Yes	No	No	Fair productivity est.
Loon Creek	Yes	Yes	Yes	Yes	No	No	Fair productivity est.
Sulphur Creek	Yes	Yes	Yes	Yes	No	No	
Bear Valley Creek	Yes	Yes	Yes	Yes	No	No	
Marsh Creek	Yes	Yes	Yes	Yes	Yes	No	
North Fk Salmon River	Yes	Yes	No	No	Yes	No	
Lemhi River	Yes	Yes	Yes	Yes	No	No	
East Fk Salmon River	Yes	No	Yes	Yes	No	No	Hatchery strays (>10%)
Valley Creek	Yes	No	Yes	Yes	No	No	Hatchery strays (>10%)
Chamberlain Creek	Yes	Yes	Yes	No	Yes	No	
Naches River	Yes	Yes	Yes	Yes	Yes	No	
Little Wenatchee River	Yes	No	Yes	Yes	Yes	Yes	Hatchery strays (>10%)
Entiat River	Yes	No	Yes	Yes	No	No	Hatchery release ending

We then assessed the accuracy and length of the series of abundance estimates. We assumed that abundance estimates generated from expanded redd counts or adjusted weir counts would compare well with estimates in the Chiwawa Basin, which were based on expanded redd counts. In addition, we looked for populations that had an abundance data series that extended from at least 1981 to present. Based on this analysis, we identified 18 populations with abundance estimates that could be compared to those from the Chiwawa Basin (Table 1).

Next, we determined if the potential reference populations came from watersheds with habitat conditions similar to those in the Chiwawa Basin. For this exercise, we searched recovery plans and draft recovery plans to identify tributary factors that limit Chinook abundance, productivity, and survival within the reference populations. We compared these factors with those limiting

Chinook salmon in the Chiwawa Basin. Based on this analysis, we identified eight populations with habitat impairments similar to those in the Chiwawa Basin (Table 1).

Finally, we examined the potential reference populations to see if they experienced out-of-basin effects similar to spring Chinook from the Chiwawa Basin. In this case, we compared the number of mainstem dams that each potential reference population passes during migration. Six of the potential reference populations pass less than six mainstem dams; the other populations pass eight mainstem dams (Table 1). Only the Little Wenatchee population passes seven dams, similar to the Chiwawa population.

In sum, there were no reference populations that matched the Chiwawa spring Chinook population on all the criteria identified above. Differential out-of-basin effects and freshwater habitat conditions prevented most reference populations from matching with Chiwawa spring Chinook. However, some of the potential reference populations were similar to the Chiwawa population on several criteria and warranted further investigation. We selected the following populations for further investigation: Sesech River, Marsh Creek, Naches River, Little Wenatchee, and Entiat River.

We included the Little Wenatchee because it is within the Wenatchee River basin and experiences similar out-of-basin effects and has the same climatic and environmental conditions as the Chiwawa. A confounding effect with the Little Wenatchee is that Chiwawa hatchery fish have strayed into the Little Wenatchee. However, straying of Chiwawa hatchery fish should decrease with the change in source water to the Chiwawa acclimation ponds in 2006. We also included the Entiat River because it is an adjacent basin to the Chiwawa and experiences similar climatic and environmental conditions. The spring Chinook hatchery program that has operated in the Entiat since 1975 has been discontinued. Therefore, this population offers a unique opportunity to compare the Chiwawa population to a population in which the hatchery program has been discontinued.

Step 2: Graphic and Statistical Analysis

Graphic Analysis

Although we were unable to find potential reference populations that matched with the Chiwawa population on all criteria considered under Step 1, spawner abundance, natural-origin recruits (NORs), and productivity of some of the potential reference populations may nevertheless track closely with the Chiwawa population. If the time series of abundance, NORs, and productivity of a potential reference population tracks closely with the abundance, NORs, and productivity of the Chiwawa population, the reference population may provide a reasonable reference condition for testing the effects of supplementation on the Chiwawa population.

Under Step 2, we used graphing techniques to examine the relationship of abundance, NORs, and productivity between the Chiwawa population and the five reference populations (Sesech River, Marsh Creek, Naches River, Little Wenatchee, and Entiat River). We compiled spawner abundance, NORs, and productivity data from local biologists and the NOAA Fisheries Salmon Population Summary Database. We then compared time series plots of spawner abundance, NORs, and productivity data of potential reference populations with the Chiwawa population (Figures 2, 3, and 4; plots on the left side of figures). The time series only included the period 1981 to 1992, which represented the period before supplementation of the Chiwawa population (pre-treatment period). We also plotted the relationship between the abundance, NORs, and productivity of each potential reference population to the Chiwawa population (Figures 2, 3, and 4; plots on right side of figures). These plots show whether the reference populations closely tracked the Chiwawa population. As a point of reference, data points that fall along the dashed line would represent a perfect relationship between the two populations (i.e., both populations have identical abundance, NORs, and productivity estimates). While a perfect relationship between two independent populations is unrealistic, a strong linear relationship between the two populations indicates populations with similar trends.

Based on analysis of spawner abundance, the Naches River time series tracked more closely with the abundance of Chiwawa spring Chinook than did the other potential reference populations. The poor relationship with the other potential reference streams was largely because of the relatively high abundance of Chiwawa spring Chinook during the mid-1980s. As with spawner abundance, analyses of NORs indicated a close relationship between the Naches and Chiwawa populations. The other potential reference populations tracked poorly with the Chiwawa. The analyses of productivity indicated close relationships between potential reference populations and the Chiwawa population. The Naches, Sesech, and Little Wenatchee populations tracked the closest with the Chiwawa population.

When analyzing the potential effects of a supplementation program on fish performance, it is common to transform the data to meet various assumptions of statistical analysis. The most common transformation used to adjust abundance, NORs, and productivity data is the natural logarithm (LN or $\log_e$). We therefore transformed the spawner abundance, NORs, and productivity data using LN and re-plotted the relationships between the potential reference populations and the Chiwawa population (Figures 5, 6, and 7). We added 1 to each observation before taking its logarithm to avoid taking the logarithm of 0, which is undefined (note that the LN of 1 is 0).

By transforming spawner abundance, NORs, and productivity data, most of the potential reference populations tracked more closely with the Chiwawa population. The Naches, Entiat, and Little Wenatchee abundance data tracked the closest with the Chiwawa abundance data (Figure 5). For NORs, Marsh Creek and the Little Wenatchee populations tracked the closest with the Chiwawa (Figure 6). For productivity, the Naches, Sesech, and Little Wenatchee tracked the closest with the Chiwawa (Figure 7).

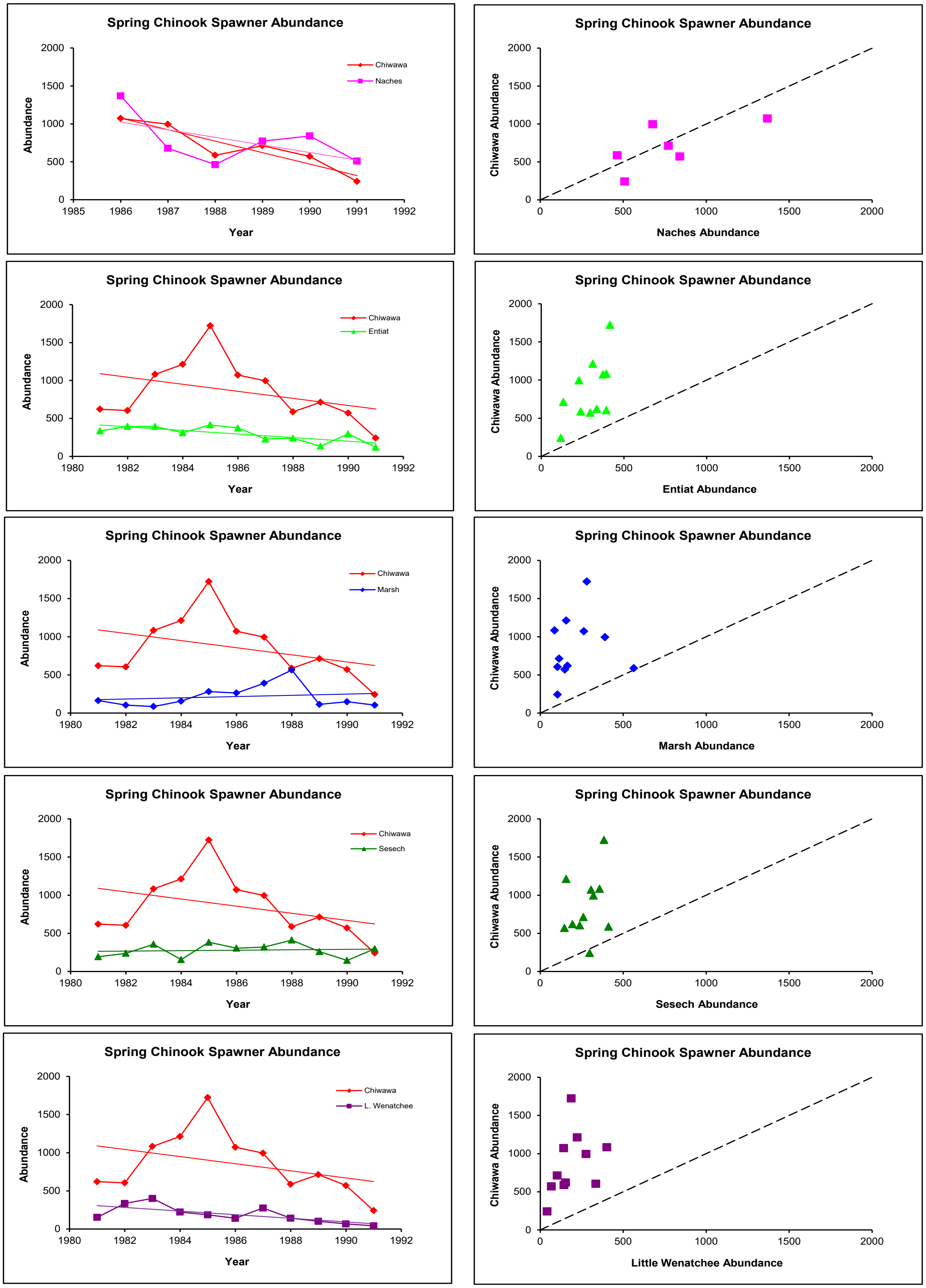

Figure 2. Time series of spawner abundance of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

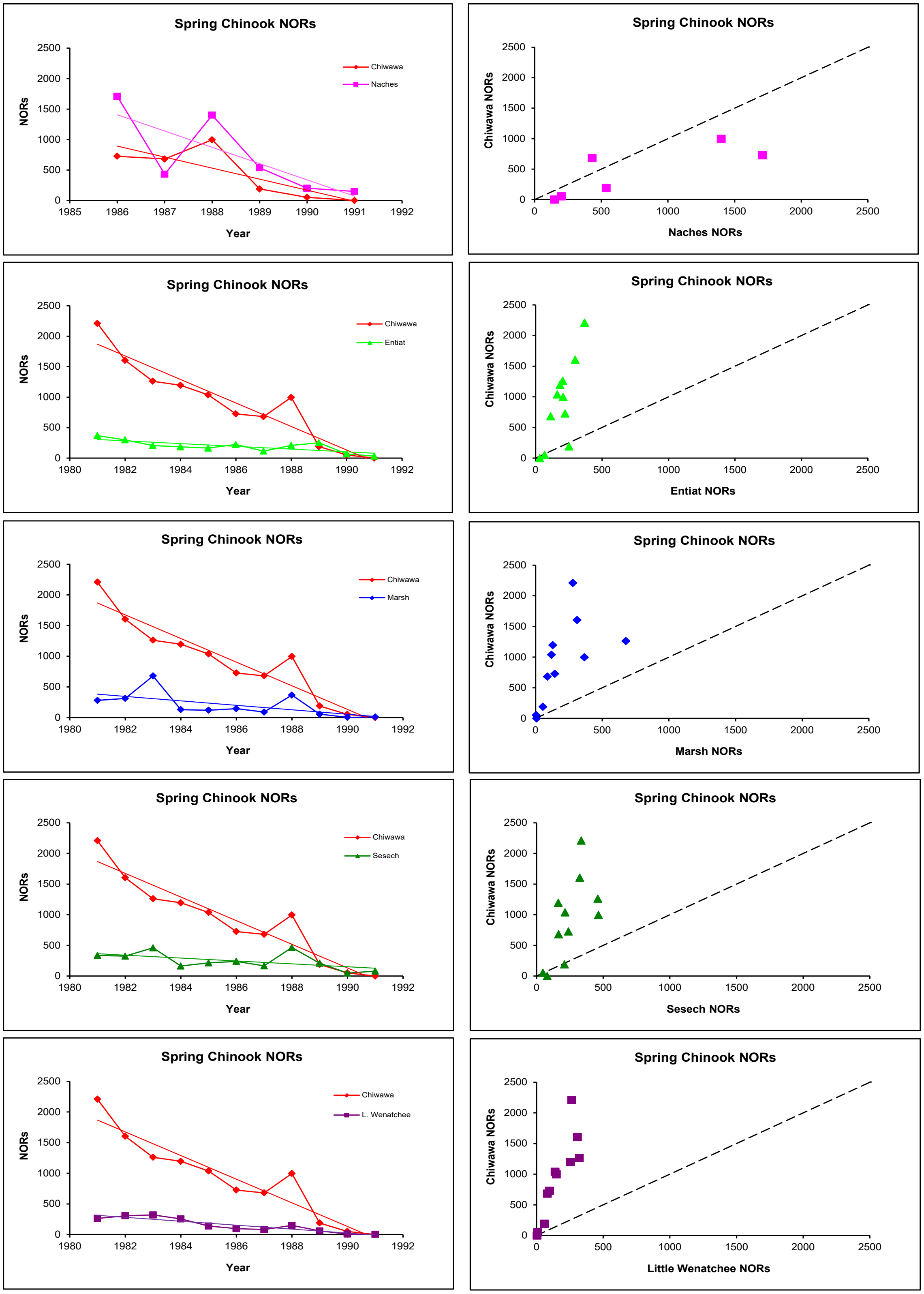

Figure 3. Time series of natural-origin recruits (NORs) of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

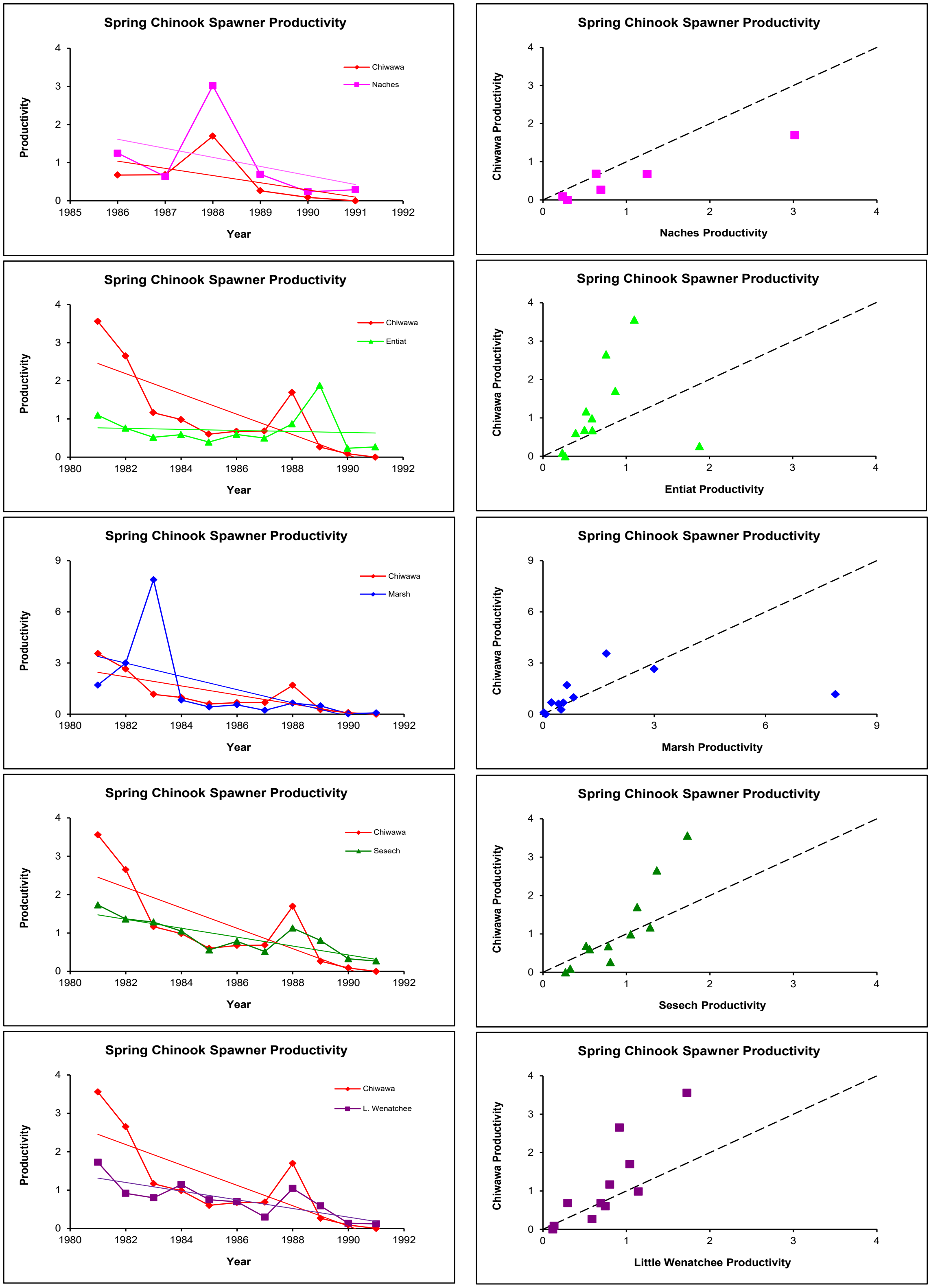

Figure 4. Time series of adult productivity of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

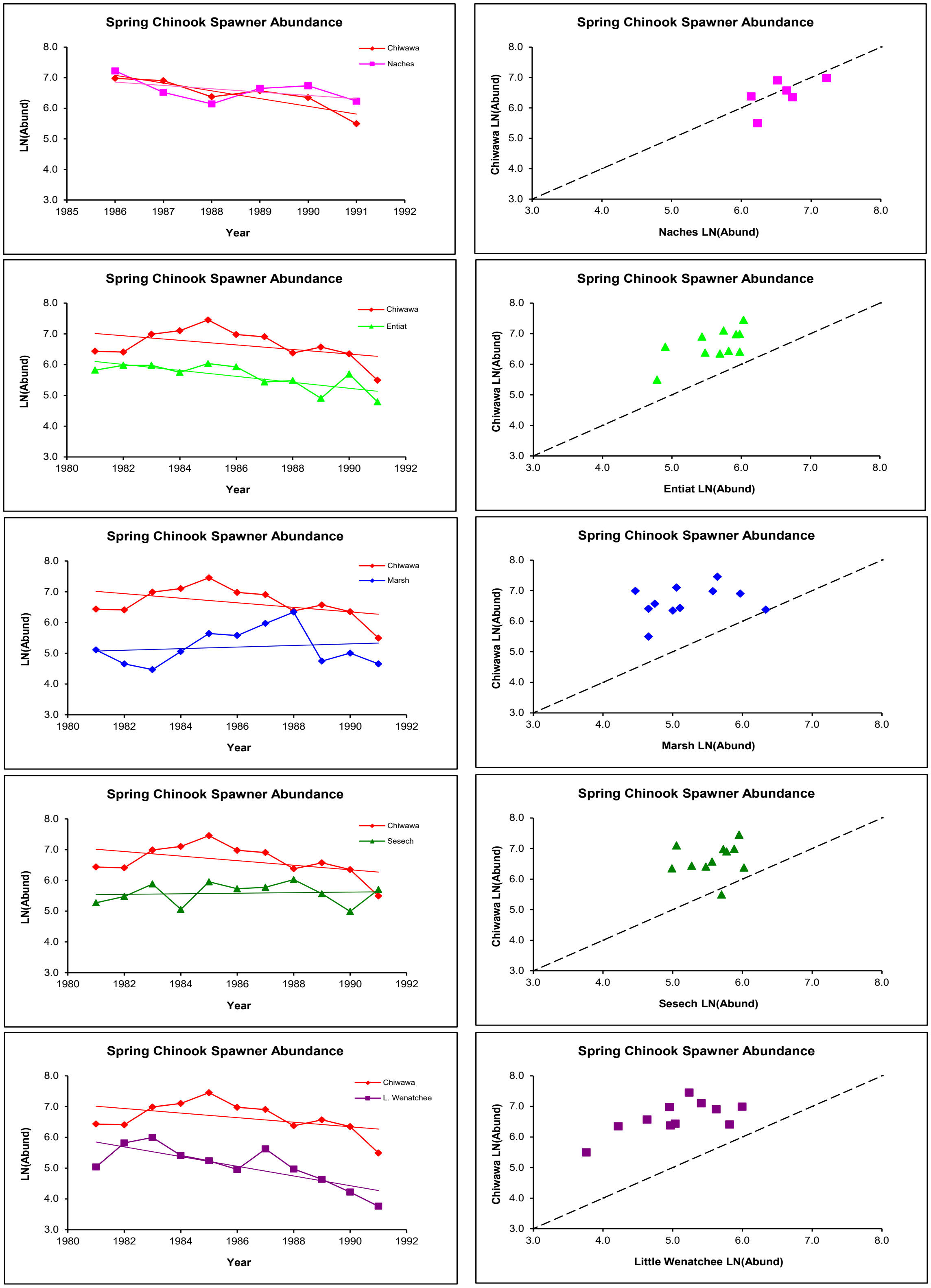

Figure 5. Time series of natural log spawner abundance of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

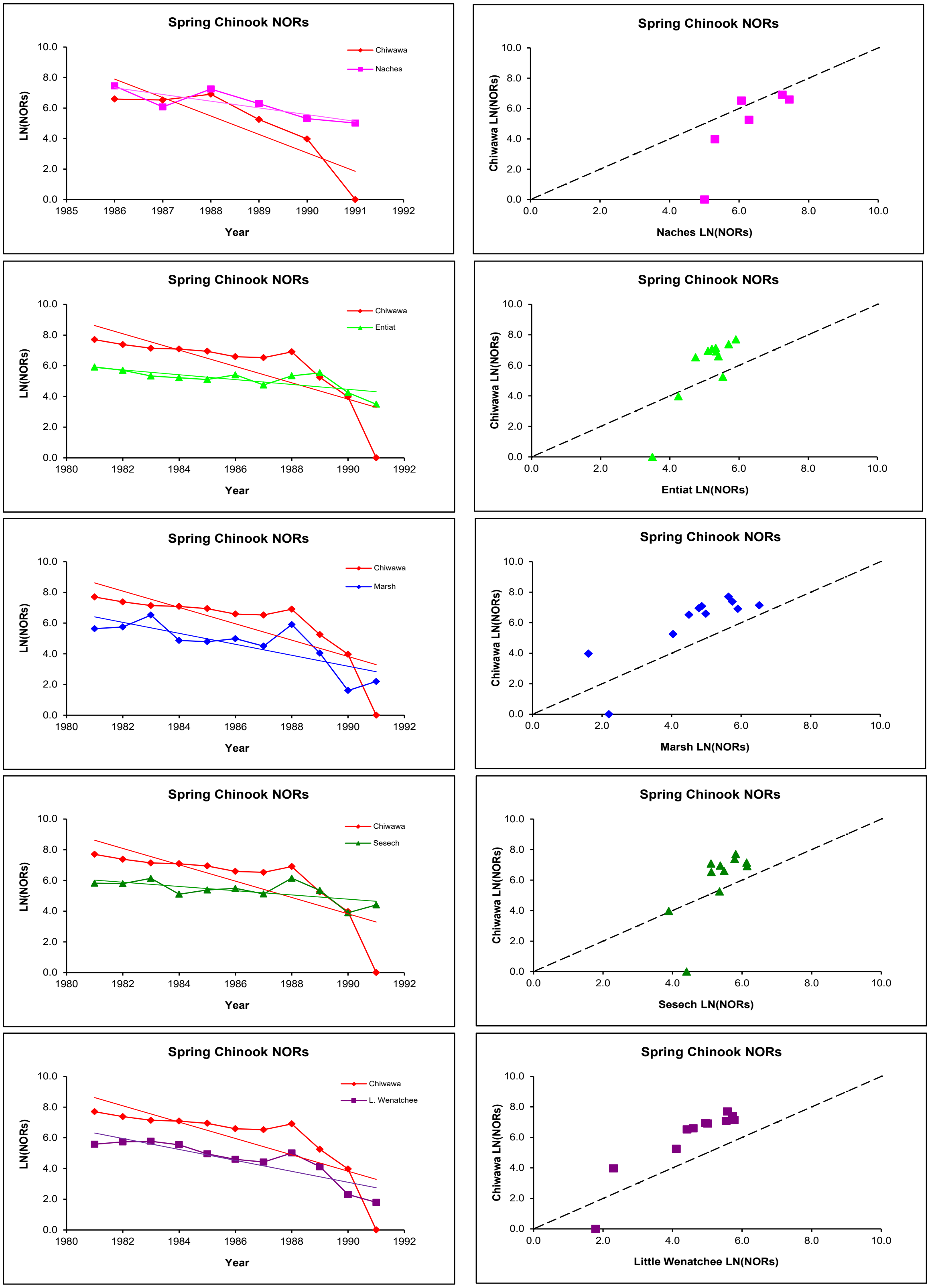

Figure 6. Time series of natural log natural-origin recruits (NORs) of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

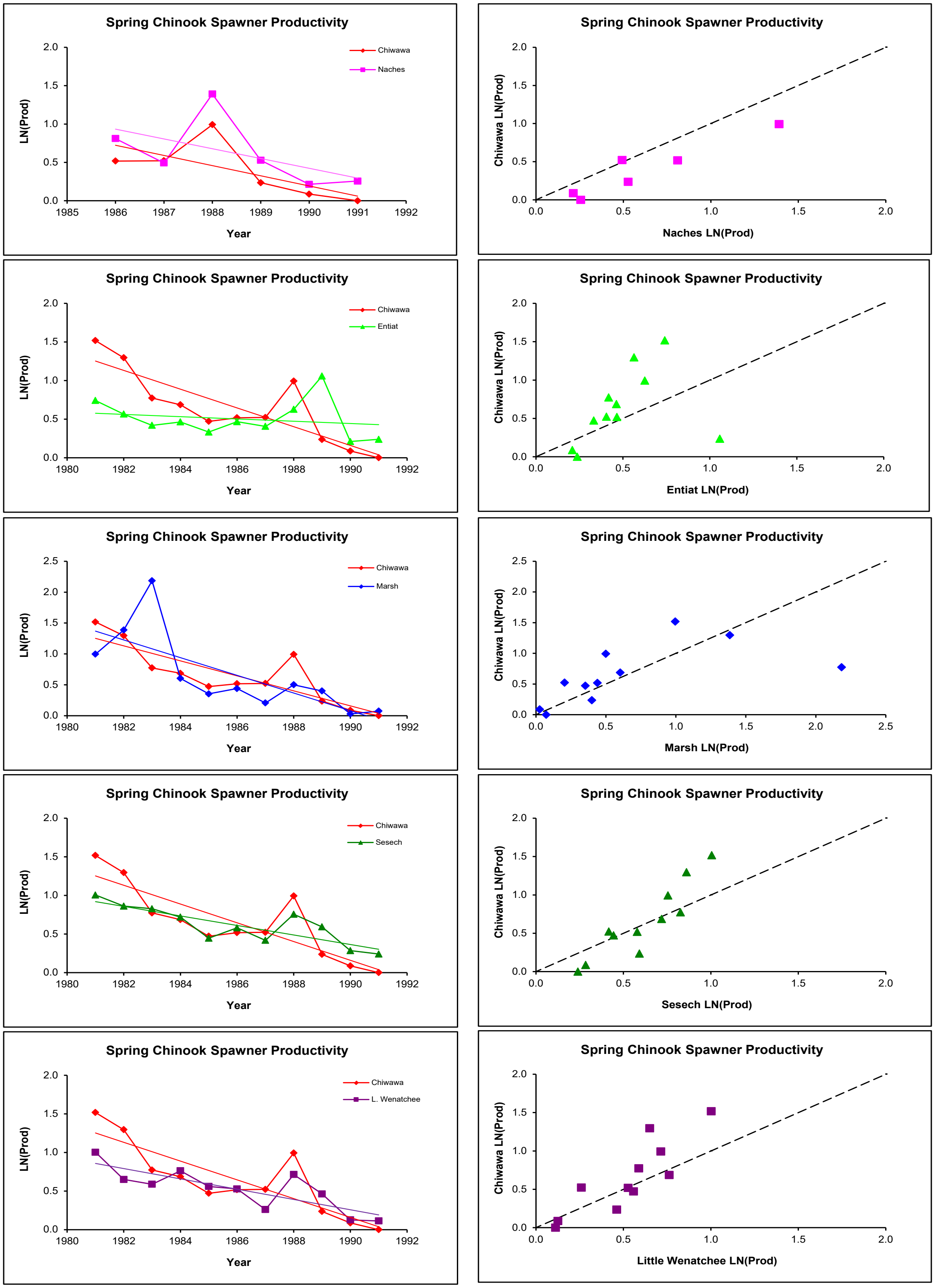

Figure 7. Time series of natural log adult productivity of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

Correlations and Trends

Other methods for evaluating the suitability of potential reference populations under Step 2 include correlation and trend analyses. For correlation analysis, we simply calculated the Pearson correlation coefficient, which is an index of the strength of the association between the potential reference populations and the Chiwawa population. The coefficient ranges from -1 to 1, where a value near 1 or -1 represents that strongest association between the populations. A value of 0 means no association. We used only spawner abundance, NORs, and productivity data during the pre-treatment period (1981-1992). We assumed that populations with coefficients greater than 0.6 represented reasonable reference conditions.

For trend analyses, we used least squares techniques to compute a straight-line trend through the spawner abundance and productivity data for the potential reference populations and the Chiwawa population. Trends were fit to the pre-treatment time series data (1981-1992). We then used t-tests to determine if the slopes of the trends between potential reference populations and the Chiwawa population differed significantly.

It is important to note that time-series trend analyses are susceptible to temporal correlations in the data. Autoregressive integrated moving average (ARIMA) models can be used to describe the correlation structure in temporal data (Gotelli and Ellison 2004). However, these models require a long time series (N > 40) and therefore we could not use them to model the spring Chinook data. As such, we were unable to correct for any temporal correlation that may exist within the time series.

Tests of correlation with spawner abundance data indicated that the Naches River closely correlated with the Chiwawa population (Table 2). There was no difference in abundance trends between the potential reference populations and the Chiwawa population (Table 2; Figure 2). For NORs, all potential reference populations correlated with the Chiwawa population (Table 2). However, trends in NORs of all reference populations, except Naches, differed significantly from the Chiwawa population (Table 2; Figure 3). For productivity, the Naches, Sesech, and Little Wenatchee correlated with the Chiwawa population (Table 2). Only the Entiat productivity trend differed significantly from the Chiwawa population trend (Table 2; Figure 4).

Table 2. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Chiwawa spring Chinook population; d.f. = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at P < 0.05.

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
Spawner Abundance Data				
Naches	0.684*	-0.659	8	0.528
Entiat	0.598*	-0.596	18	0.559
Marsh	0.147	-1.341	18	0.197
Sesech	0.274	-1.265	18	0.222
Little Wenatchee	0.399	-0.591	18	0.562
Natural-Origin Recruits				
Naches	0.803*	0.666	8	0.524
Entiat	0.795*	-7.495	18	0.000

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
Marsh	0.605*	-5.786	18	0.000
Sesech	0.648*	-6.874	18	0.000
Little Wenatchee	0.880*	-7.206	18	0.000
Productivity Data				
Naches	0.960*	0.169	8	0.870
Entiat	0.272	-3.057	18	0.007
Marsh	0.320	0.605	18	0.553
Sesech	0.903*	-2.059	18	0.054
Little Wenatchee	0.848*	-2.065	18	0.054

We also ran correlation and trend analyses on natural-log transformed spawner abundance, NORs, and productivity data. These analyses indicated that the Naches, Entiat, and Little Wenatchee abundance data correlated with the Chiwawa population data (Table 3). None of the abundance trends of the potential reference populations differed significantly from the Chiwawa population trend (Table 3; Figure 5). For NORs, all potential reference populations correlated with the Chiwawa population (Table 3). Only trends in NORs of the Entiat and Sesech differed significantly from the Chiwawa population (Table 2; Figure 6). For productivity, the Naches, Marsh, Sesech, and Little Wenatchee correlated with the Chiwawa population data (Table 3). Only the Entiat productivity trend differed significantly from the Chiwawa population trend (Table 3; Figure 7).

Table 3. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Chiwawa spring Chinook population; d.f. = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$. Analyses were conducted on natural-log transformed abundance and productivity data.

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
LN Spawner Abundance Data				
Naches	0.642*	-1.323	8	0.222
Entiat	0.652*	0.412	18	0.685
Marsh	0.294	-1.324	18	0.202
Sesech	0.149	-1.431	18	0.170
Little Wenatchee	0.670*	1.325	18	0.202
LN Natural-Origin Recruits				
Naches	0.824*	-1.985	8	0.082
Entiat	0.886*	-2.563	18	0.019
Marsh	0.830*	-1.038	18	0.313
Sesech	0.730*	-2.664	18	0.016
Little Wenatchee	0.927*	-1.150	18	0.265
LN Productivity Data				

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
Naches	0.944*	-0.042	8	0.968
Entiat	0.373	-3.043	18	0.007
Marsh	0.610*	0.428	18	0.674
Sesech	0.913*	-2.050	18	0.055
Little Wenatchee	0.862*	-1.811	18	0.087

In summary, based on correlation, trend, and graphic analyses, the Naches, Entiat, and Little Wenatchee populations appear to be reasonable reference populations for comparing spawner abundance data with Chiwawa data. For NORs, the Naches, Marsh, and Little Wenatchee appear to be reasonable reference populations. For productivity, the Naches, Marsh, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for the Chiwawa population.

Minimal Detectable Differences (MDD)

Given a suite of potential reference populations, it is important to conduct power analyses to determine the minimum differences that can be detected when comparing the reference populations to the supplemented population. As a final exercise under Step 2, we examined potential reference populations for the smallest minimal detectable differences. Before conducting power analyses, several decisions needed to be made, including what statistical procedures will be used to analyze the data, the desired level of statistical power (probability of rejecting a false null hypothesis), the size of the type-I error (the probability of rejecting a true null hypothesis of no difference), and the number of samples (i.e., years) included in the analysis. In this case, the number of samples represents the number of treatment (supplementation) years. The number of pre-treatment years (1981-1992) was based on the number of years of quality data available for Chiwawa spring Chinook and potential reference populations.

We designed the study as a modified BACI (Before-After, Control-Impact) design, which includes replication before and after supplementation in both the treated (T) population and the reference (R) populations. A common approach used to analyze data from BACI designs includes analysis of difference scores (Stewart-Oaten et al. 1992; Smith et al. 1993). Differences are calculated between paired treatment and reference population scores (i.e., T-R). Another approach is to calculate ratios (treatment/reference; T/R) for paired treatment and reference population scores (Skalski and Robson 1992). Finally, differences in annual changes in paired treatment and reference population scores can be calculated (i.e., ΔT-ΔR) (Murdoch and Peven 2005; Hays et al. 2006).[17] These derived difference and ratio scores are then analyzed for a before-after treatment effect with a two-sample t-test, Aspin-Welch modification of the t-test, or a randomization test. For power analyses, we calculated minimal detectable differences assuming the use of an independent two-sample t-test with a type-I error rate of 0.05, power of 0.80 (beta or type-II error rate of 0.20), and sample sizes (treatment years) of 5, 10, 15, 20, 25, and 50 years.

[17] The difference of annual difference scores was estimated by first subtracting the population parameter (e.g., spawner abundance) in year 2 from year 1. This continues for all years in the data series for both treatment ($T_{t+1} – T_t$) and reference populations ($R_{t+1} – R_t$). We then calculated differences between paired treatment and reference annual difference scores [$(T_{t+1} – T_t) - (R_{t+1} – R_t) = \Delta T-\Delta R$].

The power analysis calculated the minimal detectable difference between mean difference or ratio scores before and during supplementation. We used existing data to calculate variances for the pre-supplementation and supplementation periods. Thus, variances were known and unequal. For both spawner abundance and NORs, the null hypothesis tested was that the mean difference or ratio before supplementation equaled the mean difference or ratio during supplementation. The alternative hypothesis was that the mean difference or ratio before supplementation was less than the mean difference during supplementation (one-tail test; Difference < 0). For productivity, the null hypothesis tested was that the mean difference or ratio before supplementation equaled the mean difference or ratio during supplementation. The alternative hypothesis was that the mean difference or ratio before supplementation was greater than the mean difference during supplementation (one-tail test; Difference > 0).

Based on spawner abundance data, power analysis indicated that the Sesech-Chiwawa pairing consistently produced the smallest detectable differences (Table 4). However, when the abundance data were transformed using natural logs, the Entiat-Chiwawa pairing produced the smallest detectable difference (Table 5). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 334 to 394 adult spawners; transformed data ranged from 0.479 to 1.010. These analyses indicate that the Naches, Entiat, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for comparing spawner abundance data with Chiwawa data. The Marsh Creek population produced some of the largest detectable differences and based on these analyses may not be a reasonable reference population.

Table 4. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on spawner abundance data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	638	604	560	396	652
	10	464	448	444	354	481
	15	405	395	406	341	424
	20	376	368	387	334	394
	25	358	352	376	331	376
	50	322	319	354	323	340
T/R	5	0.600	2.084	39.251	1.569	5.498
	10	0.506	1.548	24.729	1.508	3.828
	15	0.478	1.367	19.646	1.490	3.256
	20	0.465	1.275	16.828	1.481	2.954
	25	0.458	1.219	14.974	1.475	2.765
	50	0.447	1.105	10.573	1.465	2.366
ΔT-ΔR	5	1,049	761	717	518	766
	10	750	542	539	411	547
	15	650	467	480	376	473
	20	598	429	450	359	434

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	25	567	405	431	348	410
	50	506	355	395	329	361

Table 5. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed spawner abundance data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	0.975	0.871	2.061	0.828	1.013
	10	0.721	0.613	1.375	0.648	0.722
	15	0.637	0.525	1.138	0.588	0.623
	20	0.595	0.479	1.010	0.559	0.571
	25	0.569	0.450	0.928	0.541	0.539
	50	0.521	0.390	0.749	0.505	0.473
T/R	5	0.157	0.162	2.343	0.160	0.368
	10	0.116	0.115	1.474	0.125	0.247
	15	0.102	0.099	1.170	0.114	0.206
	20	0.095	0.090	1.001	0.108	0.183
	25	0.091	0.085	0.890	0.104	0.169
	50	0.082	0.075	0.625	0.098	0.138
ΔT-ΔR	5	1.261	1.288	3.076	1.160	1.467
	10	0.898	0.900	2.020	0.887	1.001
	15	0.776	0.768	1.653	0.797	0.840
	20	0.713	0.698	1.463	0.751	0.755
	25	0.675	0.655	1.325	0.724	0.701
	50	0.600	0.564	1.038	0.670	0.585

Based on NORs, power analysis indicated that the Entiat-Chiwawa, Marsh-Chiwawa, and Little Wenatchee-Chiwawa pairings produced the smallest detectable differences (Table 6). When NORs were transformed using natural logs, the Little Wenatchee-Chiwawa pairing produced the smallest detectable difference (Table 7). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 483 to 640 NORs; transformed data ranged from 0.958 to 2.262. These analyses indicate that the Entiat, Marsh, and Little Wenatchee populations appear to be reasonable reference populations for comparing NORs with Chiwawa data.

Table 6. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-origin recruits.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	1,139	541	573	630	546
	10	809	511	515	550	503
	15	698	502	498	526	489
	20	640	497	489	514	483
	25	604	494	484	507	479
	50	534	489	474	493	472
T/R	5	0.469	2.538	5.196	1.976	6.973
	10	0.451	2.183	4.183	1.894	5.118
	15	0.446	2.072	3.854	1.869	4.492
	20	0.445	2.017	3.691	1.857	4.170
	25	0.444	1.986	3.594	1.850	3.973
	50	0.443	1.924	3.405	1.836	3.572
ΔT-ΔR	5	1,639	500	519	609	531
	10	1,239	386	409	433	396
	15	1,109	348	374	372	351
	20	1,046	329	356	341	328
	25	1,009	318	346	321	314
	50	943	295	325	281	285

Table 7. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed natural-origin recruits.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	2.380	1.646	1.967	2.247	1.174
	10	2.291	1.479	1.505	1.835	1.026
	15	2.270	1.428	1.351	1.702	0.980
	20	2.262	1.403	1.273	1.636	0.958
	25	2.258	1.389	1.227	1.597	0.945
	50	2.253	1.361	1.133	1.522	0.920
T/R	5	0.322	0.332	0.739	0.398	0.356
	10	0.301	0.289	0.581	0.334	0.322
	15	0.296	0.275	0.530	0.314	0.312
	20	0.294	0.269	0.504	0.305	0.307
	25	0.293	0.265	0.488	0.299	0.304

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	50	0.291	0.258	0.458	0.288	0.298
ΔT-ΔR	5	2.858	2.400	2.355	3.283	2.109
	10	2.560	1.714	1.881	2.311	1.552
	15	2.485	1.481	1.728	1.979	1.365
	20	2.456	1.360	1.652	1.805	1.269
	25	2.443	1.285	1.607	1.697	1.210
	50	2.430	1.130	1.519	1.471	1.092

Using untransformed productivity data, power analysis indicated that the Little Wenatchee-Chiwawa pairing consistently produced the smallest detectable differences (Table 8). The Marsh-Chiwawa pairings produced the largest detectable differences. When we analyzed natural-log transformed productivity data, the Naches-Chiwawa and Little Wenatchee-Chiwawa pairings produced the smallest detectable differences (Table 9). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 0.754 to 1.839; transformed data ranged from 0.277 to 0.477. These analyses indicate that the Naches, Entiat, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for comparing productivity data with Chiwawa data. The Marsh Creek population produced some of the largest detectable differences and based on these analyses may not be a reasonable reference population.

Table 8. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on productivity data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	2.181	1.382	2.033	3.517	1.192
	10	1.442	1.119	1.900	2.265	0.901
	15	1.186	1.033	1.859	1.828	0.804
	20	1.047	0.991	1.839	1.588	0.754
	25	0.959	0.966	1.828	1.432	0.724
	50	0.764	0.917	1.806	1.074	0.664
T/R	5	1.364	1.773	0.863	0.876	2.167
	10	1.095	1.359	0.831	0.687	1.587
	15	1.011	1.221	0.822	0.625	1.391
	20	0.971	1.152	0.817	0.594	1.290
	25	0.949	1.110	0.814	0.575	1.228
	50	0.910	1.027	0.908	0.538	1.102
ΔT-ΔR	5	3.298	1.864	3.211	4.420	1.942
	10	2.263	1.382	2.968	2.811	1.291

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	15	1.909	1.220	2.894	2.248	1.066
	20	1.723	1.137	2.859	1.938	0.944
	25	1.606	1.087	2.839	1.735	0.866
	50	1.365	0.986	2.800	1.259	0.695

Table 9. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed productivity data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	0.540	0.551	0.674	0.890	0.585
	10	0.367	0.452	0.542	0.590	0.413
	15	0.308	0.421	0.499	0.486	0.355
	20	0.277	0.405	0.477	0.430	0.324
	25	0.257	0.396	0.465	0.393	0.305
	50	0.215	0.378	0.440	0.314	0.265
T/R	5	0.915	1.286	0.743	0.697	1.685
	10	0.744	0.973	0.704	0.541	1.227
	15	0.691	0.868	0.692	0.489	1.072
	20	0.666	0.815	0.687	0.463	0.993
	25	0.652	0.783	0.683	0.447	0.943
	50	0.628	0.719	0.677	0.416	0.843
ΔT-ΔR	5	0.885	0.810	1.028	1.252	0.971
	10	0.631	0.609	0.822	0.809	0.640
	15	0.546	0.542	0.755	0.655	0.525
	20	0.502	0.508	0.722	0.570	0.463
	25	0.475	0.487	0.702	0.516	0.423
	50	0.423	0.446	0.664	0.391	0.333

Step 3: Quantitative Method for Ranking Selection Criteria

Not surprisingly, different selection criteria produced different results (Table 10). Determining whether a given population is or is not a suitable reference population based on selection criteria such as graphic analysis can be subjective. In addition, treating each selection criterion as equally important may not be appropriate. For example, using the information in Table 10, is it appropriate to select a reference population that has two or three "Yes" entries, or should only populations with four "Yes" entries be selected as suitable reference populations? This approach does not allow certain selection criteria to carry more weight in the overall selection process. That is, correlation may be more important than graphic analysis in the overall selection process. In order to reduce subjectivity, we developed a method of scoring and weighting each selection criterion. This method allows a more quantitative process for selecting suitable reference populations.

Table 10. Summary of results from graphic analysis, correlations, trend analysis, and power analysis (minimal detectable differences). "Yes" indicates that the population is a suitable reference population for the Chiwawa population; "No" indicates that it may not be a suitable reference population.

Potential reference populations	Graphic analysis	Correlation	Trends	Minimal detectable differences
Spawner Abundance				
Naches	Yes	Yes	Yes	Yes
Entiat	Yes	Yes	Yes	Yes
Marsh	No	No	Yes	No
Sesech	No	No	Yes	Yes
Little Wenatchee	Yes	Yes	Yes	Yes
Natural-Origin Recruits				
Naches	Yes	Yes	Yes	No
Entiat	No	Yes	No	Yes
Marsh	Yes	Yes	Yes	Yes
Sesech	No	Yes	No	No
Little Wenatchee	Yes	Yes	Yes	Yes
Productivity				
Naches	Yes	Yes	Yes	Yes
Entiat	No	No	No	Yes
Marsh	No	Yes	Yes	No
Sesech	Yes	Yes	Yes	Yes
Little Wenatchee	Yes	Yes	Yes	Yes

We developed scoring methods for each of the following five selection criteria:

(1) The proportion of natural-origin spawners (pNOS) in the reference population for the period before supplementation (pre-pNOS);

(2) pNOS in the reference population for the period following supplementation (post-pNOS);

(3) The correlation between the reference and supplemented populations before supplementation;

(4) The relative difference in slopes between the reference and supplemented populations before supplementation; and

(5) The coefficient of variation (CV) of the ratio of supplemented to reference populations before the period of supplementation.

Each selection criteria was scored from 0 to 1, with 0 being the worst possible score and 1 being the best.

The pre- and post-pNOS values were calculated as the average pNOS values before and after supplementation, respectively. Because pNOS values range from 0-1, we did not need to rescale these values. When using reference populations to evaluate the effects of supplementation programs, it is important that the reference populations maintain high values of pNOS throughout the life of the monitoring program. Therefore, we heavily weighted the mean pNOS scores. We assigned weights of 30 and 40 to the mean pre- and post-pNOS scores, respectively. The relatively larger weight for the post-supplementation period is to reduce the likelihood of retaining a reference population that becomes influenced by hatchery fish during the supplementation period.

We assessed the association between the reference and supplemented populations during the pre-supplementation period by calculating the Pearson correlation coefficient, which ranges from -1 to 1. To scale the coefficient between 0 and 1, we took the absolute value of the coefficient. Thus, a coefficient of -0.92 would be reported as 0.92. For our analyses, we were not concerned with the direction of the relationship, only the strength of the relationship. The correlation coefficient was given a weight of 12.5.

As noted earlier, we used least squares to fit a linear trend to each of the reference populations and the supplemented population during the pre-supplementation period. Using the slope estimates for each trend line, we calculated the relative difference in slopes as the slope of the supplemented population minus the slope of the reference population, divided by the slope of the reference population. To scale this value between 0 and 1, we used absolute values, and depending on the direction of the slopes, we subtracted the relative difference from 1. The latter was needed to make sure a larger relative difference value indicated a small difference in slopes between the supplemented and reference populations. The relative difference score was given a weight of 7.5.

Finally, as a means to score effect size, we calculated the CV of the ratio of supplemented to reference population parameters (i.e., T/R). The CV was calculated as the standard deviation of the ratios divided by the absolute value of the mean ratios. The CV was subtracted from 1. This scaled the value from 0 to 1 with larger values representing the best condition. The CV was given a weight of 10, which is greater than the weight for trend, but less than the weight for correlation.

The total score for a reference population was calculated by multiplying the estimated value, which ranged from 0 to 1, by its weight. The sum of the five weighted values provided a total score, which ranged from 0 to 100. Based on several simulations, we set the cut-off score at 81. That is, if the total score for a given reference population equaled or exceeded 81, the population was included as a suitable reference population. If the total score fell below 81, the population was not considered a suitable reference. Based on the distribution of all scores possible, a score of 81 or greater represented only 3% of the total distribution. Thus, a cut-off of 81 is quite conservative.

Under Step 3, we used this method to select the final suite of suitable reference populations. Table 11 shows results from scoring each of the reference populations using the quantitative method. Using the cut-off criterion of 81, only the Naches, Marsh, and Sesech populations would be considered suitable reference populations for the Chiwawa supplementation program. Both the Entiat and Little Wenatchee populations failed to meet the minimum score, largely because of the influence of hatchery fish within those populations (i.e., relatively low pNOS values).

Table 11. Results from scoring potential reference populations using the selection criteria (pNOS, correlation, trend, and effect size). Populations with scores less than 81 were considered unsuitable as reference populations. Populations with scores equal to or greater than 81 were considered suitable references. These results were based on natural-log transformed data.

Potential reference populations	Population metric		
	Abundance	NORs	Productivity
Naches	85	88	91
Entiat	23	21	16
Marsh	79	91	87
Sesech	84	85	88
Little Wenatchee	51	53	49

An important benefit from scoring the different selection criteria is that the total scores can be used to weight the outcome of differing statistical results. For example, analyses may show that when three suitable reference populations are compared to the supplemented population, two of the reference populations may indicate a significant treatment effect, while the third indicates no effect. Under this scenario it is not clear if the supplementation program has or has not affected the abundance or productivity of the supplemented population. If, however, the two reference populations that produced a significant result had higher total scores than the reference population that did not indicate a significant result, one can place more weight on the results from populations with higher total scores.

Conclusions

The purpose of this exercise was to develop a method for selecting suitable reference populations that could be used to assess the effects of supplementation programs on spawner abundance, NORs, and productivity. The selection process included a three-step process (Figure 8). Step 1 identified populations with similar life-history characteristics, few or no hatchery spawners, a long time series of accurate abundance and productivity estimates, and similar freshwater habitat impairments and out-of-basin effects. Populations that met these criteria were then examined for their graphical and statistical relationship with the supplemented population (Step 2). The statistical analysis under Step 2 were converted to a quantitative model (Step 3) that was used to generate a weighted score for pNOS, correlation, trends, and effect sizes for each potential reference population. Reference populations with total scores of 81 or greater were selected as suitable reference populations.

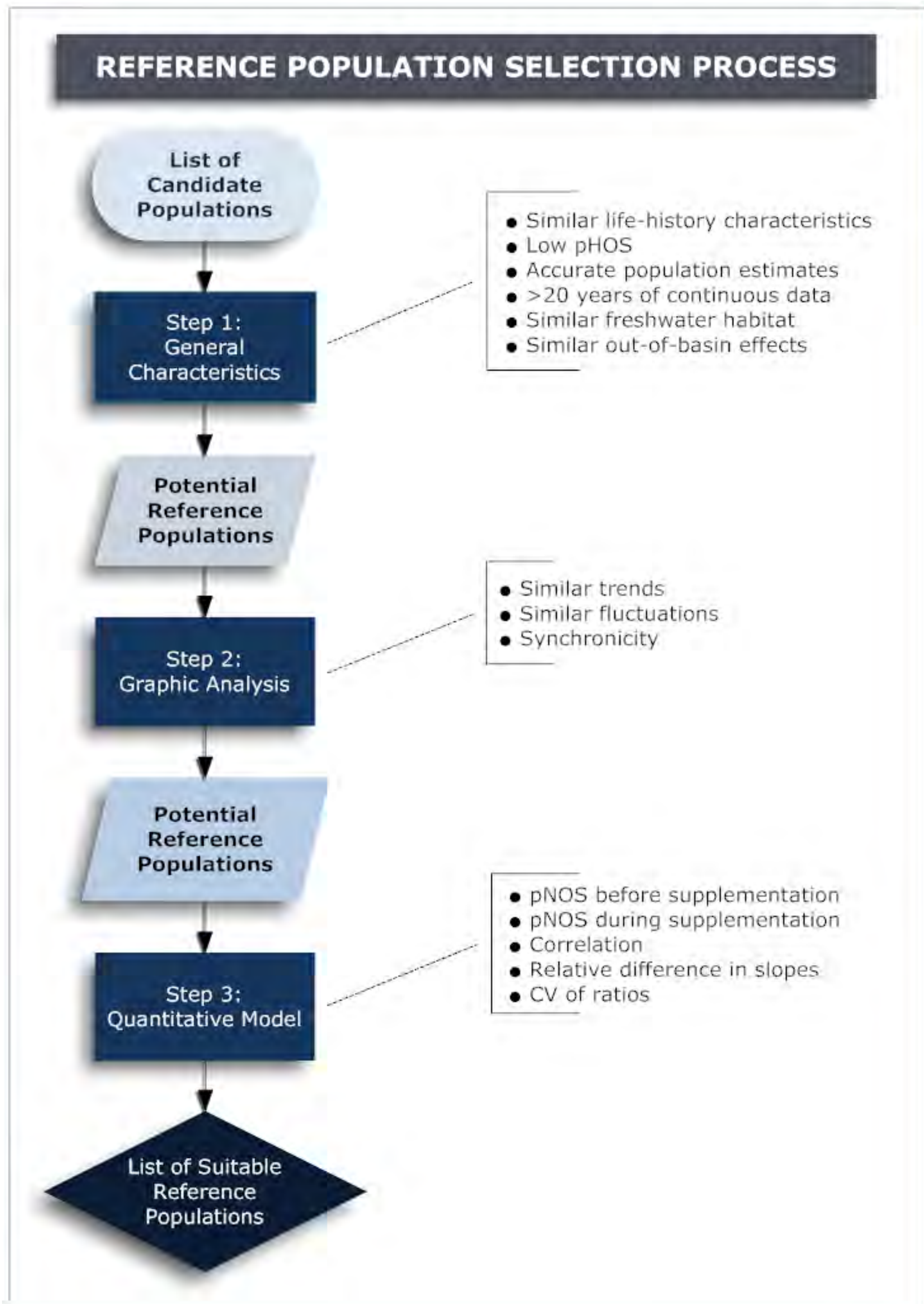

Figure 8. Three-step process for selecting suitable reference populations for supplemented populations.

We used this approach to select suitable reference populations for analyzing the effects of the Chiwawa spring Chinook supplementation program on fish abundance and productivity. The method indicated that the Naches, Marsh, and Sesech populations would serve as suitable reference populations for the Chiwawa spring Chinook supplementation program. Both the Entiat and Little Wenatchee populations failed to meet the minimum score, largely because of the influence of hatchery fish within those populations (i.e., relatively low pNOS values). However, because the presence of hatchery spring Chinook within those populations should decrease, they may serve as unique reference populations in which the comparisons change from all populations receiving hatchery fish to only the Chiwawa population receiving hatchery fish. Therefore, we will continue to include both the Little Wenatchee and Entiat populations in future analyses.

An important assumption in the use of reference populations is that the supplemented and reference populations that tracked each other before supplementation would continue to track each other in the absence of supplementation. Given that the reference populations did not match the Chiwawa population on all criteria examined (Table 1) and some reference populations tracked the Chiwawa population more poorly than others (Figures 2-7; Tables 2-4), there may be some uncertainty as to whether differences observed between the Chiwawa and reference populations during the supplementation period are associated with the hatchery program, "nuisance" factors[18], or a combination of both. In addition, we have no ability to regulate or control activities in reference areas. Any large-scale change (man-made or natural) in reference areas could affect our ability to assess the effectiveness of the supplementation program.

Because we have no ability to maintain reference areas for long periods of time and may not be able to control all activities even within the supplemented populations, we propose the use of a "causal-comparative" approach to strengthen the certainty of our inferences (Pearsons and Temple 2010). The causal-comparative approach relies on correlative data to try and make a case for causal inference.[19] Correlation is used to rule out alternative hypotheses (note that we make our case as much if not more by disproving plausible alternatives as we do by showing that the data are consistent with a hypothesis). For example, large scale land-use activities or natural events can affect stream flows, fine sediment recruitment, and water temperatures. Changes in these factors can affect the freshwater survival and productivity of fish independently of supplementation programs. If changes in habitat, migratory, and ocean conditions do not affect reference and treatment populations similarly, inferences associated with supplementation programs may be confounded. By measuring and tracking these extraneous factors within reference and treatment areas, we can assess the effects of these state variables on population conditions independent of the supplementation programs. This allows us to more effectively assess the influence of supplementation programs on populations.

To that end, we recommend that the following state variables be measured and tracked within the Chiwawa Basin and each of the reference areas: mean annual precipitation, total and riparian forest cover, road density, impervious surface, and alluvium. These variables can be used to describe differences in water temperatures at different life stages (pre-spawning, egg incubation, and summer rearing) and substrate characteristics, including fine sediments and embeddedness (Jorgensen et al. 2009). They can be used to assess possible changes in spawner abundance, NORs, and productivity that are independent of supplementation.

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[18] A "nuisance" factor is any factor that is outside the control of the experimenter and can affect the response variable (spawner abundance or productivity). In this case, nuisance factors may include differences in freshwater habitat trends and conditions, out-of-basin effects (e.g., migration and ocean survival), and hatchery strays that affect the Chiwawa and reference populations differently.

[19] It is important to point out that correlation does not demonstrate cause-and-effect. It only suggests a relationship between variables. Thus, inferences based on correlation lack the certainty that is associated with a design-based approach.

Analyses with Reference Populations

Once suitable reference populations are selected, methods for analyzing the supplemented and reference populations need to be identified. What follows is a description of different analyses that can be used to assess the effects of supplementation programs on spawner abundance, NORs, and productivity using reference populations. Later in this report we describe methods for assessing supplementation effects when reference populations are not available.

We used some of the reference populations selected for the Chiwawa program to illustrate the different methods for evaluating the effects of the supplementation program on spawner abundance, NORs, and productivity. For abundance, we selected the Naches, Entiat, Little Wenatchee, and Sesech populations as suitable references for the Chiwawa population. For NORs, we selected the Naches, Entiat, Marsh, and Little Wenatchee populations as suitable references. For productivity, we selected the Naches, Sesech, Little Wenatchee, and Marsh Creek as suitable references for the Chiwawa. As noted earlier, we included the Little Wenatchee and Entiat populations, even though they did not meet all the criteria for suitable reference populations.

Analysis of Trends

As a first step, we used trend analyses to assess the effects of the Chiwawa supplementation program on spring Chinook spawner abundance, NORs, and productivity. Here, we compared the slopes of the trends between each treatment/reference pair before and during supplementation using t-tests. If the hatchery program is successfully supplementing the natural spring Chinook population, trends in spawner abundance and NORs should deviate significantly (i.e., the slope of the supplemented population should be greater than the slopes of the reference populations during the supplementation period). For productivity, the slope of the supplemented population, relative to the reference population, should increase or remain the same.

Trend analysis indicated that the relationship of slopes of spawner abundance between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 9; Table 12). This was true for both transformed and untransformed abundance data. Before supplementation, spawner abundances trended down in both the Chiwawa and reference populations (Figure 9). During the period of supplementation, abundances in both the Chiwawa and reference populations trended upward. Interestingly, in nearly all treatment/reference comparisons, the Pearson correlation coefficient was greater in the supplementation period than in the pre-supplementation period (Table 12). This was most evident in the transformed abundance data (Figure 9).

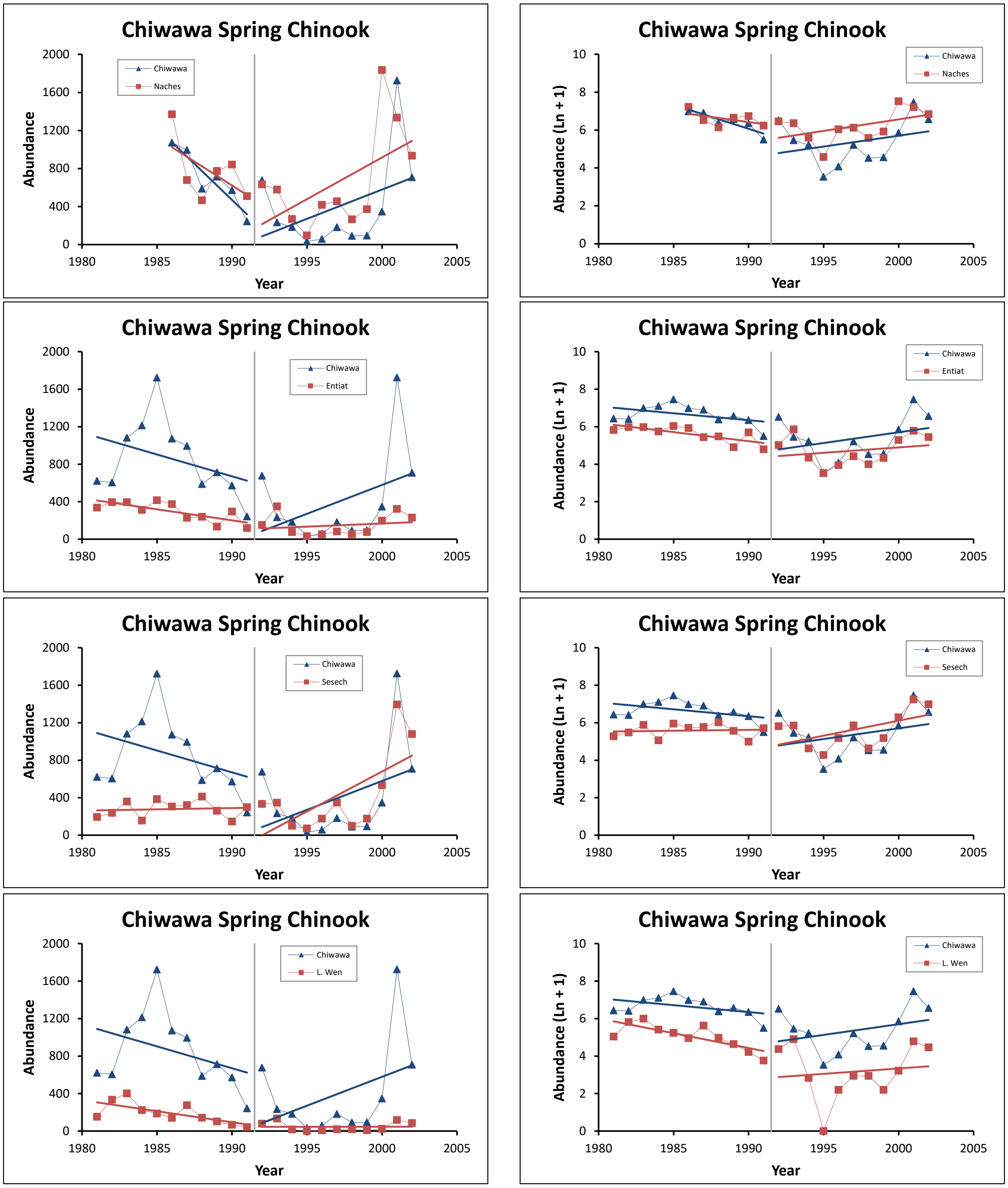

Figure 9. Trends in spring Chinook spawner abundance in the Chiwawa and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed spawner abundance data; those on the right include natural-log transformed data.

Table 12. Pearson correlation coefficients and t-test results comparing slopes of spawner abundance trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses include both untransformed and natural-log transformed spawner abundance data.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Spawner Abundance						
Naches	0.684*	0.595	-0.659	-0.414	0.528	0.684
Entiat	0.598*	0.672*	-0.596	1.162	0.559	0.260
Sesech	0.274	0.904*	-1.265	-0.418	0.222	0.681
Little Wenatchee	0.399	0.685*	-0.591	1.330	0.562	0.200
LN Spawner Abundance						
Naches	0.642*	0.813*	-1.323	-0.047	0.222	0.963
Entiat	0.652*	0.860*	0.412	0.422	0.685	0.678
Sesech	0.149	0.878*	-1.431	-0.333	0.170	0.743
Little Wenatchee	0.670*	0.861*	1.325	0.316	0.202	0.756

Trend analysis indicated that the relationship of slopes of NORs between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 10; Table 13). Before supplementation, Chiwawa NORs trended downward more strongly than the reference populations (Figure 10). However, during the supplementation period, both the Chiwawa and reference population NORs trended upward in parallel. In nearly all treatment/reference comparisons, the Pearson correlation coefficient was greater in the pre-supplementation period than in the supplementation period (Table 13).

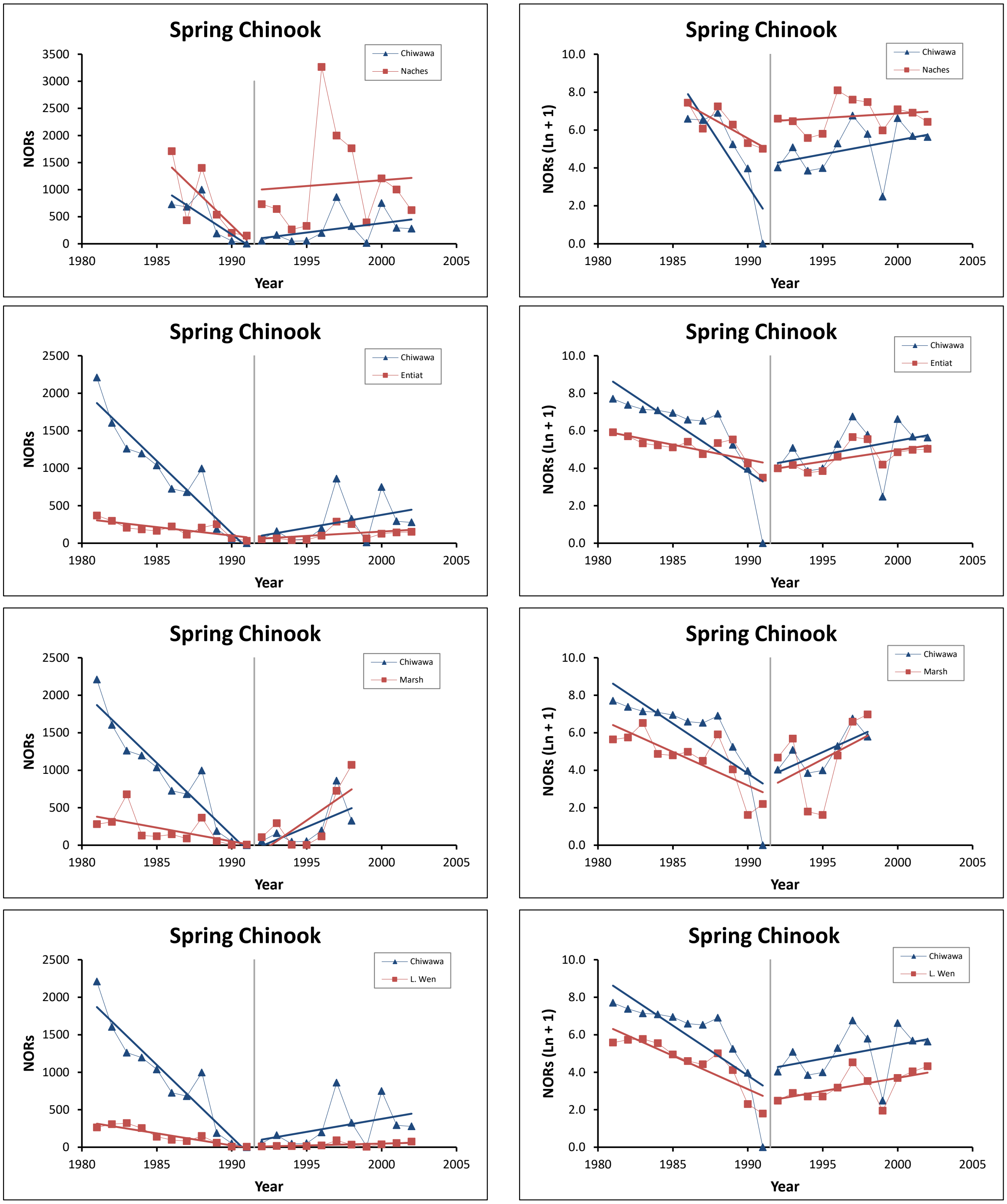

Figure 10. Trends in spring Chinook natural-origin recruits (NORs) in the Chiwawa and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed NORs; those on the right include natural-log transformed data.

Table 13. Pearson correlation coefficients and t-test results comparing slopes of natural-origin recruits trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$. Analyses include both untransformed and natural-log transformed natural-origin recruits.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Natural-Origin Recruits						
Naches	0.803*	0.432	0.666	0.140	0.524	0.890
Entiat	0.795*	0.754*	-7.495	0.847	0.000	0.408
Marsh	0.605*	0.677*	-5.786	-0.718	0.000	0.489
Little Wenatchee	0.880*	0.758*	-7.206	1.128	0.000	0.274
LN Natural-Origin Recruits						
Naches	0.824*	0.710*	-1.985	0.693	0.082	0.497
Entiat	0.886*	0.796*	-2.563	0.202	0.019	0.842
Marsh	0.830*	0.835*	-1.038	-0.134	0.313	0.896
Little Wenatchee	0.927*	0.898*	-1.150	0.046	0.265	0.964

As with NORs and spawner abundance data, trend analysis indicated that the relationship of slopes of productivity (recruits/spawner) between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 11; Table 14). This was true for both transformed and untransformed productivity data. Before supplementation, productivities trended down in both the Chiwawa and reference populations (Figure 11). During the period of supplementation, productivities fluctuated widely in both the Chiwawa and reference populations. Nevertheless, during the supplementation period, productivities generally increased in both the reference and Chiwawa populations. Unlike with spawner abundance, the Pearson correlation coefficients resulting from analysis of productivity data were generally higher in the pre-supplementation period than during the supplementation period (Table 14).

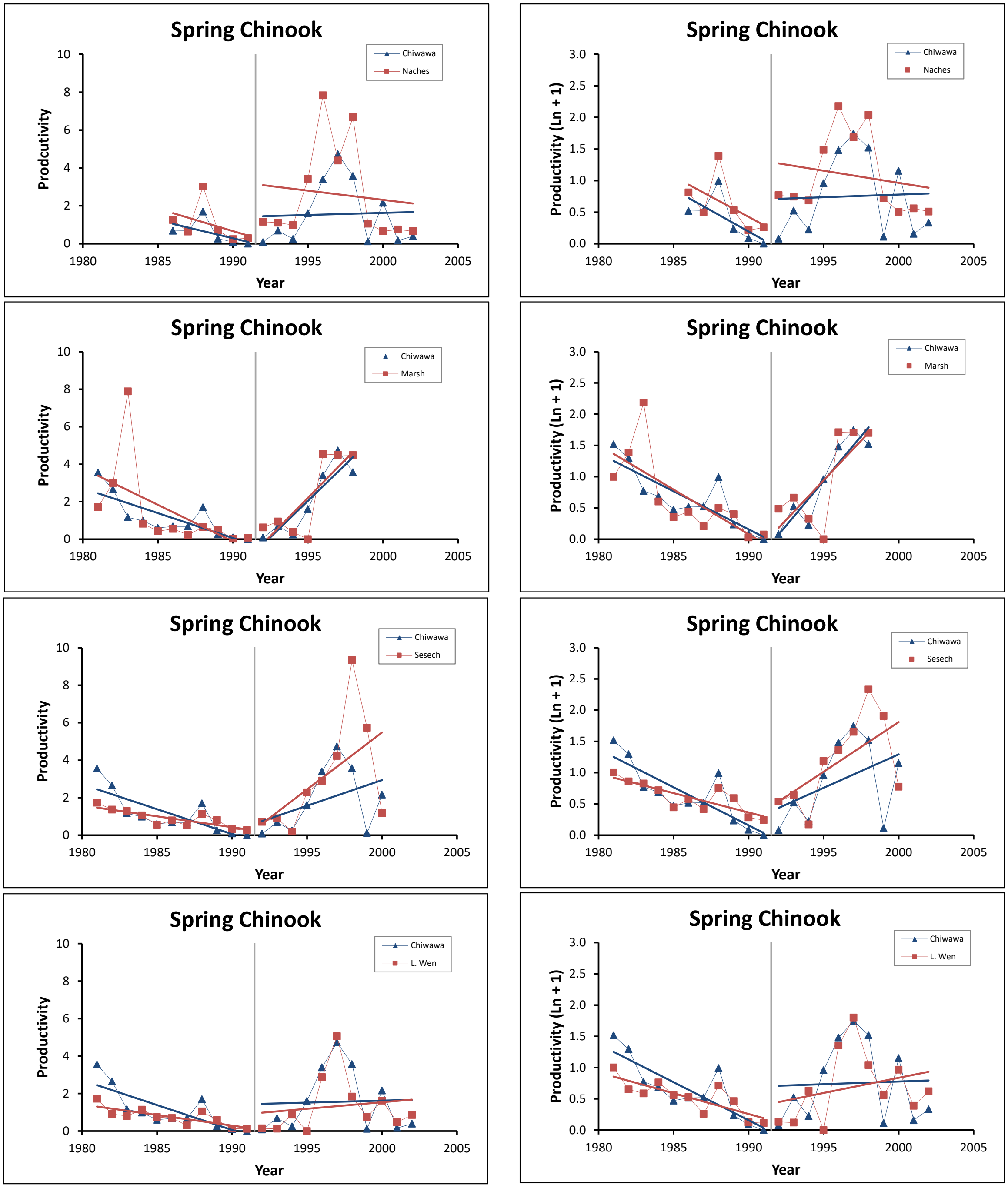

Figure 11. Trends in spring Chinook productivity (recruits/spawner) in the Chiwawa (supplemented) and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed productivity data; those on the right include natural-log transformed data.

Table 14. Pearson correlation coefficients and t-test results comparing slopes of productivity (recruits/spawner) trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses include both untransformed and natural-log transformed productivity data.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Productivity						
Naches	0.960*	0.802*	0.169	0.387	0.870	0.703
Marsh	0.320	0.910*	0.605	-0.132	0.553	0.898
Sesech	0.903*	0.491	-2.059	-0.837	0.054	0.417
Little Wenatchee	0.848*	0.864*	-2.065	-0.213	0.054	0.834
LN Productivity						
Naches	0.944*	0.805*	-0.042	0.526	0.968	0.605
Marsh	0.610*	0.804*	0.428	0.281	0.674	0.784
Sesech	0.913*	0.531	-2.050	-0.463	0.055	0.651
Little Wenatchee	0.862*	0.751*	-1.811	-0.480	0.087	0.637

Using trend analysis, we found no evidence that the supplementation program has significantly increased the spawner abundance and NORs of spring Chinook in the Chiwawa Basin. Even though we documented an increasing trend in spawner abundance and NORs during the supplementation period, a similar increase in spawner abundance and NORs was observed in the reference populations. In addition, we found no evidence that the supplementation program has increased the productivity of spring Chinook in the Chiwawa Basin. Importantly, the productivity of spring Chinook in the Chiwawa Basin did not trend downward during the supplementation period. Thus, based on trend analysis, it appears that the supplementation program has not increased or decreased the abundance and productivity of spring Chinook in the Chiwawa Basin.

We note that this exercise only tests the slopes of the trend lines. It does not test for differences in elevations of the trend lines. A supplementation program could increase spawner abundance, NORs, and productivity of the target population without changing the slopes of the trend lines. That is, supplementation could cause the elevation of the trend line to be greater during the supplementation period than during the pre-supplementation period. In the next section we evaluate elevation differences by testing mean differences before and after supplementation.

Analysis of Mean Differences, Ratios, and Rates

For assessing mean differences between supplemented and reference populations, we derived three different response variables using transformed and untransformed spawner abundance, NORs, and productivity data. The first included difference scores, which were calculated as the difference between paired treatment and reference data (T-R). The second included ratios, which were calculated as the ratio of paired treatment and reference data (T/R). Finally, we calculated the differences in annual changes in paired treatment and reference population data (ΔT-ΔR; see footnote #2).

If the hatchery program is successfully supplementing the natural spring Chinook population, the mean difference or ratio score of paired spawner abundance data and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean difference or ratio score during the supplementation period should be equal to or higher than the pre-supplementation period. We tested the following statistical hypotheses.

Spawner Abundance and NORs:

Ho: Mean Difference (or Ratio) before supplementation ≥ Mean Difference (or Ratio) during supplementation.

Ha: Mean Difference (or Ratio) before supplementation < Mean Difference (or Ratio) during supplementation (i.e., $\mu_{pre} - \mu_{post} < 0$).

Productivity (Recruits/Spawner):

Ho: Mean Difference (or Ratio) before supplementation ≤ Mean Difference (or Ratio) during supplementation.

Ha: Mean Difference (or Ratio) before supplementation > Mean Difference (or Ratio) during supplementation (i.e., $\mu_{pre} - \mu_{post} > 0$).[20]

For each set of response variables, we tested before/after supplementation effects using a one-tailed Aspin-Welch unequal-variance test. We used the Aspin-Welch unequal-variance test instead of Student's t-test, because in nearly every case, the variances of response variables in the pre-treatment and supplementation periods were unequal.[21] This was true even for natural-log transformed variables. We used the modified Levene equal-variance test to assess the equality of variance. In some cases, the distributions of response variables were not normal (based on the Omnibus Normality test and examination of histograms, normal probability plots, and box plots). Therefore, we also used a randomization test, based on 10,000 Monte Carlo simulations, to assess differences in response variables before and during supplementation. The randomization procedure only allowed the testing of two-tailed hypotheses. Therefore, we generated 95% confidence intervals on the mean difference ($\mu_{pre} - \mu_{post}$) using bootstrapping methods to determine the direction of the difference. We generated 5,000 bootstrap samples to calculate confidence intervals.

All these statistical methods assume that the samples of derived difference or ratio scores from the pre-supplementation and supplementation periods were independent. However, BACI designs, like time-series trend analysis, are repeated-measures designs and therefore are susceptible to temporal correlations in the data. This means that the two samples of difference or ratio scores may not be independent. Under this scenario, ARIMA models can be used to describe the correlation structure in temporal data (Gotelli and Ellison 2004). ARIMA models can be fit individually to the reference and supplemented time series data, or to a derived data series created by taking the ratio or difference of the supplemented/reference data at each time step. ARIMA models, however, require a long time series (N > 40) and therefore we could not use them to model

20 Because of the logic of null hypothesis testing, the rejection of the null hypothesis of no difference in productivity would mean that the supplementation program has reduced the productivity of the target population (here rejection of the null indicates "harm"). Notice that the rejection of the null hypothesis of no difference in spawner abundance means that the supplementation program has improved the spawner abundance in the target population (here rejection of the null indicates "benefit").

21 In cases in which the variances were equal, both the Aspin-Welch test and Student's t-test gave the same result.

the spring Chinook data. Thus, we acknowledge that our analyses may be confounded if the samples are not independent.

Difference Scores (T-R)

Analysis of supplementation effects on spawner abundance using difference scores indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 15; Figure 12). Only the Little Wenatchee-Chiwawa pairing using transformed abundance data indicated a significant increase in spawning abundance following supplementation. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction (i.e., CIs > 0). That is, compared to the reference populations, spawner abundance decreased in the Chiwawa Basin during the supplementation period (Figure 12).

Table 15. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	1.066	0.848	184	0.322	-162 – 472
Entiat	1.872	0.962	316	0.078	17 – 633
Sesech	4.502	0.999	607	0.000	349 – 851
Little Wenatchee	1.773	0.954	321	0.093	0 – 690
LN Spawner Abundance					
Naches	2.603	0.990	0.701	0.026	0.210 – 1.214
Entiat	1.701	0.946	0.388	0.108	-0.033 – 0.811
Sesech	5.394	0.999	1.327	0.000	0.891 – 1.805
Little Wenatchee	-2.259	0.018	0.609	0.034	-1.125 – -0.097

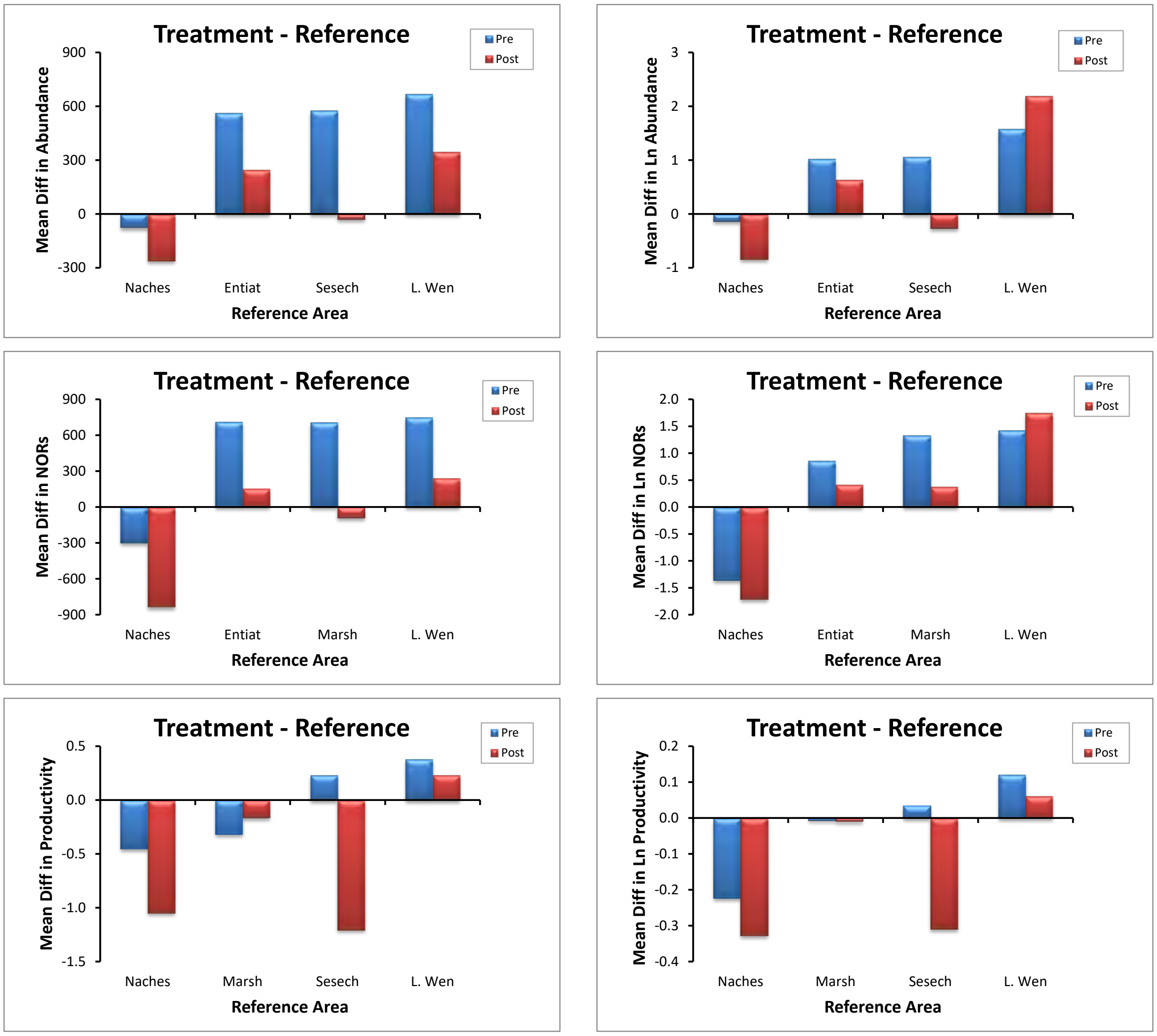

Figure 12. Mean difference (Treatment – Reference) scores of untransformed (figures on the left) and transformed (figures on the right) spawner abundance, natural-origin recruits (NORs), and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Positive effects of supplementation on spawner abundance and NORs are indicated when the post-supplementation (red) bars are greater than their corresponding pre-supplementation (blue) bars. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on NORs using difference scores indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 16; Figure 12). The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, NORs decreased in the Chiwawa Basin during the supplementation period (Figure 12).

Table 16. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	1.787	0.953	537	0.081	-60 – 1039
Entiat	2.879	0.993	558	0.007	201 – 916
Marsh	3.817	0.999	795	0.001	381 – 1153
Little Wenatchee	2.668	0.991	510	0.013	145 – 863
LN Natural-Origin Recruits					
Naches	0.430	0.659	0.354	0.686	-0.948 – 1.975
Entiat	0.788	0.779	0.445	0.465	-0.504 – 1.583
Marsh	1.45	0.916	0.953	0.168	-0.169 – 2.243
Little Wenatchee	-0.813	0.214	-0.319	0.506	-0.948 – 0.484

Analysis of supplementation effects on productivity (adult recruits/spawner) using difference scores indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 17; Figure 12). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period. These tests indicate that supplementation has not negatively affected the productivity of spring Chinook salmon in the Chiwawa Basin.

Table 17. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean difference scores during the supplementation period were less than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	1.134	0.139	0.594	0.296	-0.427 – 1.540
Marsh	-0.203	0.579	0.152	0.932	-0.304 – 1.381
Sesech	1.607	0.071	1.435	0.151	-0.403 – 2.917
Little Wenatchee	0.431	0.335	0.147	0.665	-0.498 – 0.762
LN Productivity					
Naches	0.770	0.227	0.104	0.480	-0.125 – 0.378
Marsh	0.012	0.495	0.003	0.992	-0.375 – 0.493
Sesech	1.463	0.087	0.343	0.161	-0.135 – 0.732
Little Wenatchee	0.390	0.351	0.060	0.701	-0.229 – 0.347

Ratio Scores (T/R)

As with difference scores, analysis of supplementation effects on spawner abundance using ratios indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 18; Figure 13). Only the Little Wenatchee-Chiwawa pairing indicated a significant increase in spawning abundance following supplementation. Analysis with both transformed and untransformed Little Wenatchee-Chiwawa data indicated a significant effect. In contrast, only difference scores derived from transformed data indicated a significant effect. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, spawner abundance decreased in the Chiwawa Basin during the supplementation period (Figure 13).

Table 18. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if the mean ratios during the supplementation period were greater than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	2.110	0.970	0.398	0.065	0.056 – 0.737
Entiat	1.254	0.888	0.731	0.223	-0.365 – 1.834
Sesech	4.251	0.999	2.428	0.000	1.278 – 3.435
Little Wenatchee	-2.649	0.009	3.897	0.018	-6.579 – -1.202
LN Spawner Abundance					
Naches	2.783	0.993	0.120	0.021	0.045 – 0.199
Entiat	1.273	0.890	0.055	0.220	-0.026 – 0.135
Sesech	5.143	0.999	0.244	0.000	0.160 – 0.335
Little Wenatchee	-3.462	0.002	0.327	0.003	-0.516 – -0.154

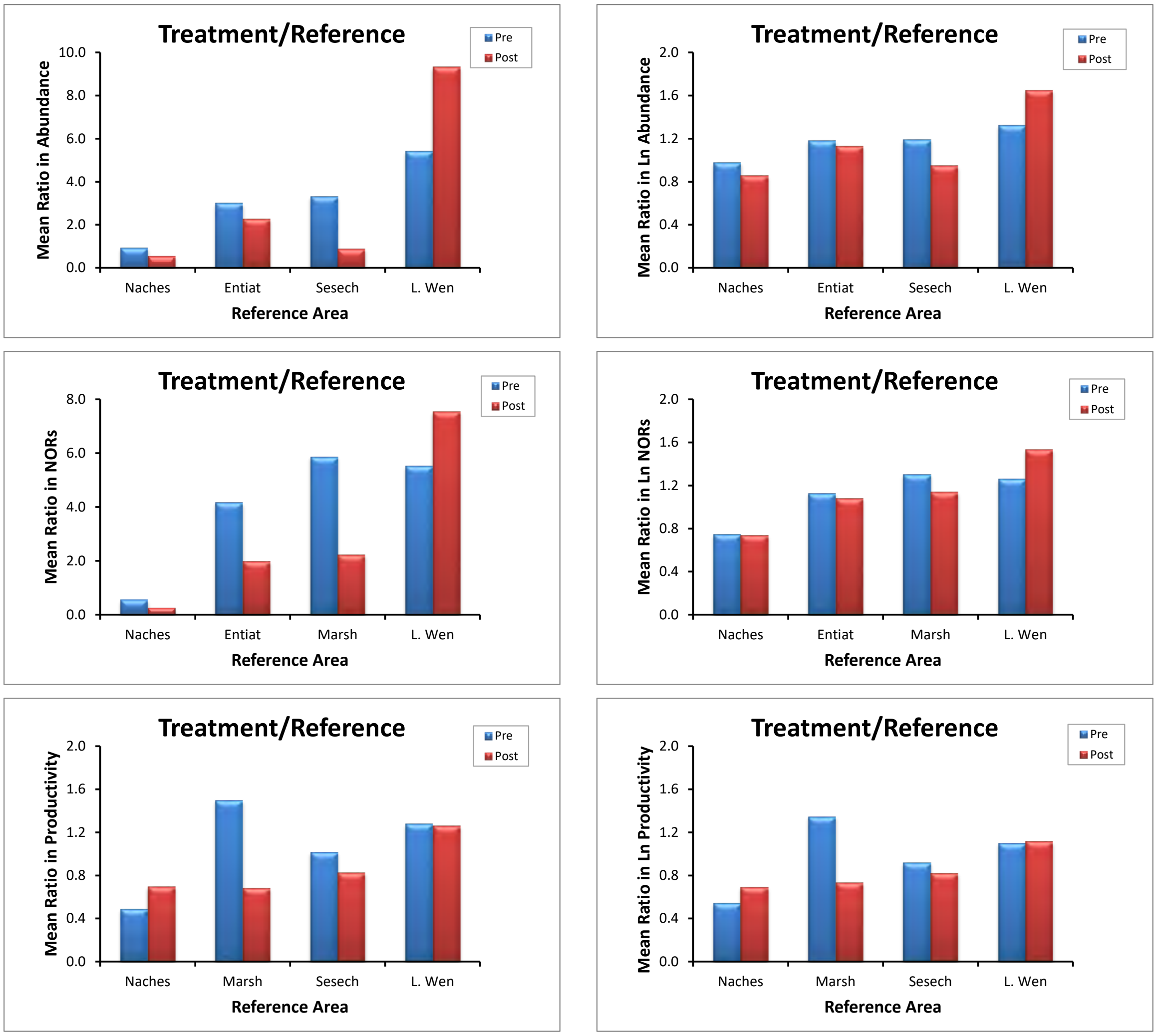

Figure 13. Mean ratios (Treatment/Reference) scores of untransformed (figures on the left) and transformed (figures on the right) spawner abundance, natural-origin recruits (NORs), and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Positive effects of supplementation on spawner abundance and NORs are indicated when the post-supplementation (red) bars are greater than their corresponding pre-supplementation (blue) bars. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on NORs using ratios indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 19; Figure 13). Only the Little Wenatchee-Chiwawa pairing indicated a significant increase in transformed NORs following supplementation. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, NORs decreased in the Chiwawa Basin during the supplementation period (Figure 13).

Table 19. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if the mean ratios during the supplementation period were greater than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	1.318	0.881	0.306	0.219	-0.157 – 0.670
Entiat	2.447	0.987	2.172	0.028	0.593 – 3.871
Marsh	2.001	0.965	3.638	0.075	0.532 – 7.201
Little Wenatchee	-1.148	0.136	2.020	0.284	-5.055 – 1.516
LN Natural-Origin Recruits					
Naches	0.057	0.522	0.009	0.967	-0.230 – 0.351
Entiat	0.359	0.638	0.049	0.759	-0.173 – 0.336
Marsh	0.603	0.721	0.161	0.579	-0.272 – 0.681
Little Wenatchee	-1.914	0.038	0.277	0.027	-0.504 – 0.031

Analysis of supplementation effects on productivity (adult recruits/spawner) using ratios indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 20; Figure 13). Although the Aspin-Welch test indicated a significant effect when comparing the Chiwawa to the Marsh Creek population, both the randomization test and the bootstrap CI did not indicate a significant effect. These tests indicate that supplementation has probably not negatively affected the productivity of spring Chinook salmon in the Chiwawa Basin.

Table 20. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	-0.677	0.745	0.209	0.688	-0.700 – 0.425
Marsh	2.236	0.022	0.814	0.054	0.112 – 1.459
Sesech	0.677	0.253	0.191	0.515	-0.356 – 0.718
Little Wenatchee	0.033	0.487	0.018	0.979	-0.879 – 1.162
LN Productivity					
Naches	-0.639	0.734	0.148	0.616	-0.548 – 0.316
Marsh	1.952	0.036	0.613	0.081	-0.003 – 1.170
Sesech	0.447	0.330	0.098	0.663	-0.301 – 0.515
Little Wenatchee	-0.034	0.513	0.015	0.982	-0.692 – 0.861

Difference of Annual Difference Scores (ΔT-ΔR)

Analysis of supplementation effects on spawner abundance using difference scores of annual changes indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 21; Figure 14). None of the statistical analyses detected a significant increase in annual change in the Chiwawa Basin relative to the reference populations.

Table 21. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if mean difference scores of annual change during the supplementation period were greater than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	0.009	0.503	2	0.995	-502 – 539
Entiat	-0.239	0.407	48	0.826	-414 – 327
Sesech	-0.126	0.451	20	0.902	-311 – 266
Little Wenatchee	-0.318	0.377	65	0.761	-452 – 311
LN Spawner Abundance					
Naches	-0.425	0.339	0.142	0.698	-0.744 – 0.466
Entiat	-0.084	0.467	0.028	0.933	-0.681 – 0.593
Sesech	-0.349	0.366	0.117	0.740	-0.741 – 0.515
Little Wenatchee	0.001	0.500	0.000	0.999	-0.663 – 0.687

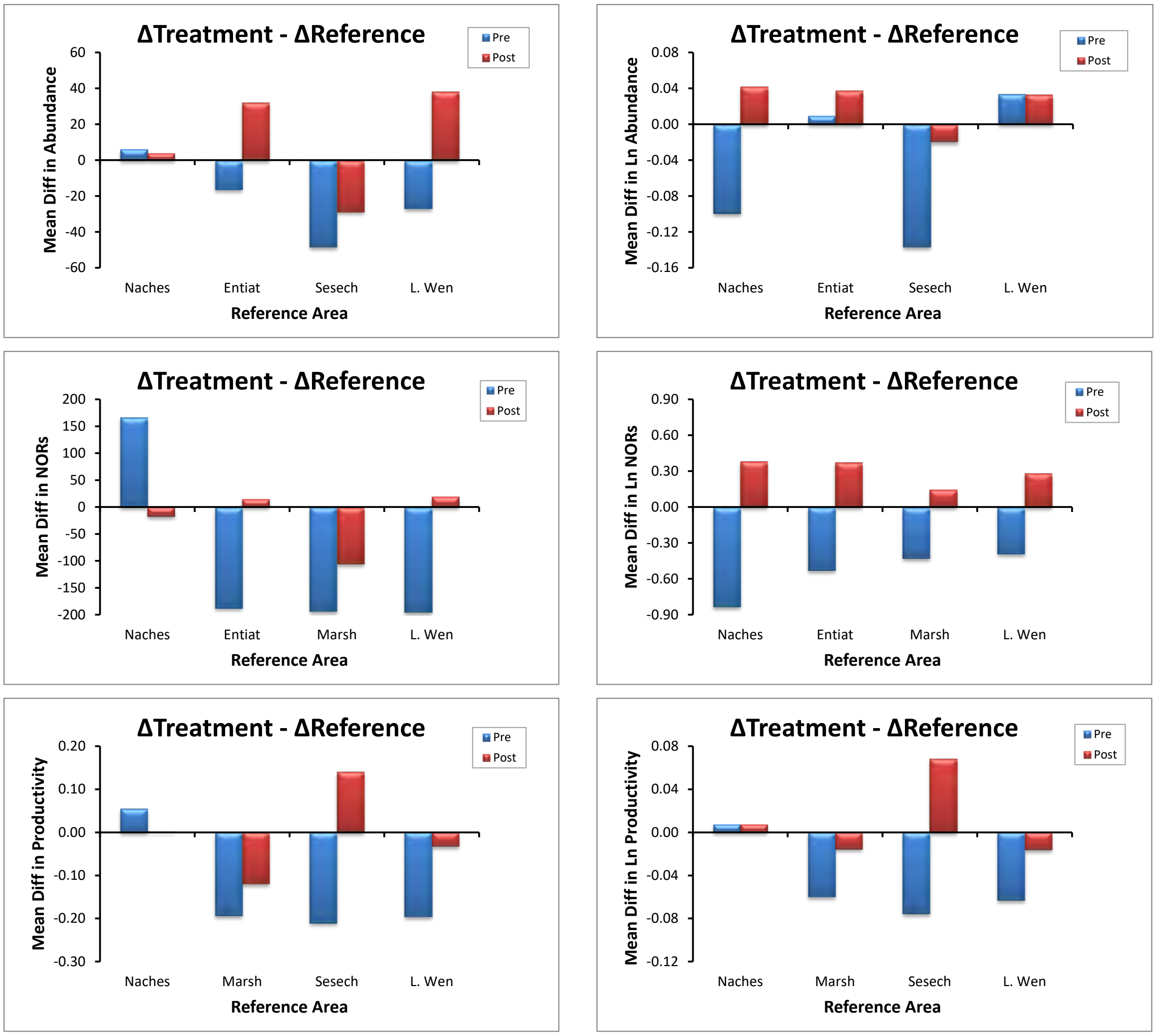

Figure 14. Mean difference scores of annual changes (ΔTreatment – ΔReference) of untransformed (figures on the left) and transformed (figures on the right) spawner abundance and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin.

Analysis of supplementation effects on NORs using difference scores of annual changes indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 22; Figure 14). None of the statistical analyses detected a significant increase in annual change in the Chiwawa Basin relative to the reference populations.

Table 22. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if mean difference scores of annual change during the supplementation period were greater than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	0.399	0.652	184	0.741	-699 – 989
Entiat	-1.381	0.092	202	0.194	-471 – 86
Marsh	-0.505	0.311	88	0.624	-425 – 206
Little Wenatchee	-1.437	0.084	214	0.179	-481 – 64
LN Natural-Origin Recruits					
Naches	-1.301	0.118	1.214	0.224	-2.783 – 0.531
Entiat	-1.408	0.088	0.901	0.188	-1.977 – 0.387
Marsh	-0.712	0.244	0.570	0.517	-1.952 – 0.975
Little Wenatchee	-1.154	0.132	0.674	0.274	-1.706 – 0.497

Analysis of supplementation effects on productivity (adult recruits/spawner) using difference scores of annual changes indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 23; Figure 14). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period.

Table 23. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean difference scores of annual change during the supplementation period were less than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	0.002	0.475	0.054	0.952	-1.464 – 1.583
Marsh	-0.063	0.525	0.074	0.948	-2.395 – 2.031
Sesech	-0.317	0.621	0.350	0.628	-2.387 – 1.695
Little Wenatchee	-0.347	0.633	0.163	0.728	-1.023 – 0.725
LN Productivity					
Naches	0.000	0.500	0.000	0.999	-0.408 – 0.445
Marsh	-0.126	0.549	0.044	0.904	-0.715 – 0.595
Sesech	-0.449	0.668	0.144	0.727	-0.685 – 0.509
Little Wenatchee	-0.200	0.578	0.047	0.842	-0.466 – 0.391

We believe results from analysis of mean differences of annual change (ΔT-ΔR) in spawning abundance, NORs, and productivity are difficult to interpret and may be insensitive to treatment effects. A simpler analysis, which is also easier to interpret, is the use of trend analysis. Therefore, we recommend that analyses using differences of annual change be replaced with trend analysis.

Corrections for Density Dependence and Carrying Capacity

The analyses described above assume that the density of spawners or recruits does not affect the survival and productivity of fish. However, it is well known that the density of fish can affect the number of recruits as well as the productivity of the population. This occurs through the relationship between density and mortality. Mortality of fish can be generally classified as density independent and density dependent. In general, when densities are low, the mortality is density independent, but as densities increase, the amount of density-dependent mortality increases. Monitoring programs can make use of this information to derive density-corrected estimates of productivity. In this section, we describe two different methods for deriving density-corrected estimates of productivity.

The first method controlled the effects of density on productivity (adult recruits/spawner; R/S) by partitioning observed productivities into density-independent and density-dependent productivity. When abundance is below the minimum number of spawners (S) needed to produce the maximum number of recruits (K_{sp}), the observed productivity is used in statistical tests. However, when the abundance is equal to or above K_{sp}, the modeled value of productivity (R/K_{sp}) is used in statistical tests.

$$Adj\ R/S = \begin{cases} R/S, & if\ S < K_{sp} \\ R/K_{sp}, & if\ S \geq K_{sp} \end{cases}$$

The density-independent and density-dependent productivities were then combined in a single test.

The second method was based on one of the goals of supplementation, which is to fill the capacity of the environment with fish. This method corrects for differences in carrying capacities between the supplemented and reference populations. We did this by calculating the percent saturation of NORs. That is, we calculated the fraction of the habitat (τ) that was filled with NORs by dividing the observed NOR by the modeled maximum number of NORs (K_R) that the habitat could support.

$$\tau = \frac{NOR_{obs}}{K_R}$$

Note that 1-τ represents the unused portion of the carrying capacity and is the term that is multiplied by the exponential growth equation to derive the logistic growth equation. We included τ in the statistical analyses.

These two methods require the estimation of carrying capacity (K_R) and the spawning abundance that produces the maximum number of recruits (K_{sp}). We estimated these parameters for both reference populations and the supplemented population using Ricker, Beverton-Holt, and smooth hockey stick stock-recruitment models. We used only spawner abundance as a predictor of subsequent brood recruitment. We made the following assumptions in proceeding with the analysis:

- *Density-dependent mortality*—For some time period before recruitment, the brood instantaneous mortality rate is proportional to the number of parent spawners (Ricker 1954).
- *Lognormal variation*—At any particular spawning stock size, the variation in recruitment is log-normally distributed about its average, and acts multiplicatively (Quinn and Deriso 1999).
- *Measurement error*—Error in spawning stock size estimates (measurement error) is small relative to the range of spawning stock sizes observed (Hilborn and Walters 1992). Variation in realized recruitment at any particular spawning stock size (process error) dominates recruitment measurement error.
- *Stationarity*—The average stock-recruitment relationship is constant over time (Hilborn and Walters 1992). That is, environmental conditions randomly affect survival independent of stock size or time.

In general, the methods we used to fit the models to the data followed those outlined in Hilborn and Walters (1992) and Froese (2008). The Ricker model, which assumes that the number of recruits increases to a maximum and then declines as the number of spawners increases, takes the form:

$$\boldsymbol{E(R) = \alpha S e^{-\beta S}}$$

where E(R) is the expected recruitment, S is spawner abundance, α is the number of recruits per spawner at low spawning levels, and β describes how quickly the recruits per spawner drop as the number of spawners increases. We estimated K_R as:

$$\boldsymbol{K_R = \left(\frac{\alpha}{\beta}\right) e^{-1}}$$

and K_{sp} as:

$$\boldsymbol{K_{sp} = \frac{1}{\beta}}$$

The Beverton-Holt model assumes that the number of recruits increases constantly toward an asymptote as the number of spawners increases. After the asymptote is reached, the number of recruits neither increases nor decreases. The asymptote represents the maximum number of recruits the system can support (i.e., carrying capacity for the system; K_R). The Beverton-Holt curve takes the form:

$$\boldsymbol{E(R) = \frac{(\alpha S)}{(\beta + S)}}$$

where E(R) and S are as above, α is the maximum number of recruits produced (K_R), and β is the number of spawners needed to produce (on average) recruits equal to one-half the maximum number of recruits. Because $K_{sp} = \infty$ in the Beverton-Holt model, we estimated K_{sp} as the number of spawners needed to produce 0.99(K_R).

Like the Beverton-Holt model, the smooth hockey stick model assumes that the number of recruits increases toward an asymptote (carrying capacity; K_R) as the number of spawners increases. After the carrying capacity is reached, the number of recruits neither increases nor decreases. The carrying capacity represents the maximum number of recruits the system can support. This curve takes the form (Froese 2008):

$$\boldsymbol{E(R) = R_{\infty}\left(1 - e^{-\left(\frac{\alpha}{R_{\infty}}\right)S}\right)}$$

where E(R) and S are as above, α is the slope at the origin of the spawner-recruitment curve, and R_{∞} is the carrying capacity of recruits (note that $R_{\infty} = K_R$). As with the Beverton-Holt model, we estimated K_{sp} as the number of spawners needed to produce $0.99(K_R)$.

We used non-linear regression to fit the three models to spawner-recruitment data. Before fitting the models, we transformed recruitment data using natural logs. We estimated bias and uncertainty measures (95% CI) for the model parameters using bootstrap procedures, which assumed that the {R, S} sample represented or approximated the population. The number of bootstrap samples was 3,000. We computed and stored the non-linear regression results for each bootstrap sample. We then calculated the bootstrap 95% CI by arranging the 3,000 bootstrap parameter values in sorted order and selected the 2.5 and 97.5 percentiles from the list.

We used Akaike's Information Criterion for small sample size (AIC_c) to determine which model(s) best explained the relationship between spawners and recruitment in the supplemented and reference populations. AIC_c was estimated as:

$$\boldsymbol{AIC_c = -2log\big(£(\theta|data)\big) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)}$$

where *log(£(θ|data))* is the maximum likelihood estimate, *K* is the number of estimable parameters (structural parameters plus the residual variance parameter), and *n* is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate *log(£(θ|data))*, which was calculated as $log(\sigma^2)$, where σ^2 = residual sum of squares divided by the sample size ($\sigma^2 = RSS/n$). AIC_c assessed model fit in relation to model complexity (number of parameters). The model with the smallest AIC_c value represented the "best approximating" model within the model set. Remaining models were ranked relative to the best model using AIC_c difference scores (ΔAIC_c), Akaike weights (w_i), and evidence ratios. Models with ΔAIC_c values less than 2 indicated that there is substantial support for these models as being the best-fitting models within the set (Burnham and Anderson 2002). Models with values greater than 2 had less support. Akaike weights are probabilities estimating the strength of the evidence supporting a particular model as being the best model within the model set. Models with small w_i values are less plausible as competing models (Burnham and Anderson 2002). If no single model could be specified as the best model, a "best subset" of competing models was identified using (1) AIC_c differences to indicate the level of empirical support each model had as being the best model, (2) evidence ratios based on Akaike weights to indicate the relative probability that any model is the best model, and (3) coefficients of determination (R^2) assessing the explanatory power of each model.

Stock-Recruitment Analysis

We successfully fit stock-recruitment models to the Chiwawa and reference population data. The span of spawner data for the Chiwawa and reference populations was greater than 14 times the minimum observed spawners, which should provide sufficient contrast for estimation of model parameters. In addition, the span of recruitment data was greater than 12 times the minimum observed recruitment, again providing sufficient contrast for estimation of parameters. The relationship between natural log R/S and spawners indicated that some of the highest productivities occurred at the lower spawner levels and the lowest productivities generally occurred at the highest spawner levels (Figure 15). This is consistent with the assumption of density-dependent mortality.

Although model fits were generally poor, explaining less than 40% of the residual variation in natural-log recruitment data, we were able to estimate average maximum recruitment levels (K_R) and the spawning levels needed to produce maximum recruitment (K_{sp}) (Table 24; Figure 15). For all populations examined, Akaike information criterion was unable to identify a best approximating model (i.e., ΔAIC_c values were less than 2, indicating support for all three models). However, evaluation of 95% CIs and the asymptotic correlation coefficients indicated that the smooth hockey stick model may be the best approximating model for each population. Therefore, we used estimates of K_R and K_{sp} derived from the smooth hockey stick model to correct for density dependence and different carrying capacities in treatment-reference comparisons.

As part of the regression diagnostics, we examined the dependence of the model residuals on time and found a significant ($P < 0.05$), positive, one-year-lag autocorrelation for the Entiat (0.562), Marsh (0.551), Sesech (0.564), and Little Wenatchee (0.629) populations. For the purposes of our work here, we did not attempt to correct for this one-year-lag correlation in the residuals. Future analyses will explore the use of autoregressive models (e.g., AR1; Noakes et al. 1987) to correct for autocorrelation.

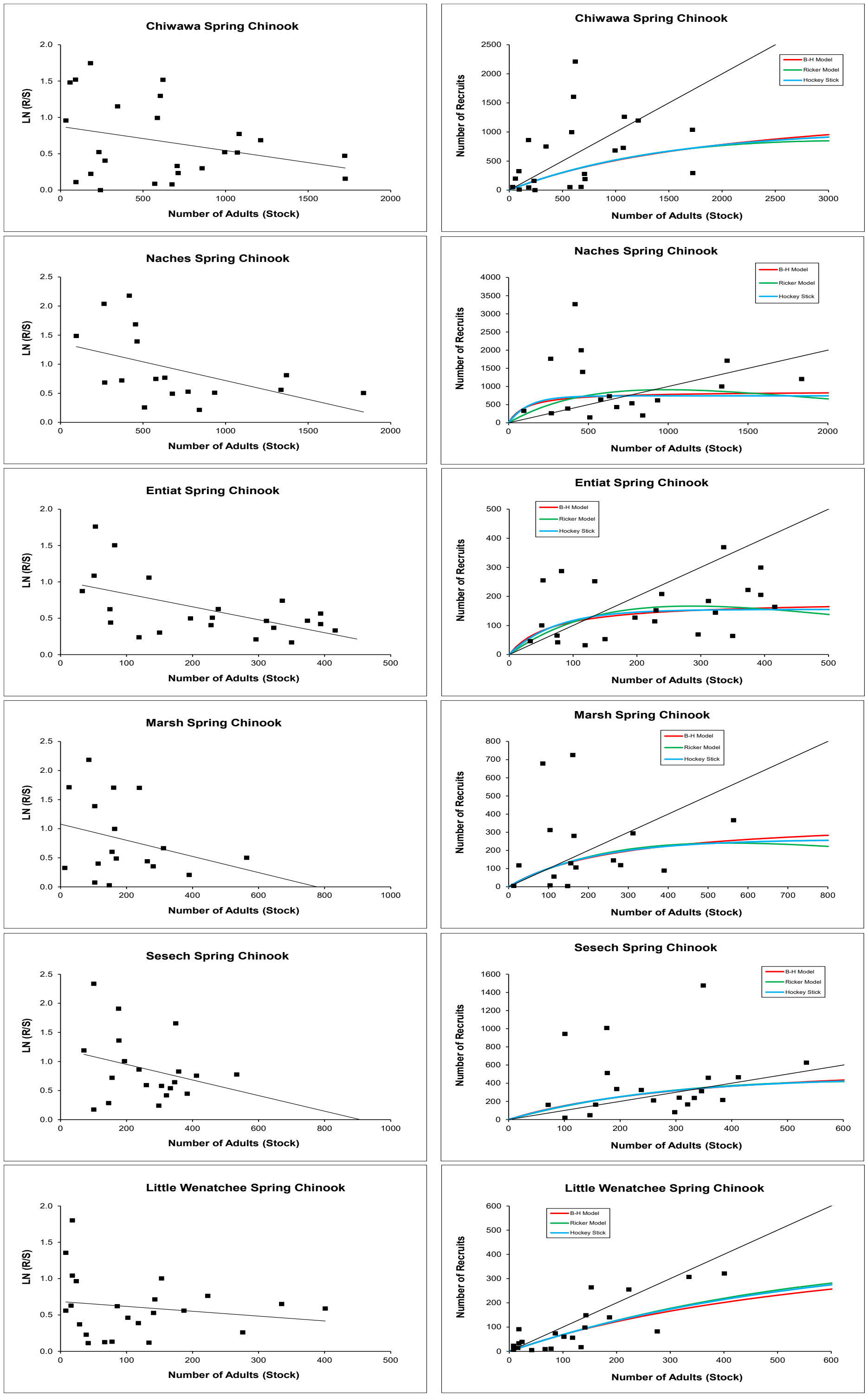

Figure 15. Relationships between natural log recruits/spawner (LN R/S) and spawners (Stock) in the Chiwawa and reference populations (figures on the left) and relationships between numbers of untransformed recruits and spawners in the Chiwawa and reference populations (figures on the right). Figures on the right also show the fit of the Ricker, Beverton-Holt, and the smooth hockey stick models to the data (black straight line represents R=S).

Table 24. Results from fitting Ricker, Beverton-Holt, and smooth hockey stick models to stock-recruitment data from the Chiwawa and reference populations. 95% CI on parameter estimates are based on 3,000 bootstrap trials; Corr coef = asymptotic correlation of the parameter estimates; K_R = maximum natural origin recruits (recruits at carrying capacity); K_{sp} = number of spawners needed to produce K_R; AICc = Akaike's Information Criterion for small sample size; Adj R^2 = coefficient of determination that is adjusted for the number of parameters in the model.

Model	Parameter	Parameter value	Bootstrap 95% CI	Corr coef	K_R	K_{sp}	AICc	Adj R^2
Chiwawa Population								
Ricker	α	0.7048	-0.6197 1.1055	0.791	852	3,285	-47.949	0.125
	β	0.000304	-0.000668 0.000609					
Beverton-Holt	α	1687.4	-65654539 3062.1	0.989	1,687	43,760	-47.962	0.125
	β	2308.5	-99999538 4526.1					
Smooth hockey stick	α	6.956	-41.313 8.2270	-0.708	1,049	6,847	-47.949	0.125
	β	0.7118	-2.397 1.122					
Naches Population								
Ricker	α	2.5223	-2.0003 3.9672	0.844	912	983	-45.063	-0.143
	β	0.001018	-0.000752 0.001717					
Beverton-Holt	α	869.4	97.4 1641.4	0.858	869	11,455	-46.801	-0.097
	β	111.8	-346.2 569.8					
Smooth hockey stick	α	6.612	5.9223 7.006	-0.399	744	565	-46.831	-0.095
	β	6.013	-89.071 12.026					
Entiat Population								
Ricker	α	1.5843	0.1609 2.4178	0.867	167	286	-68.365	-0.049
	β	0.003496	0.001141 0.005906					
Beverton-Holt	α	186.1	67.9 304.3	0.880	186	1,277	-69.895	0.029
	β	65.0	-59.1 189.2					
Smooth hockey stick	α	5.045	4.381 5.378	-0.450	155	344	-69.379	0.003
	β	2.180	-89.369 3.704					
Marsh Creek Population								
Ricker	α	1.1852	-1.8268 1.9269	0.823	241	552	-32.237	0.218

Model	Parameter	Parameter value	Bootstrap 95% CI	Corr coef	K_R	K_{sp}	AICc	Adj R^2
	β	0.001810	-0.003063 0.003625					
Beverton-Holt	α	383.3	-85109314 665.4	0.970	383	5,310	-32.291	0.234
	β	282.4	-99999944 564.9					
Smooth hockey stick	α	5.565	-22.631 6.584	-0.694	261	984	-32.264	0.227
	β	1.265	-108.574 2.531					
Sesech Population								
Ricker	α	1.6835	-2.9253 2.5951	0.912	421	680	-54.589	-0.005
	β	0.001470	-0.002951 0.002941					
Beverton-Holt	α	689.9	-986.8 2366.7	0.981	690	6,591	-54.678	0.000
	β	351.7	-1059.0 1762.5					
Smooth hockey stick	α	6.1528	-22.851 6.815	-0.821	470	1,185	-54.633	-0.002
	β	0.8000	-119.370 2.909					
Little Wenatchee Population								
Ricker	α	0.7447	0.0828 1.0280	0.735	356	1,298	-66.978	0.357
	β	0.000770	-0.003052 0.001541					
Beverton-Holt	α	564.7	-74423355 1067.6	0.994	565	13,400	-67.055	0.358
	β	719.7	-99999856 1413.4					
Smooth hockey stick	α	6.0181	-49.5620 8.1122	-0.683	411	2,544	-67.000	0.357
	β	0.7550	-0.9539 1.0452					

<u>Method 1: Productivity Data Adjusted for Density Dependence</u>

Analysis of supplementation effects on productivity (adult recruits/spawner adjusted for density-dependent effects based on the smooth hockey stick model) using difference scores indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 25; Figure 16). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period, even though productivity did decrease during the supplementation period (Figure 16). These results are consistent with those based on unadjusted productivity data (Table 17). This is because most abundance estimates were below the level of assumed density dependence.

Table 25. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data corrected for density dependence. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	0.904	0.190	0.496	0.412	-0.511 – 1.497
Marsh	-0.203	0.579	0.152	0.927	-1.298 – 1.372
Sesech	1.607	0.071	1.435	0.146	-0.359 – 2.911
Little Wenatchee	0.431	0.335	0.147	0.668	-0.487 – 0.781
LN Productivity					
Naches	0.570	0.290	0.083	0.568	-0.168 – 0.362
Marsh	0.012	0.495	0.003	0.991	-0.373 – 0.480
Sesech	1.463	0.087	0.343	0.171	-0.125 – 0.732
Little Wenatchee	0.390	0.351	0.060	0.709	-0.218 – 0.365

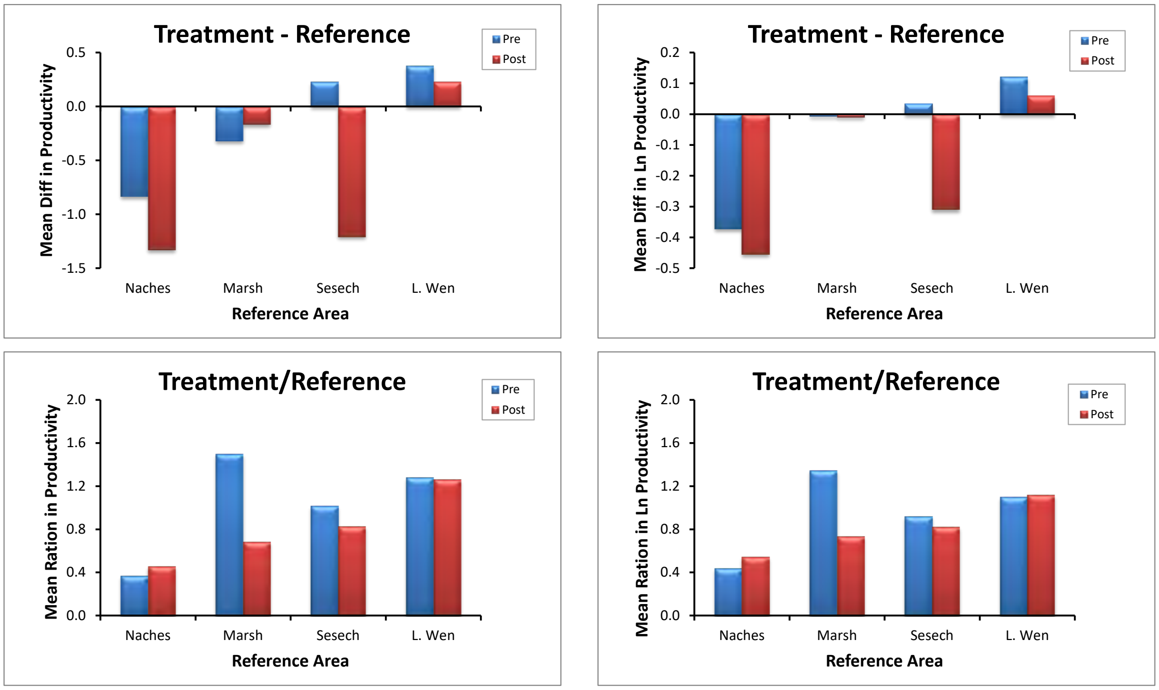

Figure 16. Mean differences (Treatment – Reference; figures on the top) and mean ratios (Treatment/Reference; figures on the bottom) of transformed and untransformed productivity data (adjusted for density dependence) before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on productivity (adult recruits/spawner adjusted for density-dependent effects) using ratios indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 26; Figure 16). The Aspin-Welch test and the 95% CIs did indicate a significant effect when comparing the Chiwawa to the Marsh Creek population. These results are consistent with those using unadjusted productivity data (Table 20). Again, this is because most abundance estimates were below the level of assumed density dependence.

Table 26. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data corrected for density dependence. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	-0.529	0.696	0.087	0.597	-0.394 – 0.214
Marsh	2.236	0.022	0.814	0.056	0.140 – 1.470
Sesech	0.677	0.253	0.191	0.496	-0.343 – 0.727
Little Wenatchee	0.033	0.487	0.018	0.978	-0.902 – 1.181
LN Productivity					
Naches	-0.621	0.726	0.104	0.536	-0.406 – 0.191

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Marsh	1.952	0.036	0.613	0.076	0.005 – 1.163
Sesech	0.447	0.330	0.098	0.649	-0.312 – 0.498
Little Wenatchee	-0.034	0.513	0.015	0.980	-0.697 – 0.852

Our analyses assume that there is a spawner abundance (K_{sp}) at which density-independent effects end and density-dependent effects begin. In reality, density-dependent effects occur at low spawning abundance and intensify as spawning abundance increases (evident in the changing slope of the three stock-recruitment curves used in our analyses). We did not account for these increasing density-dependent effects at spawner abundances less than K_{sp}. If we accounted for the increasing effects of density dependence at spawning abundances less than K_{sp}, the analysis with and without productivity adjustments may give different results.

Method 2: Fraction of Carrying Capacity Filled with NORs

We analyzed the effects of supplementation on filling the capacity of the habitat with natural-origin recruits. The smooth hockey stick model derived the carrying capacity (K_R) estimates for the Chiwawa and reference populations. The fraction of the carrying capacity filled with Chinook recruits before and during supplementation for the Chiwawa and reference populations is provided in Table 27. These data indicate that for the Chiwawa population, the mean fraction of the K_R filled with fish decreased significantly from the pre-supplementation period through the supplementation period (Table 27). Likewise, the Entiat and Little Wenatchee populations showed a significant decline in the mean fraction of K_R filled with adult recruits. In contrast, the mean fraction of K_R in the Naches and Marsh Creek populations increased during the same period (Table 27).[22] Interestingly, the fraction of K_R filled with adult recruits for all populations trended downward during the pre-supplementation period (Figure 17). During the supplementation period, however, the fraction of K_R filled with adult recruits trended upward for all populations. These results suggest that agents of mortality outside the Chiwawa and reference populations were reducing recruitment to the populations.

[22] Although we do not show the results here, statistical analysis of the mean fraction of carrying capacity filled by adult recruits using natural-log transformed data produced the same result as using untransformed data. This was true for all populations.

Table 27. Fraction of the carrying capacity that was filled with Chinook salmon adult recruits in the Chiwawa and reference populations before (pre) and during (post) supplementation in Chiwawa Basin. The smooth hockey stick model estimated carrying capacity for each population. Statistical results from comparing the pre and post mean scores using the Aspin-Welch unequal-variance test are provided at the bottom of the table.

Supplementation period	Chiwawa	Reference populations			
		Naches	Entiat	Marsh	L. Wenatchee
Pre-supplementation period (1981-1992)	2.11		2.38	1.07	0.64
	1.53		1.93	1.20	0.75
	1.20		1.32	2.60	0.78
	1.14		1.19	0.49	0.62
	0.99		1.06	0.46	0.34
	0.70	2.30	1.43	0.56	0.24
	0.65	0.58	0.74	0.34	0.20
	0.95	1.88	1.34	1.40	0.36
	0.18	0.72	1.63	0.22	0.15
	0.05	0.27	0.45	0.02	0.02
	0.00	0.20	0.21	0.03	0.01
Pre-Mean:	0.86	0.99	1.24	0.76	0.37
Pre-Range:	0.00 – 2.11	0.20 – 2.30	0.21 – 2.38	0.02 – 2.60	0.01 – 0.78
Post-supplementation period (1992-2002)	0.05	0.98	0.34	0.41	0.03
	0.15	0.86	0.41	1.13	0.04
	0.04	0.35	0.27	0.02	0.03
	0.05	0.44	0.30	0.02	0.03
	0.19	4.39	0.65	0.45	0.06
	0.82	2.68	1.85	2.78	0.22
	0.31	2.37	1.65	4.10	0.08
	0.01	0.53	0.42		0.02
	0.71	1.62	0.82		0.10
	0.28	1.35	0.93		0.14
	0.27	0.83	0.98		0.18
Post-Mean:	0.26	1.49	0.78	1.27	0.08
Post-Range:	0.04 – 0.82	0.35 – 4.39	0.30 – 1.85	0.02 – 4.10	0.02 – 0.22
One-sided Aspin-Welch t-test of pre and post means	t = 2.846; P = 0.007	t = -0.967; P = 0.825	t = 1.833; P = 0.041	t = -0.799; P = 0.776	t = 3.321; P = 0.003

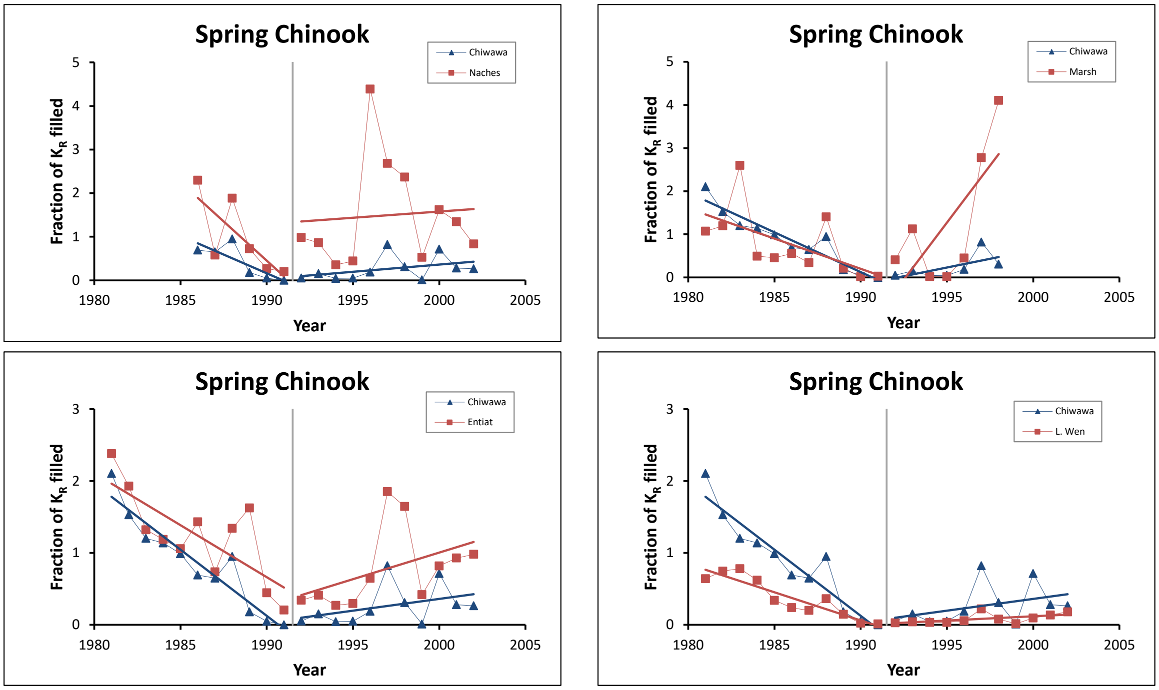

Figure 17. Trends in the fraction of the carrying capacity that was filled with Chinook salmon adult recruits in the Chiwawa and reference populations before (pre) and during (post) supplementation in Chiwawa Basin. The vertical lines in the figures separate the pre- and post-supplementation periods. The smooth hockey stick model estimated carrying capacity for each population.

We then compared the mean difference scores and ratios between the Chiwawa and reference populations before and during supplementation using data representing the fraction of K_R filled with adult recruits. In most of the Chiwawa-reference population comparisons, the absolute value of the mean difference between the fraction of K_R filled with recruits was greater in the supplementation period than during the pre-supplementation period; two of the four pairings were significant (Table 28; Figure 18). Analysis of difference scores using natural-log transformed data indicated that three of the four pairings were significant (Table 28).

Results from analyses using ratios were similar to results using difference scores. Mean ratio scores were generally smaller during the supplementation period than during the pre-supplementation period (Figure 18). This indicated that the mean fraction of K_R filled by adult recruits in most reference populations was greater during the supplementation period than during the pre-supplementation period (i.e., the denominator in the ratio increased between the pre- and post-supplementation periods). In contrast, the fraction of K_R filled by adult recruits in the Chiwawa decreased from the pre- to post-supplementation period (i.e., the numerator in the ratio decreased between the pre- and post-supplementation periods). Thus, unlike the Chiwawa population, the capacity of most reference populations was becoming more saturated during the period when the Chiwawa was being supplemented. Statistical analysis with mean ratios indicated that two of the four pairings were significant (Table 29).

Analyses comparing the Little Wenatchee with the Chiwawa indicate that adult recruits to the Little Wenatchee have been well below its carrying capacity. During the pre-supplementation period, the capacity of the Little Wenatchee was on average 37% saturated with adult recruits. During the supplementation period, the capacity of the Little Wenatchee declined to 8% saturation with adult recruits (a 22% decline). The Chiwawa, during the pre-supplementation period, was on average 86% saturated. During the supplementation period, percent saturation in the Chiwawa decreased to 26% (a 30% decrease). During the same time periods, the capacity of the Entiat population, which until recently has been supplemented, declined from 124% to 78% saturation (a 63% decline).

Table 28. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on the fraction of the habitat capacity (K_R) that is filled with natural origin recruits. Analyses include both transformed and untransformed data. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Fraction of Capacity Filled					
Naches	1.550	0.071	0.657	0.145	-0.173 – 1.378
Entiat	0.835	0.207	0.141	0.422	-0.167 – 0.475
Marsh	2.026	0.040	1.141	0.055	0.064 – 2.054
Little Wenatchee	2.166	0.023	0.310	0.031	0.035 – 0.569
LN Fraction of Capacity Filled					
Naches	2.123	0.026	0.311	0.039	0.031 – 0.575
Entiat	1.405	0.087	0.122	0.176	-0.034 – 0.289
Marsh	2.547	0.017	0.519	0.017	0.125 – 0.864
Little Wenatchee	1.744	0.049	0.130	0.100	-0.004 – 0.273

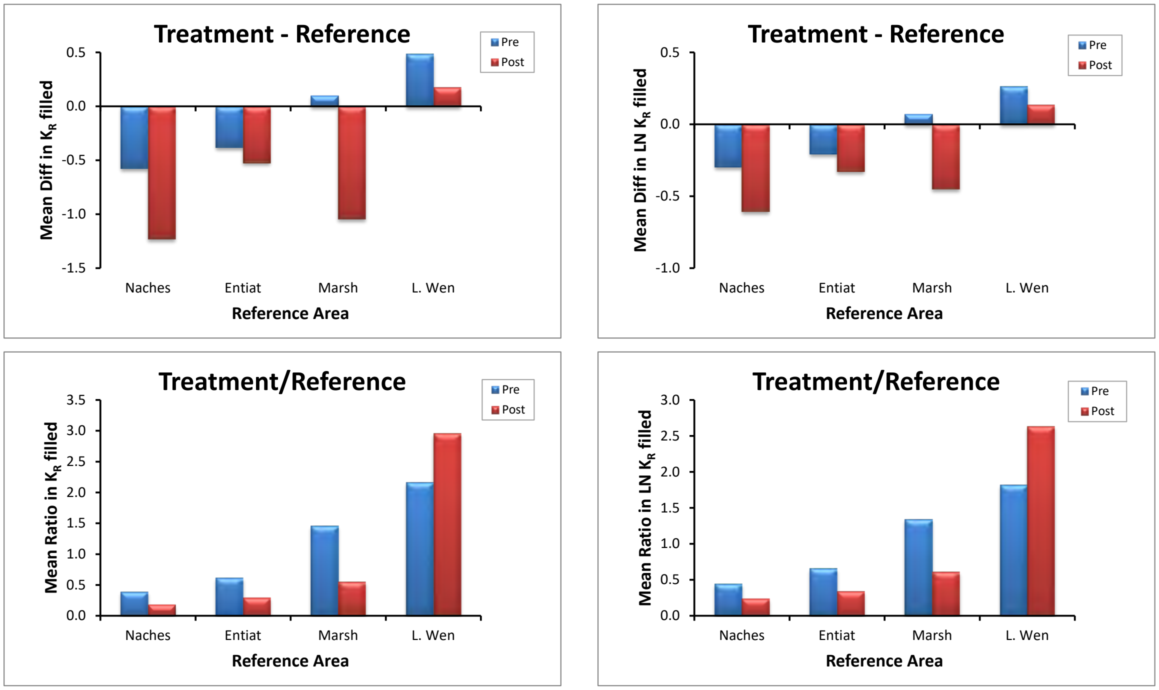

Figure 18. Mean differences (Treatment – Reference; figures on the top) and mean ratios (Treatment/Reference; figures on the bottom) of transformed and untransformed fractions of carrying capacity filled with adult recruits before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin.

Table 29. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on the fraction of the habitat capacity (K_R) that is filled with natural origin recruits. Analyses include both transformed and untransformed data. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test	Bootstrap 95% CI
	t-value	P-value	Effect size	P-value	
Fraction of Capacity Filled					
Naches	1.317	0.119	0.217	0.219	-0.103 – 0.482
Entiat	2.449	0.013	0.321	0.028	0.085 – 0.577
Marsh	2.001	0.035	0.905	0.070	0.138 – 1.788
Little Wenatchee	-1.148	0.864	0.791	0.278	-1.979 – 0.578
LN Fraction of Capacity Filled					
Naches	1.257	0.127	0.207	0.249	-0.099 – 0.484
Entiat	2.346	0.016	0.313	0.031	0.072 – 0.583
Marsh	1.737	0.056	0.729	0.111	0.028 – 1.531
Little Wenatchee	-1.525	0.924	0.815	0.142	-1.751 – 0.195

Comparing Stock-Recruitment Curves

As a final set of treatment and reference population comparisons, we compared the stock-recruitment curves of the Chiwawa population (using {R, S} data only from the supplementation period) to the reference populations (using all available {R, S} data). Specifically, we tested whether the regression parameters were equal between the Chiwawa population and the reference populations, and whether the fitted curves coincided between populations. Earlier in this report we described the data, methods, and results of fitting the Ricker, Beverton-Holt, and smooth hockey stick curves to the data. Because AIC_c was unable to identify a best approximating model, here we included all three models in our analyses. We tested the following hypotheses.

Parameter equivalence:

Ho: Stock-recruitment parameters (α and β) of the Chiwawa population = Stock-recruitment parameters of the reference populations.

Ha: Stock-recruitment parameters (α and β) of the Chiwawa population ≠ Stock-recruitment parameters of the reference populations.

Curve equivalence:

Ho: Modeled stock-recruitment curves of the Chiwawa population = Modeled stock-recruitment curves of the reference populations.

Ha: Modeled stock-recruitment curves of the Chiwawa population ≠ Modeled stock-recruitment curves of the reference populations.

We used two-sided randomization tests to test the null hypotheses of equal model parameters and that fitted curves coincided. Because the total number of permutations was in the millions, we used a Monte Carlo approach to randomly select 10,000 permutations. The test statistic for comparing the model parameters was formed by summing the difference between the population parameter estimates for each pair of populations. The test statistic for comparing the whole curve was formed by summing the difference between the estimated predicted values for each pair of populations at 500 equally spaced points along the curve.

<u>*Ricker Relationships*</u>

Ricker curves differed significantly between the Chiwawa and reference populations (Figure 19; Table 30). Interestingly, however, the parameters in the Ricker model did not differ significantly among most populations (Table 30). Only the β parameter differed significantly between the Chiwawa and Entiat populations.

In the Ricker model, the α parameter represents intrinsic productivity (i.e., recruits per spawner at low spawner densities). In this analysis, there was not enough evidence in the stock-recruitment data to reject the hypothesis of inequality in intrinsic productivity. Thus, this test was unable to demonstrate that supplementation, based on the Ricker curve, affected productivity in the Chiwawa population.

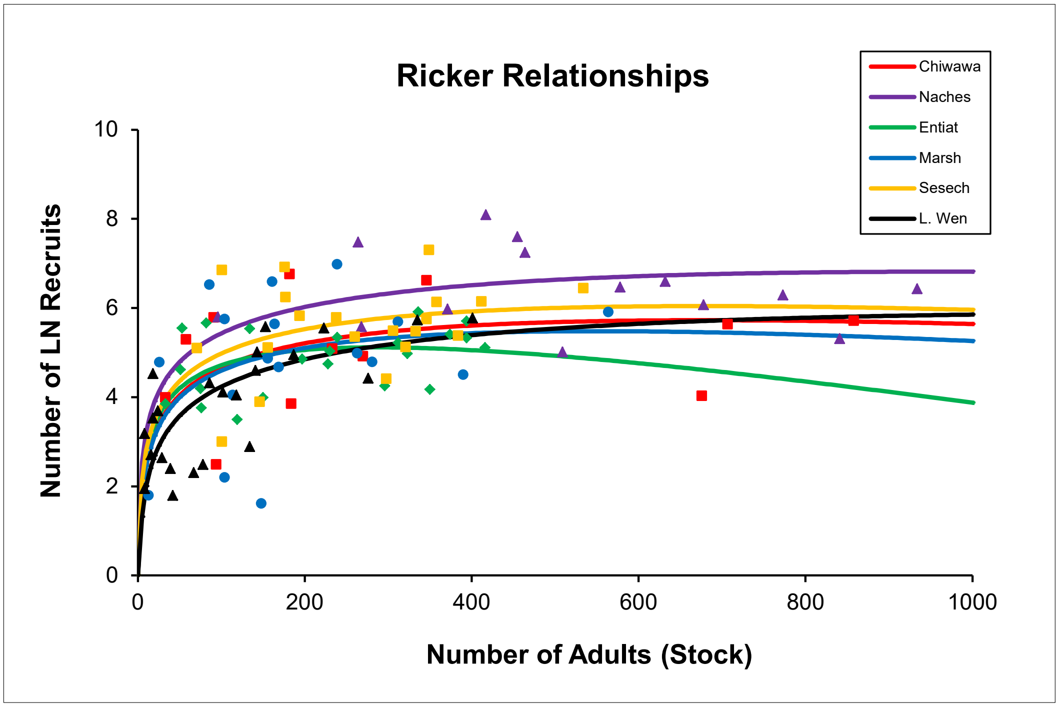

Figure 19. Scatter plot of the number of spawners and natural log adult recruits and fitted Ricker curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 30. Randomization test results comparing the equality of Ricker curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Naches	0.008	α = 1.2247	α = 2.5267	0.236
		β = 0.0015	β = 0.0010	0.600
Chiwawa v. Entiat	0.004	α = 1.2247	α = 1.5836	0.978
		β = 0.0015	β = 0.0035	0.025
Chiwawa v. Marsh	0.034	α = 1.2247	α = 1.1855	0.997
		β = 0.0015	β = 0.0018	0.688
Chiwawa v. Sesech	0.036	α = 1.2247	α = 1.6818	0.972
		β = 0.0015	β = 0.0015	0.997
Chiwawa v. L. Wenatchee	0.034	α = 1.2247	α = 0.7439	0.969
		β = 0.0015	β = 0.0008	0.203

Beverton-Holt Relationships

Beverton-Holt curves differed significantly only between the Chiwawa and Naches populations (Figure 20; Table 31). There was no significant difference in curves between the Chiwawa and the other reference populations. The parameters in the Beverton-Holt model did not differ significantly among any of the populations (Table 31). This was true even for the Chiwawa and Naches populations.

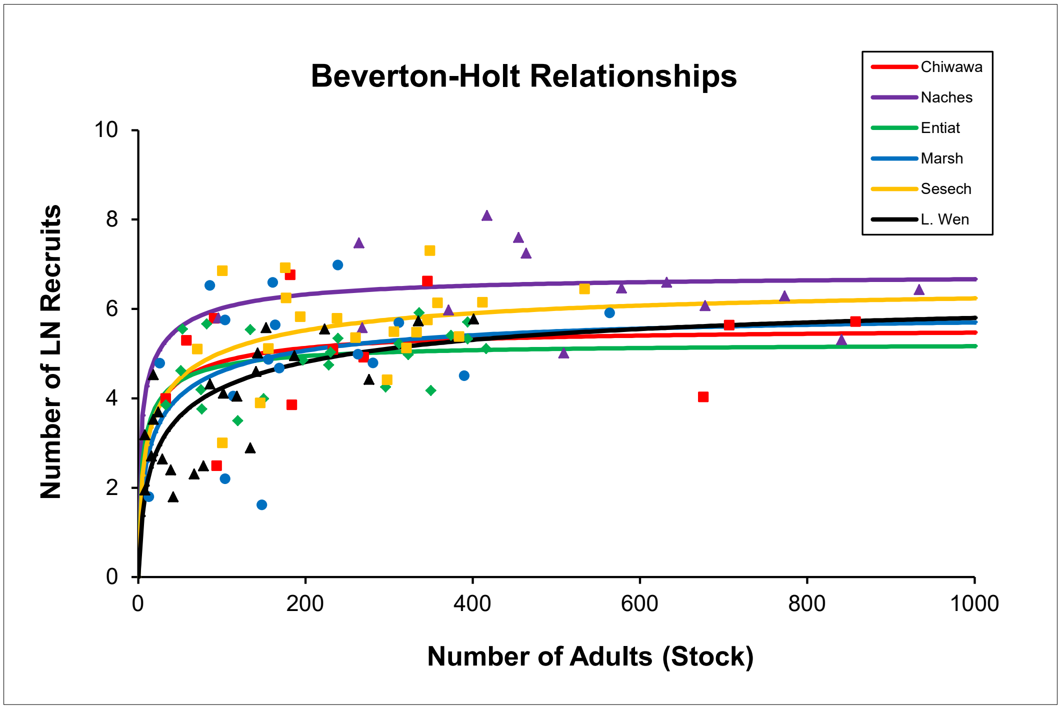

Figure 20. Scatter plot of the number of spawners and natural log adult recruits and fitted Beverton-Holt curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 31. Randomization test results comparing the equality of Beverton-Holt curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Naches	0.036	α = 264.25	α = 870.62	0.777
		β = 113.79	β = 112.24	0.963
Chiwawa v. Entiat	0.746	α = 264.25	α = 186.34	0.960
		β = 113.79	β = 65.33	0.954
Chiwawa v. Marsh	0.850	α = 264.25	α = 381.79	0.944
		β = 113.79	β = 281.04	0.891

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Sesech	0.272	α = 264.25	α = 689.31	0.821
		β = 113.79	β = 351.59	0.869
Chiwawa v. L. Wenatchee	0.654	α = 264.25	α = 568.69	0.864
		β = 113.79	β = 725.87	0.751

Smooth Hockey Stick Relationships

Smooth hockey stick curves differed significantly between the Chiwawa and Naches populations and the Chiwawa and Sesech populations (Figure 21; Table 32). There was no significant difference in curves between the Chiwawa and the other reference populations. Most of the parameters in the smooth hockey stick model did not differ significantly among the populations (Table 32). However, the productivity parameter β did differ significantly between the Chiwawa and the Naches and the Chiwawa and Little Wenatchee populations. The β parameter for the Naches was significantly greater than the Chiwawa, while the β parameter for the Little Wenatchee was significantly less than the Chiwawa.

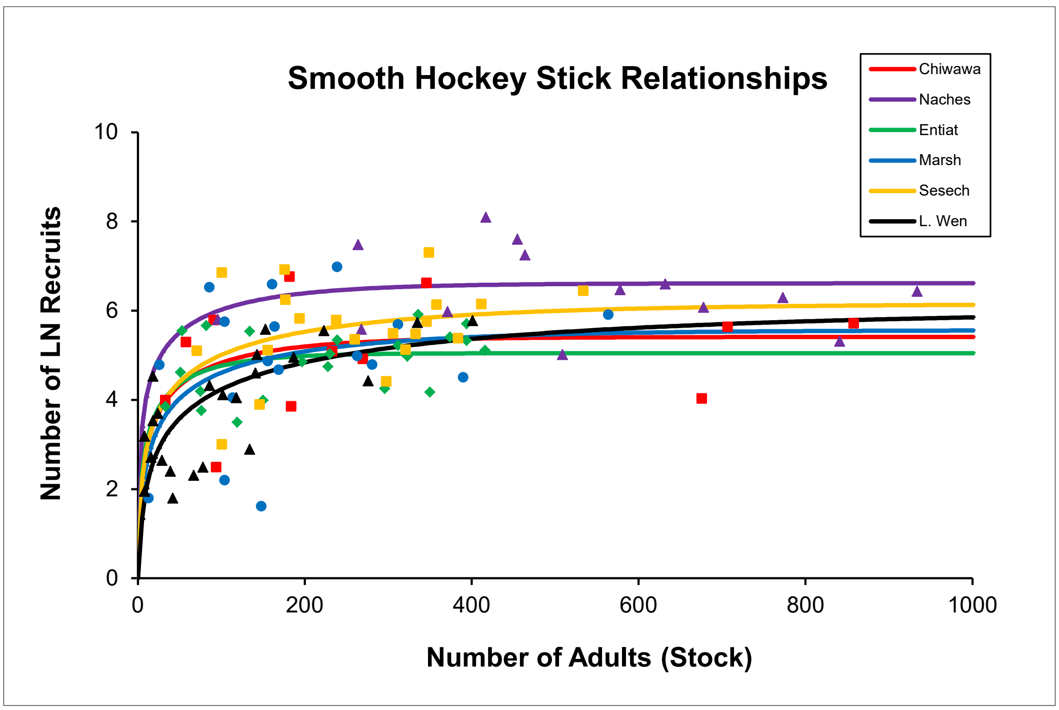

Figure 21. Scatter plot of the number of spawners and natural log adult recruits and fitted smooth hockey stick curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 32. Randomization test results comparing the equality of smooth hockey stick curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Naches	0.000	α = 5.41	α = 6.61	0.000
		β = 1.84	β = 5.99	0.000
Chiwawa v. Entiat	0.999	α = 5.41	α = 5.05	0.999
		β = 1.84	β = 2.17	0.999
Chiwawa v. Marsh	0.999	α = 5.41	α = 5.56	0.999
		β = 1.84	β = 1.27	0.999
Chiwawa v. Sesech	0.000	α = 5.41	α = 6.15	0.000
		β = 1.84	β = 1.80	0.999
Chiwawa v. L. Wenatchee	0.990	α = 5.41	α = 6.02	0.999
		β = 1.84	β = 0.75	0.000

Comparing different stock-recruitment curves and their parameters did not provide strong evidence that the supplementation program has negatively affected the productivity of the Chiwawa population.

Analysis without Reference Populations

In some cases, suitable reference populations may not exist to compare with supplemented populations. It is therefore important to have alternative analyses to assess supplementation effects. In this section, we describe methods that can be used to assess supplementation effects when suitable reference populations are not available. We discuss before-after comparisons, correlation analysis, and comparisons to standards as alternatives when reference populations are unavailable.

Before-After Comparisons

Before-after analyses compare population metrics (spawner abundance, NORs, and productivity) before supplementation to those during supplementation. In this case, data collected before supplementation represent the reference condition. The assumption is that population trajectories measured during the pre-supplementation period would continue in the absence of supplementation. We compared trends in abundance and productivity, mean abundance and productivity, and stock-recruitment relationships before and after supplementation.

Trend Analysis

Comparing trends before and after supplementation can be used to assess the effects of supplementation. Here, we compared the slopes of trends of spawner abundance, NORs, and productivity before and during supplementation using t-tests. If the hatchery program is successfully supplementing the natural spring Chinook population, the trend for spawner abundance and NORs during supplementation should be greater than the slope during the pre-supplementation period. For productivity, the slope during the supplementation period should increase or remain the same as that during the pre-supplementation period.

Visual examination of trends of Chiwawa data indicates that spawner abundance, NORs, and productivity decreased during the pre-supplementation period, but increased during the supplementation period (Figure 22). Only the changes in NOR trends were significant (Figure 22). This was true for both transformed and untransformed data.

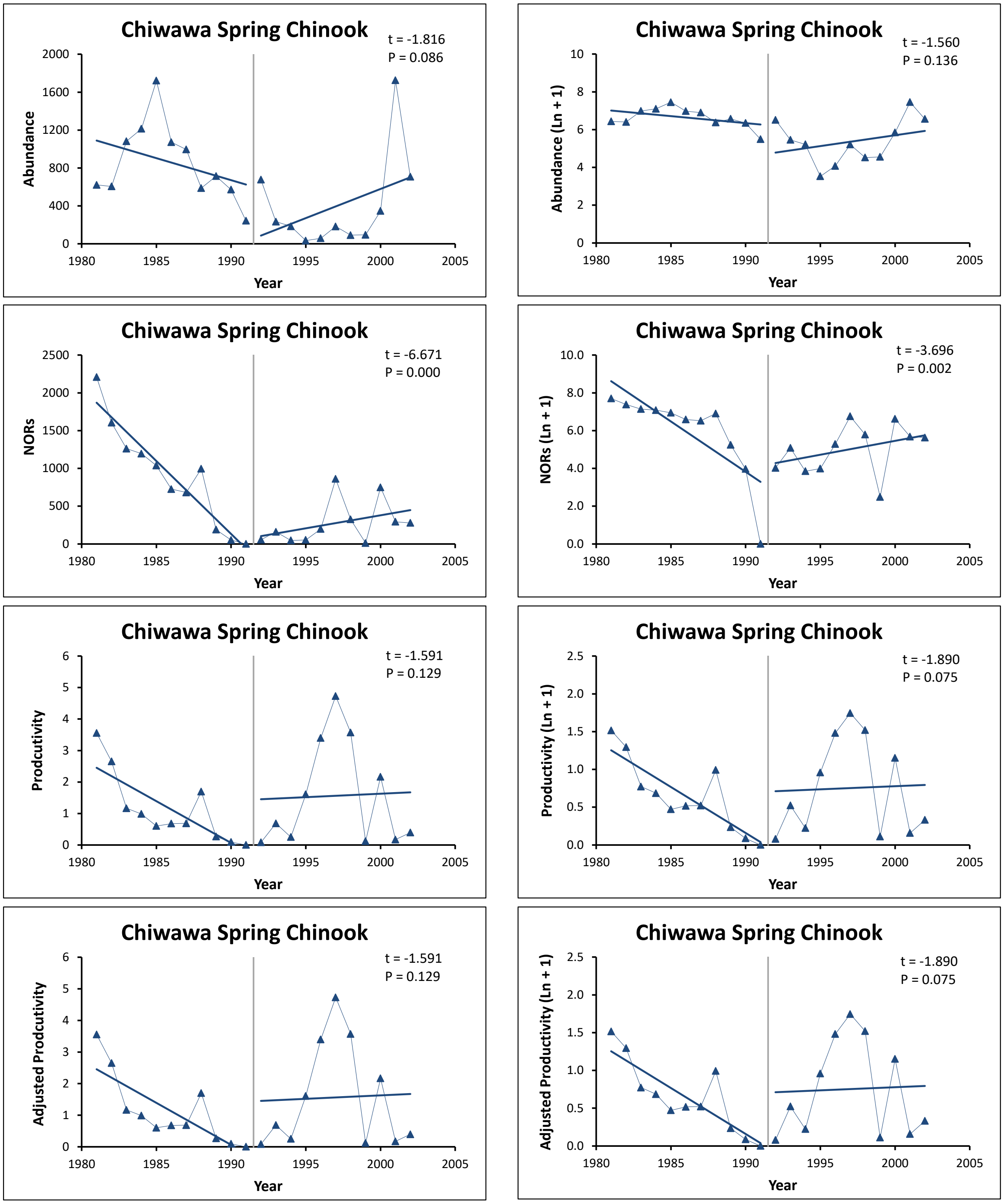

Figure 22. Trends in Chiwawa spring Chinook spawner abundance, natural-origin recruits (NORs), productivity (adults recruits per spawner), and adjusted productivity (adjusted for density dependence) before and during supplementation. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left show untransformed data; figures on the right include natural-log transformed data. Figures include results of t-tests comparing slope of trends before and during supplementation.

Analysis of Mean Scores

We also compared mean spawner abundance, NORs, and productivity data before and after supplementation. If the hatchery program is successfully supplementing the natural spring Chinook population, mean spawner abundance and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean productivity during the supplementation period should be equal to or higher than the pre-supplementation period. We tested the following statistical hypotheses.

Spawner Abundance and NORs:

Ho: Mean spawner abundance and NORs before supplementation ≥ Mean spawner abundance and NORs during supplementation.

Ha: Mean spawner abundance and NORs before supplementation < Mean spawner abundance and NORs during supplementation.

Productivity (Recruits/Spawner):

Ho: Mean productivity before supplementation ≤ Mean productivity during supplementation.

Ha: Mean productivity before supplementation > Mean productivity during supplementation.

We tested before-after supplementation effects using a one-tailed Aspin-Welch unequal-variance test. We also used a randomization test, based on 10,000 Monte Carlo simulations, to assess differences in spawner abundance and productivity before and during supplementation. The randomization procedure only allowed the testing of two-tailed hypotheses. Therefore, we generated 95% confidence intervals on the mean difference (μ_{pre} - μ_{post}) using bootstrapping methods to determine if the significant result from the randomization test was in the right direction. We generated 5,000 bootstrap samples to calculate confidence intervals.

Mean spawner abundance during the supplementation period was significantly less than the pre-supplementation spawner abundance (Table 33). Mean spawner abundance decreased 46% between the pre- and post-supplementation periods. Likewise, mean NORs decreased significantly between the two periods (Table 33). On the other hand, productivity increased slightly, but not significantly, between the pre- and post-supplementation periods (Table 33). This was true for both adjusted and transformed productivity data.

Table 33. Statistical results comparing mean scores of spawner abundance, natural-origin recruits (NORs), and productivity (using both untransformed and natural-log transformed) before and during supplementation of Chiwawa spring Chinook. Randomization tests were based on 10,000 Monte Carlo samples and 95% CI were based on 5,000 bootstrap samples.

Population metric	Mean scores		Test on means			
			Aspin-Welch test		Random test P-value	Bootstrap 95% CI
	Before	During	t-value	P-value		
Abundance	856	393	2.383	0.986	0.028	112 - 843
LN Abundance	6.6	5.4	3.304	0.997	0.004	0.56 – 1.99
NORs	905	275	2.846	0.993	0.009	214 – 1034
LN NORs	6.0	5.0	1.197	0.876	0.250	-0.40 – 2.54
Productivity	1.13	1.56	-0.721	0.759	0.479	-1.55 – 0.73
LN Productivity	0.64	0.75	-0.450	0.671	0.649	-0.55 – 0.35
Adj Productivity	1.12	1.56	-0.721	0.759	0.477	-1.54 – 0.71
LN Adj Productivity	0.64	0.75	-0.450	0.671	0.652	-0.57 – 0.34

Analysis of Stock-Recruitment Curves

The third method compared stock-recruitment curves of the Chiwawa population during supplementation with those generated before supplementation. Specifically, we tested whether the regression parameters were equal between the pre- and post-supplementation periods, and whether the fitted curves coincided between the two time periods. We used the methods described earlier to fit the Ricker, Beverton-Holt, and smooth hockey stick curves to the two data sets. We tested the following hypotheses.

Parameter equivalence:

Ho: Stock-recruitment parameters (α and β) of the pre-supplementation period = Stock-recruitment parameters of the supplementation period.

Ha: Stock-recruitment parameters (α and β) of the pre-supplementation period ≠ Stock-recruitment parameters of the supplementation period.

Curve equivalence:

Ho: Modeled stock-recruitment curves from the pre-supplementation period = Modeled stock-recruitment curves from the pre-supplementation period.

Ha: Modeled stock-recruitment curves from the pre-supplementation period ≠ Modeled stock-recruitment curves from the pre-supplementation period.

We were only able to fit stock-recruitment curves to the post-supplementation data. Non-linear regression was unable to converge on a solution using only pre-supplementation data. Therefore, we were unable to use this method to test supplementation effects on the Chiwawa spring Chinook population. If we could have fit curves to both the pre- and post-supplementation periods, we would have used two-sided randomization tests to evaluate the null hypotheses of equal model parameters and that fitted curves coincided.

Before describing correlation approaches, it is important to note that comparing before-after data can sometimes be misleading. For example, the spawner abundance, NORs, and productivity data presented in Figure 22 suggest that supplementation is increasing the abundance and productivity of spring Chinook in the Chiwawa Basin. However, when we compared these trends to those from reference populations during the same time periods (Figures 9-11), it becomes clear that supplementation was not responsible for increasing the trends in spawner abundance, NORs, and productivity of the Chiwawa population. Thus, whenever possible, it is wise to compare before-after data with a reference population.

Correlation Analyses

A simple way to see if the supplementation program is increasing or decreasing productivity is to assess the association between the proportion of adult spawners that are made up of hatchery adults (pHOS) and productivity (recruits/spawner). If the supplementation program is working as planned, the increase in hatchery fish spawning naturally should increase the productivity of the population. It should not decrease the productivity of the population.

We tested the association between pHOS and adult productivity[23] using Pearson correlation. During the pre-supplementation period, productivity averaged 1.13 recruits/spawner; during the supplementation period, productivity averaged 1.39 recruits/spawner. This increase in productivity did not appear to be strongly correlated to pHOS (Figure 23). Correlation analysis showed that there was no significant association between pHOS and productivity, even though productivity increased with increasing pHOS.

23 Note that the analysis could also include juvenile productivity (e.g., smolts/spawner).

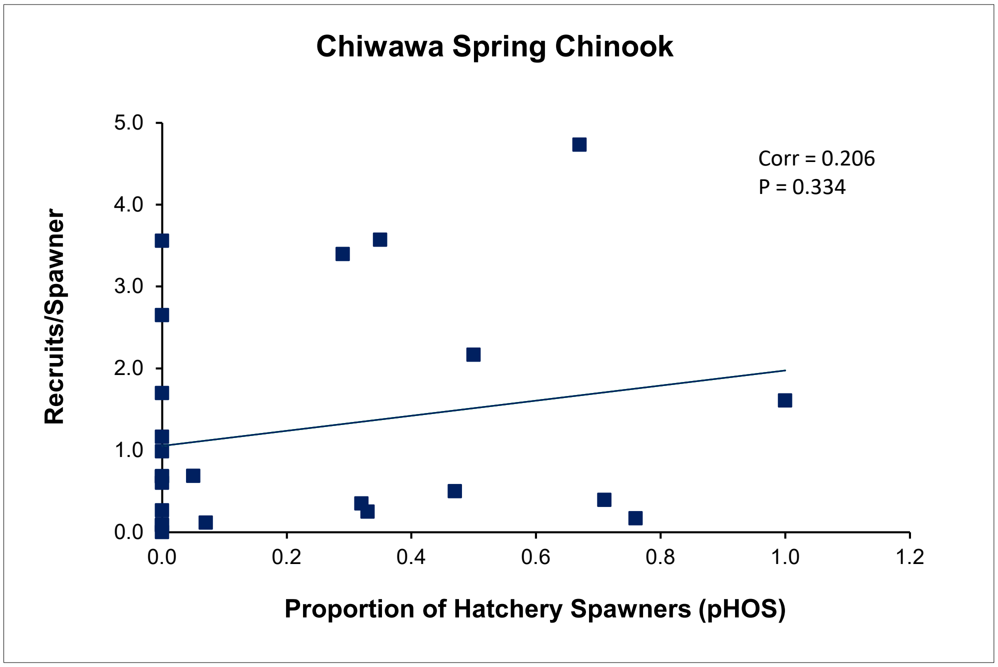

Figure 23. Association between the proportion of spawners that are made up of hatchery adults (pHOS) and the number of natural-origin recruits. The Pearson correlation coefficient (Corr) and its P-value (P) are shown in the figure.

The association between pHOS and productivity can also be assessed by testing the correlation between pHOS and the residuals from stock-recruitment curves fitted to the Chiwawa spawner and natural-origin recruitment data. This approach removes the effects of density dependence on the relationship between pHOS and productivity. A significant negative association provides evidence that hatchery-origin spawners may not be as productive as natural-origin spawners.

The Ricker, Beverton-Holt, and smooth hockey stick models were fit to the Chiwawa stock and recruitment data (including {S, R} data from both the pre- and post-supplementation period, 1981-2004) using methods described earlier. Residuals were calculated by subtracting the predicted recruitment values from the observed (modeled) values. Pearson correlation then tested the association between pHOS and the residuals from each model.

Although there was a negative trend in residuals with increasing pHOS, suggesting that hatchery-origin spawners may not be as productive as natural-origin spawners, the association was not significant (Figure 24). Thus, based on these analyses, there is no strong evidence that the supplementation program has significantly benefited or harmed the natural spring Chinook population.

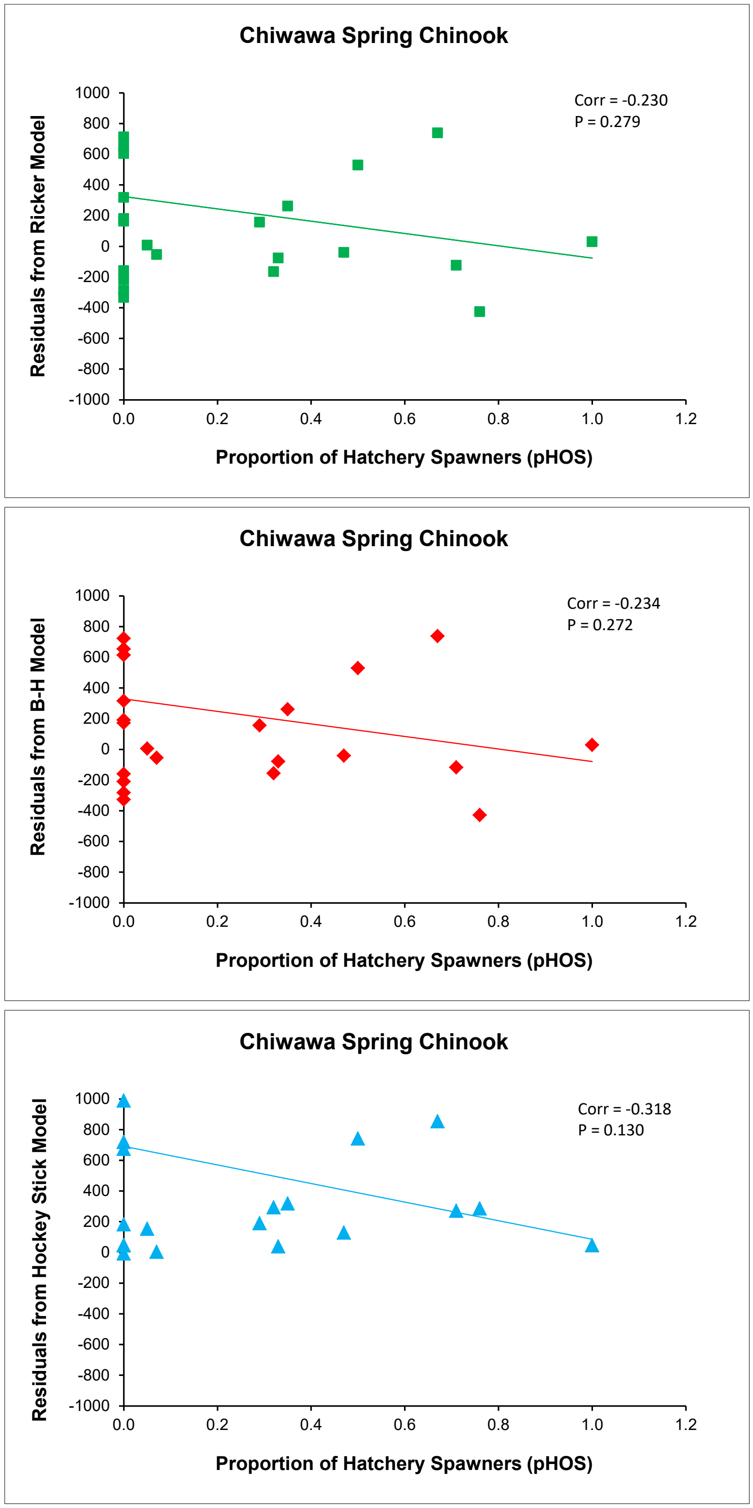

Figure 24. Association between the proportion of spawners that are made up of hatchery adults (pHOS) and the residuals from Ricker, Beverton-Holt (B-H), and smooth hockey stick stock-recruitment models. The Pearson correlation coefficient (Corr) and its P-value (P) are shown in the figures.

Comparison to Standards

In those cases in which suitable reference populations are not available and there are no pre-supplementation data, the investigator is left with comparing population parameters to relevant standards. Standards can include performance of natural-origin fish in similar environments (a type of reference condition), mitigation requirements, quantitative objectives of the program, Biological Assessment and Management Plan (BAMP) values, or other appropriate standards. An example of a statistical hypothesis would be:

Ho: Productivity (Recruits/Spawner) of the supplemented population ≥ standard productivity.

Ha: Productivity (Recruits/Spawner) of the supplemented population < standard productivity.

For these analyses to be useful, the standards must be based on biological reality.

Conclusions and Recommendations

Hatcheries are an important component of fish production within the Upper Columbia Basin. The goal of some of these programs is to supplement natural production in declining populations. The supplementation programs generally use both hatchery and natural (spawned and reared in nature from either wild or hatchery parents) adults for hatchery broodstock. These programs are designed to supplement natural populations by increasing natural reproduction while preventing the establishment of a domesticated hatchery stock. Thus, the programs should increase total spawning escapement and NORs, and not reduce the productivity of the natural population. Measuring the success of these programs is challenging and expensive.

In this paper, we described methods that can be used to determine if supplementation programs are achieving some of their goals. This paper focused on the use of reference populations to determine if the supplementation programs increase total spawning escapement, NORs, and maintain or increase productivities. In some cases, suitable reference populations may not be available (e.g., we found no suitable reference populations for Upper Columbia steelhead and sockeye). In these cases, alternative methods are needed to assess supplementation effects. We also described these alternative methods in this paper.

Identification of Reference Populations

Finding suitable reference populations that match well with supplemented populations is a difficult and time-consuming process. Our three-step selection process included identification of populations with similar life-history characteristics, few or no hatchery spawners, a long time series of accurate abundance and productivity estimates, and similar freshwater habitat impairments and out-of-basin effects. Those populations that met these criteria were then examined for their relationship with the supplemented population (in this case, the Chiwawa spring Chinook population). Several criteria were scored, including pNOS, correlation, trend, and effect size. Reference populations with total weighed scores of 81 or greater were selected as suitable reference populations.

This selection process provided a valuable framework for selecting suitable reference populations for supplemented populations. Interestingly, we found that a given reference population may match well with one parameter of the supplemented population (e.g., spawning escapement), but not for all parameters (e.g., not NORs or productivity). The reason for this may be related to errors in the estimation of population parameters and/or differential factors limiting population parameters of supplemented and reference populations. Therefore, depending on the parameter analyzed, a different suite of reference populations may be needed.

An important assumption in the use of reference populations is that the supplemented and reference populations that tracked each other before supplementation would continue to track each other in the absence of supplementation. Given that the reference populations did not match the Chiwawa population on all criteria examined, and some reference populations tracked the Chiwawa population more poorly than others, there may be some uncertainty as to whether differences observed between the supplemented and reference populations during the supplementation period are associated with the hatchery program, or other unaccounted factors. For example, any large-scale change (man-made or natural) within the reference or supplemented population could affect our ability to assess the effectiveness of the supplementation program.

To account for some of these uncontrollable factors, we recommend the use of a "causal-comparative" approach to strengthen the certainty of our inferences. This approach relies on correlative data to try and make a case for causal inference. We recommend that the following state variables be measured and tracked within the supplemented and reference populations: mean annual precipitation, total and riparian forest cover, road density, impervious surface, and alluvium. These variables can be used to describe differences in water temperatures at different life stages (pre-spawning, egg incubation, and summer rearing) and substrate characteristics, including fine sediments and embeddedness. These state variables can be used to help explain possible changes in spawner abundance, NORs, and productivity that are independent of supplementation. In addition, the use of multiple reference streams reduces the possibility that man-made changes to a single reference stream will influence the interpretation of the results.

Analyses with Reference Populations

Using reference populations, we evaluated the effects of supplementation on natural-log transformed and untransformed total spawning escapement, NORs, and productivity by comparing trends, analyzing mean differences, ratios, and rates, and comparing stock-recruitment curves and their parameters. For trend analysis, we compared the slopes of the trends between each supplemented/reference pair before and during supplementation. If the hatchery program is successfully supplementing the natural population, trends in spawner abundance and NORs should deviate significantly during the supplementation period (i.e., the slope of the supplemented population should be greater than the slopes of the reference populations during the supplementation period), but not during the pre-supplementation period. For productivity, the slope of the supplemented population, relative to the reference population, should increase or remain the same.

Because trend analysis only tests the slopes of the trend lines, it does not test for differences in elevations of the trend lines, additional analyses were needed to determine if supplementation increased spawner abundance, NORs, and productivity of the target population without changing the slopes of the trend lines. To do this, we derived three different response variables using natural-log transformed and untransformed spawner abundance, NORs, and productivity data. The first derived variable included difference scores, which were calculated as the difference between paired treatment and reference data (T-R). The second included ratios, which were calculated as the ratio of paired treatment and reference data (T/R). Finally, we calculated the differences in annual changes in paired treatment and reference population data (ΔT-ΔR). If the hatchery program is successfully supplementing the natural population, the mean difference or ratio score of paired spawner abundance data and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean difference or ratio score during the supplementation period should be equal to or higher than the pre-supplementation period.

As a final set of analyses, we compared the stock-recruitment curves of the supplemented population (using stock and recruitment data only from the supplementation period) to the reference populations (using all available stock and recruitment data). Specifically, we tested whether the regression parameters were equal between the supplemented population and the reference populations, and whether the fitted curves coincided between populations. Here, we were most interested in comparing the productivity parameters in the models.

Surprisingly, these different analyses yielded similar results when they were applied to the Chiwawa spring Chinook and reference population data. Trend analysis was unable to detect a significant difference in trends between the supplemented and reference populations during the supplementation period. Even though we measured an increasing trend in spawner abundance, NORs, and productivity in the supplemented population during the supplementation period, these same parameters trended upward in the reference populations. Likewise, we were unable to detect a significant supplementation effect using difference scores, ratios, and differences in annual changes. However, we found the results from analysis of mean differences of annual change difficult to interpret and they may be insensitive to treatment effects. A simpler analysis, which is also easier to interpret, is to use trend analysis. Finally, comparing stock-recruitment curves and their parameters did not provide strong evidence that supplementation has affected the productivity of the natural population.

Based on these results, we do not recommend using difference scores of annual change (ΔT-ΔR), nor do we recommend comparing stock-recruitment curves and their parameters. As noted above, difference scores of annual change are difficult to interpret and may be redundant with trend analysis. Testing stock-recruitment curves and their parameters appears redundant with testing differences in productivity using difference scores or ratios. In addition, the analyses are computer intensive and do not appear to be very sensitive to changes.

There was little difference in results using difference scores and ratios. It appears that ratios may be more sensitive to change than difference scores (e.g., we found significant differences in some comparisons using ratios but not with difference scores), but ratios can be more difficult to interpret than difference scores. Nevertheless, we recommend the use of ratios in future analyses.

Correcting for Density Dependence and Carrying Capacity

The analyses described so far assumed that the density of spawners or recruits did not affect the survival and productivity of fish. However, without controlling for density effects, productivity of the population would continue to decline with increasing abundance. This scenario could occur in supplementation programs that increase the number of spawners, and could result in lower productivities relative to reference populations. In addition, lower productivities may be caused by differential environmental carrying capacities rather than the capacity of the supplemented fish to produce offspring. Therefore, we described two different methods for deriving density-corrected estimates of productivity. The first controlled the effects of density on productivity by partitioning observed productivities into density-independent and density-dependent productivity. These productivities were then combined in a single test. The second method corrected for differences in carrying capacities between the supplemented and reference populations. This was accomplished by calculating the percent saturation of NORs, which was estimated as the ratio of observed NORs to the maximum number of NORs that the habitat could support.

We fit Ricker, Beverton-Holt, and smooth hockey stick models to stock and recruitment data to estimate the maximum number of NORs (NORs at carrying capacity) and the maximum number of spawners needed to produce maximum NORs. We fit models to the supplemented and reference populations. Using information-theoretic criterion and evaluating the precision of estimated parameters, we found that the smooth hockey stick model provided the best estimates of maximum NORs and spawners. We used these modeled values to estimate density-independent and density-dependent productivities, and saturation of NORs.

Statistical analyses, using difference scores and ratios of adjusted Chiwawa spring Chinook productivity data, found no significant effects of supplementation on the productivity of the supplemented population. Indeed, the results from correcting for density dependence were similar to those without correcting for density dependence. This is in part because the abundance of the supplemented and reference populations has been below their respective carrying capacities in most years. This was clearly demonstrated in the analyses of NORs corrected for carrying capacity. In the supplemented population, the mean fraction of the carrying capacity filled with NORs decreased significantly during the supplementation period. In other words, the carrying capacity was filled with more NORs during the pre-supplementation period than during the supplementation period, which is contrary to the goal of supplementation. By comparison, two of the reference populations showed a similar decrease in saturation, while the other two reference populations actually increased in saturation. Analyzing the saturation scores using BACI-design analyses indicated that two of the four pairings differed significantly. That is, the percent saturation of the supplemented population decreased significantly relative to two reference populations.

Because productivity can be affected by the abundance of spawners and recruits, we recommend that future analyses comparing supplemented and reference populations adjust for density-dependent effects and differential carrying capacities. Although we detected only slight differences between adjusted and unadjusted results, as supplemented stocks recover, it will become more important to adjust productivities to account for density dependence. Importantly, the analyses using percent saturation placed NORs in the context of the carrying capacity of the environment. This will help managers determine if supplementation programs are filling or over-filling the capacity of the habitat with NORs.

As we noted earlier, analyses using productivities adjusted for density dependence assume that there is a spawner abundance at which density-independent effects end and density-dependent effects begin. In reality, density-dependent effects occur at low spawning abundance and intensify as spawning abundance increases. We did not account for these increasing density-dependent effects at lower spawner abundances. This is an area that needs additional attention.

Analyses without Reference Populations

Because of the rigorous criteria we used to select reference populations, it is likely that reference populations may not exist for making comparisons with supplemented populations. For example, we used the criteria described in this paper to identify reference populations for supplemented steelhead and sockeye populations in the Upper Columbia Basin. We were unsuccessful in identifying any suitable reference populations. Therefore, in the absence of suitable reference populations, it is important to have alternative methods for assessing supplementation effects. We described three different types of analyses one can use to assess supplementation effects in the absence of reference populations. They include before-after comparisons, correlation analysis, and comparisons to standards.

Before-after analyses compare population metrics before supplementation with those during supplementation. In this case, data collected before supplementation represent the reference condition. The assumption is that population trajectories measured during the pre-supplementation period would continue in the absence of supplementation. We compared trends in spawner abundance, NORs, and productivity before and after supplementation. In addition, we compared mean scores in these three parameters before and after supplementation. Finally, we attempted to compare stock-recruitment parameters before and after supplementation. The hypotheses examined were that the spawner abundance and NORs would be greater during the supplementation period, and that productivities would not decline during the supplementation period.

Trend analysis indicated that the all three Chiwawa spring Chinook population parameters trended downward during the pre-supplementation period, but trended upward during supplementation. On the other hand, mean spawner abundance and NORs were lower during the supplementation period than during the pre-supplementation period. Mean productivities increased, but not significantly, during the supplementation period. We were unable to compare pre- and post-supplementation stock-recruitment curves because we were unable to fit stock-recruitment models to the pre-supplementation data.

We used correlation analyses to determine if the proportion of hatchery-origin fish that spawn naturally on the spawning grounds (pHOS) increased productivity. In addition, we used correlation to assess the association between pHOS and the residuals from stock-recruitment relationships. A significant negative association provides evidence that hatchery-origin spawners may not be as productive as natural-origin spawners. The analysis indicated that the productivity of Chiwawa spring Chinook increased with increasing pHOS, but the association was not significant. In contrast, there was a negative association between pHOS and the stock-recruitment residuals, but again the association was not significant. The latter analysis accounts for density-dependent effects.

In concert, the before-after comparisons and correlation analyses do not provide conclusive evidence that the supplementation program has increased spawner abundance and NORs, or that it has significantly reduced the productivity of the supplemented population. Although increasing the number of hatchery fish on the spawning grounds appears to reduce NORs and productivity, mean productivity actually increased during the supplementation period compared to the pre-supplementation period.

It is important to note that relying on only one set of analysis could result in drawing a wrong conclusion. For example, if we had only conducted trend analysis, we may have concluded wrongly that the Chiwawa spring Chinook supplementation program significantly increased spawner abundance, NORs, and productivity in the supplemented population. The analysis of mean scores and correlations indicates that the supplementation program has not increased spawner abundance or NORs in the supplemented population. Therefore, in the absence of suitable reference populations, we recommend that analyses include the evaluation of trends, means scores, and correlations. By conducting more than one set of analyses, one can use weight-of-evidence to assess the effects of supplementation programs.

Under the scenario that there are no reference populations or pre-supplementation data, one is left with comparing population parameters to relevant standards. These standards could come from mitigation requirements, quantitative objectives, or published or unpublished standards. One could also use correlation to evaluate the association between productivity and pHOS, but this requires a wide range in pHOS values to be most effective. A more extreme approach, which probably would not gain much traction with managers, is to shutoff the supplementation program for some time and then evaluate the effects of the program in a before-after design. The Entiat spring Chinook hatchery program provides a unique opportunity to evaluate this type of management decision.

Some Concerns and Limitations

No matter how hard we try to explain different sources of variation in population data, we are limited by the quality of the data. Teasing out the effects of supplementation requires long time series of population data. Because funding levels and methods change over time, the quality (i.e., accuracy and precision) of the data also changes over time. Importantly, the population parameters examined in this paper (spawner abundance, NORs, and productivity) are rarely measured directly in the field. That is, other population metrics, such as numbers of redds, number of fish counted at weirs or dams, scales, tags, etc., are sampled in the field. These metrics are then used to calculate spawner abundance[24], NORs, and productivity, often based on assumptions about fish/redd, pre-spawning loss, marking rates, and sampling rates. This has a tendency to increase the variability in the data independent of supplementation programs. In our studies, we can only control sampling within the supplemented populations, and even that is limited by available funding. We have no control over the sampling within reference populations. Thus, we have to assume that sampling within the reference populations will continue and that sampling effort will remain comparable to that in the supplemented populations.

In our analyses, we included both the Entiat and Little Wenatchee populations as references for the Chiwawa population. In the analyses, we treated them as equivalent to the other reference populations. That is, the statistical procedures used to compare the supplemented population to each reference population were identical. This is appropriate. However, the interpretation of the results must be different when comparing the Entiat and Little Wenatchee to the supplemented population, because they are populations that were influenced by hatchery fish. As noted earlier, the Entiat spring Chinook hatchery program has been discontinued. Therefore, it provides a unique type of reference where the comparison changes from both populations being supplemented to only one population being supplemented. For the Little Wenatchee, nearly all the strays came from the Chiwawa program. Straying should stop or be greatly reduced with the change in water supply to the Chiwawa Rearing Ponds. In sum, one must be careful in how they interpret these test-reference results.

Finally, it is important to point out that for this paper, we conducted 463 statistical tests. Because we set our Type I error rate at 0.05, by random chance alone, we may have incorrectly rejected about 23 null hypotheses. Inasmuch as this work was designed to evaluate different ways to analyze test-reference data, the number of future analyses will be greatly reduced based on the results from this work. However, if the Type I error rate is a concern to managers, researchers can

24 The smooth hockey stick model, which we used to estimate density-dependent correction factors for productivity and NORs, is sensitive to errors in spawner escapement estimates. Therefore, it is important to use accurate and precise estimates of spawner escapement.

use a lower error rate, such as $\alpha = 0.01$. Another option is to analyze test-reference data graphically. Although this is subjective, there are no statistical analyses and therefore no concerns with violating assumptions of statistical tests, including temporal correlation. We believe researchers should use the statistical procedures recommended in this report to support graphic analysis.

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Appendix S
Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2018 Annual Report

MONITORING AND EVALUATION OF THE CHELAN AND GRANT COUNTY PUDs HATCHERY PROGRAMS

2018 ANNUAL REPORT

September 15, 2019

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TABLE OF CONTENTS

LIST OF APPENDICES

PREFACE

This annual report is the result of coordinated field efforts conducted by Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation), Chelan County Public Utility District (Chelan PUD), the Confederated Tribes of the Colville Reservation (Colville Tribes), the U.S. Fish and Wildlife Service (USFWS), and BioAnalysts, Inc. An extensive amount of work was conducted in 2006 through 2018 to collect the data needed to monitor the performance of the Chelan and Grant County PUD Hatchery Programs. This work was directed and coordinated by the Habitat Conservation Plans (HCP) Hatchery Committees, consisting of the following members: Matt Cooper and Bill Gale, USFWS; Brett Farman, National Marine Fisheries Service (NMFS); Catherine Willard, Chelan PUD; Keely Murdoch and Tom Scribner, the Yakama Nation; Mike Tonseth, WDFW; Kirk Truscott, Colville Tribes; and Tracy Hillman, BioAnalysts (Chair). This report also includes monitoring efforts funded by Grant County Public Utility District (Grant PUD). Grant PUD funds the Nason and White spring Chinook and Methow summer Chinook monitoring programs as well as co-funds the Wenatchee Summer Chinook program. Work funded by Grant PUD was directed and coordinated by the Priest Rapids Coordinating Committee (PRCC) Hatchery Sub-Committee, which consists of the same agency and tribal representatives listed for the HCP Hatchery Committee and replaces Chelan PUD representatives with Grant PUD representatives, Todd Pearsons, Peter Graf, and Deanne Pavlik-Kunkel.

The approach to monitoring the hatchery programs was guided by the updated monitoring and evaluation plan for PUD hatchery programs (Hillman et al. 2017). Technical aspects of the updated monitoring and evaluation program were developed by the Hatchery Evaluation Technical Team (HETT), which consisted of the following scientists: Matt Cooper, USFWS; Tracy Hillman, BioAnalysts; McLain Johnson, WDFW; Tom Kahler, Douglas PUD; Greg Mackey, Douglas PUD; Andrew Murdoch, WDFW; Keely Murdoch, Yakama Nation; Todd Pearsons, Grant PUD; Mike Tonseth, WDFW; and Catherine Willard, Chelan PUD. The updated plan also directs the analyses of hypotheses developed by the HETT. Most of the analyses outlined in the updated plan will be conducted in the five-year statistical reports and the ten-year program review reports.

Chelan and Grant PUDs funded most of the work reported in this document. Bonneville Power Administration purchased some of the Passive Integrated Transponder (PIT) tags that were used to mark juvenile Chinook and steelhead captured in tributaries and helped fund a portion of the screw trap efforts in Nason Creek. We thank Charlie Paulsen for analyzing PIT-tag data for each program. This is the 13th annual report written under the direction of the HCP.

"I often say that when you can measure something and express it in numbers, you know something about it. When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science, whatever it may be."

Lord Kelvin

SECTION 1: INTRODUCTION

Chelan and Grant PUDs implement hatchery programs as part of their respective agreements related to the operation of Rocky Reach, Rock Island, Wanapum, and Priest Rapids Hydroelectric Projects. The fish resource management agencies developed the following general goal statements for the hatchery programs, which were adopted by the HCP Hatchery Committees and PRCC Hatchery Sub-Committee (hereafter, Hatchery Committees):

1. *Support the recovery of ESA-listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.*

   Includes the Wenatchee spring Chinook, Wenatchee summer steelhead, and Methow spring Chinook programs.

2. *Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when spawning escapement is sufficient to support harvest.*

   Includes the Wenatchee sockeye, Wenatchee summer/fall Chinook, Methow summer/fall Chinook, Okanogan summer/fall Chinook, and Okanogan sockeye programs.

3. *Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural tributary spawning populations.*

   Includes the Chelan Falls summer Chinook program.

Following the development of the Hatchery and Genetic Management Plans (HGMPs), artificial propagation programs are now characterized into three categories. The first type, integrated conservation programs, are intended to support or restore natural populations. These programs focus on increasing the natural production of targeted fish populations. A fundamental assumption of this strategy is that adults spawned in the hatchery will produce more adult offspring than if they were left to spawn in the river and ultimately provide a demographic boost to the natural population. The second type, safety-net programs, are extensions of conservation programs, but are intended to function as reserve capacity for conservation programs in years of low returns. The safety-net provides a demographic and genetic reserve for the natural population. That is, in years of abundant returns, they function like segregated programs, and in years of low returns, they can be managed as conservation programs. Lastly, harvest augmentation programs are intended to increase harvest opportunities while limiting interactions with wild-origin counterparts.

Monitoring is needed to determine if the hatchery programs are meeting the intended management objectives of conservation, safety-net, or harvest augmentation programs. Objectives for hatchery programs are generally grouped into three categories of performance indicators:

1. In-Hatchery Indicators: Are the programs meeting the hatchery production objectives?

2. In-Nature Indicators: How do hatchery fish from the programs perform after release?

a. Conservation Programs:
   - How do the programs affect target population abundance and productivity?
   - How do the programs affect target population long-term fitness?

b. Safety-Net Programs:
   - How do the programs affect target population long-term fitness?

c. Harvest Augmentation Programs:
   - Do the programs provide harvest opportunities?

3. Risk Assessment Indicators: Do the programs pose risks to other populations?

The specific objectives identified in the updated monitoring and evaluation plan are as follows:

1. *Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.*
2. *Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.*
3. *Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.*
4. *Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.*
5. *Determine if the run timing, spawn timing, and spawning distribution of both the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.*
6. *Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.*
7. *Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.*
8. *Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.*
9. *Determine if hatchery fish were released at the programmed size and number.*
10. *Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations*

Two additional regional objectives that were not explicit in the goals specified above but were included in the updated monitoring and evaluation plan because they relate to goals and concerns of all artificial production programs include:

11. *Determine if the incidence of disease has increased in the natural and hatchery populations.*
12. *Determine if the release of hatchery fish affects non-target taxa of concern (NTTOC) within acceptable limits.*

Objective 12 was completed using an extensive risk assessment that concluded risks from the PUD hatchery programs were within containment objectives approved by the Hatchery Committees (Pearsons et al. 2012; Mackey et al. 2014).

Objectives in the updated plan have been organized in a hierarchy where productivity indicators are the primary metrics used to assess if conservation and safety-net program goals have been met; harvest rates and effects on non-targeted populations are used for harvest programs. In cases where productivity indicators are not available, or results are equivocal, monitoring indicators may be used to help evaluate the performance of the program. Evaluations of monitoring indicators may not provide sufficiently powerful conclusions on which to base management actions; although they may provide insight as to why a productivity indicator did or did not meet the program goal. Therefore, the relationship between hatchery programs and indicators can be viewed in a chain-of-causation: management actions within the hatchery programs affect the status of monitoring indicators, which in turn influence productivity indicators (Figure 1.1).

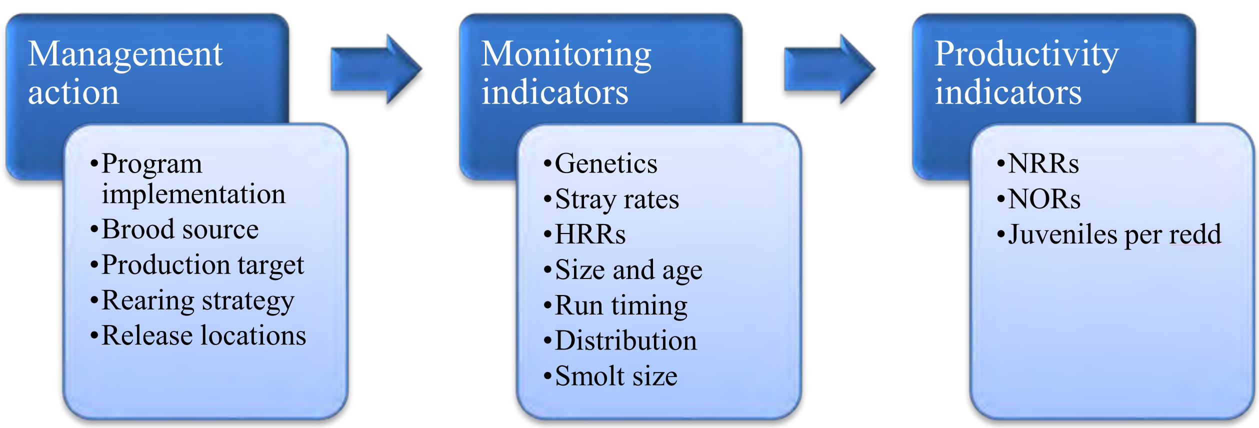


Figure 1.1. Relationship of indicators to the assessment of propagation programs. Management actions affect monitoring indicators, which influence productivity indicators. Monitoring indicators may be used to hypothesize the magnitude of influence on productivity.

Attending each objective is one or more testable hypotheses (see Hillman et al. 2017). Each hypothesis will be tested statistically following the routines identified in the updated monitoring and evaluation plan. Most of these analytical routines will be conducted at the end of five-year monitoring blocks, as outlined in the updated plan.

Both monitoring and productivity indicators will be used to evaluate the success of the hatchery programs. If the statistical power of tests that involve productivity indicators is insufficient to inform sound management decisions, some of the monitoring indicators may be used to guide management. Figure 1.2 shows the categories of indicators associated with each component of monitoring.

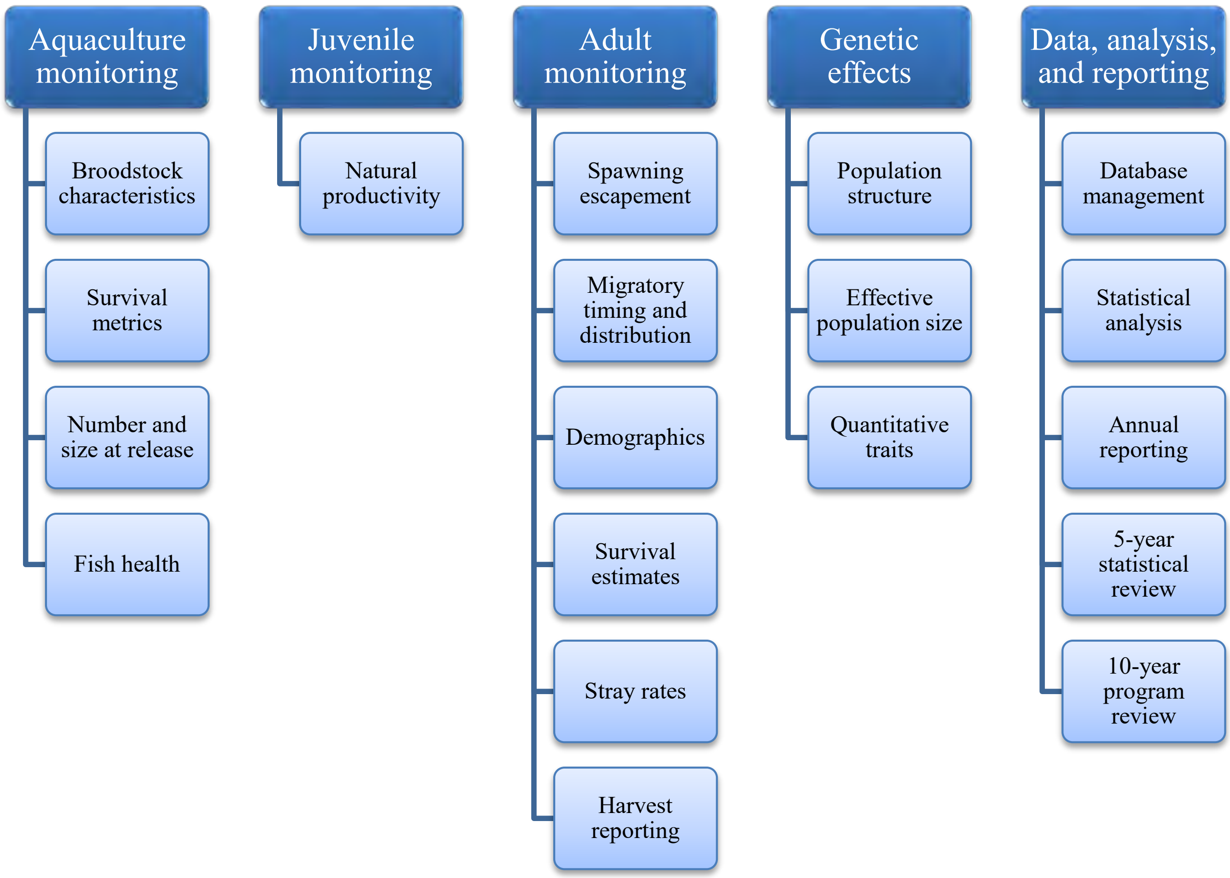


Figure 1.2. Overview of monitoring and evaluation plan categories and components (not including regional objectives).

Throughout each five-year, statistical, monitoring period, annual reports will be generated that describe the monitoring and evaluation data collected during a specific year. This is the 13th annual report developed under the direction of the Hatchery Committees. The purpose of this report is to describe monitoring activities conducted in 2018. Activities included broodstock collection, collection of life-history information, within-hatchery spawning and rearing activities, juvenile monitoring within streams, and redd and carcass surveys. Data from reference areas are not included in this annual report (reference data are in the five-year statistical reports). To the extent currently possible, we have included information collected before 2018.

This report is divided into several sections, each representing a different species, stock, or spawning aggregate (i.e., steelhead, sockeye salmon, spring Chinook salmon, and summer Chinook salmon). For all species, we provide annual broodstock information; hatchery rearing history, release data, and survival estimates; disease information; juvenile migration and productivity estimates; redd counts, distribution, and spawn timing; spawning escapements; and life-history characteristics. For salmon species, we also provide information on carcasses. Brood year 2011 was the final sockeye salmon hatchery release and beginning in 2013, only natural adult and juvenile sockeye productivity monitoring results are reported. Beginning in 2013, we added a separate section on Nason Creek spring Chinook salmon and in 2014 we added a separate section on White River spring Chinook salmon. The Colville Tribes began conducting monitoring of

Okanogan summer Chinook in 2013; however, we retained the Okanogan summer Chinook section in this report because the PUDs have summer Chinook mitigation obligations in the Okanogan River basin. The Okanogan summer Chinook section includes monitoring information up to the return of brood year 2013 Chinook. Monitoring results for brood years 2013 to present can be found in annual reports prepared by the Colville Tribes to Bonneville Power Administration (BPA). Monitoring results of Grant PUD's fall Chinook salmon mitigation produced at Priest Rapids Hatchery can be found in annual reports written by WDFW and Grant PUD.

Finally, we end each section by addressing compliance issues with ESA/HCP mandates. For each Hatchery Program, WDFW and the PUDs are authorized annual take of ESA-listed spring Chinook and steelhead through Section 10 of the Endangered Species Act (ESA), including:

1. ESA Section 10(a)(1)(A) Permit No. 18583, which authorizes the annual take of adult and juvenile endangered upper Columbia River (UCR) spring Chinook and threatened UCR steelhead associated with implementing artificial propagation programs for the enhancement of UCR steelhead. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, monitoring and evaluation activities, and management of adult returns related to UCR steelhead artificial propagation programs in the UCR region (NMFS 2017).
2. ESA Section 10(a)(1)(A) Amended Permit No. 18121, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and threatened UCR steelhead associated with implementing artificial propagation programs in the Chiwawa River for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2013, amended in 2015).
3. ESA Section 10(a)(1)(A) Permit No. 18118, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and threatened UCR steelhead associated with implementing artificial propagation programs in Nason Creek for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2013, amended in 2015).
4. ESA Section 10(a)(1)(A) Permit No. 18120, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and threatened UCR steelhead associated with implementing artificial propagation programs in the White River for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2013, amended in 2015).
5. ESA Section 10(a)(1)(A) Permit No. 1347, which authorizes the annual incidental take of adult and juvenile endangered UCR spring Chinook and threatened UCR steelhead through actions associated with implementing artificial propagation programs for the enhancement of non-listed anadromous fish populations in the UCR. The authorization includes incidental takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities associated with non-listed summer

Chinook, fall Chinook, and sockeye salmon artificial propagation programs in the UCR region (NMFS 2003b).

6. ESA Section 10(a)(1)(A) Permit No. 18583, which authorizes the annual take of adult and juvenile endangered upper Columbia River (UCR) spring Chinook and threatened UCR steelhead associated with implementing artificial propagation programs for the enhancement of Wenatchee sub-basin steelhead. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, monitoring and evaluation activities, and management of adult returns related to the Wenatchee steelhead artificial propagation program in the UCR region (NMFS 2017).
7. ESA Section 10(a)(1)(A) Permit No. 1395, which authorizes the annual take of adult and juvenile endangered upper Columbia River (UCR) spring Chinook and endangered UCR steelhead associated with implementing artificial propagation programs for the enhancement of UCR steelhead. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, monitoring and evaluation activities, and management of adult returns related to UCR steelhead artificial propagation programs in the UCR region (NMFS 2003a).

These permits are relevant for the brood years included in this report.

SECTION 2: SUMMARY OF METHODS

Sampling in 2018 followed the methods and protocols described in Hillman et al. (2017). In this section, we only briefly review the methods and protocols. More detailed information can be found in the updated monitoring and evaluation plan (Hillman et al. 2017).

2.1 Broodstock Collection and Sampling

Methods for collecting broodstock are described in the Annual Broodstock Collection Protocols (WDFW 2018). Generally, broodstock were collected over the migration period (to the extent allowed in ESA-permit provisions) in proportion to their temporal occurrence at collection sites, with in-season adjustments dictated by 2018 run timing and trapping success relative to achieving weekly and annual collection objectives. Pre-season weekly collection objectives are shown in Table 2.1 and assumptions associated with broodstock trapping are provided in Table 2.2.

Table 2.1. Weekly collection objectives for steelhead and Chinook in 2018.

Collection week beginning day	Chiwawa/Nason Spring Chinook[a]		Hatchery Chelan Falls Summer Chinook	Wild Wenatchee Summer Chinook	Wild Methow Summer Chinook	Wenatchee Steelhead	
	Hatchery	Wild				Hatchery	Wild
4 June	6	6					
11 June	10	8					
18 June	22	14					
25 June	34	20		52			
2 Jul	22	18	96	62	14	1	1
9 Jul	10	8	84	16	28	1	1
16 Jul			72	30	28	1	2
23 Jul			60	26	22	1	3
30 Jul			48	24	14	1	3
6 Aug			24	16	10	3	3
13 Aug				14	8	3	3
20 Aug				10	6	4	4
27 Aug				6	6	4	4
3 Sep				4		5	5
10 Sep				2		4	5
17 Sep				2		8	5
24 Sep						10	5
1 Oct						8	4
8 Oct						8	8
15 Oct						6	8
22 Oct						2	2
Total	104	150	384	264	136	70	66

[a] Chiwawa NOR spring Chinook (n = up to 76) were collected from the Chiwawa Weir with no specific weekly objectives generated, which is consistent with the Broodstock Collection Protocols. Chiwawa HOR spring Chinook (n = 38) were targeted at Tumwater Dam to ensure production goals are met if insufficient NOR adults are collected. Previously, PIT-tagged Chiwawa NOR

spring Chinook were also targeted at Tumwater Dam. All Nason Creek spring Chinook were collected at Tumwater Dam from the week of 1 June through the week of 15 July proportionate to run timing.

Table 2.2. Biological and trapping assumptions associated with collecting broodstock for the Chelan and Grant PUD Hatchery Programs, 2018.[1]

Assumptions	Wenatchee Steelhead	Chiwawa Spring Chinook	Nason Spring Chinook		Wenatchee Summer Chinook	Chelan Falls Summer Chinook	Methow Summer Chinook
			Conservation Program	Safety Net Program			
Production level	247,300 yearling smolts	144,026 yearling smolts	125,000 yearling smolts	98,670 yearling smolts	500,001 yearling smolts	576,000 yearling smolts	200,000 yearling smolts
Broodstock required	136 adults (not to exceed 33% of NOR population)	76 adults (not to exceed 33% of NOR population)	74 adults (not to exceed 33% of population)	66 adults	264 adults (not to exceed 33% of the population)	384 adults	136 adults (not to exceed 33% of the population)
Trapping period	1 July-14 Nov	1 June – 15 July (Tumwater) 1 June-15 Aug (Chiwawa Weir)	1 June – 15 July	1 June – 15 July	27 June – 15 Sept (Dryden) 15 July- 15 Sept (Tumwater)	1 July – 15 Sep	1 July – 15 Sept
# days/week	5	7 (Tumwater) Not to exceed 15 cumulative trapping days (Chiwawa Weir)	7	7	7 (Dryden) 2 (Tumwater)	7	3
# hours/day	24	24 (Tumwater) 24 up/24 down (Chiwawa Weir)	24	24	24	24	16
Broodstock composition	50% WxW; 50% HxH	100% WxW	100% WxW	100% HxH	100% WxW	100% HxH	100% WxW
Trapping site	Dryden Dam for HxH; Tumwater for WxW. (Tumwater will be used if weekly quota not achieved for WxW (hatchery) at Dryden Dam)	Tumwater Dam and Chiwawa Weir	Tumwater Dam	Tumwater Dam	Dryden Dam (Tumwater will be used if weekly quota not achieved at Dryden Dam)	Chelan River Water Conveyance Canal Trap	Wells Dam east or west ladder

Several biological parameters were measured during broodstock collection at adult collection sites. Those parameters included the date and start and stop time of trapping; number of each species

[1] Throughout this document, "HxH" refers to hatchery-origin by hatchery-origin crosses and "WxW" refers to natural-origin by natural-origin crosses.

collected for broodstock; origin, size, and sex of trapped fish; age from scale analysis; and pre-spawn mortality. For each species, trap efficiency, extraction rate, and trap operation effectiveness were estimated following procedures in Hillman et al. (2017). In addition, a representative sample of most species trapped but not taken for broodstock were sampled for origin, sex, age, and size (stock assessment).

2.2 Within Hatchery Monitoring

Methods for monitoring hatchery activities are described in Hillman et al. (2017). Biological information collected from all spawned adult fish included age at maturity, length at maturity, spawn time, and fecundity of females. In addition, all fish were checked for tags and females were sampled for pathogens.

Throughout the rearing period in the hatchery, fish were sampled for growth, health, and survival. Each month, lengths and weights were collected from a sample of fish and rearing density indices were calculated. In addition, fish were examined monthly for health problems following standard fish health monitoring practices for hatcheries. Various life-stage survivals were estimated for each hatchery stock. These estimates were then compared to the "standard" survival rates identified in Table 2.3 to provide insight as to how well the hatchery operations were performing. Failure to achieve a survival standard could indicate a problem with some part of the hatchery program. However, failure to meet a standard may not be indicative of the overall success of the program to meet the goals identified in Section 1.

Table 2.3. Standard life-stage survival rates for fish reared within the Chelan PUD hatchery programs (from Hillman et al. 2017).

Life stage	Standard survival rate (%)
Collection-to-spawning (females)	90
Collection-to-spawning (males)	85
Unfertilized egg-to-eyed	92
Unfertilized egg-to-ponding	98
30 d after ponding	97
100 d after ponding	93
Ponding-to-release	90
Transport-to-release	95
Unfertilized egg-to-release	81

Nearly all hatchery fish from each stock were marked (adipose fin clip) and/or tagged (coded-wire tag) in 2018. Different combinations of marks and tags were used depending on the stock. In addition, Chelan PUD personnel PIT tagged 10,100 juvenile WxW Chiwawa spring Chinook and 10,100 juvenile Nason Creek spring Chinook (5,050 WxW and 5,049 HxH); 11,110 Wenatchee WxW steelhead (Circular Ponds) and 22,220 Wenatchee WxW and HxH steelhead (Raceway); and 10,499 Chelan River summer Chinook, 5,052 Methow (Carlton) summer Chinook, and 20,998 Wenatchee summer Chinook (10,500 Raceway and 10,498 Circular Ponds). PIT tags will be used to estimate migration timing and survival rates (e.g., smolt-to-adult) outside the hatchery.

Lastly, the size and number of fish released were assessed and compared to programmed production levels. Numbers released, and their sizes, should fall within 10% of the programmed targets identified in Table 2.4. However, because of constraints due to run size and proportions of wild and hatchery adults, production levels may not be achieved every year.

Table 2.4. Targets for fish released from the PUD hatchery programs; CV = coefficient of variation.

Hatchery stock	Release targets	Size targets		
		Fork length (CV)	Weight (g)	Fish/pound
Wenatchee Summer Chinook	500,001	163 (9.0)	45.4	18[a]
Methow Summer Chinook	200,000	163 (9.0)	45.4	13-18
Chelan Falls Summer Chinook (yearlings)	576,000	161 (9.0)	45.4	13[b]
Chiwawa Spring Chinook	144,026	155 (9.0)	37.8	18
Nason Spring Chinook	223,670	155 (9.0)	37.8	18[c]
Wenatchee Steelhead	247,300	191 (9.0)	75.6	6

[a]An experimental release size of 30-45 grams (10-15 FPP) was in place for brood years 2012-2014.
[b]An experimental release size of 20-45 grams (10-22 FPP) was in place for brood years 2012-2014.
[c] This is an approximate goal.

2.3 Juvenile Sampling

Juvenile sampling within streams included operation of rotary screw traps, snorkel observations, and PIT tagging. Methods for sampling juvenile fish are described in Hillman et al. (2017).

A rotary screw trap operated on the Wenatchee River near the town of Cashmere at RM 8.3 (Lower Wenatchee Trap), in Nason Creek (Nason Creek Trap) about 0.6 miles upstream from the mouth, in the White River (White River Trap) about 5.8 miles upstream from the mouth, and in the Chiwawa River (Chiwawa River Trap) about 0.4 miles upstream from the mouth. All rotary screw traps operated throughout the smolt migration period. The Chiwawa Trap operated between 6 March and 4 December 2018, the Nason Creek Trap operated from 1 March to 30 November 2018, the White River trap operated from 1 March through 30 November 2018, and the Lower Wenatchee Trap operated between 22 March and 24 July 2018. Throughout the trapping period, the traps were briefly inoperable during periods when flows were too high or low, during high water temperatures, during large hatchery releases, and because of heavy debris loads, ice, and mechanical malfunctions.

The following data were collected at each trap site: water temperature, discharge, number and identification of all species captured, degree of smoltification for anadromous fish, presence of marks and tags, size (fork lengths and weights), and scales from smolts. Trap efficiencies at each trap site were estimated by using mark-recapture trials conducted over a wide range of discharges. Linear regression models relating discharge and trap efficiencies were developed to estimate daily trap efficiencies during periods when no mark-recapture trials were conducted. The total number of fish migrating past the trap each day was estimated as the quotient of the daily number of fish captured and the estimated daily trap efficiency. Summing the daily totals resulted in the total emigration estimate.

Snorkel observations were used to estimate the number of juvenile spring Chinook salmon, juvenile rainbow/steelhead, and bull trout within the Chiwawa River basin. The focus of the study was on juvenile spring Chinook salmon. Sampling followed a stratified random design with proportional allocation of sites among strata. Strata were identified based on unique combinations of geology, land type, valley bottom type, stream state condition, and habitat types. A total of 201 randomly selected sites were surveyed during August (Table 2.5). Counts of fish within each sampling site were adjusted based on detection efficiencies, which were related to water temperature. That is, non-linear models that described relationships between water temperatures and detection efficiencies (Hillman et al. 1992) were used to estimate total numbers of fish within sampling sites. These numbers were then converted to densities by dividing total fish numbers by the wetted surface area and water volume of sample sites. Total numbers within a stratum were estimated as the product of fish densities times the total wetted surface or water volume for the stratum. The sum of fish numbers across strata resulted in the total number of fish within the basin. The calculation of total numbers, densities, and degrees of certainty are explained fully in Hillman and Miller (2004).

Table 2.5. Location of strata and numbers of randomly sampled snorkel sites within each stratum that were sampled in the Chiwawa River Basin in 2018.

Reach/stratum	River miles (RM)	Number of randomly selected sites
Chiwawa River		
1	0.0-3.8	11
2	3.8-5.5	5
3	5.5-7.9	8
4	7.9-8.9	6
5	8.9-10.8	5
6	10.8-11.8	6
7	11.8-20.0	30
8	20.0-25.4	24
9	25.4-28.8	10
10	28.8-31.1	25
Phelps Creek		
1	0.0-0.4	1
Chikamin Creek (includes Minnow Creek)		
1	0.0-1.5	19
Rock Creek		
1	0.0-0.7	12
Unnamed stream on USGS map		
1	0.0-0.1	1
Big Meadow Creek		
1	0.0-1.0	9
Alder Creek		
1	0.0-0.1	6
Brush Creek		
1	0.0-0.1	6
Clear Creek		
1	0.0-0.1	2

Working in collaboration with the Comparative Survival Study (CSS) funded by BPA, crews PIT tagged juvenile wild Chinook, wild steelhead, wild sockeye, and in some instances wild coho salmon collected at the rotary screw traps and collected within the Chiwawa River and Nason Creek using electrofishing techniques. The proposed number of wild spring Chinook and steelhead to be tagged at each location is provided in Table 2.6. The goal of this tagging program is to estimate freshwater juvenile productivity, better understand life-history characteristics, overwinter movement, and survival of salmonids, and to calculate SARs for tagged stocks in the Wenatchee River basin. The PIT-tagging effort funded by the PUDs in the Chiwawa River and Nason Creek is specifically directed at addressing uncertainties of estimating abundance using rotary screw traps (e.g., juvenile outmigration during times when trapping is not possible).

Table 2.6. Number of wild spring Chinook, steelhead (≥65 mm), and sockeye proposed for PIT tagging at different locations within the Wenatchee River basin, 2018. NT = no sample size target.

Sampling location	Target sample size		
	Wild spring Chinook	**Wild steelhead**	**Wild Sockeye**
Chiwawa Trap	2,500-8,000	500-2,000	NT
Nason Creek Trap	2,500-8,000	500-2,000	NT
White River Trap	200-500	NT	NT
Lower Wenatchee Trap	1,000-2,500	50-250	3,000-5,000
Chiwawa Remote Sampling	3,000	NT	NT
Nason Remote Sampling	3,000	NT	NT

Survival rates for various juvenile life-stages were calculated based on estimates of seeding levels (total egg deposition), parr abundance, numbers of emigrants, and smolt abundance. Total egg deposition was estimated as the product of the number of redds counted in the basin times the mean fecundity of female spawners. An electronic egg counter was used to estimate fecundity of females collected for broodstock. Numbers of emigrants and smolts were estimated at trapping sites and numbers of parr were estimated using snorkel observations only in the Chiwawa River basin. Survival estimates could not be calculated for some stocks (e.g., summer Chinook) because specific life-stage abundance estimates were lacking.

2.4 Spawning/Carcass Surveys

Methods for conducting carcass and spawning ground surveys are detailed in Hillman et al. (2017). Information collected during spawning surveys included spawn time, redd location, and redd abundance. Data collected during carcass surveys included sex, size (fork length and postorbital-to-hypural length), scales for aging[2], degree of egg voidance, DNA samples, and identification of marks or tags. The sampling goal for carcasses was 20% of the spawning population.

[2] In this report, we use two methods of describing age. One is termed the "European Method." This method has two digits, separated by a period. The first digit represents the number of winters the fish spent in freshwater before migrating to the sea. The second digit indicates the number of winters the fish spent in the ocean. For example, a fish designated as 1.2 spent one winter in freshwater and two in the ocean. A fish designated as 0.3 migrated to the ocean in its first year and spent three winters in the ocean. The other method describes the total age of the fish (egg-to-spawning adult, i.e., gravel-to-gravel), so fish demarcated as 0.3 or 1.2 are considered 4-year-olds, from the same brood.

Steelhead surveys were conducted throughout the mainstem Wenatchee River and downstream from PIT-tag interrogation systems on the Chiwawa River, Nason Creek, and Peshastin Creek. These surveys were conducted during March through June in reaches and index areas described in Table 2.7. Total redd counts in these reaches were estimated by expanding counts within non-index areas by expansion factors developed within index areas.

Table 2.7. Description of reaches and index areas surveyed for steelhead redds in the Wenatchee River basin.

Stream	Code	Reach*	Index/reference area
Wenatchee River	W1	Mouth to Sleepy Hollow Br	River Bend to Sleepy Hollow Br
	W2	Sleepy Hollow Br to L. Cashmere Br	Sleepy Hollow Br to Cashmere Boat Rmp
	W3	L. Cashmere Br to Dryden Dam	Williams Canyon to Dryden Dam
	W5	Peshastin Br to Leavenworth Br	Irrigation Flume to Leavenworth Br
	W6	Leavenworth Br to Icicle Rd Br	Leavenworth Boat Ramp to Icicle Ck
	W7	Icicle Rd Br to Tumwater Dam	Icicle Br to Penstock Br
	W8	Tumwater Dam to Tumwater Br	Island below Swiftwater to Swiftwater CG
	W9	Tumwater Br to Chiwawa R	Tumwater Br to Plain
	W10	Chiwawa R to Lk Wenatchee	Chiwawa Pump St. to Lk Wenatchee
Peshastin Creek	P1	Mouth to PIT Detection Site	Mouth to PIT Detection Site
Chiwawa River	C1	Mouth to Rd 62 Br RM 6.4	Mouth to PIT Detection Site
Nason Creek	N1	Mouth to PIT Detection Site	Mouth to PIT Detection Site

* Reaches 2, 6, 8, 9, and 10 (major spawning areas) are surveyed weekly, while Reaches 1, 3, 5, and 7 (minor survey areas) are surveyed during peak spawning.

Beginning in 2014, adult steelhead escapement estimates in the majority of tributaries in the Wenatchee River basin were generated using mark-recapture techniques based on steelhead PIT tagged at Priest Rapids Dam.[3] Mark-recapture estimates in the tributaries were then added to the estimates based on redd surveys to generate a total spawning escapement to the Wenatchee River basin.

Spring Chinook redd and carcass surveys were conducted during August through September in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), upper Wenatchee River, Little Wenatchee River, and the White River (including the Napeequa River and Panther Creek). Survey reaches for spring Chinook are described in Table 2.8.

Table 2.8. Description of reaches surveyed for spring Chinook redds and carcasses in the Wenatchee River basin.

Stream	Code	Reach	River mile (RM)
Chiwawa River	C1	Mouth to Grouse Creek	0.0-11.7
	C2	Grouse Creek to Rock Creek	11.7-19.3
	C3	Rock Creek to Schaefer Creek	19.3-22.4
	C4	Schaefer Creek to Atkinson Flats	22.4-25.6

[3] We assume steelhead escapement to tributaries based on mark-recapture techniques represents spawning escapement.

Stream	Code	Reach	River mile (RM)
	C5	Atkinson Flats to Maple Creek	25.6-27.0
	C6	Maple Creek to Phelps Creek	27.0-30.3
	C7	Phelps Creek to Buck Creek	30.3-31.4
Rock Creek	R1	Mouth to Chiwawa River Road Bridge	0.0-0.5
Chikamin Creek	K1	Mouth to Chiwawa River Road Bridge	0.0-0.5
Nason Creek	N1	Mouth to Kahler Creek Bridge	0.0-3.9
	N2	Kahler Creek Bridge to Hwy 2 Bridge	3.9-8.3
	N3	Hwy 2 Bridge to Lower RR Bridge	8.3-13.2
	N4	Lower RR Bridge to Whitepine Creek	13.2-15.4
Little Wenatchee River	L1	Mouth to Old Fish Weir	0.0-2.7
	L2	Old Fish Weir to Lost Creek	2.7-5.2
	L3	Lost Creek to Rainy Creek	5.2-9.2
	L4	Rainy Creek to Falls	9.2-12.4
White River	H1	Mouth to Sears Creek Bridge	0.0-6.4
	H2	Sears Creek Bridge to Napeequa River	6.4-11.0
	H3	Napeequa River to Grasshopper Meadows	11.0-12.9
	H4	Grasshopper Meadows to Falls	12.9-16.1
Napeequa River	Q1	Mouth to Take Out	0.0-1.0
Panther Creek	T1	Mouth to Boulder Field	0.0-1.0
Wenatchee River	W8	Tumwater Dam to Tumwater Bridge	30.9-35.6
	W9	Tumwater Bridge to Chiwawa River	35.6-48.4
	W10	Chiwawa River to Lake Wenatchee	48.4-54.2
Chiwaukum Creek	U1	Mouth to Metal Bridge	0.0-1.0
Icicle Creek	I1	Mouth to Hatchery	0.0-2.8
	I2	Hatchery to Sleeping Lady	2.8-3.3
	I3	Sleeping Lady to Snow Creek	3.3-3.8
Peshastin Creek	P1	Mouth to Camas Creek	0.0-5.9
	P2	Camas Creek to Mouth of Scotty Creek	5.9-16.3
Ingalls Creek	D1	Mouth to Trailhead	0.0-1.0

The sockeye salmon hatchery program ended after the 2011 brood year. As a result, monitoring activities that focused on evaluating the effects of the supplementation program on the natural population switched to monitoring the abundance and productivity of the natural population (McElhaney et al. 2000). Thus, estimation of spawn time and carcass surveys were discontinued in 2014. Nevertheless, this report retains the results of carcass sampling during the period 1993-2013. Survey reaches in which carcasses and live fish (for area-under-the-curve estimates) were conducted are identified in Table 2.9.

From 2009-2013, mark-recapture methods were used to estimate sockeye spawning escapement within the White River, while area-under-the-curve (AUC) methods were used to estimate spawning escapement within the Little Wenatchee River. Beginning in 2014, mark-recapture methods were used to estimate the spawning escapement of sockeye in both the White River and Little Wenatchee watersheds.

Table 2.9. Description of reaches surveyed for sockeye salmon carcasses and live fish in the Wenatchee River basin during survey years 1993-2013.

Stream	Code	Reach	River mile (RM)
Little Wenatchee River	L1	Mouth to Old Fish Weir	0.0-2.7
	L2	Old Fish Weir to Lost Creek	2.7-5.2
	L3	Lost Creek to Rainy Creek	5.2-9.2
White River	H1	Mouth to Sears Creek Bridge	0.0-6.4
	H2	Sears Creek Bridge to Napeequa River	6.4-11.0
	H3	Napeequa River to Grasshopper Meadows	11.0-12.9
Napeequa River	Q1	Mouth to End	0.0-1.0

Wenatchee summer Chinook redd and carcass surveys were conducted from September through November throughout the entire mainstem Wenatchee River, which was divided into ten reaches (Table 2.10). Surveys were conducted weekly in all reaches. All redds were enumerated during weekly census counts.

Table 2.10. Description of reaches surveyed for summer Chinook redds in the Wenatchee River basin.

Code	Reach	River mile
W1	Mouth to Sleepy Hollow Br	0.0-3.3
W2	Sleepy Hollow Br to L. Cashmere Br	3.3-9.5
W3	L. Cashmere Br to Dryden Dam	9.5-17.8
W4	Dryden Dam to Peshastin Br	17.8-20.0
W5	Peshastin Br to Leavenworth Br	20.0-23.9
W6	Leavenworth Br to Icicle Rd Br	23.9-26.4
W7	Icicle Rd Br to Tumwater Dam	26.4-30.9
W8	Tumwater Dam to Tumwater Br	30.9-35.6
W9	Tumwater Br to Chiwawa River	35.6-47.9
W10	Chiwawa River to Lake Wenatchee	47.9-54.2

Summer Chinook redd and carcass surveys were also conducted in the Methow and Chelan rivers from September through November. Total (map) redd counts were conducted in these rivers. Table 2.11 describes the survey reaches on the Methow River. The Colville Tribes conducted summer Chinook redd and carcass surveys in the Okanogan River basin. Those results are reported in a separate report (annual report to BPA).

Table 2.11. Description of reaches surveyed for summer Chinook redds and carcasses on the Methow, Chelan, Okanogan, and Similkameen rivers.

Stream	Code	Reach	River mile (RM)
Methow River	M1	Mouth to Methow Bridge	0.0-14.8
	M2	Methow Bridge to Carlton Bridge	14.8-27.2
	M3	Carlton Bridge to Twisp Bridge	27.2-39.6
	M4	Twisp Bridge to MVID	39.6-44.9
	M5	MVID to Winthrop Bridge	44.9-49.8
	M6	Winthrop Bridge to Hatchery Dam	49.8-51.6
Chelan River	CoT	Columbia Tailrace	0.0-0.1
	ChT	Chelan Tailrace	0.1-0.3
	HC	Habitat Channel	0.2-0.6
	HP	Habitat Pool	0.6-0.7
Okanogan River	O1	Mouth to Mallot Bridge	0.0-16.9
	O2	Mallot Bridge to Okanogan Bridge	16.9-26.1
	O3	Okanogan Bridge to Omak Bridge	26.1-30.7
	O4	Omak Bridge to Riverside Bridge	30.7-40.7
	O5	Riverside Bridge to Tonasket Bridge	40.7-56.8
	O6	Tonasket Bridge to Zosel Dam	56.8-77.4
Similkameen River	S1	Driscoll Channel to Oroville Bridge	0.0-1.8
	S2	Oroville Bridge to Enloe Dam	1.8-5.7

For summer and spring Chinook, total spawning escapements for each population were estimated as the product of total number of redds times the ratio of fish per redd for a specific stock.[4] Fish per redd ratios were estimated as the ratio of males to females sampled at broodstock collection sites and monitoring sites (e.g., Leavenworth National Fish Hatchery, Dryden Dam, Tumwater Dam, Chiwawa Weir, etc.). For steelhead, spawning escapement was estimated with a combination of PIT-tag-based tributary and redd-based mainstem Wenatchee River estimates. Total spawning escapement for sockeye salmon in the Little Wenatchee and White River watersheds was estimated using mark-recapture methods. Adult sockeye were PIT tagged at Tumwater Dam and Bonneville Dam[5] and detected in the Little Wenatchee and White rivers with stationary PIT-tag interrogation systems.

Derived metrics calculated from carcass surveys, broodstock sampling, stock assessments, and harvest records included proportion of hatchery spawners, stray rates, age-at-maturity, length-at-age, smolt-to-adult survival (SAR), hatchery replacement rates (HRR), harvest rates, and natural replacement rates (NRR). The target HRRs (from Hillman et al. 2017) for different stocks raised in the PUD hatchery programs are provided in Table 2.12. Methods for calculating derived variables are described in Hillman et al. (2017) and in "White Papers" developed by the Hatchery Evaluation Technical Team (HETT) (see Appendices in Hillman et al. 2012). The abundance of

[4] Expansion factor = (1 + (number of males/number of females)).

[5] Adult sockeye that were tagged at Bonneville Dam and detected at Tumwater Dam were included in the mark-recapture analyses.

hatchery and natural-origin Chinook salmon spawners was based upon the proportion of carcasses by origin that were collected on the spawning grounds.

Table 2.12. Hatchery replacement rate (HRR) targets for stocks raised in the PUD Hatchery Programs.

Program	Number of broodstock	Smolts released	HRR targets
Chiwawa Spring Chinook	74	144,026	6.7
Nason Creek Spring Chinook (conser.)	77	125,000	6.7
Wenatchee Summer Chinook	262	500,001	5.7
Methow Summer Chinook	118	200,000	3.0
Wenatchee Steelhead	140	247,300	6.9

Derived data that rely on CWTs (e.g., HRR, SAR, stray rates, etc.) are five or more years behind release information because of the lag time for returning adult fish to enter the fishery and spawning grounds, and the processing of tags. Consequently, complete information on rates and ratios based on CWTs is generally only available for brood years before 2013.

In addition to the data required in the M&E Plan, this report contains data and analyses that go beyond the requirements of the M&E Plan. We include information on broodstock collection efforts including numbers of adult fish collected, mortalities, and numbers spawned. We also include the size, age, and sex ratios of broodstock; egg take, acclimation days, and tagging information; and incidence of disease. For natural-origin fish, we estimate juvenile carrying capacities and calculate the change in precision of stock-recruitment parameters as additional years of data are added to the time series. Finally, we include estimates of PNI, post-release survival and travel times (from release location to McNary Dam), and SARs. Although these data and analyses are not a requirement of the M&E Plan, they provide information that supports the M&E Plan and are used to help manage the hatchery programs.

SECTION 3: WENATCHEE STEELHEAD

The goal of summer steelhead supplementation in the Wenatchee Basin is to use artificial production to replace adult production lost because of mortality at Rock Island and Rocky Reach dams, as well as inundation compensation for Rocky Reach Dam, while not reducing the natural production or long-term fitness of steelhead in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Rock Island and Rocky Reach Anadromous Fish Agreement and Habitat Conservation Plans.

Prior to 1998, steelhead eggs were received from Wells Hatchery (adult broodstock were collected at Wells Dam); fish were reared at Eastbank Fish Hatchery and then released into the Wenatchee River. Beginning in 1998, the program changed to collecting broodstock within the Wenatchee River basin. Currently, adult hatchery steelhead are collected from the run-at-large at the right and left-bank traps at Dryden Dam, and at Tumwater Dam if the weekly quotas cannot be achieved at Dryden Dam. Natural-origin (WxW) adult steelhead are collected from the run-at-large at Tumwater and Dryden dams if the weekly quotas cannot be achieved at Dryden Dam.

Before 2012, the goal was to collect up to 208 adult steelhead (50% natural-origin fish and 50% hatchery-origin fish) for the Wenatchee steelhead program. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (which began in 2012) is to collect about 130 adult steelhead (64 natural-origin and 66 hatchery-origin fish) for a 247,300 smolt program, but the number of broodstock collected cannot exceed 33% of the natural Wenatchee steelhead population. Broodstock collection occurs from about 1 July through 15 November at Dryden and Tumwater dams, with trapping occurring up to 24 hours per day, five days a week. The intent of the current program is to target adults necessary to meet a 50% natural-origin, conservation-oriented program and a 50% hatchery-origin safety-net program.

Before the 2012 brood year, adult steelhead were held and spawned at Wells Fish Hatchery because of unsuitable adult holding temperatures at Eastbank Fish Hatchery. Beginning with the 2012 brood year, holding and spawning of adult steelhead have occurred at Eastbank Fish Hatchery with the installation of a water chiller system. Before 2012, juvenile steelhead were reared at a combination of facilities including Eastbank, Chelan, Turtle Rock, Rocky Reach Annex, and Chiwawa facilities. Juvenile steelhead reared in these facilities were trucked to release locations on the Wenatchee River, Chiwawa River, and Nason Creek. A percentage of the fish have also been released volitionally from Blackbird Pond and Rolfing Pond. Beginning in the fall of 2012, the entire Wenatchee steelhead program overwinters at the Chiwawa Acclimation Facility. Some of these fish are transferred to short-term remote acclimation sites (e.g., Blackbird Pond and Rolfing Pond), while others are planted from trucks throughout the Wenatchee, Nason, and Chiwawa basins.

Before 2012, the production goal for the Wenatchee steelhead supplementation program was to release 400,000 yearling smolts into the Wenatchee Basin at six fish per pound. Since 2012, the revised production goal is to release 247,300 smolts (123,650 for conservation and 123,650 for safety net). Targets for fork length and weight are 191 mm (CV = 9.0) and 75.6 g, respectively; the target size at release is six fish per pound. Over 96% of these fish receive CWTs. In addition, since 2006, juvenile steelhead from different parental-cross groups (e.g., WxW, HxW, and HxH) have been PIT tagged annually. No intentional HxW crosses have been part of the Wenatchee steelhead program since brood year 2009.

Beginning in 2010 and consistent with ESA Section 10(a)(1)(A) permit 1395, adult management activities have been conducted to remove excess hatchery-origin steelhead before they spawn in the natural environment. This is accomplished through removal at Tumwater Dam and/or through conservation fisheries. The objective of these activities is to achieve proportion of hatchery-origin spawners (pHOS) and Proportionate Natural Influence (PNI) goals for the Wenatchee steelhead program. Results of adult management activities are submitted to NOAA Fisheries in a separate annual report by 31 August of the year the adult management was concluded.

3.1 Broodstock Sampling

This section focuses on results from sampling brood years 2017 and 2018, which were collected at Dryden and Tumwater dams. The 2017 brood begins the tracking of the life cycle of steelhead released in 2018. The 2018 brood is included because juveniles from this brood are still maintained within the hatchery.

Origin of Broodstock

A total of 126 Wenatchee steelhead from the 2016 return (2017 brood) were collected at Dryden and Tumwater dams (Table 3.1). About 43.7% of these were natural-origin (adipose fin present and no CWT) fish and the remaining 56.3% were hatchery-origin (adipose fin present and CWT) adults. Origin was determined by analyzing scales and/or otoliths. The number of steelhead spawned from the 2017 brood totaled 119 adults (44.5% natural-origin and 55.5% hatchery-origin).

A total of 164 steelhead were collected from the 2017 return (2018 brood) at Dryden and Tumwater dams; 77 (47.0%) natural-origin (adipose fin present and no CWT) and 87 (53.0%) hatchery-origin (adipose fin present and CWT) adults. A total of 145 steelhead were spawned; 48.3% were natural-origin fish and 51.7% were hatchery-origin fish (Table 3.1). Origin was confirmed by sampling scales and/or otoliths.

Table 3.1. Numbers of wild and hatchery steelhead collected for broodstock, numbers of hatchery fish surplused at Tumwater Dam, numbers that died before spawning, and numbers of steelhead spawned, 1998-2018. Unknown-origin fish (i.e., undetermined by scale analysis, no elastomer, no CWT, no fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes surplus broodstock that were culled.

Brood year	Wild steelhead					Hatchery steelhead						Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Number surplused	Prespawn loss[a]	Mortality	Number spawned	Number released	
1998	35	0	0	35	0	43	0	4	2	37	0	72
1999	58	5	1	52	0	67	0	1	2	64	0	116
2000	39	2	1	36	0	101	0	9	12	60	20	96
2001	64	5	8	51	0	114	0	5	6	103	0	154
2002	99	0	1	96	2	113	0	1	0	64	48	160
2003	63	10	4	49	0	92	0	2	0	90	0	139
2004	85	3	0	75	7	132	0	1	0	61	70	136
2005	95	8	0	87	0	114	0	7	1	104	2	191
2006	101	5	0	93	3	98	0	0	0	69	29	162
2007	79	0	2	76	1	97	0	0	14	58	25	134

Brood year	Wild steelhead					Hatchery steelhead						Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Number surplused	Prespawn loss[a]	Mortality	Number spawned	Number released	
2008	104	0	3	77	22	107	0	0	28	54	25	131
2009	101	2	0	86	13	107	0	1	4	73	29	159
2010	106	1	1	96	8	105	747	2	23	75	5	171
2011	104	8	1	91	4	104	403	13	2	70	0	161
Average[b]	*81*	*4*	*2*	*71*	*4*	*100*	*382*	*3*	*7*	*70*	*18*	*142*
Median	*95*	*3*	*1*	*77*	*2*	*105*	*382*	*2*	*2*	*67*	*13*	*147*
2012	63	3	0	59	1	66	1293	0	1	65	0	124
2013	63	8	1	49	5	84	342	9	7	68	0	117
2014	65	0	1	64	0	70	597	0	2	68	0	132
2015	76	5	0	58	13	60	314	0	8	52	0	110
2016	67	0	1	66	0	66	36	0	0	66	0	132
2017	58	1	1	56	0	68	0	2	3	63	0	119
2018	77	3	0	70	4	87	0	3	8	75	1	145
Average[c]	*65*	*3*	*1*	*59*	*3*	*69*	*369*	*2*	*4*	*64*	*0*	*123*
Median	*64*	*2*	*1*	*59*	*1*	*67*	*324*	*0*	*3*	*66*	*0*	*124*

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] This average and median represent the program before recalculation in 2011.
[c] This average and median represent the current program, which began in 2012.

Age/Length Data

Broodstock ages were determined from examination of scales and/or otoliths. For the 2017 brood year, natural-origin and hatchery-origin steelhead consisted primarily of 2-salt adults (Table 3.2). For the 2018 brood year, natural and hatchery-origin steelhead consisted primarily of 1-salt adults (Table 3.2).

Table 3.2. Percent of hatchery and wild steelhead of different ages (saltwater ages) collected from broodstock, 1998-2018.

Brood year	Origin	Saltwater age		
		1	2	3
1998	Wild	39.4	60.6	0.0
	Hatchery	20.9	79.1	0.0
1999	Wild	50.0	48.3	1.7
	Hatchery	81.8	18.2	0.0
2000	Wild	56.4	43.6	0.0
	Hatchery	67.9	32.1	0.0
2001	Wild	51.7	48.3	0.0
	Hatchery	14.9	85.1	0.0
2002	Wild	55.6	44.4	0.0
	Hatchery	94.6	5.4	0.0
2003	Wild	13.1	85.3	1.6
	Hatchery	29.4	70.6	0.0
2004	Wild	94.8	5.2	0.0
	Hatchery	95.2	4.8	0.0

Brood year	Origin	Saltwater age		
		1	2	3
2005	Wild	22.1	77.9	0.0
	Hatchery	20.5	79.5	0.0
2006	Wild	28.7	71.3	0.0
	Hatchery	60.3	39.7	0.0
2007	Wild	40.3	59.3	0.0
	Hatchery	62.1	37.9	0.0
2008	Wild	65.4	33.7	0.9
	Hatchery	88.8	11.2	0.0
2009	Wild	39.8	57.8	2.4
	Hatchery	23.4	76.6	0.0
2010	Wild	65.2	33.7	1.1
	Hatchery	76.5	23.5	0.0
2011	Wild	27.5	72.5	0.0
	Hatchery	36.0	64.0	0.0
2012	Wild	42.4	52.5	5.1
	Hatchery	40.9	59.1	0.0
2013	Wild	40.7	57.4	1.9
	Hatchery	45.5	54.5	0.0
2014	Wild	47.5	50.8	1.6
	Hatchery	29.4	70.6	0.0
2015	Wild	15.9	82.5	1.6
	Hatchery	47.2	52.7	0.0
2016	Wild	33.8	66.2	0.0
	Hatchery	42.4	57.6	0.0
2017	Wild	10.5	84.2	5.3
	Hatchery	10.3	88.2	1.5
2018	Wild	72.6	27.4	0.0
	Hatchery	98.8	1.2	0.0
Average	***Wild***	***43.5***	***55.4***	***1.1***
	Hatchery	***51.8***	***48.2***	***0.1***
Median	***Wild***	***40.7***	***57.4***	***0.0***
	Hatchery	***45.5***	***54.5***	***0.0***

There was little difference between mean lengths of hatchery and natural-origin steelhead in the 2017 and 2018 brood years (Table 3.3). For the 2018 brood year, natural-origin fish were on average 2-10 cm larger than hatchery-origin fish for 1- and 2-salt fish. There were no 3-salt fish of hatchery or natural-origin for the 2018 brood year.

Table 3.3. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, 1998-2018; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1998	Wild	63	15	4	79	20	5	-	0	-
	Hatchery	61	9	4	73	34	4	-	0	-
1999	Wild	65	29	5	74	28	5	77	1	-
	Hatchery	62	54	4	73	12	4	-	0	-
2000	Wild	64	22	3	74	17	5	-	0	-
	Hatchery	60	57	3	71	27	4	-	0	-
2001	Wild	61	33	6	77	31	5	-	0	-
	Hatchery	62	17	4	72	97	4	-	0	-
2002	Wild	64	55	4	77	44	4	-	0	-
	Hatchery	63	106	4	73	6	4	-	0	-
2003	Wild	69	8	6	77	52	5	91	1	-
	Hatchery	66	27	4	75	65	4	-	0	-
2004	Wild	63	73	6	78	4	2	-	0	-
	Hatchery	61	59	3	73	3	1	-	0	-
2005	Wild	59	21	4	74	74	5	-	0	-
	Hatchery	59	23	4	72	89	4	-	0	-
2006	Wild	63	27	5	75	67	6	-	0	-
	Hatchery	61	41	4	72	27	5	-	0	-
2007	Wild	64	31	6	76	46	5	-	0	-
	Hatchery	60	60	4	71	36	5	-	0	-
2008	Wild	64	68	4	77	35	4	80	1	-
	Hatchery	60	95	4	72	12	2	-	0	-
2009	Wild	65	33	5	76	48	6	81	2	0
	Hatchery	63	18	4	75	59	5	-	-	-
2010	Wild	64	60	5	74	31	5	76	1	-
	Hatchery	61	53	5	73	23	5	-	-	-
2011	Wild	62	28	5	76	74	5	-	0	-
	Hatchery	60	36	4	74	64	4	-	0	-
2012	Wild	63	25	3	74	31	5	74	3	2
	Hatchery	59	27	3	74	39	4	-	0	-
2013	Wild	61	22	5	77	31	5	74	1	-
	Hatchery	60	35	3	74	42	4	-	0	-
2014	Wild	61	29	4	75	31	4	61	1	-
	Hatchery	60	20	3	72	48	4	-	0	-
2015	Wild	61	10	3	77	52	4	85	1	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	59	26	3	76	29	5	-	0	-
2016	Wild	63	22	4	74	43	4	-	0	-
	Hatchery	61	28	4	71	38	5	-	0	-
2017	Wild	62	6	3	78	48	5	73	3	4
	Hatchery	60	7	2	75	60	5	93	1	-
2018	Wild	64	53	3	75	18	5	-	0	-
	Hatchery	62	84	3	65	1	-	-	0	-
Average	***Wild***	***63***	***32***	***4***	***76***	***39***	***5***	***77***	***1***	***2***
	Hatchery	***61***	***42***	***4***	***73***	***39***	***4***	***93***	***0***	***-***

Sex Ratios

Male steelhead in the 2017 brood year made up about 50.0% of the adults collected, resulting in an overall male to female ratio of 1.00:1.00 (Table 3.4). For the 2018 brood year, males made up 51.2% of the adults collected, resulting in an overall male to female ratio of 1.05:1.00. On average (1998-2018), the sex ratio is slightly less than the 1:1 ratio assumed in the broodstock protocol (Table 3.4).

Table 3.4. Numbers of male and female wild and hatchery steelhead collected for broodstock, 1998-2018. Ratios of males to females are also provided.

Brood year	Number of wild steelhead			Number of hatchery steelhead			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1998	13	22	0.59:1.00	15	28	0.54:1.00	0.56:1.00
1999	22	36	0.61:1.00	35	32	1.09:1.00	0.84:1.00
2000	18	21	0.86:1.00	60	41	1.46:1.00	1.26:1.00
2001	38	26	1.46:1.00	40	74	0.54:1.00	0.78:1.00
2002	32	67	0.48:1.00	81	32	2.53:1.00	1.14:1.00
2003	19	44	0.43:1.00	44	48	0.92:1.00	0.68:1.0
2004	43	42	1.02:1.00	90	42	2.14:1.00	1.58:1.00
2005	36	59	0.61:1.00	46	68	0.68:1.00	0.65:1.00
2006	38	63	0.60:1.00	47	51	0.92:1.00	0.75:1.00
2007	36	43	0.84:1.00	49	48	1.02:1.00	0.93:1.00
2008	61	43	1.42:1.00	68	39	1.74:1.00	1.57:1.00
2009	44	57	0.77:1.00	54	53	1.02:1.00	0.89:1.00
2010	49	57	0.86:1.00	62	43	1.44:1.00	1.11:1.00
2011	44	60	0.73:1.00	50	54	0.93:1.00	0.82:1.00
2012	30	33	0.91:1.00	31	35	0.89:1.00	0.90:1.00
2013	33	30	1.10:1.00	38	46	0.83:1.00	0.93:1.00
2014	30	33	0.91:1:00	36	36	1.00:1.00	0.96:1.00

Brood year	Number of wild steelhead			Number of hatchery steelhead			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2015	34	42	0.81:1.00	34	26	1.31:1.00	1.00:1.00
2016	34	33	1.03:1.00	33	33	1.00:1.00	1.02:1.00
2017	29	26	1.12:1.00	34	34	1.00:1.00	1.00:1.00
2018	38	39	0.97:1.00	46	41	1.12:1.00	1.05:1.00
Total	***721***	***876***	***0.82:1.00***	***993***	***904***	***1.09:1.00***	***0.96:1:00***

Fecundity

Fecundities for Wenatchee steelhead in brood years 2017 and 2018 averaged 6,425 and 5,024 eggs per female, respectively (Table 3.5). Mean fecundity for the 2017 brood year was greater, while the 2018 brood year was less than the 5,685 eggs per female assumed in the broodstock protocol.

Table 3.5. Mean fecundity of wild, hatchery, and all female steelhead collected for broodstock, 1998-2018.

Brood year	Mean fecundity		
	Wild	Hatchery	Total
1998	6,202	5,558	5,924
1999	5,691	5,186	5,424
2000	5,858	5,729	5,781
2001	5,951	6,359	6,270
2002	5,776	5,262	5,626
2003	6,561	6,666	6,621
2004	5,118	5,353	5,238
2005	5,545	6,061	5,832
2006	5,688	5,251	5,492
2007	5,840	5,485	5,660
2008	5,693	5,153	5,433
2009	6,199	6,586	6,408
2010	5,458	5,423	5,442
2011	6,276	6,100	6,203
2012	5,309	6,388	5,891
2013	5,749	5,770	5,762
2014	5,831	5,847	5,839
2015	6,220	5,532	5,895
2016	5,392	4,956	5,174
2017	6,656	6,217	6,425
2018	5,145	4,910	5,024
Average	***5,817***	***5,704***	***5,779***
Median	***5,776***	***5,558***	***5,781***

To estimate fecundities by length, weight, and age[6], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of steelhead females during the spawning of 2013 through 2018 broodstock. For those brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin steelhead. For these years, hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between female size and fecundity.

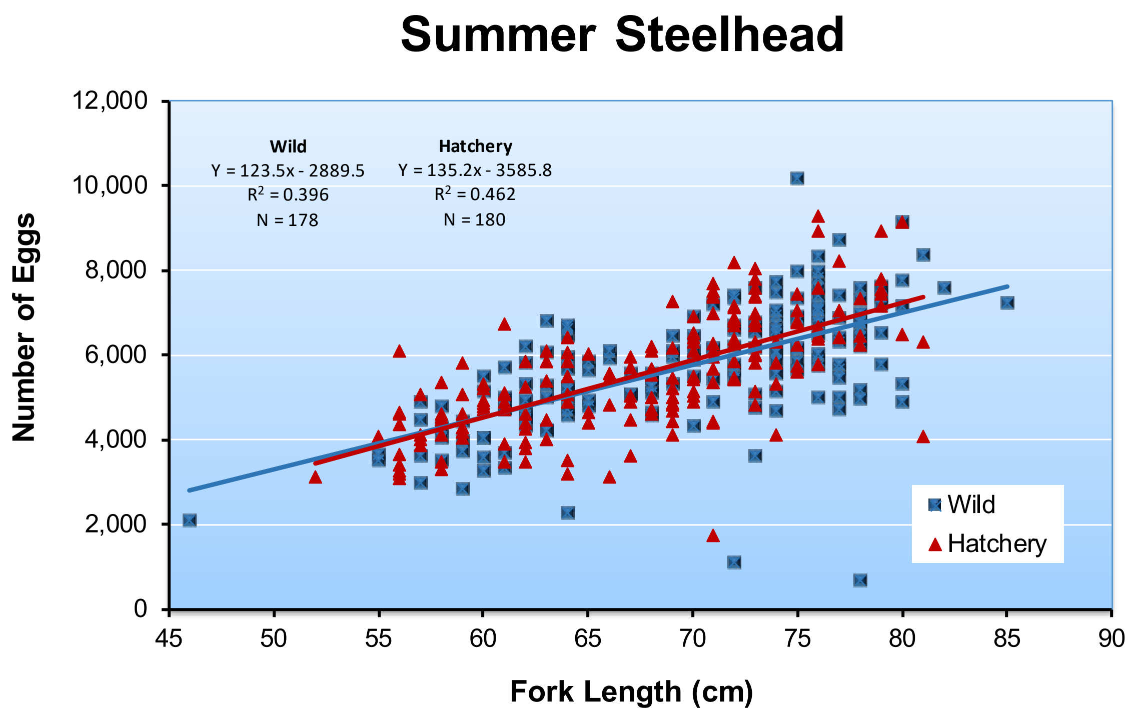
Mean fecundity by salt age varied between hatchery and natural-origin steelhead and over time (Table 3.6). On average, mean fecundities varied between hatchery and natural-origin steelhead by 110 eggs for 1-salt fish and 232 eggs for 2-salt fish. There were no hatchery-origin 3-salt steelhead.

Table 3.6. Mean fecundity by age (saltwater ages) for hatchery and wild steelhead collected from broodstock, brood years 2013-2018; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fecundity								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	4,035	5	260.7	6,224	20	858.1	-	0	-
	Hatchery	4,496	10	866.2	6,320	24	1096	-	0	-
2014	Wild	4,924	10	530.9	6,528	18	1,225.2	6,896	1	-
	Hatchery	4,732	3	957.4	5,831	28	1,095.2	-	0	-
2015	Wild	3,879	2	1,492.7	6,361	26	1,565.1	7,238	1	-
	Hatchery	3,951	6	636.3	6,144	19	1,102.4	-	0	-
2016	Wild	4,151	8	1,049.1	5,790	25	866.7	-	0	-
	Hatchery	4,654	8	992.1	5,191	24	1,014.7	-	0	-
2017	Wild	4,004	1	-	6,854	25	1,079.7	5,888	3	1,003.2
	Hatchery	3,998	3	501.2	6,446	29	1,090.7	-	0	-
2018	Wild	5,086	28	1055.7	5,551	5	554.5	-	0	-
	Hatchery	4,910	37	785.0	-	0	-	-	0	-
Average	***Wild***	***4,347***	***9***	***877.8***	***6,218***	***20***	***1,024.9***	***6,674***	***1***	***1,003.2***
	Hatchery	***4,457***	***11***	***789.7***	***5,986***	***21***	***1,079.8***	***-***	***0***	***-***

We pooled fecundity data from brood years 2013 through 2019 to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 3.1, 3.2, and 3.3. All fecundity variables increase linearly with fork length and weight. In addition, the relationships between fish size and fecundity data were similar for hatchery and natural-origin steelhead.

6 Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.



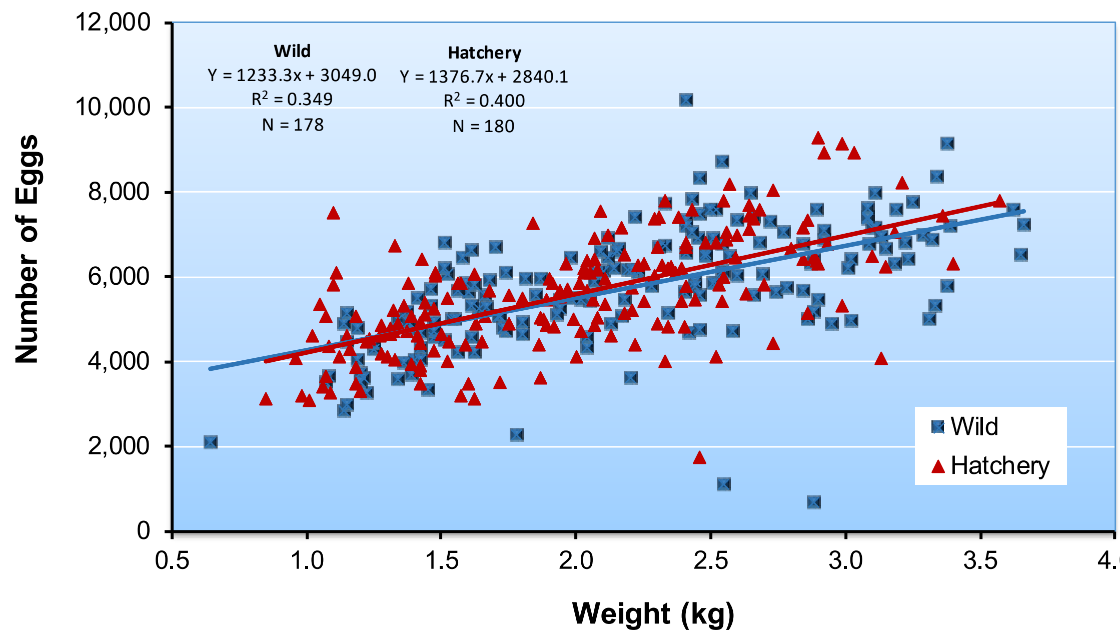


Figure 3.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin summer steelhead for return years 2013-2019.

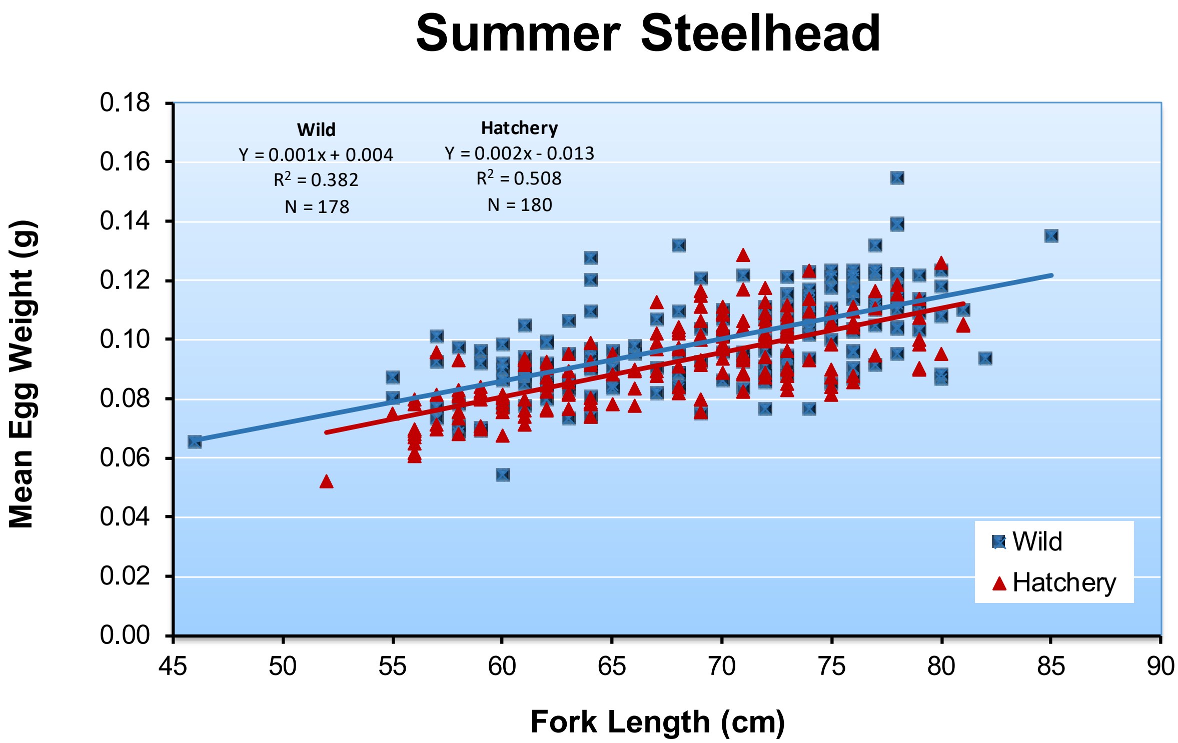


Figure 3.2. Relationships between mean egg weight and fork length for natural and hatchery-origin summer steelhead for return years 2013-2019.

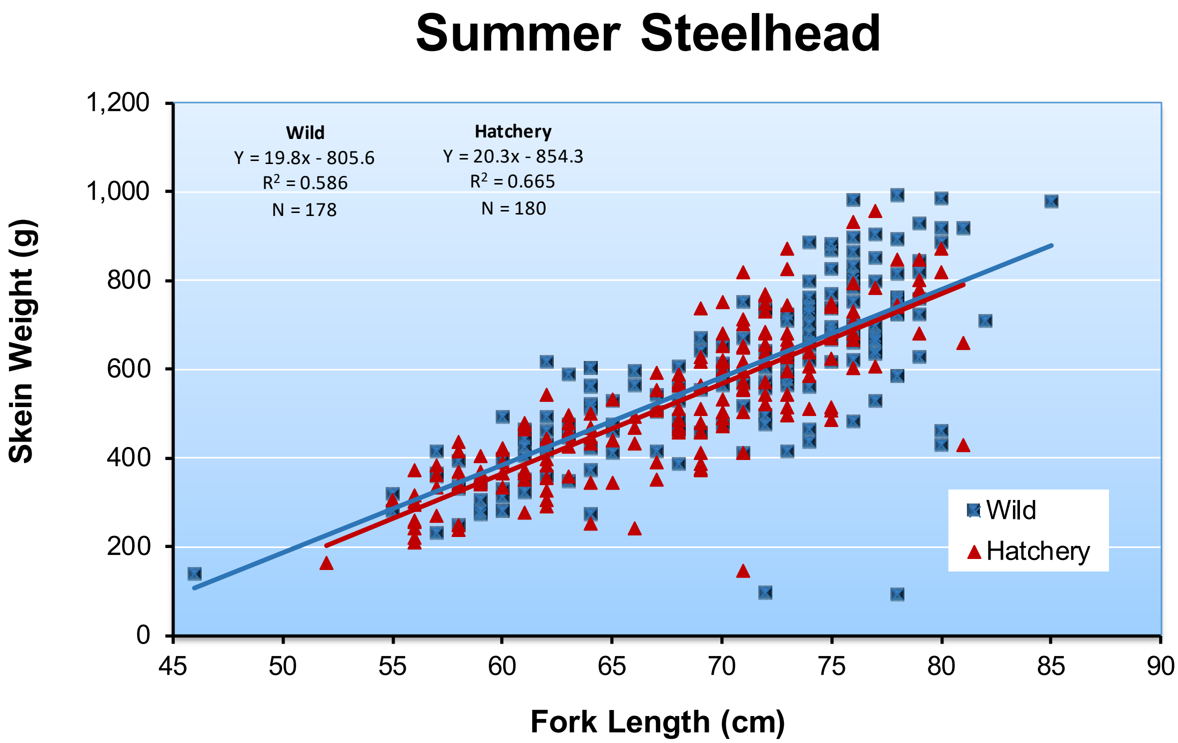


Figure 3.3. Relationships between skein weight and fork length for natural and hatchery-origin summer steelhead for return years 2013-2019.

3.2 Hatchery Rearing

Rearing History

Number of eggs taken

From 1998-2011, a total of 493,827 eggs were required to meet the program release goal of 400,000 smolts. This was based on the unfertilized egg-to-release survival standard of 81%. Since 2011, the egg take target has ranged from 352,280-376,408[7] in order to meet the revised release target of 247,300 smolts. Between 1998 and 2011, the egg take goal was reached 57% of the time (Table 3.7). Since 2011, the target has been reached or exceeded 100% of the time (Table 3.7).

Table 3.7. Numbers of eggs taken from steelhead broodstock, 1998-2018.

Brood year	Number of eggs taken
1998	224,315
1999	303,083
2000	280,872
2001	549,464

7 The egg take target varies from year to year because of variability in fecundity and in-hatchery survival.

Brood year	Number of eggs taken
2002	503,030
2003	532,708
2004	408,538
2005	672,667
2006	546,382
2007	462,662
2008	439,980
2009	633,229
2010	499,499
2011	522,049
Average (1998-2011)	***488,782***
Median (1998-2001)	***501,265***
2012	371,151
2013	339,949
2014	395,453
2015	324,212
2016	341,511
2017	391,950
2018	361,735
Average (2012-present)	***360,852***
Median (2012-present)	***361,735***

Number of acclimation days

Juvenile WxW steelhead from the Chelan Fish Hatchery and HxH steelhead from the Eastbank Fish Hatchery were transferred to Chiwawa Acclimation Facility in November 2017. All fish stayed at the Chiwawa Acclimation Facility until they were forced released from the facility the following spring in late April.

Juvenile Wenatchee steelhead at the Chiwawa Acclimation Facility were acclimated and reared on Wenatchee and Chiwawa River water. Before 2012, Wenatchee steelhead were reared on Columbia River water from January through May before being trucked and released into the Wenatchee River basin (Table 3.8).

Table 3.8. Water source and mean acclimation period for Wenatchee steelhead, brood years 1998-2018.

Brood year	Release year	Parental origin	Water source	Number of Days
1998	1999	H x H	Wenatchee/Chiwawa	36
		H x W	Wenatchee/Chiwawa	36
		W x W	Wenatchee/Chiwawa	36
1999	2000	H x H	Wenatchee/Chiwawa	138
		H x W	Wenatchee/Chiwawa	138

Brood year	Release year	Parental origin	Water source	Number of Days
		W x W	Wenatchee/Chiwawa	138
		H x W	Eastbank	0
		W x W	Eastbank	0
2000	2001	H x H	Wenatchee/Chiwawa	122
		H x W	Wenatchee/Chiwawa	122
		H x W	Wenatchee/Chiwawa	122
		W x W	Wenatchee/Chiwawa	122
2001	2002	H x H	Columbia	92
		H x H	Wenatchee/Chiwawa	63
		H x W	Columbia	92
		H x W	Wenatchee/Chiwawa	63
		W x W	Columbia	153
2002	2003	H x H	Columbia	98
		H x W	Columbia	98
		W x W	Columbia	117
2003	2004	H x H	Columbia	88
		H x W	Wenatchee/Chiwawa	84
		W x W	Columbia	148
2004	2005	H x H	Columbia	160
		H x W	Columbia	160
		W x W	Columbia	160
2005	2006	H x H	Columbia	116
		H x W	Columbia	113
		W x W	Columbia	141
2006	2007	Early H x W	Columbia	111
		Late H x W	Columbia	112
		W x W	Columbia	148
2007	2008	Early H x W	Columbia	94-95
		Late H x W	Columbia	91-93
		W x W	Columbia	138
2008	2009	Early H x W	Columbia	120-121
		Early H x W	Columbia/Wenatchee	120-121/28-95
		Late H x W	Columbia	114-115
		W x W	Columbia	152-153
2009	2010	Early H x W	Columbia	93-94
		Early H x W	Columbia/Wenatchee	99-111
		Early H x W	Wenatchee	31-129

Brood year	Release year	Parental origin	Water source	Number of Days
		Late H x W	Columbia	84-87
		W x W	Columbia/Nason	118-120/28
2010	2011	H x H	Wenatchee	188-192
		H x H	Wenatchee	37-87
		H x H	Columbia	181
		W x W	Columbia	148-149
		W x W	Columbia/Nason	113-114/42-101
		W x W	Columbia	148-149
2011	2012	W x W	Wenatchee	160-201
		W x W	Wenatchee	179-188
		W x W	Wenatchee	21-72
		W x W	Nason	56-107
2012	2013	H x H	Wenatchee	168-189
		H x H	Wenatchee	168-225
		W x W	Wenatchee	168-225
		W x W	Wenatchee	168-189
		W x W	Chiwawa	187
2013	2014	H x H	Wenatchee[a]	7-67
		H x H	Wenatchee	168-169
		W x W	Wenatchee	176-197
		W x W	Chiwawa	179-204
2014	2015	H x H	Wenatchee[a]	41-110
		H x H	Wenatchee	161-179
		W x W	Wenatchee	157-172
		W x W	Chiwawa	168-171
2015	2016	H x H	Wenatchee[a]	23-81
		H x H	Wenatchee	156-172
		W x W	Wenatchee	162-178
		W x W	Chiwawa	160-176
2016	2017	H x H	Wenatchee[a]	16-83
		H x H	Wenatchee	166-185
		W x W	Wenatchee	166-185
		W x W	Chiwawa	169-183
2017	2018	H x H	Wenatchee[a]	161-167
		W x W	Wenatchee	161-167
		W x W	Chiwawa	171-172

[a] Steelhead overwintered in Pond 3 at the Chiwawa Acclimation Facility on Chiwawa River water before they were transferred to Blackbird Pond.

Release Information

Numbers released

In 2011, the HCP Hatchery Committee agreed to reduce the Wenatchee summer steelhead program from 400,000 smolts to 247,300 smolts. Based on this new goal and the number of WxW steelhead present, all HxH steelhead were transferred to the Ringold Fish Hatchery to be included in their production program for the 2012 release.

The release of 2017 brood Wenatchee steelhead achieved 102.7% of the 247,300 target with about 253,994 smolts released into the Wenatchee and Chiwawa rivers and Nason Creek (Table 3.9; Appendix A). Distribution of juvenile steelhead released in each of the three streams was determined by the mean proportion of steelhead redds in each basin. About 23.4% and 30.7% of the steelhead were released in Nason Creek and the Chiwawa River, respectively. The balance of the program was split between the Wenatchee River downstream from Tumwater Dam (7.4%) and the Wenatchee River upstream from the dam (38.5%).

Table 3.9. Numbers of steelhead smolts released from the hatchery, brood years 1998-2017. Before brood year 2011, the release target for steelhead was 400,000 smolts. Beginning with brood year 2011, the release target is 247,300 smolts.

Brood year	Release year	Number of smolts
1998	1999	172,078
1999	2000	175,701
2000	2001	184,639
2001	2002	335,933
2002	2003	302,060
2003	2004	374,867
2004	2005	294,114
2005	2006	452,184
2006	2007	299,937
2007	2008	306,690
2008	2009	327,143
2009	2010	484,772
2010	2011	354,314
Average (1998-2010)		***312,649***
Median (1998-2010)		***306,690***
2011	2012	206,397
2012	2013	249,004
2013	2014	229,836
2014	2015	264,758
2015	2016	195,344
2016	2017	255,168
2017	2018	253,994

Brood year	Release year	Number of smolts
Average (2011-present)		***236,357***
Median (2011-present)		***249,004***

Numbers marked

The 2017 brood conservation program for Wenatchee hatchery steelhead were marked with coded wire tags (CWT) in the snout (no adipose clip). The safety net program was marked with CWT in the snout and adipose fin clipped. The safety net program made up 41.8% of the juveniles released (Table 3.10).

Table 3.10. Release location and marking scheme for the 1998-2017 brood Wenatchee steelhead.

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate[a]	Number released
1998	Chiwawa River	H x H	0.000	Red Left	0.994	52,765
	Chiwawa River	H x W	0.000	Green Left	0.990	37,013
	Chiwawa River	W x W	0.000	Orange Left	0.827	82,300
1999	Wenatchee River	H x H	0.000	Green Left	0.911	45,347
	Wenatchee River	H x W	0.000	Orange Left	0.927	30,713
	Chiwawa River	H x H	0.000	Red Right	0.936	25,622
	Chiwawa River	H x W	0.000	Green Right	0.936	43,379
	Chiwawa River	W x W	0.000	Orange Right	0.936	30,600
2000	Chiwawa River	H x H	0.000	Red Left	0.963	33,417
	Chiwawa River	H x W	0.000	Green Left	0.963	57,716
	Chiwawa River	H x W	0.000	Green Right	0.949	48,029
	Chiwawa River	W x W	0.000	Orange Right	0.949	45,477
2001	Nason Creek	H x W	0.000	Green Right	0.934	75,276
	Nason Creek	W x W	0.000	Orange Right	0.934	48,115
	Chiwawa River	H x W	0.000	Green Left	0.895	92,487
	Chiwawa River	H x H	0.000	Red Left	0.895	120,055
2002	Chiwawa River	H x H	0.000	Red Left	0.920	156,145
	Chiwawa River	H x W	0.000	Green Left	0.928	33,528
	Nason Creek	W x W	0.000	Orange Right	0.928	112,387
2003	Wenatchee River	H x H	0.000	Red Left	0.968	117,663
	Chiwawa River	H x W	0.000	Green Left	0.927	191,796
	Nason Creek	W x W	0.000	Orange Right	0.962	65,408
2004	Wenatchee River	H x H	0.500	Red Left	0.804	39,636

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate[a]	Number released
	Chiwawa River	H x W	0.000	Green Left	0.977	153,959
	Nason Creek	W x W	0.000	Pink Right	0.940	100,519
2005	Wenatchee River	H x H	1.000	Red Left	0.983	104,552
	Wenatchee River	H x W	0.616	Green Left	0.979	190,319
	Chiwawa River	H x W	0.616	Green Left	0.979	18,634
	Chiwawa River	W x W	0.000	Pink Right	0.969	14,124
	Nason Creek	W x W	0.000	Pink Right	0.969	124,555
2006	Wenatchee River	H x W (early)	1.000	Green Right	0.918	66,022
	Wenatchee River	H x W (late)	0.671	Green Left	0.935	92,176
	Chiwawa River	H x W (late)	0.671	Green Left	0.935	41,240
	Chiwawa River	W x W	0.000	Pink Right	0.945	7,500
	Nason Creek	W x W	0.000	Pink Right	0.945	92,999
2007	Wenatchee River	H x W (early)	0.967	Green Right	0.950	64,310
	Wenatchee River	H x W (late)	0.586	Green Left	0.951	97,549
	Chiwawa River	H x W (late)	0.586	Green Left	0.951	43,011
	Chiwawa River	W x W	0.000	Pink Right	0.952	7,026
	Nason Creek	W x W	0.000	Pink Right	0.952	94,794
2008	Blackbird Pond	HxW (early)	0.917	Green Right	0.910	49,878
	Wenatchee River	H x W (early)	0.917	Green Right	0.910	48,624
	Wenatchee River	H x W (late)	0.595	Green Left	0.908	74,848
	Chiwawa River	H x W (late)	0.595	Green Left	0.908	25,835
	Chiwawa River	W x W	0.000	Pink Right	0.904	25,778
	Nason Creek	W x W	0.000	Pink Right	0.904	102,170
2009	Blackbird Pond	H x W (early)	0.969	Green Right	0.934	50,248
	Wenatchee River	H x W (early)	0.969	Green Right	0.934	105,239
	Wenatchee River	H x W (late)	0.973	Green Left	0.975	27,612
	Wenatchee River	H x W (late)	0.000	Green Left	0.975	45,435
	Chiwawa River	H x W (early)	0.969	Green Right	0.934	23,835
	Chiwawa River	H x W (late)	0.973	Green Left	0.975	33,047
	Chiwawa River	H x W (late)	0.000	Green Left	0.975	54,381
	Nason Creek	W x W	0.000	Pink Right	0.979	145,029
2010	Wenatchee River	H x H	0.994	-	0.984	24,838

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate[a]	Number released
	Wenatchee River	H x H	0.994	-	0.984	45,000
	Wenatchee River	H x H	0.994	-	0.984	92,113
	Chiwawa River	W x W	0.000	Pink Right	0.917	81,174
	Nason Creek	W x W	0.000	Pink R/Pink L	0.884	20,000
	Nason Creek	W x W	0.000	Pink Right	0.917	91,189
2011	Wenatchee River	W x W	0.985	CWT	0.953	70,885
	Wenatchee River	W x W	0.985	CWT	0.953	24,992
	Wenatchee River	W x W	0.000	CWT	0.987	25,569
	Chiwawa River	W x W	0.985	CWT	0.953	31,050
	Nason Creek	W x W	0.000	CWT	0.989	18,254
	Nason Creek	W x W	0.985	CWT	0.953	36,225
2012	Wenatchee River	W x W	0.000	CWT	0.965	14,824
	Wenatchee River	H x H	1.000	AD/CWT	0.920	9,841
	Wenatchee River	W x W	0.000	CWT	0.965	28,362
	Wenatchee River	H x H	1.000	AD/CWT	0.920	76,695
	Chiwawa River	W x W	0.000	CWT	0.965	12,760
	Chiwawa River	H x H	1.000	AD/CWT	0.920	34,503
	Nason Creek	W x W	0.000	CWT	0.965	43,854
	Nason Creek	W x W	0.000	CWT	0.965	28,165
2013	Wenatchee River	W x W	0.000	CWT	0.963	36,736
	Wenatchee River	H x H	0.998	AD/CWT	0.990	55,055
	Wenatchee River	H x H	0.998	AD/CWT	0.990	25,316
	Chiwawa River	W x W	0.000	CWT	0.963	9,360
	Chiwawa River	H x H	0.998	AD/CWT	0.990	14,040
	Nason Creek	W x W	0.000	CWT	0.963	50,503
	Nason Creek	H x H	0.998	AD/CWT	0.990	38,826
2014	Wenatchee River	W x W	0.000	CWT	0.968	72,345
	Wenatchee River	H x H	0.996	AD/CWT	0.996	58,130
	Wenatchee River	H x H	0.996	AD/CWT	0.996	28,122
	Chiwawa River	W x W	0.000	CWT	0.968	20,443
	Chiwawa River	H x H	0.996	AD/CWT	0.996	14,599
	Nason Creek	W x W	0.000	CWT	0.968	41,188

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate[a]	Number released
	Nason Creek	H x H	0.996	AD/CWT	0.996	29,931
2015	Wenatchee River	W x W	0.000	CWT	0.972	52,446
	Wenatchee River	H x H	0.993	AD/CWT	0.980	28,633
	Wenatchee River	H x H	0.993	AD/CWT	0.980	21,386
	Chiwawa River	W x W	0.000	CWT	0.972	20,022
	Chiwawa River	H x H	0.993	AD/CWT	0.980	17,752
	Nason Creek	W x W	0.000	CWT	0.972	35,148
	Nason Creek	H x H	0.993	AD/CWT	0.980	19,957
2016	Wenatchee River	W x W	0.000	CWT	0.968	68,976
	Wenatchee River	H x H	0.998	AD/CWT	0.963	92,387
	Wenatchee River	H x H	1.000	AD/CWT	0.999	933
	Chiwawa River	W x W	0.000	CWT	0.968	21,292
	Chiwawa River	H x H	0.998	AD/CWT	0.963	24,741
	Chiwawa River	H x H	1.000	AD/CWT	0.960	251
	Nason Creek	W x W	0.000	CWT	0.968	34,403
	Nason Creek	H x H	0.998	AD/CWT	0.963	12,063
	Nason Creek	H x H	1.000	AD/CWT	0.967	122
2017	Wenatchee River	W x W	0.000	CWT	0.990	31,283
	Wenatchee River	W x W	0.000	CWT	0.990	31,284
	Wenatchee River	H x H	1.000	AD/CWT	0.990	26,962
	Wenatchee River	H x H	1.000	AD/CWT	0.990	26,961
	Chiwawa River	W x W	0.000	CWT	0.990	26,121
	Chiwawa River	W x W	0.000	CWT	0.990	26,120
	Chiwawa River	H x H	1.000	AD/CWT	0.990	12,872
	Chiwawa River	H x H	1.000	AD/CWT	0.990	12,871
	Nason Creek	W x W	0.000	CWT	0.990	16,516
	Nason Creek	W x W	0.000	CWT	0.990	16,516
	Nason Creek	H x H	1.000	AD/CWT	0.990	13,244
	Nason Creek	H x H	1.000	AD/CWT	0.990	13,244

[a] Tagging rate was adjusted for tag loss before the fish were released.

Numbers PIT tagged

Table 3.11 summarizes the number of hatchery steelhead of different parental origins that have been PIT-tagged and released into the Wenatchee River basin.

Table 3.11. Summary of PIT-tagging activities for Wenatchee hatchery steelhead, brood years 2006-2017.

Brood year	Release location	Parental origin	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2006	Wenatchee River	H x W (early)	10,036	479	24	9,533
	Wenatchee/Chiwawa rivers	H x W (late)	10,031	922	20	9,089
	Chiwawa River/Nason	W x W	10,019	152	352	9,515
2007	Wenatchee River	H x W (early)	9,852	22	10	9,820
	Wenatchee/Chiwawa rivers	H x W (late)	10,063	73	78	9,912
	Chiwawa River/Nason	W x W	10,038	55	1	9,982
2008	Wenatchee River	H x W (early)	10,101	59	15	10,027
	Wenatchee/Chiwawa rivers	H x W (late)	10,104	106	17	9,981
	Chiwawa River/Nason	W x W	10,101	159	80	9,862
2009	Wenatchee/Chiwawa rivers	H x W (early)	10,114	574	11	9,529
	Wenatchee (Blackbird)	H x W (early)	8,100	0	0	8,100
	Wenatchee/Chiwawa rivers	H x W (late)	10,115	271	11	9,833
	Chiwawa pilot	H x W (early)	10,107	532	103	9,472
	Chiwawa River/Nason	W x W	10,101	38	3	10,060
2010	Wenatchee River	HxH	10,100	624	21	9,455
	Chiwawa River/Nason	WxW	10,100	206	0	9,894
	Wenatchee (Blackbird)	HxH	10,101	235	8	9,858
	Wenatchee River	HxH	10,100	46	28	10,026
2011	Wenatchee/Chiwawa/Nason	WxW (circular)	10,101	139	30	9,932
	Wenatchee/Chiwawa/Nason	WxW (raceway)	20,220	121	35	20,064
2012	Wenatchee/Chiwawa/Nason	WxW (circular)	15,244	176	4	15,064
	Wenatchee/Chiwawa/Nason	HxH (raceway)	10,223	140	13	10,070
2013	Wenatchee/Chiwawa/Nason	WxW	5,100	95	1	5,004
	Wenatchee/Chiwawa/Nason	HxH	10,201	84	12	10,105
2014	Wenatchee/Chiwawa/Nason	WxW	9,051	53	0	8,998
	Wenatchee/Chiwawa/Nason	HxH	10,129	243	76	9,810
2015	Wenatchee/Chiwawa/Nason	WxW	12,101	60	0	12,041
	Wenatchee/Chiwawa/Nason	HxH	11,115	55	0	11,060

Brood year	Release location	Parental origin	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2016	Wenatchee/Chiwawa/Nason	WxW	5,050	183	3	4,864
	Wenatchee/Chiwawa/Nason	HxH & WxW	12,626	204	7	12,415
	Wenatchee (Blackbird)	HxH	2,525	2	11	2,512
2017	Chiwawa	WxW	11,110	74	0	11,036
	Chiwawa	HxH & WxW	22,220	282	26	21,912

2018 Brood Wenatchee WxW Summer Steelhead (Circular Ponds)—A total of 11,110 Wenatchee WxW summer steelhead were PIT tagged at the Chiwawa Acclimation Facility on 19-22 February 2019. These fish were tagged in circular ponds #1 and #3. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 150-151 mm in length and 40-41 g at time of tagging.

2018 Brood Wenatchee HxH and WxW Summer Steelhead (Raceway)—A total of 22,220 Wenatchee HxH and WxW summer steelhead were PIT tagged at the Chiwawa Acclimation Facility on 25 February – 8 April 2019. These fish were tagged in raceway #2. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 109-149 mm in length and 14-34 g at time of tagging.

Fish size and condition at release

All 2017 brood steelhead were trucked and released in April 2018. Both WxW and HxH fish did not meet the targets for length, weight, or coefficient of variation (CV) for fork length (Table 3.12). The HxH group was combined with the WxW group in Pond 2 once they were transferred to Chiwawa Acclimation Facility. The HxH and WxW fish were approximately the same size at the time of transfer but Pond 2 fish were smaller at the time of release.

Table 3.12. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of steelhead smolts released from the hatchery, brood years 1998-2017. Size targets are provided in the last row of the table. RCY = raceway; circular = recirculating aquaculture system; NA = not available.

Brood year	Release year	Parental origin	Rearing vessel	Fork length (mm)		Mean weight	
				Mean	CV	Grams (g)	Fish/pound
1998	1999	H x H	RCY	201	11.1	92.3	5
		H x W	RCY	190	12.8	76.9	6
		W x W	RCY	173	12.0	55.3	8
1999	2000	H x H	RCY	181	8.9	70.6	6
		H x W	RCY	187	7.2	75.3	6
		W x W	RCY	184	11.3	71.5	6
2000	2001	H x H	RCY	218	15.2	122.4	4
		H x W	RCY	209	10.6	107.5	4
		W x W	RCY	205	10.7	100.9	5
2001	2002	H x H	RCY	179	17.4	67.0	7

Brood year	Release year	Parental origin	Rearing vessel	Fork length (mm)		Mean weight	
				Mean	CV	Grams (g)	Fish/pound
		H x W	RCY	192	15.6	82.8	6
		W x W	RCY	206	11.6	102.6	4
2002	2003	H x H	RCY	194	13.1	83.0	6
		H x W	RCY	191	13.0	77.4	6
		W x W	RCY	180	19.1	70.3	7
2003	2004	H x H	RCY	191	14.4	73.1	6
		H x W	RCY	199	12.9	83.9	5
		W x W	RCY	200	11.1	90.1	5
2004	2005	H x H	RCY	204	11.3	87.2	6
		H x W	RCY	202	13.5	71.9	5
		W x W	RCY	198	12.4	76.6	6
2005	2006	H x H	RCY	215	12.6	116.6	4
		H x W	RCY	198	11.8	86.3	5
		W x W	RCY	189	15.4	55.3	6
2006	2007	H x H (early)	RCY	213	12.1	109.6	4
		H x W (late)	RCY	186	11.8	68.3	7
		W x W	RCY	178	11.1	58.6	8
2007	2008	H x W (early)	RCY	192	17.4	77.1	6
		H x W (late)	RCY	179	19.3	63.8	7
		W x W	RCY	183	12.3	62.8	7
2008	2009	H x W (early)	RCY	184	11.6	68.0	7
		H x W (late)	RCY	186	11.6	73.5	6
		W x W	RCY	181	13.0	59.7	8
2009	2010	H x W (early)	Circular	197	11.3	84.2	5
		H x W (late)	RCY	192	11.1	72.7	6
		W x W	RCY	190	9.6	70.5	6
2010	2011	H x H	RCY	183	14.1	68.9	4
		W x W	RCY	188	10.5	68.1	7
		H x W	Circular	NA	NA	NA	NA
2011	2012	H x H	RCY	NA	NA	NA	NA
		W x W	RCY	NA	NA	NA	NA
		W x W	Circular	156	17.1	45.2	10
2012	2013	H x H / W x W	RCY	150	16.1	40.8	11
		H x H / W x W	RCY	157	16.4	45.0	10
		W x W	Circular	156	18.7	49.0	9
2013	2014	H x H / W x W	RCY	157	14.5	49.4	9

Brood year	Release year	Parental origin	Rearing vessel	Fork length (mm)		Mean weight	
				Mean	CV	Grams (g)	Fish/pound
		H x H	RCY	127	16.2	26.8	17
		W x W	Circular	162	20.4	55.8	8
2014	2015	H x H / W x W	RCY	152	15.4	40.9	11
		H x H	RCY	145	13.5	36.6	12
		W x W	Circular	162	15.3	50.6	9
2015	2016	H x H / W x W	RCY	163	16.1	53.1	9
		H x H	RCY	162	9.4	46.1	10
		W x W	Circular	180	13.8	70.6	6
2016	2017	H x H / W x W	RCY	155	19.3	44.6	10
		H x H	RCY	147	11.0	32.6	14
		W x W	Circular	152	19.9	42.6	9
2017	2018	W x W	RCY	139	18	34	13
		H x H	RCY	135	22	31	15
		W x W	Circular	164	14	56	8
		W x W	Circular	161	16	54	8
Targets				***191***	***9.0***	***75.6***	***6***

Survival Estimates

Overall survival of 2017 brood year Wenatchee steelhead (WxW and HxH) from green (unfertilized) egg to release was near the standard set for the program. Losses were greatest at the unfertilized egg to eyed egg survival stage. Survival was highest at the transport to release stage (Table 3.13).

The Wenatchee steelhead program, from its inception, has experienced highly variable fertilization rates. It is unknown at this time what mechanisms may be influencing stock performance at these stages.

Table 3.13. Hatchery life-stage survival rates (%) for steelhead, brood years 1998-2017. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1998	92.0	100.0	85.5	91.7	99.2	98.8	97.8	99.9	76.7
1999	91.2	100.0	66.9	93.0	95.9	94.9	93.1	99.7	58.0
2000	83.9	96.2	77.6	86.7	99.3	98.9	97.7	99.5	65.7
2001	90.0	100.0	73.0	91.8	99.1	97.8	91.3	99.7	61.1
2002	99.0	100.0	69.2	93.1	95.9	94.4	89.6	89.6	60.0
2003	87.0	96.8	86.3	83.8	97.2	94.8	97.6	85.3	70.4

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2004	97.6	98.5	83.4	93.7	97.8	94.1	92.2	99.9	72.0
2005	91.3	95.1	81.3	92.1	95.6	91.8	89.7	99.6	67.2
2006	99.1	95.3	73.2	85.4	95.4	94.6	87.8	98.5	54.9
2007	100.0	100.0	80.3	92.0	95.7	92.7	89.8	99.1	66.3
2008	100.0	100.0	87.1	88.4	99.0	97.4	96.6	99.5	74.4
2009	97.3	100.0	89.0	97.2	96.0	95.2	88.6	96.6	76.6
2010	96.7	100.0	93.8	93.9	91.0	86.2	80.6	96.0	70.9
2011[a]	96.3	94.4	74.2	97.7	96.6	89.5	86.4	98.4	62.7
2012	95.2	98.4	74.7	99.7	97.8	94.0	90.1	98.9	67.1
2013	80.8	97.0	75.0	96.5	97.8	96.6	93.4	99.2	67.6
2014	100.0	100.0	83.3	96.7	95.8	89.9	87.9	98.7	70.8
2015	93.3	98.6	68.5	94.9	96.6	95.8	92.7	97.8	60.3
2016	100	100	86.9	97.5	99	97.4	88.2	94.7	74.7
2017	98.4	96.8	86.4	98.1	98.0	97.2	95.0	98.5	80.6
Average	***94.5***	***98.4***	***79.8***	***93.2***	***96.9***	***94.6***	***91.3***	***97.5***	***67.9***
Median	***96.5***	***99.3***	***80.8***	***93.4***	***96.9***	***94.9***	***90.7***	***98.8***	***67.4***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival estimates are only for WxW steelhead.

3.3 Disease Monitoring

Rearing of the 2017 brood Wenatchee summer steelhead was similar to previous years with fish being held on Chelan spring water, Eastbank well water, and Chelan well water before being transferred for overwinter acclimation at the Chiwawa Acclimation Facility. All fish were force-released into Nason Creek, Chiwawa River, and the Wenatchee River. The 2017 Wenatchee summer steelhead had no significant health issues during the rearing period.

3.4 Natural Juvenile Productivity

During 2018, juvenile steelhead were sampled at the Lower Wenatchee, Chiwawa, and Nason Creek traps and counted during snorkel surveys within the Chiwawa River basin. Because the snorkel surveys targeted juvenile Chinook salmon, the entire distribution of juvenile steelhead in the Chiwawa River basin was not surveyed. Therefore, the parr numbers presented below represent a minimum estimate.

Parr Estimates

A total of 11,854 (±12%) age-0 (<100 mm) and 3,151 (±17%) age-1+ (100-200 mm)[8] steelhead/rainbow were estimated in the Chiwawa River basin in August 2018 (Table 3.14 and 3.15). During the survey period 1992-2018, numbers of age-0 and 1+ steelhead/rainbow have ranged from 1,410 to 45,727 and 754 to 22,130, respectively, in the Chiwawa River basin (Table

[8] A steelhead/rainbow trout larger than 200 mm (8 in) was considered a resident trout.

3.14 and 3.15; Figure 3.4). Numbers of all fish counted in the Chiwawa River basin are reported in Appendix B.

Juvenile steelhead/rainbow were distributed primarily throughout the lower seven reaches of the Chiwawa River (downstream from Rock Creek). Their densities were highest in the lower portions of the river and in tributaries. Age-0 steelhead/rainbow most often used riffle and multiple channel habitats in the Chiwawa River, although they also associated with woody debris in pool and glide habitat. In tributaries, they were generally most abundant in small pools. Those that were observed in riffles selected stations in quiet water behind small and large boulders, or occupied stations in quiet water along the stream margin. In pool and multiple-channel habitats, age-0 steelhead/rainbow used the same kinds of habitat as age-0 Chinook salmon.

Age-1+ steelhead/rainbow most often used pool, riffle, and multiple-channel habitats. Those that used pools were usually in deeper water than subyearling steelhead/rainbow and Chinook salmon. Like age-0 steelhead/rainbow, age-1+ steelhead/rainbow generally selected stations in quiet water behind boulders in riffles, but the two age groups rarely occurred together. Age-1+ steelhead/rainbow used deeper and faster water than did subyearling steelhead/rainbow.

Table 3.14. Total numbers of age-0 steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2018; NS = not sampled.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	4,927	NS	NS	NS	NS	NS	NS	NS	NS	**4,927**
1993	3,463	0	356	185	NS	NS	NS	NS	NS	**4,004**
1994	953	0	256	24	0	177	0	0	0	**1,410**
1995	6,005	0	744	90	0	371	40	107	0	**7,357**
1996	3,244	0	71	40	0	763	127	0	0	**4,245**
1997	6,959	224	84	324	0	1,124	58	50	0	**8,823**
1998	2,972	22	280	96	113	397	18	22	0	**3,921**
1999	5,060	20	253	189	0	255	34	27	0	**5,838**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	35,759	192	1,449	1,826	0	6,345	156	0	0	**45,727**
2002	12,137	0	2,252	889	0	4,948	277	18	0	**20,521**
2003	9,911	296	996	1,166	96	5,366	73	116	0	**18,020**
2004	8,464	110	583	113	40	957	35	78	0	**10,380**
2005	4,852	120	2,931	477	45	2,973	65	0	0	**11,463**
2006	10,669	21	858	872	34	3,647	73	71	0	**16,245**
2007	8,442	53	2,137	348	11	2,955	65	28	34	**14,073**
2008	9,863	0	2,260	859	0	1,987	57	168	36	**15,230**
2009	13,231	0	1,183	449	0	2,062	170	67	17	**17,179**
2010	17,572	0	2,870	1,478	5	2,843	182	35	33	**25,018**
2011	35,825	0	1,503	804	0	1,066	56	152	40	**39,446**
2012	21,537	0	1,817	1,501	0	2,164	42	54	19	**27,134**
2013	17,889	0	602	816	0	2,189	44	99	43	**21,682**
2014	12,256	21	1,617	1,039	0	1,005	32	56	57	**16,083**
2015	4,532	0	1,989	1,675	0	1,761	170	62	19	**10,208**

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
2016	10,971	0	1,419	996	0	2,721	50	62	25	**16,244**
2017	10,120	0	2,127	1,025	0	3,954	36	22	12	**17,296**
2018	7,655	0	1,022	1,674	0	1,387	20	78	18	**11,854**
Average	***10,972***	***43***	***1,266***	***758***	***14***	***2,226***	***78***	***57***	***15***	***15,166***
Median	***9,164***	***0***	***1,183***	***816***	***0***	***2,025***	***57***	***55***	***6***	***14,652***

Table 3.15. Total numbers of age-1+ steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2018; NS = not sampled.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	2,533	NS	NS	NS	NS	NS	NS	NS	NS	**2,533**
1993	2,530	0	228	102	NS	NS	NS	NS	NS	**2,860**
1994	4,972	0	476	296	5	107	0	0	0	**5,856**
1995	8,769	0	494	71	0	183	0	0	0	**9,517**
1996	11,381	0	6	27	0	435	0	0	0	**11,849**
1997	6,574	160	0	105	0	66	0	0	0	**6,905**
1998	10,403	0	133	49	0	0	0	0	0	**10,585**
1999	21,779	0	68	201	0	82	0	0	0	**22,130**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	9,368	16	186	407	0	646	0	0	0	**10,623**
2002	7,200	0	199	165	0	1,526	0	0	0	**9,090**
2003	4,745	362	426	599	0	47	0	0	0	**6,179**
2004	7,700	107	209	0	0	174	0	0	0	**8,190**
2005	4,624	63	957	257	0	287	0	0	0	**6,188**
2006	7,538	76	748	1,186	0	985	0	0	0	**10,533**
2007	6,976	0	945	96	0	431	0	0	0	**8,448**
2008	8,317	0	1,168	298	0	793	0	0	0	**10,576**
2009	4,998	16	320	102	0	167	21	0	5	**5,629**
2010	8,324	32	366	393	0	780	21	0	0	**9,916**
2011	13,329	0	415	470	0	689	0	0	0	**14,903**
2012	7,671	0	285	410	0	210	0	0	0	**8,576**
2013	6,439	0	0	48	0	766	0	0	0	**7,253**
2014	4,568	13	96	211	0	165	0	0	31	**5,084**
2015	614	0	40	100	0	0	0	0	0	**754**
2016	3,418	0	256	40	0	309	0	8	0	**4,031**
2017	5,535	0	415	76	0	897	0	0	0	**6,923**
2018	2,778	0	66	64	0	243	0	0	0	**3,151**
Average	***7,042***	***34***	***340***	***231***	***0***	***416***	***2***	***0***	***2***	***8,011***
Median	***6,775***	***0***	***256***	***105***	***0***	***265***	***0***	***0***	***0***	***7,722***

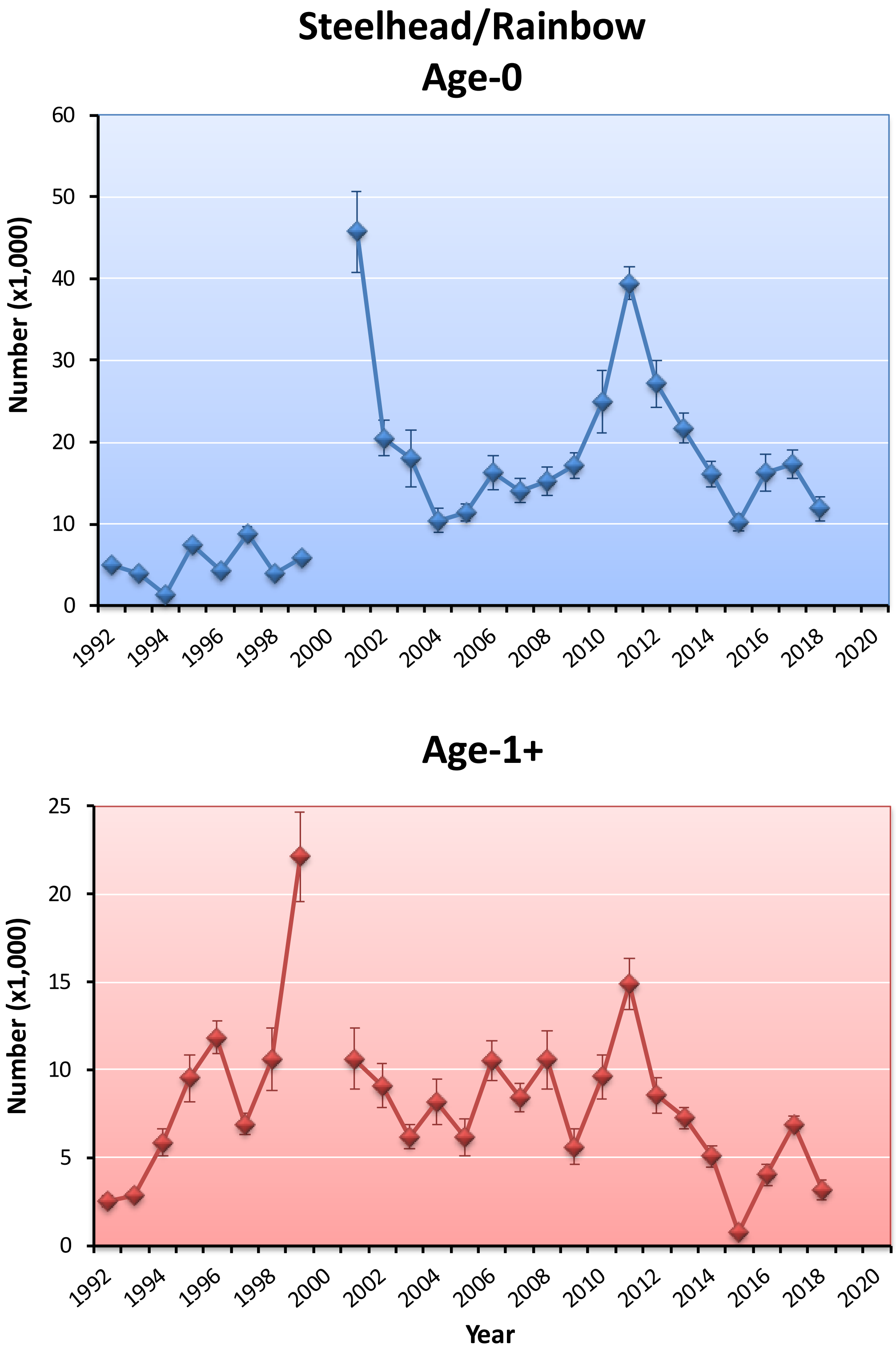


Figure 3.4. Numbers of subyearling and yearling steelhead/rainbow trout within the Chiwawa River basin in August 1992-2018; ND = no data. Vertical bars indicate 95% confidence bounds.

Emigrant and Smolt Estimates

Numbers of steelhead smolts and emigrants were estimated at the Chiwawa, Nason, and Lower Wenatchee traps in 2018.

Chiwawa Trap

The Chiwawa Trap operated between 6 March and 4 December 2018. During the trapping period, the trap was inoperable for 39 days because of high or low river discharge, debris, major hatchery releases, and mechanical issues. Throughout the trapping season, the trap operated in two positions, the upper position and low-flow position. Monthly captures of all fish collected at the Chiwawa Trap are reported in Appendix C.

A total of 147 wild steelhead/rainbow smolts, 364 hatchery smolts, 379 wild parr and fry, and 15 hatchery parr were captured at the Chiwawa Trap in 2018. Based on capture efficiencies, the total number of wild steelhead (including fry, parr, and smolts/transitionals) from the Chiwawa River basin was 13,824 (95% CI = ±35,748). Removing fry from the estimate, a total of 13,495 (±35,747) juvenile steelhead emigrated from the Chiwawa River basin in 2018 (Table 3.16). Most (86%) of the hatchery steelhead were collected in May, while most (85%) of the wild steelhead smolts were captured in April (Figure 3.5). Although steelhead/rainbow parr and fry emigrated throughout the sampling period, peaks in emigration were observed in April, June, August, and in November (Figure 3.5). Of the total number of wild steelhead captured, 72% were classified as parr and fry. Three mark-recapture efficiency trials were conducted in 2018 using 89 fish. This produced an observed pooled trap efficiency of 4.5%.

Table 3.16. Estimated numbers of wild steelhead that emigrated from the Chiwawa River basin during migration years 2015-2018. Estimates are provided with and without fry. Numbers in parentheses indicate 95% confidence intervals.

Migration year	Numbers of wild steelhead migrants	
	Migrants (excluding fry)	Migrants (including fry)
2015	46,500 (±156,250)	52,274 (±156,251)
2016	32,277 (±108,458)	34,092 (±114,557)
2017	27,849 (±129,192)	28,142 (±91,356)
2018	13,495 (±35,747)	13,824 (±35,748)
Average	***30,030***	***32,083***
Median	***30,063***	***31,117***

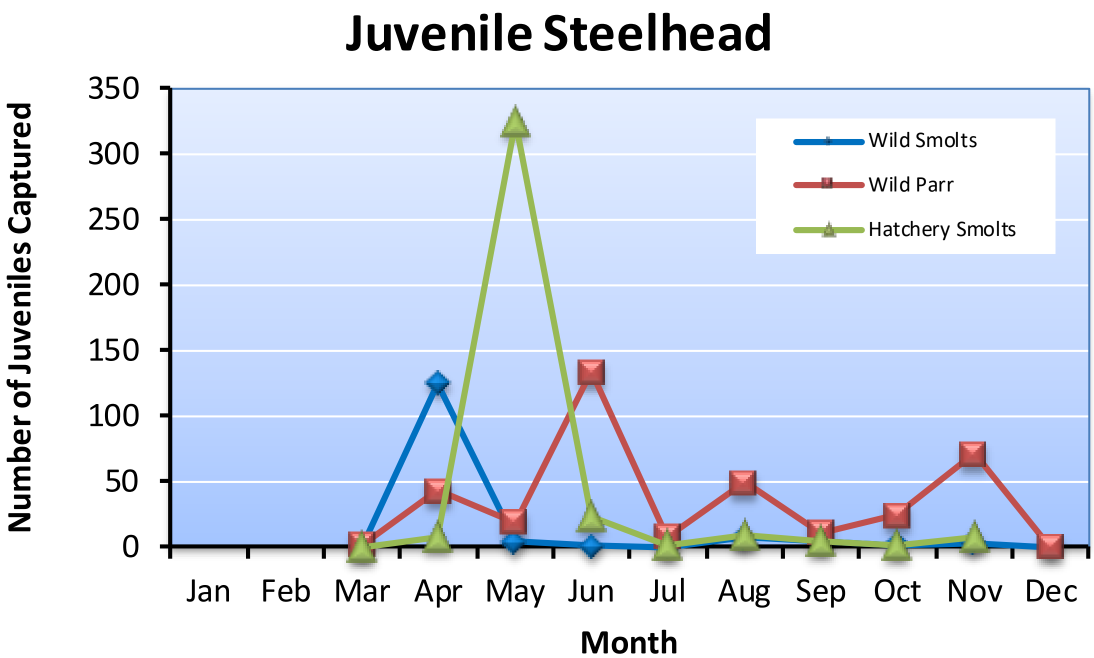


Figure 3.5. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Chiwawa Trap, 2018.

Wild steelhead smolts/transitionals sampled in 2018 averaged 170 mm in length, 49.3 g in weight, and had a mean condition of 0.96 (Table 3.17). These size estimates were larger than the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 159 mm, 45.2 g, and condition of 1.02). Wild steelhead parr sampled in 2018 at the Chiwawa Trap averaged 86 mm in length, averaged 8.8 g, and had a mean condition of 1.03 (Table 3.17). Parr sampled in 2018 were smaller than the overall mean of parr sampled in previous years (overall means, 91 mm, 12.4 g, and condition of 1.07).

Table 3.17. Mean fork length (mm), weight (g), and condition factor of wild juvenile steelhead collected in the Chiwawa Trap, 1997-2018. Numbers in parentheses indicate 1 standard deviation; NA = not available.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
1997	Fry	5	38 (4)	0.6 (0.2)	1.17 (0.32)
	Parr	150	121 (37)	22.8 (17.2)	1.06 (0.20)
	Smolt/Transitional	107	169 (32)	51.1 (30.4)	0.97 (0.14)
1998	Fry	6	44 (4)	0.9 (0.2)	1.07 (0.11)
	Parr	506	99 (45)	17.6 (28.8)	1.07 (0.11)
	Smolt/Transitional	112	156 (30)	42.3 (20.7)	1.03 (0.08)
1999	Fry	NA	NA	NA	NA
	Parr	122	114 (32)	18.5 (14.2)	1.03 (0.12)
	Smolt/Transitional	130	164 (36)	50.4 (33.4)	1.02 (0.20)
2000	Fry	7	46 (5)	1.1 (0.4)	1.05 (0.24)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	218	137 (65)	42.1 (52.5)	1.08 (0.15)
	Smolt/Transitional	104	170 (25)	50.8 (25.3)	0.98 (0.07)
2001	Fry	96	44 (6)	1.0 (0.3)	1.11 (0.18)
	Parr	733	79 (26)	7.2 (10.1)	1.10 (0.12)
	Smolt/Transitional	54	182 (33)	67.8 (40.3)	1.05 (0.22)
2002	Fry	43	44 (4)	0.8 (0.3)	0.96 (0.14)
	Parr	584	90 (32)	10.6 (11.9)	1.04 (0.10)
	Smolt/Transitional	91	154 (42)	47.6 (36.7)	1.09 (0.11)
2003	Fry	58	45 (4)	0.9 (0.3)	0.97 (0.17)
	Parr	1,093	84 (32)	9.3 (14.1)	1.04 (0.11)
	Smolt/Transitional	35	175 (26)	55.8 (23.4)	1.09 (0.10)
2004	Fry	18	47 (2)	1.1 (0.2)	1.05 (0.19)
	Parr	1,012	89 (30)	9.1 (10.6)	0.97 (0.16)
	Smolt/Transitional	120	158 (25)	41.1 (19.8)	0.96 (0.14)
2005	Fry	56	43 (4)	0.9 (0.3)	1.04 (0.14)
	Parr	924	82 (33)	9.3 (15.2)	1.05 (0.11)
	Smolt/Transitional	43	171 (34)	56.5 (36.6)	1.02 (0.11)
2006	Fry	36	42 (7)	0.9 (0.5)	1.16 (0.40)
	Parr	1,200	81 (25)	7.9 (15.6)	1.12 (0.19)
	Smolt/Transitional	53	171 (14)	50.1 (12.5)	0.99 (0.09)
2007	Fry	22	38 (9)	0.6 (0.5)	0.84 (0.32)
	Parr	968	91 (30)	11.3 (18.2)	1.07 (0.13)
	Smolt/Transitional	153	152 (27)	38.8 (18.9)	1.03 (0.12)
2008	Fry	263	41 (7)	0.9 (0.5)	1.23 (0.38)
	Parr	1,168	88 (34)	11.5 (17.5)	1.10 (0.15)
	Smolt/Transitional	367	143 (36)	35.0 (27.0)	1.01 (0.10)
2009	Fry	295	40 (7)	0.8 (0.4)	1.04 (0.29)
	Parr	1,299	87 (37)	11.9 (19.7)	1.08 (0.13)
	Smolt/Transitional	204	150 (39)	42.7 (33.6)	1.06 (0.09)
2010	Fry	137	43 (5)	0.9 (0.3)	1.11 (0.27)
	Parr	932	90 (39)	12.7 (18.8)	1.09 (0.17)
	Smolt/Transitional	210	124 (35)	24.3 (19.8)	1.04 (0.10)
2011	Fry	70	40 (8)	0.8 (0.4)	1.04 (0.23)
	Parr	894	95 (42)	15.3 (24.9)	1.05 (0.13)
	Smolt/Transitional	192	163 (20)	43.6 (16.9)	0.97 (0.08)
2012	Fry	178	43 (6)	0.9 (0.4)	1.10 (0.23)
	Parr	1,503	79 (36)	9.1 (16.3)	1.06 (0.16)
	Smolt/Transitional	116	161 (27)	44.4 (20.4)	0.99 (0.08)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2013	Fry	217	45 (4)	1.0 (0.3)	1.05 (0.17)
	Parr	1,622	81 (34)	9.2 (16.0)	1.04 (0.11)
	Smolt/Transitional	83	164 (19)	46.5 (15.5)	1.03 (0.08)
2014	Fry	328	38 (8)	0.7 (0.4)	1.03 (0.29)
	Parr	1,583	81 (30)	8.3 (13.2)	1.04 (0.13)
	Smolt/Transitional	44	136 (37)	30.5 (19.6)	1.02 (0.08)
2015	Fry	345	37 (9)	0.7 (0.5)	1.42 (0.94)
	Parr	2,280	76 (23)	6.0 (7.9)	1.37 (1.05)
	Smolt/Transitional	258	167 (22)	50.1 (19.1)	1.07 (1.02)
2016	Fry	112	37 (8)	0.6 (0.4)	0.90 (0.21)
	Parr	1,406	84 (23)	7.8 (9.4)	1.06 (0.38)
	Smolt/Transitional	195	147 (33)	37.3 (23.7)	1.04 (0.20)
2017	Fry	18	37 (8)	0.7 (0.4)	0.98 (0.29)
	Parr	784	85 (24)	7.6 (7.9)	1.03 (0.08)
	Smolt/Transitional	244	156 (24)	39.4 (17.3)	0.97 (0.09)
2018	Fry	9	33 (7)	0.7 (0.4)	1.12 (0.23)
	Parr	357	86 (26)	8.75 (10.4)	1.03 (0.08)
	Smolt/Transitional	146	170 (21)	49.28 (22.1)	0.96 (0.96)
Average	***Fry***	***110***	***41***	***0.8***	***1.07***
	Parr	***970***	***91***	***12.4***	***1.07***
	Smolt/Transitional	***139***	***159***	***45.2***	***1.02***
Median	***Fry***	***58***	***42***	***0.9***	***1.05***
	Parr	***950***	***86***	***9.3***	***1.06***
	Smolt/Transitional	***118***	***162***	***45.5***	***1.02***

[a] Sample size represents the number of fish that were measured for both length and weight.

White River Trap

The White River Trap operated between 1 March and 30 November 2018. During that period, the trap was intentionally pulled for two days during periods of high discharge. Because so few steelhead are capture in the trap and there is no flow-efficiency model for the trap, there are no estimates of total steelhead emigration. However, the few steelhead captured with the trap were enumerated and measured. In 2018, wild steelhead parr averaged 133 mm in length, 24.0 g in weight, and had a mean condition of 1.00 (Table 3.18). These size estimates were less than the overall mean of steelhead parr sampled in previous years (overall means: 154 mm, 45.2 g, and condition of 1.04). No wild steelhead smolts/transitionals were collected in the White River in 2018.

Table 3.18. Mean fork length (mm), weight (g), and condition factor of steelhead smolts collected in the White River Trap, 2007-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2007	Fry	0	–	–	–
	Parr	8	166 (32)	50.2 (21.3)	1.06 (0.37)
	Smolt/Transitional	0	–	–	–
2008	Fry	0	–	–	–
	Parr	14	150 (50)	47.8 (42.3)	1.06 (0.21)
	Smolt/Transitional	0	–	–	–
2009	Fry	0	–	–	–
	Parr	12	180 (30)	64.1 (30.7)	1.02 (0.13)
	Smolt/Transitional	0	–	–	–
2010	Fry	0	–	–	–
	Parr	11	155 (40)	57.6 (30.9)	1.12 (0.15)
	Smolt/Transitional	0	–	–	–
2011	Fry	0	–	–	–
	Parr	5	141 (20)	32.9 (12.7)	1.12 (0.04)
	Smolt/Transitional	0	–	–	–
2012	Fry	1	30	0.1	0.37
	Parr	3	177 (10)	56.5 (10.9)	1.01 (0.01)
	Smolt/Transitional	2	200 (13)	78.6 (19.2)	0.98 (0.04)
2013	Fry	0	–	–	–
	Parr	7	141 (50)	39 (44.4)	1.05 (0.11)
	Smolt/Transitional	1	153	38.8	1.08
2014	Fry	0	–	–	–
	Parr	5	165 (50)	56.9 (40.4)	1.04 (0.07)
	Smolt/Transitional	0	–	–	–
2015	Fry	0	–	–	–
	Parr	5	156 (61)	51.3 (43.1)	0.95 (0.10)
	Smolt/Transitional	1	167	57.5	1.23
2016	Fry	0	–	–	–
	Parr	5	145 (23)	32.9 (12.6)	1.02 (0.06)
	Smolt/Transitional	0	–	–	–
2017	Fry	0	–	–	–
	Parr	2	141 (13)	29.2 (10.9)	1.02 (0.10)
	Smolt/Transitional	0	–	–	–
2018	Fry	0	–	–	–
	Parr	2	133 (16)	24.0 (9.9)	1.00 (0.05)
	Smolt/Transitional	0	–	–	–

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
Average	***Fry***	***0 (0)***	***30***	***0.1***	***0.37***
	Parr	***7 (4)***	***154 (15)***	***45.2 (13.1)***	***1.04 (0.05)***
	Smolt/Transitional	***0 (1)***	***173 (24)***	***58.3 (19.9)***	***1.10 (0.13)***
Median	***Fry***	***0 (0)***	***30***	***0.1***	***0.37***
	Parr	***5 (4)***	***152.5 (15)***	***40.9 (13.1)***	***1.03 (0.05)***
	Smolt/Transitional	***0 (1)***	***167 (24)***	***57.5 (19.9)***	***1.08 (0.13)***

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2018. During the nine-month sampling period the trap was inoperable for 99 days because of low discharge and flooding. The trap captured a total of 24 wild steelhead smolts, 284 hatchery steelhead smolts, 538 wild steelhead parr, and 137 wild steelhead fry. Because a flow-efficiency regression model for steelhead has not yet been developed at the current trap location, a pooled efficiency was used to estimate emigrant abundance. The estimated wild steelhead smolt/transitional emigration for 2018 was 1,664 (±1,665) (Table 3.19).

Table 3.19. Estimated numbers of wild and hatchery steelhead smolts/transitionals that emigrated from Nason Creek during migration years 2003-2018; NS = no data. Numbers in parentheses indicate 95% confidence intervals.

Migration year	Numbers of steelhead smolts/transitionals	
	Wild smolts	Hatchery smolts
2003	187 (±461)	7,798 (±5,830)
2004	0 (±0)	8,362 (±2,436)
2005	858 (±256)	11,880 (±3,664)
2006[a]	35 (±35)	NS
2007	1,703 (±808)	34,159 (±10,445)
2008	6,603 (±3,469)	131,118 (±104,661)
2009	272 (±119)	53,758 (±17,124)
2010	1,269 (±873)	76,660 (±42,095)
2011	488 (±618)	36,010 (±29,600)
2012	5,438 (±3,812)	64,423 (±61,848)
2013	1,599 (±2,221)	63,001 (±95,002)
2014	1,198 (±1,263)	62,890 (±47,205)
2015[b]	1,392 (±7,741)	51,968 (±287,566)
2016[b]	648 (±2,367)	7,056 (±25,398)
2017[b]	772 (±1,165)	23,108 (±34,159)
2018[b]	1,664 (±665)	19,621 (±62,582)
Average	***1,508 (1,864)***	***43,454 (33,927)***
Median	***1,028 (1,864)***	***36,010 (33,927)***

[a] Hatchery-origin steelhead not enumerated

[b] Pooled estimate used.

Wild steelhead smolts/transitionals sampled in 2018 averaged 159 mm in length, 39.8 g in weight, and had a mean condition of 0.98 (Table 3.20). These size estimates were greater than the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 133 mm, 27.5 g, and condition of 1.00). Wild steelhead parr sampled in 2018 at the Nason Creek Trap averaged 88 mm in length, averaged 8.5 g, and had a mean condition of 1.08 (Table 3.20). Parr sampled in 2018 were greater than the overall mean of parr sampled in previous years (overall means, 81 mm, 6.8 g, and condition of 1.06).

Table 3.20. Mean fork length (mm), weight (g), and condition factor of steelhead smolts collected in the Nason Creek Trap, 2003-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2003	Fry	NS	NS	NS	NS
	Parr	63	74 (12)	5.3 (3.1)	1.23 (0.50)
	Smolt/Transitional	3	122 (42)	21.1 (17.6)	0.93 (0.16)
2004	Fry	4	45 (5)	1.0 (0.5)	1.03 (0.30)
	Parr	678	92 (30)	10.4 (11.0)	1.05 (0.23)
	Smolt/Transitional	0	–	–	–
2005	Fry	236	38 (7)	0.6 (0.5)	0.90 (0.68)
	Parr	850	76 (18)	5.4 (4.3)	1.04 (0.19)
	Smolt/Transitional	207	143 (21)	31.1 (14.6)	1.01 (0.22)
2006	Fry[a]	NS	NS	NS	NS
	Parr	1,162	89 (28)	8.9 (11.4)	0.92 (0.14)
	Smolt/Transitional	2	81 (17)	4.5 (2.1)	0.83 (0.12)
2007	Fry	121	43 (4)	1.0 (0.3)	1.16 (0.32)
	Parr	1,534	81 (19)	6.5 (5.8)	1.06 (0.16)
	Smolt/Transitional	97	136 (27)	28.0 (13.2)	1.03 (0.19)
2008	Fry	378	43 (5)	0.8 (0.3)	0.95 (0.21)
	Parr	2,343	80 (20)	6.3 (6.5)	1.06 (0.12)
	Smolt/Transitional	206	129 (32)	25.6 (17.7)	1.04 (0.10)
2009	Fry	106	48 (1.4)	1.1 (0.1)	1.02 (0.10)
	Parr	1,085	75 (27)	6.5 (10.4)	1.05 (0.10)
	Smolt/Transitional	16	153 (28)	38.7 (15.6)	1.00 (0.05)
2010	Fry	117	46 (3)	1.1 (0.3)	1.13 (0.17)
	Parr	1,907	79 (23)	6.9 (8.1)	1.10 (0.12)
	Smolt/Transitional	56	149 (26)	37.2 (16.3)	1.05 (0.15)
2011	Fry	517	39 (6)	0.6 (0.3)	0.93 (0.30)
	Parr	1,096	73 (22)	5.5 (12.2)	1.08 (0.14)
	Smolt/Transitional	7	114 (42)	19.7 (15.6)	1.02 (0.10)
2012	Fry	29	46 (3)	0.8 (0.3)	0.82 (0.29)

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	1,166	80 (20)	6.6 (6.5)	1.06 (0.13)
	Smolt/Transitional	83	134 (30)	27.6 (14.8)	1.03 (0.16)
2013	Fry	152	44 (4)	0.8 (0.3)	0.96 (0.23)
	Parr	2,396	74 (16)	4.7 (4.2)	1.01 (0.10)
	Smolt/Transitional	22	115 (33)	19.2 (14.3)	1.02 (0.06)
2014	Fry	155	44 (4)	0.8 (0.2)	0.96 (0.17)
	Parr	991	78 (17)	5.7 (5.2)	1.02 (0.09)
	Smolt/Transitional	18	139 (24)	29.8 (12.1)	1.03 (0.10)
2015	Fry	24	43 (5)	0.9 (0.3)	1.03 (0.24)
	Parr	389	84 (19)	7.3 (6.5)	1.05 (0.08)
	Smolt/Transitional	12	145 (23)	33.0 (15.7)	0.99 (0.08)
2016	Fry	275	41 (5)	0.8 (0.3)	0.99 (0.19)
	Parr	631	79 (21)	6.3 (6.1)	1.05 (0.11)
	Smolt/Transitional	9	120 (30)	20.7 (15.6)	1.02 (0.15)
2017	Fry	76	38 (5)	0.6 (0.3)	1.05 (0.16)
	Parr	1,377	86 (19)	8.0 (6.4)	1.08 (0.09)
	Smolt/Transitional	36	153 (18)	37.1 (12.5)	1.01 (0.08)
2018	Fry	137	29 (4)	0.2 (0.2)	0.83 (0.19)
	Parr	538	88 (21)	8.5 (7.4)	1.08 (0.08)
	Smolt/Transitional	24	159 (16)	39.8 (10.4)	0.98 (0.08)
Average	***Fry***	***166 (143)***	***42 (5)***	***0.8 (0.2)***	***0.99 (0.09)***
	Parr	***1,138 (658)***	***81 (6)***	***6.8 (1.5)***	***1.06 (0.06)***
	Smolt/Transitional	***50 (67)***	***133 (20)***	***27.5 (9.5)***	***1.00 (0.06)***
Median	***Fry***	***129 (143)***	***43 (5)***	***0.8 (0.2)***	***0.99 (0.09)***
	Parr	***1,091 (658)***	***80 (6)***	***6.5 (1.5)***	***1.06 (0.06)***
	Smolt/Transitional	***20 (67)***	***136 (20)***	***28.0 (9.5)***	***1.02 (0.06)***

Lower Wenatchee Trap

The Lower Wenatchee River Trap operated between 22 March and 24 July 2018. During that time, the trap was inoperable for 18 days because of high or low river discharge, debris, elevated river temperatures, large hatchery releases, and mechanical issues. Throughout the trapping season, a single lower cone position was used. During the sampling period, a total of 37 wild steelhead parr and fry, 208 wild steelhead smolts, and 349 hatchery steelhead were captured at the trap. Because of the low numbers of steelhead encountered at the trap, it was not possible to carry out mark-recapture trials using steelhead. In addition, because there was a poor relationship between trap efficiency and river flow, a pooled estimate was used to derive the number of steelhead emigrants. Using this pooled method, it was estimated 10,496 (±105,785) wild steelhead (including fry, parr, and smolt/transitional) emigrated out of the Wenatchee River basin during the trapping season. Excluding fry, it is estimated 9,758 (±98,353) wild steelhead emigrated from the Wenatchee River basin (Table 3.21). Figure 3.6 shows the monthly captures of all steelhead collected at the Lower Wenatchee Trap. All fish captured in the trap are reported in Appendix C.

Table 3.21. Estimated numbers of wild steelhead that emigrated from the Wenatchee River basin during migration years 2000-2018. Estimates are provided with and without fry. Numbers in parentheses indicate 95% confidence intervals; NS = not sampled.

Migration year	Numbers of wild steelhead migrants	
	Migrants (excluding fry)	Migrants (including fry)
2000	33,255 (±31,868)	NS
2001	27,114 (±81,454)	NS
2002	36,790 (±103,406)	NS
2003	32,710 (±30,190)	NS
2004	32,344 (±12,749)	NS
2005	41,414 (±4,066)	NS
2006	17,499 (±33,554)	NS
2007	85,443 (±94,717)	NS
2008	31,902 (±8,979)	NS
2009	27,513 (±7,097)	NS
2010	36,826 (±22,782)	NS
2011	NS	NS
2012	NS	NS
2013	10,813 (±69,699)	NS
2014	6,149 (±32,095)	NS
2015	8,632 (±45,053)	12,207 (±123,032)
2016	10,135 (±102,145)	18,400 (±185,447)
2017	5,784 (±58,303)	7,532 (±75,918)
2018	9,758 (±98,353)	10,496 (±105,785)
Average	***26,711***	***12,159***
Median	***27,314***	***11,352***

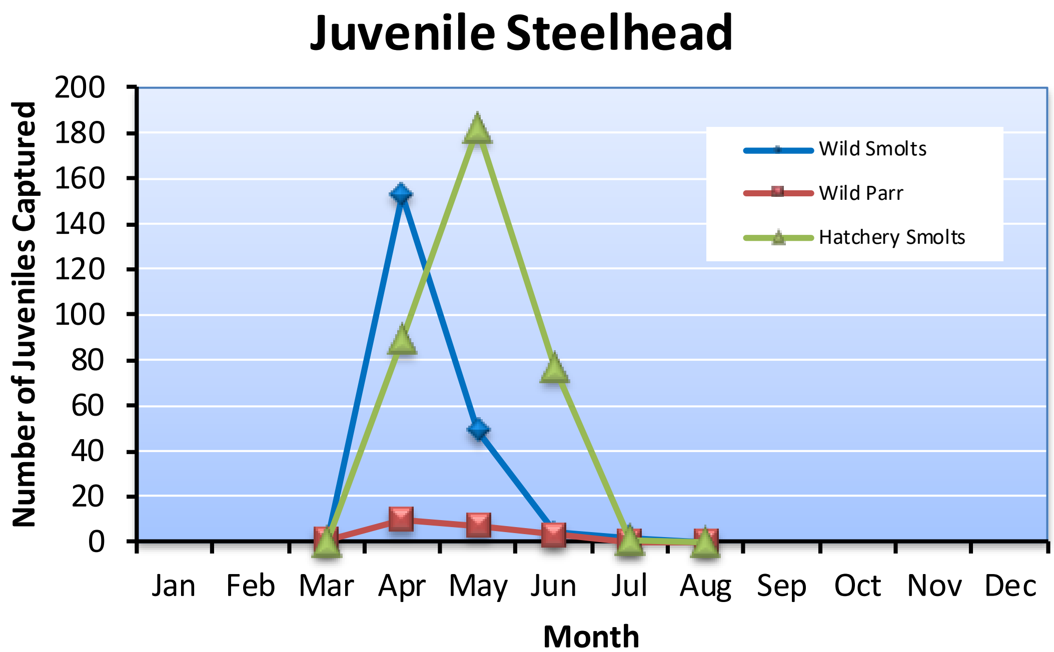


Figure 3.6. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Lower Wenatchee Trap, 2018.

Wild steelhead smolts/transitionals sampled in 2018 averaged 154.5 mm in length, 56.0 g in weight, and had a mean condition of 0.97 (Table 3.22). These size estimates were less than the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 160 mm, 49.7 g, and condition of 1.01). Wild steelhead parr sampled in 2018 at the Lower Wenatchee Trap averaged 97 mm in length, averaged 10.5 g, and had a mean condition of 1.04 (Table 3.22). Parr sampled in 2018 were larger than the overall mean of parr sampled in previous years (overall means, 91.4 mm, 9.4 g, and condition of 1.09).

Table 3.22. Mean fork length (mm), weight (g), and condition factor of wild juvenile steelhead collected in the Lower Wenatchee River Trap, 2000-2018. Numbers in parentheses indicate 1 standard deviation; NS = not sampled.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2000	Fry	3	45 (3)	1.0 (0.2)	1.01 (0.06)
	Parr	8	72 (25)	7.4 (7.7)	1.05 (0.11)
	Smolt/Transitional	18	178 (26)	39.3 (22.0)	1.01 (0.13)
2001	Fry	0	NS	NS	NS
	Parr	60	107 (29)	14.7 (14.9)	1.00 (0.10)
	Smolt/Transitional	273	170 (23)	50.1 (23.5)	0.97 (0.10)
2002	Fry	427	33 (5)	0.3 (0.2)	0.82 (0.25)
	Parr	75	110 (34)	18.5 (20.0)	1.03 (0.08)
	Smolt/Transitional	182	173 (26)	54.5 (25.9)	1.00 (0.08)
2003	Fry	15	31 (4)	0.8 (0.3)	1.02 (0.15)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	67	89 (26)	9.6 (10.1)	1.07 (0.12)
	Smolt/Transitional	328	182 (20)	61.1 (20.5)	0.98 (0.06)
2004	Fry	5	29 (4)	0.5 (0.1)	0.87 (0.13)
	Parr	58	101 (27)	13.1 (10.7)	1.05 (0.13)
	Smolt/Transitional	301	170 (21)	51.1 (19.2)	1.01 (0.10)
2005	Fry	9	30 (3)	0.4 (0.3)	1.09 (0.70)
	Parr	36	97 (25)	11.7 (14.5)	1.04 (0.10)
	Smolt/Transitional	208	173 (27)	54.9 (23.4)	1.00 (0.11)
2006	Fry	73	35 (6)	0.5 (0.3)	0.86 (0.20)
	Parr	52	93 (26)	10.4 (9.0)	1.05 (0.21)
	Smolt/Transitional	105	156 (32)	41.0 (22.5)	0.98 (0.11)
2007	Fry	146	31 (6)	0.3 (0.3)	0.79 (0.25)
	Parr	58	88 (17)	8.2 (5.5)	1.08 (0.10)
	Smolt/Transitional	436	161 (31)	45.3 (23.1)	1.00 (0.12)
2008	Fry	45	31 (5)	0.4 (0.3)	0.90 (0.24)
	Parr	68	87 (13)	7.9 (5.2)	1.14 (0.15)
	Smolt/Transitional	233	155 (32)	42.0 (22.4)	1.02 (0.12)
2009	Fry	167	31 (6)	0.5 (0.3)	0.93 (0.28)
	Parr	22	80 (39)	9.0 (16.2)	1.26 (0.23)
	Smolt/Transitional	212	159 (37)	43.6 (24.6)	1.00 (0.10)
2010	Fry	53	30 (5)	0.4 (0.3)	0.92 (0.39)
	Parr	33	81 (8)	5.6 (1.6)	1.07 (0.13)
	Smolt/Transitional	445	154 (38)	40.5 (24.5)	0.97 (0.12)
2011	Fry	NS	NS	NS	NS
	Parr	NS	NS	NS	NS
	Smolt/Transitional	NS	NS	NS	NS
2012	Fry	NS	NS	NS	NS
	Parr	NS	NS	NS	NS
	Smolt/Transitional	NS	NS	NS	NS
2013	Fry	237	32 (6)	0.5 (0.3)	1.03 (0.18)
	Parr	498	84 (28)	8.8 (13.6)	1.06 (0.13)
	Smolt/Transitional	172	162 (31)	45.3 (21.0)	0.98 (0.08)
2014	Fry	113	33 (6)	0.4 (0.3)	0.93 (0.22)
	Parr	95	91 (32)	10.5 (13.8)	1.03 (0.12)
	Smolt/Transitional	80	165 (34)	46.8 (23.1)	0.96 (0.15)
2015	Fry	25	33 (6)	0.4 (0.3)	1.15 (0.95)
	Parr	75	94 (23)	10.4 (9.4)	1.24 (1.08)
	Smolt/Transitional	230	179 (25)	60.3 (25.5)	1.05 (1.00)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2016	Fry	223	34 (7)	0.4 (0.3)	0.94 (0.22)
	Parr	102	83 (24)	7.7 (6.6)	1.04 (0.13)
	Smolt/Transitional	66	159 (30)	45.7 (27.4)	1.03 (0.07)
2017	Fry	28	31 (4)	0.3 (0.2)	0.74 (0.24)
	Parr	64	91 (19)	8.9 (5.7)	1.03 (0.07)
	Smolt/Transitional	52	149 (30)	37.0 (21.8)	1.00 (0.09)
2018	Fry	5	28 (4)	0.2 (0.1)	0.69 (0.17)
	Parr	21	97 (18)	10.5 (6.1)	1.04 (0.80)
	Smolt/Transitional	206	155 (44)	56.0 (21.6)	0.97 (0.80)
Average	***Fry***	***98***	***32***	***0.5***	***0.92***
	Parr	***82***	***91***	***10.2***	***1.08***
	Smolt/Transitional	***209***	***165***	***47.9***	***1.00***
Median	***Fry***	***98***	***32***	***0.5***	***0.92***
	Parr	***82***	***91***	***10.2***	***1.08***
	Smolt/Transitional	***209***	***165***	***47.9***	***1.00***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 1,173 juvenile steelhead/rainbow trout (1,172 wild and 1 hatchery) were PIT tagged and released in 2018 in the Wenatchee River basin (Table 3.23). Most of these were tagged at the Nason Creek and Chiwawa traps. See Appendix D for a complete list of all fish captured, tagged, lost, and released.

Table 3.23. Numbers of wild and hatchery steelhead/rainbow trout that were captured, tagged, and released at different locations within the Wenatchee River basin, 2018. Numbers of fish that died or shed tags are also given.

Sampling location	Origin	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Wild	526	8	435	1	0	435	0.19
	Hatchery	379	0	0	0	0	0	0.00
	Total	**905**	**8**	**435**	**1**	**0**	**435**	**0.11**
Nason Creek Trap	Wild	699	6	513	7	0	513	1.00
	Hatchery	733	0	0	0	0	0	0.00
	Total	**1,432**	**6**	**513**	**7**	**0**	**513**	**0.49**
White River Trap	Wild	4	0	2	0	0	2	0.00
	Hatchery	0	0	0	0	0	0	0.00
	Total	**4**	**0**	**2**	**0**	**0**	**2**	**0.00**
Lower Wenatchee Trap	Wild	245	0	222	0	0	222	0.00
	Hatchery	349	0	1	1	0	1	0.28

Sampling location	Origin	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
	Total	**594**	**0**	**223**	**1**	**0**	**223**	**0.17**
Total:	**Wild**	**1,474**	**14**	**1,172**	**8**	**0**	**1,172**	**0.54**
	Hatchery	**1,461**	**0**	**1**	**1**	**0**	**1**	**0.07**
Grand Total:		**2,935**	**14**	**1,173**	**9**	**0**	**1,173**	**0.31**

Numbers of steelhead/rainbow PIT-tagged and released as part of CSS and PUD studies during the period 2006-2018 are shown in Table 3.24.

Table 3.24. Summary of the numbers of wild and hatchery steelhead/rainbow trout that were tagged and released at different locations within the Wenatchee River basin, 2006-2018.

Sampling location	Origin	Numbers of PIT-tagged steelhead/rainbow released												
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Chiwawa Trap	Wild	1,366	832	1,431	1,127	930	1,012	1,011	1,228	1,186	1,795	1,313	909	435
	Hatchery	0	3	2	1	2	1	2	0	3	1	1	2	0
	Total	**1,366**	**835**	**1,433**	**1,128**	**932**	**1,013**	**1,013**	**1,228**	**1,189**	**1,796**	**1,314**	**911**	**435**
Chiwawa River (Angling or Electrofish)	Wild	33	167	94	35	99	0	0	0	23	0	0	0	0
	Hatchery	1	47	35	43	64	0	0	0	0	0	0	0	0
	Total	**34**	**214**	**129**	**78**	**163**	**0**	**0**	**0**	**23**	**0**	**0**	**0**	**0**
Upper Wenatchee Trap[1]	Wild	21	37	24	46	69	82	70	43	--	--	--	--	--
	Hatchery	0	0	0	0	0	0	0	0	--	--	--	--	--
	Total	**21**	**37**	**24**	**46**	**69**	**82**	**70**	**43**	**--**	**--**	**--**	**--**	**--**
Nason Creek Trap	Wild	1,167	1,335	2,154	753	1,557	805	1,087	1,998	838	383	530	1,353	513
	Hatchery	0	0	0	0	0	0	538	0	0	0	0	0	0
	Total	**1,167**	**1,335**	**2,154**	**753**	**1,557**	**805**	**1,625**	**1,998**	**838**	**383**	**530**	**1,353**	**513**
Nason Creek (Angling or Electrofish)	Wild	174	452	255	459	318	0	0	0	0	0	0	0	0
	Hatchery	26	75	87	197	32	0	0	0	0	0	0	0	0
	Total	**200**	**527**	**342**	**656**	**350**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
White River Trap	Wild	0	0	0	12	10	5	5	6	5	6	5	3	2
	Hatchery	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**12**	**10**	**5**	**5**	**6**	**5**	**6**	**5**	**3**	**2**
Upper Wenatchee (Angling or Electrofish)	Wild	413	1,001	21	7	30	--	--	--	--	--	--	--	--
	Hatchery	2	64	26	23	9	--	--	--	--	--	--	--	--
	Total	**415**	**1,065**	**47**	**30**	**39**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electrofish)	Wild	0	0	981	867	1,517	0	0	850	--	--	--	--	--
	Hatchery	0	0	11	5	57	0	0	2	--	--	--	--	--
	Total	**0**	**0**	**992**	**872**	**1,574**	**0**	**0**	**852**	**--**	**--**	**--**	**--**	**--**
	Wild	0	0	102	69	--	--	--	--	--	--	--	--	--

Sampling location	Origin	Numbers of PIT-tagged steelhead/rainbow released												
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Lower Wenatchee (Angling or Electrofish)	Hatchery	0	0	10	9	--	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**112**	**78**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electrofish)	Wild	0	0	0	92	307	--	--	--	--	--	--	--	--
	Hatchery	0	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**92**	**307**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Wild	131	461	285	227	465	0	0	613	133	290	131	106	222
	Hatchery	0	0	0	1	0	0	0	0	4	1	0	0	1
	Total	**131**	**461**	**285**	**228**	**465**	**0**	**0**	**613**	**137**	**291**	**131**	**106**	**223**
Total:	**Wild**	**3,305**	**4,285**	**5,347**	**3,694**	**5,302**	**1,904**	**2,173**	**4,738**	**2,185**	**2,474**	**1,979**	**2,371**	**1,172**
	Hatchery	**29**	**189**	**171**	**279**	**164**	**1**	**540**	**2**	**7**	**2**	**1**	**2**	**1**
Grand Total:		**3,334**	**4,474**	**5,518**	**3,973**	**5,466**	**1,905**	**2,713**	**4,740**	**2,192**	**2,476**	**1,980**	**2,373**	**1,173**

[1] 2013 was the last year that the Upper Wenatchee Trap operated.

3.5 Spawning Surveys

Surveys for steelhead redds were conducted from March through late May 2018, in the mainstem Wenatchee River and portions of select tributaries (Chiwawa River, Nason Creek, and Peshastin Creek). Beginning in 2014, adult steelhead escapement estimates in the majority of tributaries in the Wenatchee River basin were generated using mark-recapture techniques based on steelhead PIT tagged at Priest Rapids Dam (BPA funded; see Appendix E and Truscott et al. 2017 for details).

Redd Counts

A total of 38 steelhead redds were estimated in the Wenatchee River and the lower portions of select tributaries in 2018 (Table 3.25). Because steelhead escapement estimates in tributaries are based on mark-recapture techniques, there are no or limited redd counts in tributaries beginning in 2014. Additionally, mainstem redd counts since 2014 were expanded based on estimates of observer efficiency (see Appendix E). Thus, evaluation of trends in redd counts is appropriate only before 2014 or 2014 to present.

Table 3.25. Numbers of steelhead redds estimated within different streams/watersheds within the Wenatchee River basin, 2001-2017; NS = not surveyed. Redd counts from 2004-2014 have been conducted within the same areas and with the same methods. Beginning in 2014, complete redd counts were conducted only within the mainstem Wenatchee River. Therefore, trends in redd counts are only appropriate for the mainstem Wenatchee River from 2004 through 2013 or 2014 to present.

Survey year	Number of steelhead redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[a]	Icicle	Peshastin	Total
2001	25	27	NS	NS	116	19	NS	**187**
2002	80	80	1	0	315	27	NS	**503**
2003	64	121	5	3	248	16	15	**472**
2004	62	127	0	0	151	23	34	**397**

Survey year	Number of steelhead redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[a]	Icicle	Peshastin	Total
2005	162	412	0	2	459	8	97	**1,140**
2006	19	77	NS	0	191	41	67	**395**
2007	11	78	0	1	46	6	17	**159**
2008	11	88	NS	1	100	37	49	**286**
2009	75	126	0	0	327	102	32	**662**
2010	74	270	4	3	380	120	118	**969**
2011	77	235	2	0	323	180	115	**932**
2012	8	158	0	0	137	47	65	**415**
2013	27	135	NS	NS	200	48	62	**472**
2014	5	0	NS	NS	195[b]	NS	5	**205**
2015	1	1	NS	NS	258[b]	NS	1	**262**
2016	0	0	NS	NS	126[b]	NS	0	**126**
2017	0	1	NS	NS	189[b]	NS	1	**191**
2018	0	0	NS	NS	37[b]	NS	1	**38**

[a] Includes redds in Beaver and Chiwaukum creeks.
[b] Steelhead redd counts in the mainstem Wenatchee River were expanded based on estimated observer efficiency (see Appendix E).

Redd Distribution

Steelhead redds were not evenly distributed among survey reaches on the Wenatchee River in 2018 (Table 3.26). Most of the spawning (90.0% of observed redds) in the Wenatchee River occurred upstream from Tumwater Dam.

Table 3.26. Numbers and percentages of steelhead redds counted within different reaches on the Wenatchee River during March through late May 2018; CV = coefficient of variation, NA = not available, NS = not surveyed.

Reach	Reach type	Number of redds counted	Expanded redd counts		Percent of redds within stream/watershed
			Estimated	CV	
Wenatchee 1 (W1)	Non-index	0	0	-	0.0
Wenatchee 2 (W2)	Index	0	0	-	0.0
Wenatchee 3 (W3)	Non-index	0	0	-	0.0
Wenatchee 4 (W4)	Non-index	0	0	-	0.0
Wenatchee 5 (W5)	Non-index	0	0	-	0.0
Wenatchee 6 (W6)	Index	2	4	0.38	10.8
Wenatchee 6 (W6)	Non-index	0	0	-	0.0
Wenatchee 7 (W7)	NS	NS	-	-	NS
Wenatchee 8 (W8)	Index	1	3	0.50	8.1
Wenatchee 9 (W9)	Index	8	14	0.50	37.8
Wenatchee 9 (W9)	Non-index	0	0	-	0.0
Wenatchee 10 (W10)	Index	16	16	0.35	43.3

Reach	Reach type	Number of redds counted	Expanded redd counts		Percent of redds within stream/watershed
			Estimated	CV	
Wenatchee 10 (W10)	Non-index	0	0	-	0.0
Total		**27**	**37**	**0.33**	**100.0**

Spawn Timing

Steelhead began spawning mid-March in the Wenatchee River in 2018. Spawning activity appeared to begin once the mean daily stream temperature reached about 4.0°C and was observed in water temperatures ranging from 2.5-12.5°C. Steelhead spawning peaked during the middle of April in the Wenatchee River and surveys concluded during the first week of June (Figure 3.7).

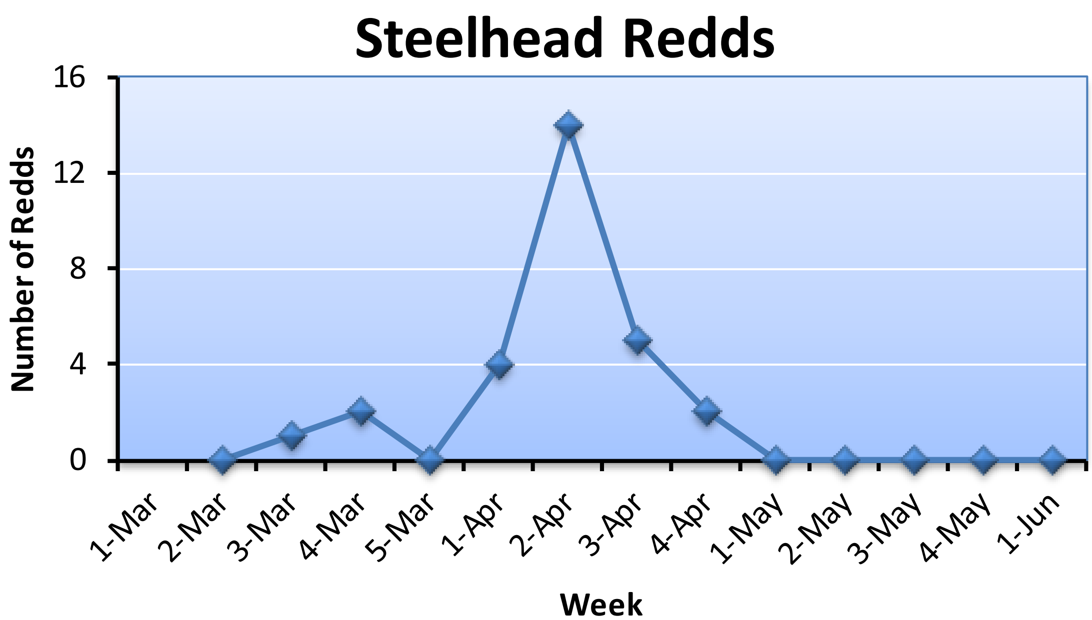


Figure 3.7. Numbers of steelhead redds counted during different weeks on the Wenatchee River, March through early June 2018.

Spawning Escapement

Before 2014, steelhead spawning escapement upstream from Tumwater Dam was calculated as the number of redds (in the Wenatchee River and tributaries upstream from the dam) times the fish per redd ratio (based on sex ratios estimated at Tumwater Dam using video surveillance).[9] Beginning in 2014, escapement in tributaries was estimated using PIT-tag mark-recapture techniques (Truscott et al. 2017; Table 3.27), while observer-efficiency-expanded redd counts were used to estimate escapement in the mainstem Wenatchee River (Appendix E). Total redd counts were also used to estimate escapement in the lower portions of the main tributaries (downstream from the PIT interrogation sites).

[9] Expansion factor = (1 + (number of males/number of females)).

Table 3.27. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within tributaries of the Wenatchee River, brood year 2018. Escapement estimates were based on PIT-tag mark-recapture techniques (Truscott et al. 2017). CV = coefficient of variation and NA = not available.

Tributary	Natural-origin steelhead		Hatchery-origin steelhead	
	Estimate	CV	Estimate	CV
Mission Creek	54	0.28	0	NA
Peshastin Creek	80	0.24	0	NA
Chumstick Creek	16	0.55	8	0.85
Icicle Creek	49	0.29	24	0.43
Chiwaukum Creek	20	0.49	20	0.51
Chiwawa River	25	0.46	31	0.43
Nason Creek	32	0.35	37	0.34

The estimated fish per redd ratio for steelhead in 2018 was 1.77 (Table 3.28). Multiplying this ratio by the total number of redds estimated in the Wenatchee River upstream from Tumwater Dam (33) resulted in a spawning escapement of 58 steelhead (Table 3.28). Adding this estimate to the mark-recapture estimates of tributary escapement (77 natural-origin and 88 hatchery-origin) indicates that 223 steelhead (CV = 0.38) escaped to spawning areas upstream from Tumwater Dam in 2018 (see Appendix E).

Table 3.28. Numbers of steelhead counted at Tumwater Dam, fish/redd estimates (based on male-to-female ratios estimated at Tumwater Dam), numbers of steelhead redds counted upstream from Tumwater Dam, total spawning escapement upstream from Tumwater Dam (estimated as the total number of redds times the fish/redd ratio), and the proportion of the Tumwater Dam count that made up the spawning escapement. Beginning in 2014, escapements include estimates from redd counts in the Wenatchee River and mark-recapture techniques in tributaries.

Survey year	Total count at Tumwater Dam	Fish/redd	Number of redds			Spawning escapement[a]	Proportion of Tumwater count that spawned
			Index area	Non-index area	Total redds		
2001	820	2.08	118	19	137	285	0.35
2002	1,720	2.68	296	179	475	1,273	0.74
2003	1,810	1.60	353	88	441	706	0.39
2004	1,869	2.21	277	92	369	815	0.44
2005	2,650	1.61	828	136	964	1,552	0.59
2006	1,053	2.05	192	34	226	463	0.44
2007	657	1.94	105	29	134	260	0.40
2008	1,328	2.81	124	35	159	447	0.34
2009	1,781	1.83	284	107	391	716	0.40
2010	2,270	2.33	546	95	641	1,494	0.66
2011	1,130	1.79	427	33	460	823	0.73
2012	1,055	2.00	273	22	295	590	0.56
2013	1,087	1.65	276	9	285	470	0.43
Average[b]	***1,488***	***2.02***	***333***	***59***	***392***	***763***	***0.50***

Survey year	Total count at Tumwater Dam	Fish/redd	Number of redds			Spawning escapement[a]	Proportion of Tumwater count that spawned
			Index area	Non-index area	Total redds		
Median	***1,328***	***2.00***	***277***	***35***	***369***	***706***	***0.44***
2014	865	1.70	124	0	124	839	0.97
2015	1,009	1.78	232	11	243	1,123	1.11
2016	1,017	1.65	120	6	126	572	0.56
2017	452	2.11	166	7	173	461	1.02
2018	504	1.77	33	0	33	223	0.44
Average[c]	***769***	***1.80***	***135***	***5***	***140***	***644***	***0.82***
Median	***865***	***1.77***	***124***	***6***	***126***	***572***	***0.97***

[a] Escapement estimates before 2014 were based on expanded redd counts in the Wenatchee River and tributaries; escapement estimates beginning in 2014 were based on expanded redd counts within the Wenatchee River and mark-recapture techniques in tributaries.
[b] The average and median are based on estimates from 2004 to 2013.
[c] The average and median are based on estimates from 2014 to present.

3.6 Life History Monitoring

Life history characteristics of steelhead were assessed by examining fish collected at broodstock collection sites, examining videotape at Tumwater Dam, and by reviewing tagging data and fisheries statistics. Before brood year 2011, some statistics could not be calculated because few steelhead were tagged with CWTs. Since brood year 2011, all steelhead released from the hatchery program have been tagged with CWTs. In addition, about 33,330 of the 2017 brood were PIT tagged. With the placement of remote PIT tag detectors in spawning streams in 2007 and 2008, statistics such as origin on spawning grounds, stray rates, and SARs can be estimated more accurately.

Migration Timing

Sampling at Tumwater Dam indicates that steelhead migrate throughout the year; however, the migration distribution is bimodal, indicating that steelhead migrate past Tumwater Dam in two pulses: one pulse during summer-autumn the year before spawning and another during winter-spring the year of spawning (Figure 3.8). Most steelhead passed Tumwater Dam during July through October and April. The highest proportion of both wild and hatchery fish migrated during October.

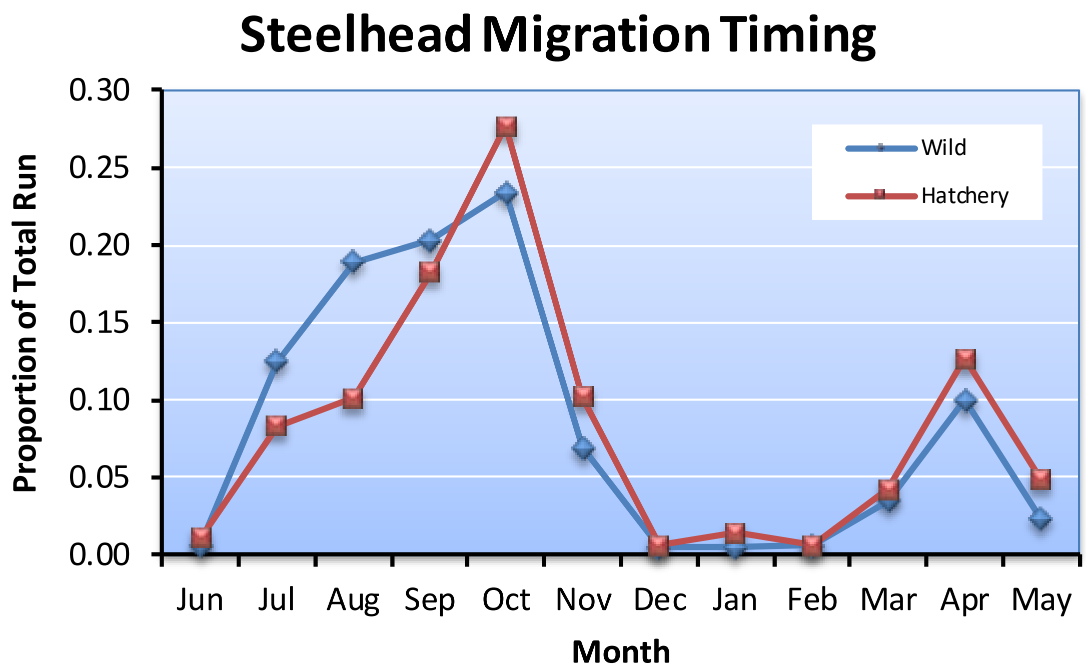


Figure 3.8. Proportion of wild and hatchery steelhead sampled at Tumwater Dam for the combined brood years of 1999-2018.

Because the migration of steelhead is bimodal, we estimated migration statistics separately for each migration pulse (i.e., summer-autumn migration and winter-spring migration). That is, we compared migration statistics for wild and hatchery steelhead passing Tumwater Dam during the summer-autumn period independent of those for the winter-spring migration period. We estimated the week and month that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during the two migration periods. We also estimated the mean weekly and monthly migration timing for wild and hatchery steelhead.

Migration timing of wild and hatchery fish at Tumwater Dam varied depending on the migration season (Table 3.29a and b; Figure 3.5). For the summer-autumn migration period, wild steelhead arrived at the dam about one week earlier than hatchery steelhead. In contrast, there was little difference in migration timing of wild and hatchery steelhead during the winter-spring migration period.

Table 3.29a. The week that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during their summer-autumn migration (June through December) and during their winter-spring migration (January through May), 1999-2018. The average week is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. Unknown-origin fish (i.e., undetermined by scale analysis, no elastomer, no CWT, no fin clips, and no additional hatchery marks) were considered naturally produced. Estimates also include steelhead collected for broodstock.

Spawn year	Origin	Steelhead Migration Time (week)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
1999	Wild	27	32	47	35	81	12	16	17	15	29
	Hatchery	25	31	47	34	47	12	16	18	15	27
2000	Wild	31	36	41	36	238	11	14	18	14	40
	Hatchery	31	34	41	36	194	12	14	16	14	69
2001	Wild	29	34	41	35	391	13	15	17	15	84
	Hatchery	30	38	41	36	227	12	16	17	15	156
2002	Wild	29	39	46	38	810	13	14	17	14	181
	Hatchery	35	42	46	41	610	12	15	18	15	124
2003	Wild	30	33	40	35	731	3	9	16	9	193
	Hatchery	30	35	51	37	372	3	9	15	9	538
2004	Wild	30	40	45	39	644	13	16	18	16	222
	Hatchery	29	40	44	38	677	11	17	19	16	361
2005	Wild	30	39	43	38	986	10	15	17	15	206
	Hatchery	27	38	42	36	1,112	12	16	18	15	377
2006	Wild	29	40	43	39	428	12	15	17	15	191
	Hatchery	29	41	43	39	334	4	13	16	12	181
2007	Wild	30	36	41	35	277	11	17	17	15	108
	Hatchery	29	38	43	36	90	11	17	18	16	214
2008	Wild	30	38	43	38	397	13	15	18	16	123
	Hatchery	33	41	45	40	554	14	18	19	17	311
2009	Wild	30	37	46	37	338	13	15	19	15	87
	Hatchery	29	35	46	36	1,133	13	16	19	16	229
2010	Wild	31	37	45	38	648	11	15	18	15	171
	Hatchery	31	40	45	40	1,207	12	16	19	16	309
2011	Wild	29	36	44	36	797	13	17	19	17	118
	Hatchery	31	39	45	39	991	15	18	19	18	240
2012	Wild	31	34	41	35	642	15	20	20	17	83
	Hatchery	32	39	43	38	715	15	19	19	17	223
2013	Wild	31	36	43	37	755	13	16	18	15	55
	Hatchery	31	42	45	40	1,431	16	17	18	16	210
2014	Wild	29	35	41	35	549	14	18	19	17	57

Spawn year	Origin	Steelhead Migration Time (week)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
	Hatchery	32	40	42	38	511	15	17	19	17	78
2015	Wild	29	38	43	37	714	11	14	17	14	48
	Hatchery	32	39	43	39	928	12	16	17	15	57
2016	Wild	34	41	45	39	610	13	16	19	16	58
	Hatchery	36	41	44	40	692	12	16	19	15	56
2017	Wild	28	39	43	36	300	16	17	19	17	15
	Hatchery	29	42	44	39	233	16	17	18	17	20
2018	Wild	31	39	43	38	173	6	14	17	13	109
	Hatchery	35	43	44	41	206	6	14	17	13	113
Average	***Wild***	***30***	***37***	***43***	***37***	***525***	***12***	***15***	***18***	***15***	***109***
	Hatchery	***31***	***39***	***44***	***38***	***613***	***12***	***16***	***18***	***15***	***195***
Median	***Wild***	***30***	***37***	***43***	***37***	***580***	***13***	***15***	***18***	***15***	***98***
	Hatchery	***31***	***40***	***44***	***39***	***582***	***12***	***16***	***18***	***16***	***196***

Table 3.29b. The month that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during their summer-autumn migration (June through December) and during their winter-spring migration (January through May), 1999-2018. The average month is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. Unknown-origin fish (i.e., undetermined by scale analysis, no elastomer, no CWT, no fin clips, and no additional hatchery marks) were considered naturally produced. Estimates also include steelhead collected for broodstock.

Spawn year	Origin	Steelhead Migration Time (month)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
1999	Wild	7	8	11	8	81	3	4	4	4	29
	Hatchery	6	8	11	8	47	3	4	4	4	27
2000	Wild	8	9	10	9	238	3	4	5	4	40
	Hatchery	8	8	10	9	194	3	4	4	4	69
2001	Wild	7	8	10	8	391	3	4	4	4	84
	Hatchery	7	9	10	9	227	3	4	4	4	156
2002	Wild	7	9	11	9	810	3	4	4	4	181
	Hatchery	9	10	11	10	610	3	4	5	4	124
2003	Wild	7	8	10	8	731	1	3	4	3	193
	Hatchery	7	8	12	9	372	1	3	4	2	538
2004	Wild	7	10	11	9	644	3	4	4	4	222
	Hatchery	7	10	10	9	677	3	4	5	4	361
2005	Wild	7	9	10	9	986	3	4	4	4	206
	Hatchery	7	9	10	9	1,112	3	4	5	4	377

Spawn year	Origin	Steelhead Migration Time (month)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
2006	Wild	7	10	10	10	428	3	4	4	4	191
	Hatchery	7	10	10	9	334	1	3	4	3	181
2007	Wild	7	9	10	9	277	3	4	4	4	108
	Hatchery	7	9	10	9	90	3	4	5	4	214
2008	Wild	7	9	10	9	397	3	4	5	4	123
	Hatchery	8	10	11	10	554	4	4	5	4	311
2009	Wild	7	9	11	9	338	3	4	5	4	87
	Hatchery	7	8	11	9	1,133	3	4	5	4	229
2010	Wild	8	9	11	9	648	3	4	5	4	171
	Hatchery	8	10	11	10	1,207	3	4	5	4	309
2011	Wild	7	9	11	9	797	4	4	5	4	118
	Hatchery	8	9	11	9	991	4	5	5	5	240
2012	Wild	8	8	10	9	642	4	4	5	4	83
	Hatchery	8	9	10	9	715	4	4	5	4	223
2013	Wild	8	9	10	9	755	4	4	5	4	55
	Hatchery	8	10	11	10	1,431	4	4	5	4	210
2014	Wild	7	9	10	9	549	4	4	5	4	57
	Hatchery	8	10	10	9	511	4	4	5	4	78
2015	Wild	7	9	10	9	714	3	4	4	4	48
	Hatchery	8	9	10	9	928	3	4	4	4	57
2016	Wild	8	10	11	9	610	3	4	5	4	58
	Hatchery	9	10	10	10	692	3	4	5	4	56
2017	Wild	7	9	10	9	300	4	4	5	4	15
	Hatchery	7	10	11	9	233	4	4	5	4	20
2018	Wild	8	9	10	9	173	2	4	4	3	109
	Hatchery	8	10	11	10	206	2	4	4	3	113
Average	***Wild***	***7***	***9***	***10***	***9***	***525***	***3***	***4***	***5***	***4***	***109***
	Hatchery	***8***	***9***	***11***	***9***	***613***	***3***	***4***	***5***	***4***	***195***
Median	***Wild***	***7***	***9***	***10***	***9***	***580***	***3***	***4***	***5***	***4***	***98***
	Hatchery	***8***	***10***	***11***	***9***	***582***	***3***	***4***	***5***	***4***	***196***

Age at Maturity

Nearly all steelhead broodstock collected at Tumwater and Dryden dams lived in saltwater 1 to 2 years (saltwater age) (Table 3.30). Very few saltwater age-3 fish returned and those that did were typically wild fish. On average, there was a difference between the saltwater age at return of wild and hatchery fish. A greater proportion of hatchery fish returned as saltwater age-1 fish than did wild fish. In contrast, a greater number of wild fish returned as saltwater-2 fish than did hatchery fish (Figure 3.9). For the 2018 brood year, fewer saltwater age-2 fish were observed with proportionally more saltwater age-1 and no saltwater age-3 fish present for both wild and hatchery steelhead.

Table 3.30. Proportions of wild and hatchery steelhead broodstock of different ages collected at Tumwater and Dryden dams, brood years 1998-2018. Age represents the number of years the fish lived in saltwater.

Brood year	Origin	Saltwater age			Sample size
		1	2	3	
1998	Wild	0.39	0.61	0.00	35
	Hatchery	0.21	0.79	0.00	43
1999	Wild	0.50	0.48	0.02	58
	Hatchery	0.82	0.18	0.00	67
2000	Wild	0.56	0.44	0.00	39
	Hatchery	0.68	0.32	0.00	101
2001	Wild	0.52	0.48	0.00	64
	Hatchery	0.15	0.85	0.00	114
2002	Wild	0.56	0.44	0.00	99
	Hatchery	0.95	0.05	0.00	113
2003	Wild	0.13	0.85	0.02	63
	Hatchery	0.29	0.71	0.00	92
2004	Wild	0.95	0.05	0.00	85
	Hatchery	0.95	0.05	0.00	132
2005	Wild	0.22	0.78	0.00	95
	Hatchery	0.21	0.79	0.00	114
2006	Wild	0.29	0.71	0.00	101
	Hatchery	0.60	0.40	0.00	98
2007	Wild	0.40	0.59	0.00	79
	Hatchery	0.62	0.38	0.00	97
2008	Wild	0.65	0.34	0.01	104
	Hatchery	0.89	0.11	0.00	107
2009	Wild	0.40	0.58	0.20	83
	Hatchery	0.23	0.77	0.0	77
2010	Wild	0.65	0.34	0.01	92
	Hatchery	0.77	0.23	0.00	98
2011	Wild	0.28	0.73	0.00	102
	Hatchery	0.36	0.64	0.00	100
2012	Wild	0.42	0.53	0.05	59
	Hatchery	0.41	0.59	0.00	66
2013	Wild	0.41	0.57	0.02	54
	Hatchery	0.46	0.55	0.00	77
2014	Wild	0.48	0.51	0.02	61

Brood year	Origin	Saltwater age			Sample size
		1	2	3	
	Hatchery	0.29	0.71	0.00	68
2015	Wild	0.16	0.83	0.02	63
	Hatchery	0.47	0.53	0.00	55
2016	Wild	0.34	0.66	0.00	65
	Hatchery	0.42	0.58	0.00	66
2017	Wild	0.11	0.84	0.05	57
	Hatchery	0.10	0.88	0.02	68
2018	Wild	0.73	0.27	0.0	73
	Hatchery	0.99	0.01	0.0	85
Average	***Wild***	***0.44***	***0.54***	***0.02***	***74***
	Hatchery	***0.55***	***0.45***	***0.00***	***88***
Median	***Wild***	***0.45***	***0.55***	***0.00***	***65***
	Hatchery	***0.48***	***0.52***	***0.00***	***92***

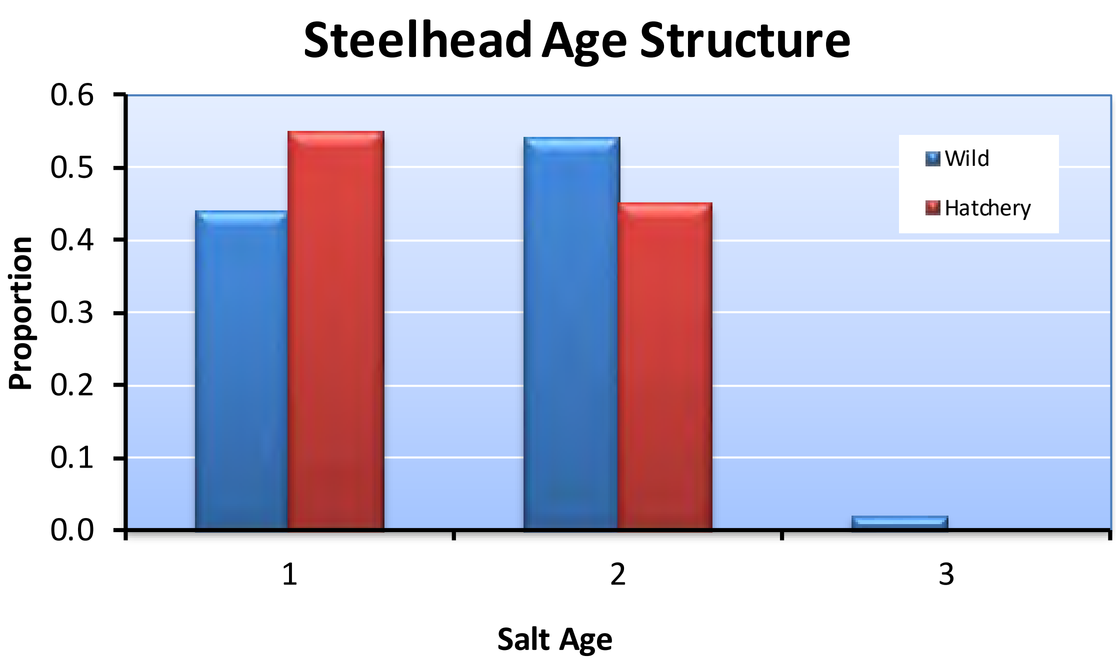


Figure 3.9. Proportions of wild and hatchery steelhead of different saltwater ages sampled at Tumwater Dam for the combined years 1998-2018.

Size at Maturity

On average, hatchery steelhead collected at Tumwater and Dryden dams were about 2 to 3 cm smaller than wild steelhead for 1- and 2-salt fish. However, hatchery 3-salt steelhead were larger than wild 3-salt steelhead; although, sample sizes are very small (Table 3.31).

Table 3.31. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, brood years 1998-2018; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1998	Wild	63	15	4	79	20	5	-	0	-
	Hatchery	61	9	4	73	34	4	-	0	-
1999	Wild	65	29	5	74	28	5	77	1	-
	Hatchery	62	54	4	73	12	4	-	0	-
2000	Wild	64	22	3	74	17	5	-	0	-
	Hatchery	60	57	3	71	27	4	-	0	-
2001	Wild	61	33	6	77	31	5	-	0	-
	Hatchery	62	17	4	72	97	4	-	0	-
2002	Wild	64	55	4	77	44	4	-	0	-
	Hatchery	63	106	4	73	6	4	-	0	-
2003	Wild	69	8	6	77	52	5	91	1	-
	Hatchery	66	27	4	75	65	4	-	0	-
2004	Wild	63	73	6	78	4	2	-	0	-
	Hatchery	61	59	3	73	3	1	-	0	-
2005	Wild	59	21	4	74	74	5	-	0	-
	Hatchery	59	23	4	72	89	4	-	0	-
2006	Wild	63	27	5	75	67	6	-	0	-
	Hatchery	61	41	4	72	27	5	-	0	-
2007	Wild	64	31	6	76	46	5	-	0	-
	Hatchery	60	60	4	71	36	5	-	0	-
2008	Wild	64	68	4	77	35	4	80	2	-
	Hatchery	60	95	4	72	12	2	-	0	-
2009	Wild	65	33	5	76	48	6	81	2	0
	Hatchery	63	18	4	75	59	5	-	0	-
2010	Wild	64	60	5	74	31	5	76	1	-
	Hatchery	61	53	5	73	23	5	-	0	-
2011	Wild	62	28	5	76	74	5	-	0	-
	Hatchery	60	36	4	74	64	4	-	0	-
2012	Wild	63	25	3	74	31	5	74	3	2
	Hatchery	59	27	3	74	39	4	-	0	-
2013	Wild	61	22	5	77	31	5	74	1	-
	Hatchery	60	35	3	74	42	4	-	0	-
2014	Wild	61	29	4	75	31	4	61	1	-
	Hatchery	60	20	3	72	48	4	-	0	-
2015	Wild	61	10	3	77	52	4	85	1	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	59	26	3	76	29	5	-	0	-
2016	Wild	63	22	4	74	43	4	-	0	-
	Hatchery	61	28	4	71	38	5	-	0	-
2017	Wild	62	6	3	78	48	5	73	3	4
	Hatchery	60	7	2	75	60	5	93	1	-
2018	Wild	64	54	3	75	18	5	-	0	-
	Hatchery	62	84	3	65	1	-	-	0	-
Average	***Wild***	***63***	***32***	***4***	***76***	***39***	***5***	***77***	***1***	***2***
	Hatchery	***61***	***42***	***4***	***73***	***39***	***4***	***93***	***0***	***-***
Median	***Wild***	***63***	***28***	***4***	***76***	***35***	***5***	***77***	***0***	***2***
	Hatchery	***61***	***35***	***4***	***73***	***36***	***4***	***93***	***0***	***-***

Contribution to Fisheries

Nearly all harvest on Wenatchee steelhead occurs within the Columbia basin. Harvest rates on steelhead in the Lower Columbia River fisheries (both tribal and non-tribal) are generally less than 5-10% (NMFS 2004). A sport fishery may be opened on Upper Columbia River steelhead when the natural-origin steelhead run is predicted to exceed 1,300 fish at Priest Rapids Dam and the total Upper Columbia River steelhead run is predicted to exceed 9,550 steelhead. To minimize effects on natural-origin steelhead in the tributary fisheries, a three-tiered system as outlined in Permit 1395 is used to determine maximum allowable natural-origin steelhead take during the fishery (Table 3.32).

Table 3.32. Three-tiered system for determining natural-origin effects during the recreational fishery on steelhead in tributaries upstream from Rock Island Dam.

Tier	Wenatchee		Methow		Okanogan	
	NOR[1]	Effect[2]	NOR[1]	Effect[2]	NOR[1]	Effect[2]
No Fishery	≤ 599	0%	≤ 499	0%	≤ 119	0%
Tier 1	600	2%	500	2%	120	5%
Tier 2	1700	4%	1600	4%	120	7%
Tier 3	2500	6%	2500	6%	600	10%

[1] Estimated natural-origin escapement to tributaries.
[2] Maximum allowable take on natural-origin fish.

No selective recreational steelhead fishery was implemented in the upper Columbia River during fall 2016 through winter 2018 (Table 3.33). Over the eight years that the Wenatchee River had a recreational fishery, average harvest has been about 183 hatchery steelhead and 16 wild steelhead hook-and-release mortalities. In the mixed population fishery within the mainstem Columbia from Priest Rapids Dam to Chief Joseph Dam, the average harvest of hatchery steelhead has been 861steelhead with 17 wild hook-and-release mortalities.

Table 3.33. Harvest and mortality estimates for Upper Columbia steelhead in the Wenatchee and mainstem Columbia River (Priest Rapids Dam to Chief Joseph Dam). Estimated steelhead sport harvest on Wenatchee hatchery steelhead and hook-and-release mortality on wild steelhead (WDFW 2016). The wild steelhead mortality estimate is based on a hook-and-release mortality rate of 5%. Mainstem harvest from Priest Rapids Dam to Chief Joseph Dam is a mixed-population steelhead fishery that may contain fish from the Wenatchee, Entiat, Methow, and Okanogan rivers.

Year	Priest Rapids Escapement			Wenatchee			Mainstem Columbia		
	H	W	Total	H	W	Total	H	W	Total
2006-2007	8,738	1,677	10,415	-	-	-	694	3	697
2007-2008	12,160	3,097	15,257	444	15	459	1,137	13	1,150
2008-2009	13,528	3,030	16,558	-	-	-	921	10	931
2009-2010	32,557	7,439	39,996	251	17	268	1,448	29	1,477
2010-2011	18,792	7,639	26,431	106	12	118	1,412	40	1,452
2011-2012	15,910	4,896	20,806	250	19	269	855	22	877
2012-2013	13,908	3,284	17,192	125	26	151	722	20	744
2013-2014	10,415	4,657	15,072	135	17	152	506	9	515
2014-2015	13,836	5,930	19,766	99	14	113	99	14	113
2015-2016	9,955	4,348	14,303	56	8	64	678	13	690
2016-2017	4,991	1,516	6,507	-	-	-	-	-	-
2017-2018	2,642	1,701	4,343	-	-	-	-	-	-
Average	***13,119***	***4,101***	***17,221***	***183***	***16***	***199***	***861***	***17***	***865***
Median	***12,844***	***3,816***	***15,908***	***130***	***16***	***152***	***855***	***13***	***811***

Origin on Spawning Grounds

With the implementation of PIT-tag mark-recapture techniques in 2014, we can estimate the contribution of natural-origin and hatchery-origin fish on the spawning grounds (Table 3.34). Based on mark-recapture estimates, naturally produced steelhead made up about 66.5% of the escapement in 2018. Importantly, the abundance of hatchery fish in the upper Wenatchee Basin is regulated through surplusing (removal) at Tumwater Dam. However, because of low steelhead returns in 2018, no surplusing of hatchery steelhead occurred in 2018.

Table 3.34. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within the Wenatchee River, brood years 2014-2018; NS = not sampled. Escapement estimates were based on PIT-tag mark-recapture techniques (see Appendix E).

Year	Origin	Survey stream										Total
		Mission	Peshastin	Chumstick	Icicle	Chiwaukum	Chiwawa	Nason	L Wen	White	Wenatchee	
2014	Natural	94	226	78	76	37	142	190	NS	NS	340	***978***
	Hatchery	31	6	7	45	9	103	148	NS	NS	251	***545***
2015	Natural	71	206	38	83	48	168	237	NS	NS	252	***1,103***
	Hatchery	23	40	0	52	12	168	68	NS	NS	298	***661***
2016	Natural	33	151	74	72	64	45	57	NS	NS	118	***614***
	Hatchery	13	0	39	18	11	134	94	NS	NS	91	***400***
2017	Natural	20	37	12	11	0	12	24	NS	NS	116	***232***
	Hatchery	12	0	0	21	0	34	26	NS	NS	138	***231***
2018	Natural	54	80	16	49	20	25	32	6	0	34	***316***

Year	Origin	Survey stream										Total
		Mission	Peshastin	Chumstick	Icicle	Chiwaukum	Chiwawa	Nason	L Wen	White	Wenatchee	
	Hatchery	0	0	8	24	20	31	37	0	8	31	*159*

Straying

Stray rates of Wenatchee steelhead can be estimated by examining the locations where PIT-tagged hatchery steelhead were last detected. PIT tagging of steelhead began with brood year 2005, which allows estimation of stray rates by return year and brood return. These data only provide estimates for brood years 2005 through 2013, because later brood years are still rearing in the ocean. The most recent completed brood year is 2013. Targets for strays based on return year (recovery year) outside the Wenatchee River basin should be less than 5%.

Based on return year and PIT-tag analysis, hatchery-origin Wenatchee steelhead have strayed into the Entiat, Methow, and Okanogan basins[10] (Table 3.35). Before 2014, hatchery-origin Wenatchee steelhead generally made up more than 5% of the escapement in the Entiat and Methow rivers. Since then, they have made up less than 5% of the escapement in those basins. (Table 3.35). Few have strayed into the Okanogan River.

Table 3.35. Number and percent of PIT-based run escapements within non-target basins that consisted of hatchery-origin Wenatchee steelhead, spawn years 2011-2017. For example, for spawn year 2014, 1.9% of the steelhead escapement in the Entiat River basin consisted of hatchery-origin Wenatchee steelhead. Percent strays should be less than 5%.

Return year	Entiat River		Methow River		Okanogan River	
	Number	Percent	Number	Percent	Number	Percent
2011	94	11.0	238	6.2	0	0.0
2012	161	26.1	108	3.9	0	0.0
2013	49	13.3	151	5.8	10	1.1
2014	9	1.9	109	3.7	0	0.0
2015	17	2.7	11	0.3	0	0.0
2016	0	0.0	70	2.5	0	0.0
2017	0	0.0	0	0.0	15	0.0
Average	***47***	***7.9***	***98***	***3.2***	***4***	***0.2***
Median	***17***	***2.7***	***108***	***3.7***	***0***	***0.0***

* Run escapement estimated at Wells Dam.

Based on brood year and PIT-tag analyses, about 9% of brood year 2013 was last detected in streams outside of the Wenatchee River basin. Beginning with brood year 2011, steelhead have been overwinter-acclimated at the Chiwawa Acclimation Facility. This may be the reason for the observed reduction in stray rates since 2011. On average, for brood years 2011 through 2013, about 5% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River basin (Table 3.36). Steelhead have been detected in the Entiat and Methow rivers as well as in the Deschutes and Tucannon rivers. Several were last detected at Wells Dam. The numbers in Table

[10] Number of strays to each basin were expanded by tag rate and detection efficiency of individual interrogation arrays where steelhead were last detected.

3.36 should be considered rough estimates because they are not based on confirmed spawning (only last detections).

Table 3.36. Number and percent of hatchery-origin Wenatchee steelhead that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2005-2013. Estimates were based on last detections of PIT-tagged hatchery steelhead.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	76	73.0	1	1.0	27	26.0	0	0.0
2006	818	60.4	3	2.4	504	37.2	0	0.0
2007	2,829	67.4	2	0.5	1,349	32.1	0	0.0
2008	1,389	88.1	2	1.4	165	10.5	0	0.0
2009	2,585	86.8	2	0.7	371	12.5	0	0.0
2010	712	78.8	1	1.0	182	20.2	0	0.0
2011	948	89.6	13	8.4	21	2.0	0	0.0
2012	1,573	90.6	9	5.1	75	4.3	0	0.0
2013	498	88.3	1	2.7	51	9.0	0	0.0
Average	***1,270***	***80.3***	***4***	***2.6***	***305***	***17.1***	***0***	***0.0***
Median	***948***	***86.8***	***2***	***1.4***	***165***	***12.5***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery steelhead that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish are typically collected at Dryden and Tumwater dams.

Genetics

Genetic studies were conducted in 2012 to determine the potential effects of the Wenatchee Supplementation Program on natural-origin summer steelhead in the Wenatchee River basin (Seamons et al. 2012; the entire report is appended as Appendix F). Temporal collections were obtained from hatchery and natural-origin adult summer steelhead captured at Dryden and Tumwater dams during summer and fall of 1997 through 2009 (excepting 2004 and 2005). Natural-origin steelhead consisted of a mixed collection representing all the spawning subpopulations located upstream. Therefore, to determine population substructure within the basin, samples were also taken from juvenile steelhead collected at smolt traps located within the Chiwawa River, Nason Creek, and Peshastin Creek, and from the Entiat River. Samples were also taken from juvenile steelhead collected at the smolt trap in the lower Wenatchee River. These, like natural-origin adult collections, consisted of a mixed collection representing all subpopulations located upstream. A total of 1,468 hatchery-origin and natural-origin adults were processed and 1,542 juvenile steelhead from the Wenatchee and Entiat Rivers were processed for genetic variation with 132 genetic (single nucleotide polymorphism loci; SNPs) markers. Peshastin Creek and the Entiat River served as no-hatchery-outplant controls. Genetic data were interrogated for the presence or absence of spatial and temporal trends in allele frequencies, genetic distances, and effective population size.

Allele Frequencies—Changes to the summer steelhead hatchery supplementation program had no detectable effect on genetic diversity of wild populations. On average, hatchery-origin adults had higher minor allele frequencies (MAF) than natural-origin adults, which may simply reflect the mixed ancestry of hatchery adults. Both hatchery and natural-origin adults had MAF similar to juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants. This suggests that the hatchery program has had little effect on allele frequencies since broodstock sources changed in 1998 from mixed-ancestry broodstock collected in the Columbia River to using broodstock collected in the Wenatchee River.

Genetic Distances—As intended, interbreeding of Wenatchee River hatchery and natural-origin adults reduced the genetic differences between Wells Hatchery adults and Wenatchee River natural-origin adults observed in the first few years after changing the broodstock collection protocol. Although there were detectable genetic differences between hatchery and natural-origin adults, the magnitude of that difference declined over time. Hatchery adults were genetically different from natural-origin adults and juveniles based on pair-wise F_{ST} and principal components analysis, most likely because of the smaller effective population size (N_b) in the hatchery population (see below). Pair-wise F_{ST} estimates and genetic distances between hatchery and natural-origin adults collected the same year declined over time suggesting that the interbreeding of hatchery and natural-origin adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year were inconclusive because of limitations in the data.

Effective Population Size—Although the effective population size of the Wenatchee River hatchery steelhead program was consistently small, it does not appear to have caused a reduction in the effective population size of wild populations. On average, estimates of N_b were much lower and varied less for hatchery adults than for natural-origin adults and juveniles. Estimates of N_b for hatchery adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1998. There was no indication that this had any effect on N_b in natural-origin adults and juveniles; N_b estimates for natural-origin adults and juveniles were, on average, higher and varied considerably over the 1998-2010 period and showed no temporal trend.

It is important to note that no new information will be reported on genetics until the next comprehensive report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[11] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the

[11] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004). For the Wenatchee steelhead program, PNI criteria are implemented in accordance with Permit 18583 to achieve a basin-wide, five-year running average of PNI ≥ 0.67. In years when the natural-origin escapement is low (i.e., < 433 fish), the Wenatchee steelhead population will be managed to meet escapement goals rather than PNI.

For brood years 2001-2018, PNI values were less than 0.67 and the five-year running average ranged from 0.49 to 0.56 (Table 3.37), suggesting that the hatchery environment has a greater influence on adaptation of Wenatchee steelhead than does the natural environment. Because of low escapement, the Wenatchee steelhead population was managed to meet escapement goals rather than PNI in one (brood year 2017) out of five brood years.

Table 3.37. Proportionate Natural Influence (PNI) values for the Wenatchee steelhead supplementation program for brood years 2001-2018. NOS = number of natural-origin steelhead on the spawning grounds; HOS = number of hatchery-origin steelhead on the spawning grounds; NOB = number of natural-origin steelhead collected for broodstock; and HOB = number of hatchery-origin steelhead included in hatchery broodstock.

Brood year	Spawners[a]			Broodstock			PNI[b]	PNI (5-yr mean)
	NOS	HOS	pHOS	NOB	HOB	pNOB		
2001	158	127	0.45	51	103	0.33	0.45	--
2002	731	542	0.43	96	64	0.60	0.59	--
2003	355	350	0.50	49	90	0.35	0.43	--
2004	371	445	0.55	75	61	0.55	0.51	--
2005	690	862	0.56	87	104	0.46	0.47	0.49
2006	253	210	0.45	93	69	0.57	0.57	0.51
2007	145	115	0.44	76	58	0.57	0.58	0.51
2008	168	279	0.62	77	54	0.59	0.50	0.53
2009	171	545	0.76	86	73	0.54	0.43	0.51
2010	524	970	0.65	96	75	0.56	0.48	0.51
2011	351	472	0.57	91	70	0.57	0.51	0.50
2012	381	209	0.35	59	65	0.48	0.59	0.50
2013	322	148	0.31	49	68	0.42	0.59	0.52
2014	476	363	0.46	64	68	0.48	0.54	0.54
2015	639	484	0.43	58	52	0.53	0.57	0.56
2016	280	324	0.54	66	66	0.50	0.50	0.56
2017	138	189	0.58	53	66	0.45	0.45	0.53
2018	316	158	0.33	70	75	0.48	0.61	0.54
Average	***359***	***377***	***0.50***	***72***	***71***	***0.50***	***0.52***	***0.52***
Median	***337***	***337***	***0.48***	***72.5***	***68***	***0.52***	***0.51***	***0.52***

[a] The presence of eroded fins or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater Dam. Unknown-origin fish (i.e., undetermined by scale analysis, no elastomer, no CWT, no fin clips, and no additional hatchery marks) were considered naturally produced. Therefore, because not all hatchery fish have eroded fins or missing adipose fins, it is likely we are underestimating WxW-cross hatchery steelhead returns based on video monitoring. The PNI estimates are appropriate for steelhead spawning upstream from Tumwater Dam but may not represent PNI for steelhead spawning downstream from Tumwater Dam. Dam.

[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery steelhead from release sites (e.g., Chiwawa River, Nason Creek, and Wenatchee River) to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 3.38).[12] Over the 14 brood years for which PIT-tagged hatchery fish are available, survival rates from the release sites to McNary Dam ranged from 0.055 to 0.785 (note that survival rates of 0.000 were associated with very small sample sizes); SARs from release to detection at Bonneville Dam ranged from 0.000 to 0.038. Average travel time from the release sites to McNary Dam ranged from 10 to 100 days.

All PIT-tagged fish were released on the same day and in the same location (Chiwawa River) in release year 2018. Fish overwinter acclimated in circular vessels that were WxW origin had higher survival and shorter travel times than both WxW and HxH origin fish reared in the raceway. Travel times and survival to McNary Dam were similar for WxW and HxH fish overwinter acclimated in the raceway.

Table 3.38. Total number of Wenatchee hatchery summer steelhead released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2017. SARs were estimated to Bonneville Dam. Standard errors are shown in parentheses. NA = not available (i.e., for SARs, not all the adults from the release groups have returned to the Columbia River).

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2003	Chiwawa	HxW	NA	Turtle Rock	29,801	0.755 (0.029)	18.2 (16.7)	0.003 (0.000)
	Nason	WxW	NA	Turtle Rock	34,823	0.648 (0.026)	19.3 (19.6)	0.004 (0.000)
	Wenatchee	HxH	NA	Turtle Rock	30,018	0.767 (0.030)	18.1 (20.6)	0.003 (0.000)
2004	Chiwawa	HxW	NA	Turtle Rock	2,439	0.480 (0.037)	26.9 (59.5)	0.011 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	853	0.485 (0.054)	21.1 (8.8)	0.008 (0.003)
	Nason	WxW	NA	Turtle Rock	8,826	0.412 (0.017)	26.7 (56.1)	0.010 (0.001)
	Wenatchee	HxH	NA	Turtle Rock	9,705	0.621 (0.022)	15.8 (6.3)	0.033 (0.002)
	Wenatchee	HxW	NA	Turtle Rock	7,379	0.606 (0.029)	19.3 (7.4)	0.013 (0.001)
2005	Chiwawa	HxW	NA	Turtle Rock	3,448	0.540 (0.065)	22.6 (27.2)	0.017 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	717	0.521 (0.128)	22.2 (8.0)	0.013 (0.004)
	Nason	WxW	NA	Turtle Rock	7,306	0.416 (0.031)	21.3 (9.2)	0.009 (0.001)
	Wenatchee	HxH	NA	Turtle Rock	8,610	0.656 (0.057)	20.1 (35.8)	0.017 (0.001)
	Wenatchee	HxW	NA	Turtle Rock	5,021	0.649 (0.074)	20.2 (9.0)	0.014 (0.002)
2006	NA	NA	NA	NA	NA	NA	NA	NA

[12] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2007	Chiwawa	HxW	NA	Turtle Rock	2,882	0.520 (0.057)	22.3 (7.9)	0.020 (0.003)
	Chiwawa	WxW	NA	Turtle Rock	785	0.467 (0.069)	18.7 (9.0)	0.038 (0.007)
	Nason	WxW	NA	Turtle Rock	8,060	0.505 (0.030)	22.3 (24.1)	0.030 (0.002)
	Wenatchee	HxW	NA	Turtle Rock	9,047	0.631 (0.041)	18.2 (17.2)	0.038 (0.002)
2008	Chiwawa	HxW L	NA	Turtle Rock	2,008	0.574 (0.080)	20.3 (7.0)	0.006 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	1,457	0.546 (0.090)	31.6 (108.5)	0.010 (0.003)
	Nason	WxW	NA	Turtle Rock	7,951	0.500 (0.037)	21.4 (17.5)	0.014 (0.001)
	Wenatchee	HxW E	NA	Turtle Rock	4,517	0.511 (0.044)	19.5 (7.7)	0.008 (0.001)
	Wenatchee	HxW L	NA	Turtle Rock	6,710	0.545 (0.038)	19.3 (6.8)	0.010 (0.001)
2009	Chiwawa	HxW E	Forced	Turtle Rock	4,874	0.576 (0.076)	24.3 (8.3)	0.012 (0.002)
	Chiwawa	HxW E	Volitional	Chiw. Circ	8,653	0.785 (0.100)	19.4 (26.0)	0.007 (0.001)
	Nason	WxW	Forced	Turtle Rock	8,918	0.504 (0.042)	27.2 (26.6)	0.017 (0.001)
	Wenatchee	HxW E	Forced	Turtle Rock	11,300	0.543 (0.041)	25.8 (54.8)	0.014 (0.001)
	Wenatchee	HxW E	Forced	Turtle Rock	6,681	0.597 (0.063)	28.9 (72.2)	0.013 (0.001)
	Wenatchee	HxW L	Forced	Turtle Rock	4,619	0.478 (0.052)	21.7 (7.6)	0.015 (0.002)
	Wenatchee	HxW E	Volitional	Blackbird	2,184	0.317 (0.054)	NA	0.010 (0.002)
	Wenatchee	WxW	Volitional	Rohlfing	566	0.443 (0.187)	NA	0.014 (0.005)
2010	Chiwawa	WxW	Forced	Turtle Rock	4,226	0.586 (0.057)	24.4 (60.1)	0.009 (0.001)
	Nason	WxW	Forced	Turtle Rock	5,256	0.548 (0.044)	23.5 (53.3)	0.010 (0.001)
	Wenatchee	HxH	Forced	Turtle Rock	8,506	0.583 (0.053)	30.2 (50.1)	0.004 (0.001)
	Wenatchee	HxH	Volitional	Blackbird	9,858	0.629 (0.046)	NA	0.006 (0.001)
	Wenatchee	HxH	Volitional	Chiw. Circ	10,031	0.413 (0.043)	21.6 (66.1)	0.001 (0.000)
2011	Chiwawa	WxW	Volitional	RCY	3,603	0.403 (0.056)	15.1 (8.3)	0.005 (0.001)
	Nason	WxW	Volitional	RCY	4,065	0.330 (0.042)	20.9 (60.9)	0.005 (0.001)
	Wenatchee	WxW	Non-movers	Circular	1,122	0.341 (0.220)	40.6 (89.1)	0.000 (--)
	Wenatchee	WxW	Non-movers	RCY	2,395	0.312 (0.071)	22.7 (57.0)	0.004 (0.001)
	Wenatchee	WxW	Volitional	Blackbird	2,099	0.378 (0.067)	48.2 (90.0)	0.010 (0.002)
	Wenatchee	WxW	Volitional	Circular	7,206	0.275 (0.042)	31.6 (74.3)	0.006 (0.001)
	Wenatchee	WxW	Volitional	RCY	4,422	0.323 (0.032)	15.2 (25.6)	0.008 (0.001)
	All	WxW	NA	Circular	1,628	0.055 (0.016)	100.4 (151.7)	0.002 (0.001)
	All	WxW	NA	RCY	3,479	0.229 (0.031)	13.6 (8.4)	0.004 (0.001)
2012	Chiwawa	HxH	Volitional	RCY	2,891	0.397 (0.055)	15.2 (7.2)	0.010 (0.002)
	Nason	WxW	Forced	Circular	4,271	0.376 (0.064)	25.0 (33.1)	0.007 (0.001)

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	Nason	WxW	Volitional	Circular	5,404	0.364 (0.048)	24.9 (31.6)	0.007 (0.001)
	L Wenatchee	HxH	Forced	RCY	587	0.146 (0.086)	52.2 (114.7)	0.000 (--)
	U Wenatchee	HxH	Volitional	RCY	2,224	0.573 (0.138)	18.7 (8.4)	0.010 (0.002)
	U Wenatchee	HxH	Forced	RCY	1,969	0.603 (0.140)	24.7 (42.5)	0.012 (0.002)
	Wenatchee	HxH	Volitional	Blackbird	1,658	0.400 (0.095)	50.0 (7.6)	0.004 (0.002)
	All	HxH	NA	RCY	769	0.293 (0.146)	97.3 (286.2)	0.004 (0.002)
	All	WxW	NA	Circular	5,397	0.327 (0.049)	25.4 (45.0)	0.007 (0.001)
2013	Chiwawa	Mixed	Volitional	RCY	1,567	0.356 (0.064)	15.2 (7.0)	0.010 (0.002)
	Nason	Mixed	Volitional	RCY	3,796	0.448 (0.115)	20.2 (9.4)	0.005 (0.001)
	Nason	Mixed	Volitional	Circ or RCY	308	0.146 (0.053)	17.4 (2.9)	0.003 (0.003)
	Nason	WxW	Non-movers	Circular	74	-- (-)	-- (-)	0.014 (0.013)
	Nason	WxW	Volitional	Circular	1,286	0.190 (0.062)	18.4 (6.4)	0.005 (0.002)
	L Wenatchee	Mixed	Non-movers	RCY	3,275	0.317 (0.131)	35.3 (69.5)	0.001 (0.001)
	U Wenatchee	Mixed	Volitional	RCY	2,862	0.455 (0.080)	16.3 (9.7)	0.008 (0.002)
	Wenatchee	HxH	Volitional	Blackbird	819	0.337 (0.128)	33.5 (11.9)	0.002 (0.002)
	All	HxH	NA	RCY	907	-- (-)	36.7 (17.6)	0.000 (-)
	All	WxW	NA	Circ or RCY	232	-- (--)	38.0 (--)	0.004 (0.004)
2014	Chiwawa	Mixed	Movers	RCY	793	0.754 (0.497)	27.7 (7.6)	NA
	Chiwawa	Mixed	Non-screen	RCY	915	0.367 (0.236)	25.0 (8.1)	NA
	Nason	Mixed	Movers	RCY	1,553	0.216 (0.084)	28.4 (29.4)	NA
	Nason	Mixed	Non-screen	RCY	1,653	0.076 (0.018)	24.2 (7.1)	NA
	Nason	WxW	Movers	Circular	949	0.244 (0.104)	47.4 (91.0)	NA
	Nason	WxW	Non-screen	Circular	873	0.369 (0.190)	20.8 (6.9)	NA
	L Wenatchee	Mixed	Non-movers	RCY	2,596	0.139 (0.026)	26.4 (59.5)	NA
	U Wenatchee	Mixed	Movers	RCY	2,042	0.278 (0.051)	21.9 (8.2)	NA
	U Wenatchee	Mixed	Non-screen	RCY	1,563	0.126 (0.026)	28.7 (8.2)	NA
	U Wenatchee	WxW	Movers	Circular	356	0.278 (0.165)	17.0 (6.5)	NA
	U Wenatchee	WxW	Non-movers	Circular	596	0.381 (0.192)	15.8 (6.8)	NA
	U Wenatchee	WxW	Non-screen	Circular	1,230	0.349 (0.104)	25.8 (57.4)	NA
	Wenatchee	HxH	Volitional	Blackbird	1,814	0.225 (0.055)	31.0 (9.8)	NA
	All	Mixed	NA	Circ or RCY	1,884	0.113 (0.030)	41.7 (61.8)	NA
2015	Chiwawa	Mixed	Movers	RCY	4,365	0.423 (0.040)	13.6 (5.7)	NA
	Nason	Mixed	Mixed	RCY	675	0.173 (0.037)	30.5 (61.8)	NA

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	Nason	Mixed	Movers	RCY	2,427	0.335 (0.054)	23.8 (61.0)	NA
	Nason	Mixed	Non-movers	RCY	2,123	0.278 (0.057)	20.0 (7.6)	NA
	Nason	WxW	Movers	Circular	1,105	0.416 (0.083)	15.5 (5.3)	NA
	Nason	WxW	Non-movers	Circular	916	0.408 (0.113)	14.9 (5.1)	NA
	L Wenatchee	Mixed	Non-movers	RCY	1,658	0.252 (0.075)	13.0 (6.5)	NA
	U Wenatchee	Mixed	Movers	RCY	2,773	0.342 (0.032)	16.3 (7.9)	NA
	U Wenatchee	Mixed	Non-movers	RCY	1,435	0.469 (0.094)	19.7 (8.9)	NA
	U Wenatchee	WxW	Movers	Circular	1,061	0.555 (0.079)	13.9 (7.3)	NA
	U Wenatchee	WxW	Non-movers	Circular	849	0.362 (0.065)	12.7 (5.5)	NA
	Wenatchee	HxH	Vlitional	Blackbird	2,337	0.364 (0.039)	42.1 (8.5)	NA
	All	Mixed	NA	Circ or RCY	1,381	0.167 (0.105)	19.4 (10.8)	NA
2016	Chiwawa	Mixed	Movers	RCY	2,254	0.382 (0.093)	16.9 (9.8)	NA
	Nason	Mixed	Mixed	RCY	1,084	0.392 (0.136)	21.8 (9.9)	NA
	Nason	WxW	Movers	Circular	3,436	0.226 (0.044)	21.1 (11.5)	NA
	Nason	WxW	Non-movers	Circular	753	--	90.6 (155.2)	NA
	L Wenatchee	Mixed	Non-movers	RCY	2,134	0.285 (0.114)	45.1 (102.5)	NA
	M Wenatchee	Mixed	Non-movers	RCY	3,452	0.135 (0.030)	54.8 (109.1)	NA
	U Wenatchee	Mixed	Movers	RCY	2,712	0.312 (0.063)	14.8 (6.5)	NA
	Wenatchee	HxH	Volitional	Blackbird	2,512	0.209 (0.055)	25.9 (11.1)	NA
	All	Mixed	NA	Circ or RCY	1,211	0.190 (0.090)	9.7 (7.7)	NA
2017	Chiwawa	HxH	Forced	RCY	10,876	0.207 (0.038)	23.6 (12.8)	NA
	Chiwawa	WxW	Forced	RCY	10,828	0.187 (0.024)	26.0 (14.7)	NA
	Chiwawa	WxW	Forced	Circular	11,036	0.532 (0.082)	18.6 (9.8)	NA

[a] All = Chiwawa River, Nason Creek, and the Wenatchee River.
[b] HxH = hatchery by hatchery cross; WxW = wild by wild cross; Mixed = both HxH and WxW crosses; E = early; and L = late.
[c] Circ = circulars; RCY = raceway.

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). For brood years 1998-2014, NRR for summer steelhead in the Wenatchee River basin averaged 0.64 (range, 0.13-3.10) if harvested fish were included in the estimate (Table 3.39).

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.9 (the calculated target value in Hillman et al. 2017). The target value of 6.9 includes harvest. In nearly all years, HRRs were greater than NRRs (Table 3.39). HRRs exceeded the estimated target value of 6.9 in 12 of the 17 years.

Table 3.39. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR with harvest) for summer steelhead in the Wenatchee River basin, brood years 1998-2014.

Brood year	Broodstock Collected	Spawning Escapement	Harvest included			
			HOR	NOR	HRR	NRR
1998	78	602	148	1,867	1.89	3.10
1999	125	343	1,944	334	15.55	0.97
2000	120	1,030	312	878	2.60	0.85
2001	178	1,655	10,335	1,050	58.06	0.66
2002	162	5,000	1,905	515	11.76	0.13
2003	155	2,598	956	504	6.17	0.27
2004	217	2,949	2,538	728	11.70	0.25
2005	209	3,609	3,106	904	14.86	0.25
2006	199	2,219	1,454	1,007	7.31	0.45
2007	176	880	535	430	3.04	0.49
2008	107	1,835	1,121	714	10.48	0.39
2009	107	1,733	1,024	709	9.57	0.41
2010	105	6,236	3,999	2,237	38.09	0.36
2011	104	3,049	859	2,189	8.26	0.72
2012	129	2,514	1,094	1,420	8.48	0.56
2013	147	1,986	1,050	936	7.14	0.47
2014	159	2,047	899	1,148	5.65	0.56
Average	***146***	***2,370***	***1,958***	***1,034***	***12.98***	***0.64***
Median	***147***	***2,047***	***1,094***	***904***	***8.48***	***0.47***

Smolt-to-Adult Survivals

Smolt-to-adult ratios (SARs) are calculated as the number of returning hatchery adults divided by the number of tagged hatchery smolts released. SARs are generally based on CWT returns. However, prior to brood year 2011, Wenatchee steelhead were not extensively tagged with CWTs. Therefore, elastomer-tagged fish were used to estimate SARs from release to capture at Priest Rapids Dam. With the return of brood year 2011, SARs are based on PIT-tag detections at Bonneville Dam.

SARs (not adjusted for tag loss) for Wenatchee steelhead ranged from 0.0009 to 0.0315 (mean = 0.0093) for brood years 1996-2010 (Table 3.40). For brood years 2011 to present, SARs (to Bonneville Dam) averaged 0.0039 (Table 3.40).

Table 3.40. Smolt-to-adult ratios (SARs) for Wenatchee hatchery steelhead. Estimates for brood years 1996-2010 were based on elastomer tags recaptured at Priest Rapids Dam. SARs were not adjusted for tag loss after release. For brood years 2011 to present, SARs are based on PIT-tag detections to Bonneville Dam.

Brood year	Number of tagged smolts released	SAR
1996	348,693	0.0034
1997	429,422	0.0041
1998	172,078	0.0009
1999	175,661	0.0111
2000	184,639	0.0017
2001	335,933	0.0308
2002	302,060	0.0063
2003	374,867	0.0025
2004	294,114	0.0038
2005	452,184	0.0107
2006	258,697	0.0100
2007	306,690	0.0315
2008	327,133	0.0090
2009	484,826	0.0080
2010[a]	192,363	0.0054
Average	***309,291***	***0.0093***
Median	***306,690***	***0.0063***
2011	30,019	0.0057
2012	25,134	0.0055
2013	15,109	0.0042
2014	18,817	0.0001
Average	***22,270***	***0.0039***
Median	***21,976***	***0.0049***

[a] Only 192,363 WxW progeny from brood year 2010 were elastomer tagged; 161,951 HxH steelhead were released.

3.7 ESA/HCP Compliance

Broodstock Collection

Collection of brood year 2017 broodstock for Wenatchee summer steelhead at Dryden and Tumwater dams began on 5 July and ended on 27 October 2016 at Dryden Dam and 28 October 2016 at Tumwater Dam consistent with the collection period identified in the 2016 broodstock collection protocol. The broodstock collection achieved a total collection of 119 steelhead, including 58 natural-origin steelhead.

About 602 steelhead were handled and released at Tumwater and Dryden dams during brood year 2017 Wenatchee steelhead broodstock collection. Most were hatchery-origin fish handled at

Tumwater Dam and all were released back into the river. Fish released at Dryden Dam were released because the weekly quota for hatchery or wild steelhead had been attained, but not for both hatchery and wild fish, or because they were non-target fish (adipose clipped), or they were unidentifiable hatchery-origin steelhead. All steelhead released were allowed to fully recover from the anesthesia and released immediately upstream from the trap sites.

In addition to steelhead encountered at Dryden Dam during steelhead broodstock collection, an estimated 41 spring Chinook salmon were captured and released unharmed immediately upstream from the trap facility. Consistent with ESA Section 10 Permit 18583 impact minimization measures, all ESA species handled were subject to water-to-water transfers.

Hatchery Rearing and Release

The 2017 brood Wenatchee steelhead reared throughout all life stages without significant mortality (defined as >10% population mortality associated with a single event). Higher than expected survival across all life stages resulted in production slightly above the targets (see Section 3.2).

Juvenile rearing occurred at three separate facilities including Eastbank Fish Hatchery, Chelan Fish Hatchery, and the Chiwawa Acclimation Facility. Multiple facilities were used to take advantage of variable water temperatures to manipulate growth of juveniles from different parental crosses. Typically, wild steelhead spawn later than their hatchery cohort and are therefore reared at Chelan Fish Hatchery on warmer water to accelerate their growth, so they achieve a size-at-release similar to HxH parental cross progeny reared on cooler water at Eastbank Fish Hatchery. All parental cross groups received final rearing and over-winter acclimation at the Chiwawa Acclimation Facility on Wenatchee River and Chiwawa River surface water before direct release (scatter planting) in the Wenatchee River basin.

The 2017 brood steelhead smolt release in the Wenatchee River basin totaled 253,994 smolts, representing about 102.7% of the program target of 247,300 smolts identified in the Rocky Reach and Rock Island Dam HCPs and within the maximum 110% allowed in ESA Section 10 Permit 18583. As specified in ESA Section 10 Permit 18583, all steelhead smolts released were externally marked or internally tagged and a representative number were PIT tagged (see Section 3.2).

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank or Chelan hatcheries or the Chiwawa acclimation facility. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 18583, the permit holders are authorized a direct take of up to 20% of the emigrating steelhead population and a lethal take not to exceed 2% of the fish captured (NMFS 2017). Based on the estimated wild steelhead population (smolt trap expansion) and hatchery juvenile steelhead population estimate (hatchery release data) for the Wenatchee River basin, the reported steelhead encounters during the 2018 emigration complied with take provisions in the Section 10 permit and are detailed in Table 3.41. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 18583 Section B.

Table 3.41. Estimated take of Upper Columbia River steelhead resulting from juvenile emigration monitoring in the Wenatchee River basin, 2018. NA = not available.

Trap location	Population estimate				Number trapped				Total	Take allowed by Permit
	Wild	Hatchery[a]	Parr	Fry	Wild	Hatchery	Parr	Fry		
Chiwawa Trap										
Population	NA	77,984	NA	NA	147	379	361	18	905	
Encounter rate	NA	NA	NA	NA	NA	0.0049	NA	NA	NA	0.2
Mortality[b]	NA	NA	NA	NA	0	0	1	0	1	
Mortality rate	NA	NA	NA	NA	0.0000	0.0000	0.0028	0.0000	0.0011	0.02
Lower Wenatchee Trap										
Population	NA	253,994	NA	NA	208	349	21	16	594	
Encounter rate	NA	NA	NA	NA	NA	0.0014	NA	NA	NA	0.2
Mortality[b]	NA	NA	NA	NA	0	1	0	0	1	
Mortality rate	NA	NA	NA	NA	0.0000	0.0029	0.0000	0.0000	0.0017	0.02
Wenatchee River Basin Total										
Population	NA	253,994	NA	NA	355	728	382	34	1,499	
Encounter rate	NA	NA	NA	NA	NA	0.0029	NA	NA	NA	0.2
Mortality[b]	NA	NA	NA	NA	0	1	1	0	2	
Mortality rate	NA	NA	NA	NA	0.0000	0.0014	0.0026	0.0000	0.0013	0.02

[a] 2017 BY smolt release data for the Wenatchee River basin.
[b] Mortality includes trapping and PIT-tag mortalities.

Spawning Surveys

Steelhead spawning ground surveys were conducted in the Wenatchee River basin during 2018, as authorized by ESA Section 10 Permit No. 18583. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Stock Assessment at Priest Rapids Dam

Upper Columbia River steelhead stock assessment sampling at Priest Rapids Dam (PRD) is authorized through ESA Section 10 Permit No. 18583 (NMFS 2017). Permit authorizations include interception and biological sampling of up to 15% of the Upper Columbia River steelhead passing PRD to determine upriver adult population size, estimate hatchery to wild ratios, determine age-class contribution, and evaluate the need for managing hatchery steelhead consistent with ESA recovery objectives, which include fully seeding spawning habitat with naturally produced Upper Columbia River steelhead supplemented with artificially propagated steelhead (NMFS 2017). The 2016-2017 run-cycle report (BY 2017) for stock assessment sampling at Priest Rapids Dam was compiled under provisions of ESA Section 10 Permit 18583. Data and reporting information are included in Appendix H.

Bull Trout

Bull trout encounters associated with implementation of hatchery production and monitoring and evaluation activities for Chinook and steelhead programs in the Wenatchee sub-basin are required to be reported as outlined in Biological Opinion 01EWF00-2013-0444. The 2018 report for bull trout encounters was compiled under provisions of ESA Section 10 Permit 18118, 18120, 18121, and 18583. Data and reporting information are included in Appendix I.

SECTION 4: WENATCHEE SOCKEYE SALMON

The goal of sockeye salmon supplementation in the Wenatchee Basin was to use artificial production to replace adult production lost because of mortality at Rock Island Dam, while not reducing the natural production or long-term fitness of sockeye in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans.

Adult sockeye were collected for broodstock from the run-at-large at Tumwater Dam. Beginning in 2011, because of passage delays at Tumwater Dam during trapping operations, sockeye broodstock were collected at Dryden Dam. The goal was to collect up to 260 natural-origin adult sockeye for the program. Broodstock collection occurred from about 7 July through 28 August with trapping occurring no more than 16 hours per day, three days a week at Tumwater Dam and up to seven days per week at the Dryden Dam left and right-bank facilities.

Adult sockeye were held and spawned at Eastbank Fish Hatchery. The fertilized eggs were also incubated at the hatchery. For brood years 1989 through 1998, unfed fry were transferred from the hatchery to Lake Wenatchee net pens. From 1998 to 2011, juvenile sockeye were reared at Eastbank Fish Hatchery until July when they were transferred to the net pens. The initial rearing at Eastbank was to increase growth rates. During most years up through 2005, juvenile sockeye were released from net pens at two different times, August and November. From 2006-2012, all juvenile sockeye were released in late October.

The production goal for the Wenatchee sockeye supplementation program was to release 200,000 subyearlings into Lake Wenatchee at 20 fish per pound. Targets for fork length and weight were 133 mm (CV = 9.0) and 22.7 g, respectively. Over 90% of these fish were marked with CWTs. In addition, from 2006-2011, about 15,000 juvenile sockeye were PIT tagged annually. Following an evaluation of the supplementation program in 2011, the Hatchery Committees decided to convert the Wenatchee sockeye hatchery program to summer steelhead in 2012. Currently, monitoring occurs annually to track the status of the natural sockeye population.

4.1 Broodstock Sampling

As noted above, the Wenatchee sockeye program was terminated in 2012. Thus, no broodstock have been collected since 2011 and the release of juvenile sockeye into Lake Wenatchee in 2012 (2011 brood) was the last. This section presents the history of the program.

Origin of Broodstock

Wenatchee sockeye broodstock have not been collected since 2011. Table 4.1 shows the history of the number of broodstock that were collected during the period 1989 to 2011.

Table 4.1. Numbers of wild and hatchery sockeye salmon collected for broodstock, numbers that died before spawning, and numbers of sockeye spawned, 1989-2011. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes sockeye that died of natural causes typically near the end of spawning and were not needed for the program, surplus sockeye killed at spawning, sockeye that died but were not recovered from the net pens, and sockeye that may have jumped out of the net pens.

Brood year	Wild sockeye					Hatchery sockeye					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	299	93	47	115	44	0	0	0	0	0	115
1990	333	7	7	302	17	0	0	0	0	0	302
1991	357	18	16	199	124	0	0	0	0	0	199
1992	362	18	5	320	19	0	0	0	0	0	320
1993	307	79	21	207	0	0	0	0	0	0	207
1994	329	15	9	236	69	5	0	0	5	0	241
1995	218	5	7	194	12	3	0	0	3	0	197
1996	291	2	0	225	64	20	0	0	0	20	225
1997	283	12	3	192	76	19	0	0	19	0	211
1998	225	37	25	122	41	6	0	0	6	0	128
1999	90	7	1	79	3	60	0	0	60	0	139
2000	256	19	1	170	66	5	0	0	5	0	175
2001	252	27	10	200	15	8	1	0	7	0	207
2002	257	0	1	256	0	0	0	0	0	0	256
2003	261	12	9	198	42	0	0	0	0	0	198
2004	211	13	12	177	9	0	0	0	0	0	177
2005	243	29	12	166	36	0	0	0	0	0	166
2006	260	2	4	214	40	0	0	0	0	0	214
2007	248	15	3	210	20	0	0	0	0	0	210
2008	258	4	11	243	0	2	0	0	2	0	245
2009	258	5	14	239	0	3	0	3	0	0	239
2010	256	3	0	198	55	0	0	0	0	0	198
2011	204	0	8	196	0	0	0	0	0	0	196
Average	***263***	***18***	***10***	***203***	***33***	***6***	***0***	***0***	***5***	***1***	***208***
Median	***258***	***12***	***8***	***199***	***20***	***0***	***0***	***0***	***0***	***0***	***207***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.

Age/Length Data

Ages of sockeye were determined from scales and otoliths collected from broodstock and are shown in Table 4.2.

Table 4.2. Percent of hatchery and wild sockeye salmon of different ages (total age) collected from broodstock, 1994-2011.

Return year	Origin	Total age		
		4	5	6
1994	Wild	57.3	41.7	1.0
	Hatchery	40.0	60.0	0.0
1995	Wild	77.3	20.7	2.0
	Hatchery	66.7	33.3	0.0
1996	Wild	65.8	34.2	0.0
	Hatchery	0.0	0.0	0.0
1997	Wild	86.5	13.5	0.0
	Hatchery	57.9	42.1	0.0
1998	Wild	9.9	88.6	1.5
	Hatchery	66.7	33.3	0.0
1999	Wild	21.8	74.7	3.5
	Hatchery	90.0	8.3	1.7
2000	Wild	97.7	2.3	0.0
	Hatchery	100.0	0.0	0.0
2001	Wild	69.9	29.6	0.5
	Hatchery	71.4	28.6	0.0
2002	Wild	31.6	67.6	0.8
	Hatchery	0.0	0.0	0.0
2003	Wild	2.6	90.5	6.9
	Hatchery	0.0	0.0	0.0
2004	Wild	97.5	2.0	0.5
	Hatchery	0.0	0.0	0.0
2005	Wild	74.2	25.8	0.0
	Hatchery	0.0	0.0	0.0
2006	Wild	34.0	65.5	0.5
	Hatchery	0.0	0.0	0.0
2007	Wild	1.9	88.4	9.7
	Hatchery	0.0	0.0	0.0
2008	Wild	95.0	4.0	1.0
	Hatchery	100.0	0.0	0.0
2009	Wild	78.5	21.5	0.0
	Hatchery	100.0	0.0	0.0
2010	Wild	67.4	32.6	0.0
	Hatchery	0.0	0.0	0.0
2011	Wild	53.7	44.3	2.0
	Hatchery	0.0	0.0	0.0

Return year	Origin	Total age		
		4	5	6
Average	***Wild***	***56.8***	***41.5***	***1.7***
	Hatchery	***38.5***	***11.4***	***0.1***
Median	***Wild***	***66.6***	***33.4***	***0.7***
	Hatchery	***20.0***	***0.0***	***0.0***

Lengths and ages of sockeye sampled during the life of the program are provided in Table 4.3.

Table 4.3. Mean fork length (cm) at age (total age) of hatchery and wild sockeye salmon collected for broodstock, 1994-2011; SD = 1 standard deviation.

Return year	Origin	Sockeye fork length (cm)								
		Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1994	Wild	56	125	3	55	91	3	54	2	3
	Hatchery	57	2	1	56	3	1	-	0	-
1995	Wild	51	153	2	55	41	4	54	4	5
	Hatchery	53	2	4	59	1	-	-	0	-
1996	Wild	52	146	4	53	76	3	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-
1997	Wild	50	166	3	53	26	5	-	0	-
	Hatchery	54	11	4	59	8	2	-	0	-
1998	Wild	51	13	4	55	117	3	53	2	3
	Hatchery	52	4	2	55	2	8	-	0	-
1999	Wild	52	19	4	50	65	4	56	3	1
	Hatchery	50	54	3	56	5	4	56	1	-
2000	Wild	52	167	2	54	4	3	-	0	-
	Hatchery	54	5	1	-	0	-	-	0	-
2001	Wild	54	151	3	56	65	4	58	1	-
	Hatchery	51	5	5	55	2	4	-	0	-
2002	Wild	54	77	2	56	165	4	57	2	0
	Hatchery	-	0	-	-	0	-	-	0	-
2003	Wild	54	5	4	60	172	2	60	13	4
	Hatchery	-	0	-	-	0	-	-	0	-
2004	Wild	53	192	3	56	4	3	63	1	-
	Hatchery	-	0	-	-	0	-	-	0	-
2005	Wild	51	132	3	57	46	4	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-
2006	Wild	52	70	3	56	135	4	54	2	3
	Hatchery	-	0	-	-	0	-	-	0	-
2007	Wild	57	4	2	58	182	5	58	20	5

Return year	Origin	Sockeye fork length (cm)								
		Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	-	0	-
2008	Wild	52	245	3	52	11	3	62	2	6
	Hatchery	53	2	3	-	-	-	-	-	-
2009	Wild	54	197	3	59	54	4	-	-	-
	Hatchery	54	2	1	-	-	-	-	-	-
2010	Wild	55	130	2	57	63	4	-	-	-
	Hatchery	-	-	-	-	-	-	-	-	-
2011	Wild	55	109	2	59	90	3	61	4	3
	Hatchery	-	-	-	-	-	-	-	-	-
Average	***Wild***	***53***	***116***	***3***	***55***	***78***	***4***	***57***	***3***	***3***
	Hatchery	***53***	***5***	***3***	***57***	***2***	***4***	***56***	***1***	***-***

Sex Ratios

Sex ratios of wild and hatchery sockeye collected during the life of the sockeye hatchery program are presented in Table 4.4.

Table 4.4. Numbers of male and female wild and hatchery sockeye collected for broodstock, 1989-2011. Ratios of males to females are also provided.

Return year	Number of wild sockeye			Number of hatchery sockeye			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	162	137	1.18:1.00	0	0	-	1.18:1.00
1990	177	156	1.13:1.00	0	0	-	1.13:1.00
1991	260	97	2.68:1.00	0	0	-	2.68:1.00
1992	180	182	0.99:1.00	0	0	-	0.99:1.00
1993	130	177	0.73:1.00	0	0	-	0.73:1.00
1994	162	167	0.97:1.00	1	4	0.25:1.00	0.95:1.00
1995	102	116	0.88:1.00	1	2	0.50:1.00	0.87:1.00
1996	150	161	0.93:1.00	0	0	-	0.93:1.00
1997	139	144	0.97:1.00	10	9	1.11:1.00	0.97:1.00
1998	115	110	1.05:1.00	2	4	0.50:1.00	1.03:1.00
1999	22	68	0.32:1.00	37	23	1.61:1.00	0.65:1.00
2000	155	101	1.53:1.00	3	2	1.50:1.00	1.53:1.00
2001	114	138	0.83:1.00	4	4	1.00:1.00	0.83:1.00
2002	128	129	0.99:1.00	0	0	-	0.99:1.00
2003	161	100	1.61:1.00	0	0	-	1.61:1.00
2004	108	103	1.05:1.00	0	0	-	1.05:1.00
2005	130	113	1.15:1.00	0	0	-	1.15:1.00
2006	130	130	1.00:1.00	0	0	-	1.00:1.00

Return year	Number of wild sockeye			Number of hatchery sockeye			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2007	127	121	1.05:1.00	0	0	-	1.05:1.00
2008	127	131	0.97:1.00	1	1	1.00:1.00	0.97:1.00
2009	133	125	1.06:1.00	0	3	0.00:1.00	1.04:1.00
2010	127	129	0.98:1.00	0	0	-	0.98:1.00
2011	106	98	1.08:1.00	0	0	-	1.08:1.00
Total	***2,074***	***2,017***	***1.03:1.00***	***58***	***48***	***1.21***	***1.03:1.00***

Fecundity

Fecundities of sockeye collected throughout the duration of the hatchery program are presented in Table 4.5.

Table 4.5. Mean fecundity of female sockeye salmon collected for broodstock, 1989-2011. Fecundities were determined from pooled egg lots and were not identified for individual females.

Return year	Mean fecundity
1989	2,344
1990	2,225
1991	2,598
1992	2,341
1993	2,340
1994	2,798
1995	2,295
1996	2,664
1997	2,447
1998	2,813
1999	2,319
2000	2,673
2001	2,960
2002	2,856
2003	3,511
2004	2,505
2005	2,718
2006	2,656
2007	3,115
2008	2,555
2009	2,459
2010	2,782
2011	2,960
Average	***2,649***
Median	***2,656***

4.2 Hatchery Rearing

Rearing History

Number of eggs taken

Numbers of eggs taken from sockeye broodstock throughout the duration of the sockeye hatchery program are shown in Table 4.6.

Table 4.6. Numbers of eggs taken from sockeye broodstock, 1989-2011.

Return year	Number of eggs taken
1989	133,600
1990	326,267
1991	231,254
1992	381,561
1993	231,700
1994	338,562
1995	247,900
1996	314,390
1997	254,459
1998	163,278
1999	190,732
2000	227,234
2001	301,925
2002	356,982
2003	319,470
2004	225,499
2005	211,985
2006	292,136
2007	302,363
2008	316,476
2009	304,963
2010	278,171
2011	290,046
Average	***271,389***
Median	***290,046***

Number of acclimation days

During the life of the program, Wenatchee sockeye were acclimated on Lake Wenatchee water in net pens. Acclimation days are presented in Table 4.7.

Table 4.7. Water source and mean acclimation period for Wenatchee sockeye, brood years 1989-2011.

Brood year	Release year	Transfer date	Release date	Number of Days	Water source
1989	1990	5-Apr	24-Oct	202	Lake Wenatchee
1990	1991	10-Apr	19-Oct	192	Lake Wenatchee
1991	1992	1-Apr	20-Oct	202	Lake Wenatchee
1992	1993	5-Apr	7-Sep	155	Lake Wenatchee
		5-Apr	26-Oct	204	Lake Wenatchee
1993	1994	5-Apr	1-Sep	149	Lake Wenatchee
		5-Apr	17-Oct	195	Lake Wenatchee
1994	1995	4-Apr	15-Sep	164	Lake Wenatchee
		4-Apr	23-Oct	202	Lake Wenatchee
1995	1996	4-Apr	25-Oct	204	Lake Wenatchee
1996	1997	4-Apr	22-Oct	201	Lake Wenatchee
1997	1998	1-Apr	9-Nov	222	Lake Wenatchee
1998	1999	1-Apr	29-Oct	211	Lake Wenatchee
1999	2000	25-Jul	28-Aug	34	Lake Wenatchee
		26-Jul	1-Nov	98	Lake Wenatchee
2000	2001	2-Jul	27-Aug	56	Lake Wenatchee
		3-Jul	27-Sep	86	Lake Wenatchee
2001	2002	15-Jul	28-Aug	44	Lake Wenatchee
		16-Jul	22-Sep	68	Lake Wenatchee
2002	2003	30-Jun	25-Aug	56	Lake Wenatchee
		1-Jul	22-Oct	113	Lake Wenatchee
2003	2004	6-Jul	25-Aug	50	Lake Wenatchee
		7-Jul	3-Nov	119	Lake Wenatchee
2004	2005	5-Jul	29-Aug	55	Lake Wenatchee
		6-Jul	2-Nov	120	Lake Wenatchee
2005	2006	11-Jul	30-Oct	111	Lake Wenatchee
2006	2007	9-10 Jul	31-Oct	113-114	Lake Wenatchee
2007	2008	7-8 Jul	29-Oct	113-114	Lake Wenatchee
2008	2009	21-Jul	28-Oct	100	Lake Wenatchee
2009	2010	19-20, 23-Jul	27-Oct	97-101	Lake Wenatchee
2010	2011	6, 11-12-Jul	26-Oct	107-113	Lake Wenatchee
2011	2012	9-10-Jul	29-Oct	112-113	Lake Wenatchee

Release Information

Numbers released

Numbers of juvenile sockeye released into Lake Wenatchee throughout the duration of the program are shown in Table 4.8. Coded wire tag marking rates and numbers of PIT-tagged juvenile sockeye released are also shown in Table 4.8.

Table 4.8. Total number of sockeye parr released and numbers of released fish with CWTs and PIT tags for brood years 1989-2011. The release target for sockeye was 200,000 fish.

Brood year	Release year	CWT mark rate	Number of released fish with PIT tags	Number released
1989	1990	Not marked	0	108,400
1990	1991	0.9308	0	270,802
1991	1992	0.8940	0	167,523
1992	1993	0.9240	0	340,597
1993	1994	0.7278	0	190,443
1994	1995	0.8869	0	252,859
1995[a]	1996	1.0000	0	150,808
1996[a]	1997	0.9680	0	284,630
1997[a]	1998	0.9642	0	197,195
1998[a]	1999	0.8713	0	121,344
1999	2000	0.9527	0	167,955
2000	2001	0.9558	0	190,174
2001	2002	0.9911	0	200,938
2002	2003	0.9306	0	315,783
2003	2004	0.9291	0	240,459
2004	2005	0.8995	0	172,923
2005	2006	0.9811	14,859	140,542
2006	2007	0.9735	14,764	225,670
2007	2008	0.9863	14,947	252,133
2008	2009	0.9576	14,858	154,772
2009	2010	0.9847	14,486	227,743
2010	2011	0.9564	5,039	241,918
2011	2012	0.9690	5,074	256,120
Average		***0.9379***	***11,994[b]***	***208,271***
Median		***0.9561***	***14,764[b]***	***197,195***

[a] These groups were only adipose fin clipped.
[b] Average and median are based on brood years 2004 to 2010.

Fish size and condition at release

The size and condition of the juvenile sockeye released into Lake Wenatchee throughout the duration of the hatchery program are presented in Table 4.9.

Table 4.9. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of sockeye released, brood years 1989-2011. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1990	128	-	18.2	25
1990	1991	131	-	18.9	24
1991	1992	117	3.0	20.6	22
1992	1993	73	6.8	4.2	44
1993	1994	103	-	13.6	40
1994	1995	75	6.1	4.5	38
1995	1996	137	8.2	14.7	30
1996	1997	107	5.6	15.1	30
1997	1998	122	6.1	21.3	21
1998	1999	112	5.4	17.0	27
1999	2000	94	9.5	9.5	48
		134	11.5	31.3	15
2000	2001	123	6.5	22.3	20
		146	8.4	26.0	12
2001	2002	118	7.4	20.7	22
		135	7.3	30.5	15
2002	2003	73	5.6	4.4	104
		118	7.7	13.7	23
		145	9.4	38.6	13
2003	2004	79	4.6	4.8	96
		118	5.9	17.0	26
		158	8.1	44.3	10
2004	2005	116	4.5	17.2	18
		151	7.0	39.3	12
2005	2006	149	7.5	43.7	10
2006	2007	138	10.6	32.4	14
2007	2008	137	9.3	33.0	14
2008	2009	138	9.6	34.6	13

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2009	2010	143	8.9	35.5	13
2010	2011	132	14.3	30.7	15
2011	2012	142	9.6	35.3	13
Targets		***133***	***9.0***	***22.7***	***20***

Survival Estimates

Life-stage survival estimates for juvenile sockeye throughout the duration of the hatchery program are shown in Table 4.10.

Table 4.10. Hatchery life-stage survival rates (%) for sockeye salmon, brood years 1989-2011. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	41.6	100.0	88.1	63.9	99.2	98.9	98.1	65.2	83.0
1990	96.2	99.4	90.8	96.3	99.9	99.2	98.4	98.4	81.1
1991	91.8	94.1	79.2	94.8	99.8	99.3	96.4	96.4	72.4
1992	91.1	98.8	92.3	98.0	99.9	99.8	98.6	98.8	89.2
1993	57.1	99.2	89.2	98.3	99.6	99.1	93.7	93.8	82.2
1994	89.8	99.2	79.2	96.0	99.5	98.6	98.3	98.2	74.7
1995	97.5	99.1	87.5	95.0	99.0	93.3	73.2	73.2	60.8
1996	99.2	100.0	95.1	98.7	99.7	99.3	96.4	96.5	90.5
1997	92.8	99.3	84.8	97.9	97.9	97.6	95.5	94.9	77.5
1998	75.4	95.5	77.7	98.4	98.6	98.2	97.1	97.2	74.3
1999	92.3	100.0	92.2	97.3	99.6	99.3	98.2	99.7	88.1
2000	84.5	98.1	93.8	97.7	96.7	96.1	91.4	96.8	83.7
2001	75.4	99.2	78.5	97.6	98.0	97.6	86.9	95.1	66.6
2002	100.0	100.0	95.7	97.8	99.6	99.2	94.6	99.8	88.5
2003	91.0	98.1	87.2	96.9	99.0	98.2	94.8	95.5	74.6
2004	88.7	92.6	88.0	93.1	97.9	97.4	93.7	96.1	76.7
2005	98.5	98.5	85.3	94.9	97.8	96.6	95.5	99.2	66.3
2006	95.3	99.1	73.2	85.4	95.4	94.6	87.8	98.5	54.9
2007	88.4	99.2	89.1	98.6	97.0	95.9	94.9	99.0	83.4
2008	97.0	100.0	59.0	88.3	99.1	97.2	93.8	97.4	48.9
2009	95.8	98.3	89.1	94.8	96.9	96.2	88.4	92.3	74.7
2010	99.0	98.0	92.6	98.2	97.5	96.5	95.6	99.6	87.0
2011	100.0	100.0	92.6	100.0	96.8	96.0	95.4	99.7	88.3
Average	***88.6***	***98.5***	***86.1***	***94.7***	***98.5***	***97.6***	***93.8***	***94.8***	***76.8***

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
Median	***92.3***	***99.2***	***88.1***	***97.3***	***99.0***	***97.6***	***95.4***	***97.2***	***77.5***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

4.3 Disease Monitoring

Because the sockeye hatchery program ended in 2012, there are no disease-monitoring results.

4.4 Natural Juvenile Productivity

Sockeye smolt abundance was estimated at a rotary screw trap located near the mouth of Lake Wenatchee during the period 1997 to 2011. Because the efficiency of the trap was difficult to assess, the operation was terminated in 2011. In 2012, the trap was relocated downstream near the mouth of the Chiwawa River and operated there for two years. Again, because few marked sockeye smolts were recaptured, the operation was terminated in 2013. Beginning in 2013, smolt abundance has been estimated at the Lower Wenatchee Trap located near Cashmere, WA.

Emigrant and Smolt Estimates

The Lower Wenatchee Trap operated between 22 March and 24 July 2018. During that time, the trap was inoperable for 18 days because of high or low river discharge, debris, elevated river temperatures, large hatchery releases, and mechanical issues. During the sampling period, a total of 10,331 wild juvenile sockeye were captured at the Lower Wenatchee Trap. There was no significant relationship between trap efficiency and river discharge ($R^2 = 0.34$, $P > 0.061$); therefore, a pooled estimate was used. Using this pooled model, the number of juvenile sockeye emigrants was estimated at 1,806,164 (95% CI = ±13,586,160) during the 2018 trapping season (Table 4.11). Figure 4.1 shows the monthly captures of sockeye collected at the Lower Wenatchee Trap in 2018. All fish captured in the Lower Wenatchee trap are reported in Appendix C.

Table 4.11. Estimated numbers of wild and hatchery sockeye smolts that emigrated from Lake Wenatchee during outmigration years 1997-2018; NS = no data. Estimates for the outmigration years 1997-2011 were based on sampling at the Upper Wenatchee smolt trap; estimates beginning in 2013 were based on sampling at the Lower Wenatchee smolt trap.

Outmigration year	Numbers of sockeye smolts	
	Wild smolts	Hatchery smolts
1997	55,359	28,828
1998	1,447,259	55,985
1999	1,944,966	112,524
2000	985,490	24,684
2001	39,353	94,046
2002	729,716	121,511
2003	5,439,032	140,322
2004	5,771,187	216,023
2005	723,413	122,399

Outmigration year	Numbers of sockeye smolts	
	Wild smolts	Hatchery smolts
2006	1,266,971	159,500
2007	2,797,313	140,542
2008[a]	549,682	121,843
2009[a]	355,549	119,908
2010[a]	3,958,888	126,326
2011	1,500,730	159,089
2012	ND	ND
2013	873,096 (±95,132)	No program
2014	1,275,027 (±211,615)	No program
2015	1,065,614 (±238,901)	No program
2016	208,250 (±29,447)	No program
2017	121,825 (±22,904)	No program
2018	1,806,164 (±13,586,160)	No program
Average	***1,567,375***	***116,235***[a]
Median	***1,065,614***	***121.511***[a]

[a] Summary statistics were calculated for years in which hatchery fish were being released (1997-2011).

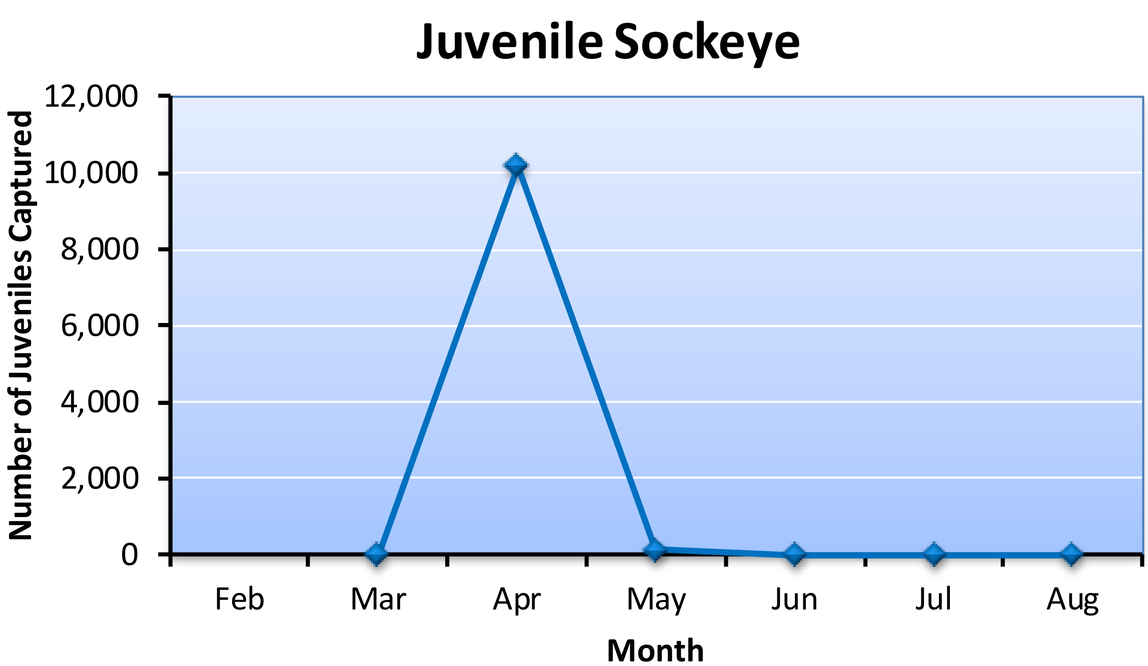


Figure 4.1. Monthly captures of wild sockeye salmon smolts at the Lower Wenatchee Trap, 2018.

Age classes of wild sockeye were determined from a length frequency analysis based on scales collected randomly (1997 through 2011) or in a stratified random sample (2012 to present) (Table 4.12). Each year, a small number of markedly smaller sockeye (<50 mm FL) are collected, and starting with run year 2013, an age-0 class was retroactively assigned based on catch records. For the available run years, most wild sockeye smolts migrated as age 1+ fish. Only in two years (1997 and 2005) did more smolts migrate as age 2+ fish. Relatively few smolts migrated at age 3+.

Table 4.12. Age structure and estimated number of wild sockeye smolts that emigrated from Lake Wenatchee, 1997-2018; ND = no data. Estimates for outmigration years 1997-2011 were based on sampling at the Upper Wenatchee smolt trap; estimates beginning in 2013 were based on sampling at the Lower Wenatchee smolt trap.

Outmigration year	Proportion of wild smolts				Total wild emigrants
	Age 0	Age 1+	Age 2+	Age 3+	
1997	ND	0.075	0.906	0.019	55,359
1998	ND	0.955	0.037	0.008	1,447,259
1999	ND	0.619	0.381	0.000	1,944,966
2000	ND	0.599	0.400	0.001	985,490
2001	ND	0.943	0.051	0.006	39,353
2002	ND	0.961	0.039	0.000	729,716
2003	ND	0.740	0.026	0.000	5,439,032
2004	ND	0.929	0.071	0.000	5,771,187
2005	ND	0.230	0.748	0.022	723,413
2006	ND	0.994	0.006	0.000	1,266,971
2007	ND	0.996	0.004	0.000	2,797,313
2008	ND	0.804	0.195	0.001	549,682
2009	ND	0.927	0.073	0.000	355,549
2010	ND	0.963	0.036	0.001	3,958,888
2011	ND	0.786	0.214	0.000	1,500,730
2012	ND	ND	ND	ND	ND
2013	0.008	0.919	0.073	0.000	873,096
2014	0.003	0.948	0.049	0.000	1,275,027
2015	0.003	0.777	0.220	0.000	1,065,614
2016	0.046	0.895	0.059	0.000	208,250
2017	0.053	0.868	0.079	0.000	121,825
2018	0.001	0.989	0.010	0.000	1,806,164
Average	***0.019***	***0.806***	***0.175***	***0.003***	***1,567,375***
Median	***0.006***	***0.919***	***0.071***	***0.000***	***1,065,614***

Freshwater Productivity

Egg-smolt survival estimates for wild sockeye salmon are provided in Table 4.13. Estimates of egg deposition were calculated based on the spawner escapement at Tumwater Dam and the sex ratio and fecundity of the broodstock. For brood years 2012 - present in which brood was not collected, a linear relationship with post-orbital to hypural length as the independent variable was used to calculate mean fecundity of sockeye sampled at Tumwater Dam ($r^2 = 0.36$, $P < 0.01$). No smolt estimates are available for brood year 2010. Egg-smolt survival rates for brood years 1995-2016 have ranged from 0.003 to 0.212 (mean = 0.081).

Table 4.13. Estimated egg deposition (estimated as mean fecundity times estimated number of females), numbers of smolts, and survival rates for wild Wenatchee sockeye salmon, brood years 1995-2016; ND = no data.

Brood year	Number of females	Mean fecundity	Total eggs	Numbers of wild smolts					Egg-smolt survival
				Age 0	Age 1+	Age 2+	Age 3+	Total	
1995	2,136	2,295	4,902,120	ND	4,152	53,549	0	57,701	0.012
1996	3,767	2,664	10,035,288	ND	1,382,133	741,032	985	2,124,150	0.212
1997	5,404	2,447	13,223,588	ND	1,203,934	394,196	236	1,598,366	0.121
1998	2,024	2,813	5,693,512	ND	590,309	2,007	0	592,316	0.104
1999	513	2,319	1,189,647	ND	37,110	28,459	0	65,569	0.055
2000	11,413	2,673	30,506,949	ND	701,257	1,414,148	0	2,115,405	0.069
2001	21,685	2,960	64,187,600	ND	4,024,884	409,754	15,915	4,450,553	0.069
2002	17,226	2,856	49,197,456	ND	5,361,433	541,113	0	5,902,546	0.120
2003	2,158	3,511	7,576,738	ND	166,385	7,602	0	173,987	0.023
2004	15,469	2,505	38,749,845	ND	1,259,369	11,189	550	1,270,833	0.033
2005	5,867	2,718	15,946,506	ND	2,786,123	107,243	0	2,893,366	0.181
2006	2,747	2,656	7,296,032	ND	442,164	25,919	3,959	472,042	0.065
2007	2,001	3,115	6,232,804	ND	329,594	142,520	0	472,114	0.076
2008	11,775	2,555	30,084,691	ND	3,812,409	321,156	ND	4,133,565	0.137
2009	3,939	2,459	9,684,965	ND	1,179,574	ND	0	ND	ND
2010	11,918	2,785	33,190,467	ND	ND	63,736	0	ND	ND
2011	9,722	2,970	28,873,491	ND	802,375	62,476	0	864,852	0.030
2012	14,753	2,693	39,245,089	10,200	1,208,726	234,435	0	1,453,361	0.037
2013	9,477	2,729	25,862,733	3,197	827,982	12,287	0	843,466	0.033
2014	31,203	2,520	78,631,560	625	186,384	9,673	0	196,681	0.003
2015	12,953	2,771	35,892,763	5,604	105,744	18,062	0	129,410	0.004
2016	23,558	2,543	59,907,994	95,004	1,786,296	--	--	--	--
Average	***9,436***	***2,707***	***27,095,993***	***4,906***	***1,342,778***	***230,028***	***1,082***	***1,568,962***	***0.073***
Median	***9,600***	***2,683***	***27,368,112***	***4,400***	***827,982***	***63,106***	***0***	***864,852***	***0.065***

Juvenile survival rates for hatchery sockeye salmon are provided in Table 4.14. Release-smolt survival rates for brood years 1995-2011 have ranged from 0.000 to 1.000 (mean = 0.570). Egg-smolt survival rates for the same brood years ranged from 0.000 to 0.710 (mean = 0.294). On average, egg-smolt survival of hatchery sockeye is about three times greater than egg-smolt survival of wild sockeye.

Table 4.14. Juvenile survival rates for hatchery Wenatchee sockeye, brood years 1995-2011.

Brood year	Number of eggs	Number of parr released	Date of release	Estimated number of smolts	Egg-smolt survival	Release-smolt survival
1995	247,900	150,808	10/25/96	28,828	0.116	0.191
1996	314,390	284,630	10/22/97	55,985	0.178	0.197
1997	254,459	197,195	11/9/98	112,524	0.442	0.571
1998	163,278	121,344	10/27/99	24,684	0.151	0.203
1999	190,732	84,466	8/28/00	30,326	0.159	0.359
		83,489	11/1/00	63,720	0.334	0.763
2000	227,234	92,055	8/27/01	30,918	0.136	0.336
		98,119	9/27/01	90,593	0.399	0.923
2001	301,925	96,486	8/28/02	36,484	0.121	0.378
		104,452	9/23/02	103,838	0.344	0.994
2002	356,982	98,509	6/16/03	5,192	0.015	0.053
		104,855	8/25/03	98,412	0.276	0.939
		112,419	10/22/03	112,419	0.315	1.000
2003	319,470	32,755	6/15/04	0	0.000	0.000
		104,879	8/25/04	19,574	0.061	0.187
		102,825	11/3/04	102,825	0.322	1.000
2004	225,499	81,428	8/29/05	159,500	0.707	0.922
		91,495	11/2/05			
2005	211,985	70,386	10/30/06	140,542	0.663	1.000
		70,156	10/30/06			
2006	292,136	225,670	10/31/07	121,843	0.412	0.540
2007	302,363	252,133	10/29/08	119,908	0.397	0.476
2008	316,476	154,772	10/28/09	126,326	0.399	0.813
2009	304,963	227,743	10/27/10	159,089	0.522	0.699
2010	278,171	241,918	10/26/11	ND[a]	--	--
2011	290,046	256,120	10/29/12	ND[a]	--	--

[a] There are no emigrant estimates for the 2010 and 2011 brood years (not enough recaptures for valid estimate).

PIT Tagging Activities

A total of 8,822 wild juvenile sockeye salmon were PIT tagged and released in 2018 at the Lower Wenatchee Trap. Numbers of wild sockeye salmon PIT-tagged and released as part of the Comparative Survival Study and PUD studies during the period 2006-2018 are shown in Table 4.15. See Appendix D for a complete list of all fish captured, tagged, lost, and released.

Table 4.15. Summary of the numbers of wild sockeye salmon that were tagged and released at the Upper and Lower Wenatchee Traps within the Wenatchee River basin, 2006-2018.

Year	Sampling location	
	Upper Wenatchee Trap	Lower Wenatchee Trap
2008	3,165	0
2009	3,683	0
2010	10,006	0
2011	--	0
2012	--	0
2013	--	0
2014	--	4,821
2015	--	3,922
2016	--	1,065
2017	--	968
2018	--	8,822

4.5 Spawning Escapement

The sockeye salmon hatchery program ended after the 2011 brood year. As a result, monitoring activities that focused on evaluating the effects of the supplementation program on the natural population transitioned to monitoring the abundance and productivity of the natural population. Broadly, the proposed monitoring and evaluation activities cover juvenile and adult life-history stages and provide the data necessary to track or estimate viable salmonid population (VSP) parameters: abundance, productivity, spatial structure, and diversity (McElhaney et al. 2000).

From 2009-2013, mark-recapture methods were used to estimate spawning escapement within the White River, while area-under-the-curve (AUC) methods were used to estimate spawning escapement within the Little Wenatchee River. Beginning in 2014, mark-recapture methods were used to estimate the spawning escapement of sockeye in both the White River and Little Wenatchee watersheds (see Appendix J for more details).

Mark-Recapture Estimates

Spawning escapement of sockeye salmon in 2018 was estimated using mark-recapture methods. This method relied on PIT tags to estimate sockeye spawning escapement (see Appendix J for more details).

Using mark-recapture methods, the estimated total escapement of sockeye in the Upper Wenatchee River basin in 2018 was 13,975 (Table 4.16). About 91% of the escapement entered the White River watershed (including the Napeequa River).

Table 4.16. Estimated escapement of adult sockeye into the Little Wenatchee and White River watersheds for return years 2009-2018. Escapement was based on recapture of PIT-tagged fish.

Return year	Tumwater Dam count	Recreational harvest	Little Wenatchee escapement	White River escapement	Total spawning escapement
2009	16,034	2,285	576	13,876	14,452
2010	35,821	4,129	2,062	19,542	21,604
2011[a]	18,634	0	2,431	14,582	17,013
2012	66,520	12,107	4,607	23,866	28,473
2013[a]	29,015	6,262	2,426	14,294	16,720
2014	99,898	16,281	4,319	49,021	53,340
2015	51,435	7,916	2,707	20,097	22,804
2016	73,697	14,630	6,747	38,802	45,549
2017	23,854	0	2,085	18,436	20,521
2018	13,975	0	974	10,411	11,384
Average	***42,888***	***6,361***	***2,893***	***22,293***	***25,186***
Median	***32,418***	***5,196***	***2,429***	***18,989***	***21,063***

[a] Spawning escapements in 2011 and 2013 were calculated using AUC counts and a regression model.

The spawning escapement of 11,384 Wenatchee sockeye was less than the overall average of 18,301 (Table 4.17).

Table 4.17. Spawning escapements for sockeye salmon in the Wenatchee River basin for return years 1989-2018; NA = not available and AUC = area under the curve.

Return year	Escapement estimation method	Spawning escapement		
		Little Wenatchee	White	Total
1989	Counts at Tumwater Dam	NA	NA	**21,802**
1990	Counts at Tumwater Dam	NA	NA	**27,325**
1991	Counts at Tumwater Dam	NA	NA	**26,689**
1992	Counts at Tumwater Dam	NA	NA	**16,461**
1993	Counts at Tumwater Dam	NA	NA	**27,726**
1994	Counts at Tumwater Dam	NA	NA	**7,330**
1995	Counts at Tumwater Dam	NA	NA	**3,448**
1996	Counts at Tumwater Dam	NA	NA	**6,573**
1997	Counts at Tumwater Dam	NA	NA	**9,693**
1998	Counts at Tumwater Dam	NA	NA	**4,014**
1999	Counts at Tumwater Dam	NA	NA	**1,025**
2000	Counts at Tumwater Dam	NA	NA	**20,735**
2001	Counts at Tumwater Dam	NA	NA	**29,103**
2002	Counts at Tumwater Dam	NA	NA	**27,565**
2003	Counts at Tumwater Dam	NA	NA	**4,855**
2004	Counts at Tumwater Dam	NA	NA	**27,556**
2005	Counts at Tumwater Dam	NA	NA	**14,011**

Return year	Escapement estimation method	Spawning escapement		
		Little Wenatchee	White	Total
2006	AUC	574	5,634	**6,208**
2007	AUC	150	1,720	**1,870**
2008	AUC	3,491	16,757	**20,248**
2009	AUC and Mark-Recap	763	7,004	**7,767**
2010	AUC and Mark-Recap	2,543	19,157	**21,700**
2011	AUC and Mark-Recap	2,431	14,582	**17,013**
2012	AUC and Mark-Recap	4,607	23,866	**28,473**
2013	AUC and Mark-Recap	2,426	14,294	**16,720**
2014	Mark-Recapture	4,391	49,021	**53,340**
2015	Mark-Recapture	2,707	20,097	**22,804**
2016	Mark-Recapture	6,747	38,321	**45,068**
2017	Mark-Recapture	2,085	18,436	**20,521**
2018	Mark-Recapture	974	10,411	**11,384**
Average		***2,607***	***18,408***	***18,301***
Median		***2,431***	***16,757***	***18,631***

4.6 Carcass Surveys

As described earlier, carcass surveys were not conducted in 2016. The information contained in this section represents carcass data collected before 2014.

Number sampled

Table 4.18 shows the number of carcasses sampled within different survey streams during the period 1993-2013.

Table 4.18. Numbers of sockeye carcasses sampled within different streams/watersheds within the Wenatchee River basin, 1989-2013.

Survey year	Numbers of sockeye carcasses			
	Little Wenatchee	White	Napeequa	Total
1993	90	195	0	**285**
1994	121	165	0	**286**
1995	0	56	0	**56**
1996	43	1,387	3	**1,433**
1997	69	1,425	41	**1,535**
1998	61	524	4	**589**
1999	40	186	0	**226**
2000	821	5,494	0	**6,315**
2001	650	3,127	0	**3,777**
2002	506	7,258	55	**7,819**
2003	86	1,002	14	**1,102**

Survey year	Numbers of sockeye carcasses			
	Little Wenatchee	White	Napeequa	Total
2004	625	6,960	138	**7,723**
2005	1	7	0	**8**
2006	101	2,158	38	**2,297**
2007	17	363	3	**383**
2008	476	5,132	125	**5,733**
2009	84	3,103	103	**3,290**
2010	217	7,832	70	**8,119**
2011	372	3,322	48	**3,742**
2012	1,309	7,479	31	**8,819**
2013	179	2,996	27	**3,202**
Average	***279***	***2,865***	***33***	***3,178***
Median	***101***	***2,158***	***14***	***2,297***

Carcass Distribution and Origin

Based on the available data (1993-2013), the largest percentage of both wild and hatchery sockeye spawned in Reach 2 on the White River (Table 4.19 and Figure 4.2). However, a greater percentage of wild fish was found in Reach 2 than hatchery fish.

Table 4.19. Numbers of wild and hatchery sockeye carcasses sampled within different reaches in the Wenatchee River basin, 1993-2013. Reach codes are described in Table 2.9.

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
1993	Wild	86	0	0	183	0	**269**
	Hatchery	4	0	0	12	0	**16**
1994	Wild	112	0	0	155	0	**267**
	Hatchery	9	0	0	9	0	**18**
1995	Wild	0	0	0	55	0	**55**
	Hatchery	0	0	0	1	0	**1**
1996	Wild	41	0	0	1,299	3	**1,343**
	Hatchery	2	0	0	88	0	**90**
1997	Wild	65	0	0	1,411	40	**1,516**
	Hatchery	4	0	0	11	1	**16**
1998	Wild	61	0	0	515	4	**580**
	Hatchery	0	0	0	9	0	**9**
1999	Wild	30	0	0	164	0	**194**
	Hatchery	10	0	0	22	0	**32**
2000	Wild	694	0	3	5,239	0	**5,936**
	Hatchery	127	0	0	252	0	**379**
2001	Wild	625	0	0	3,063	0	**3,688**

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
	Hatchery	25	0	0	64	0	**89**
2002	Wild	504	0	0	7,207	55	**7,766**
	Hatchery	2	0	0	51	0	**53**
2003	Wild	81	0	0	993	14	**1,088**
	Hatchery	5	0	0	9	0	**14**
2004	Wild	606	0	0	6,755	166	**7,527**
	Hatchery	19	0	0	205	22	**246**
2005	Wild	201	0	5	2,966	21	**3,193**
	Hatchery	1	0	0	8	0	**9**
2006	Wild	80	0	0	2,112	36	**2,228**
	Hatchery	21	0	0	46	2	**69**
2007	Wild	17	0	0	346	3	**366**
	Hatchery	0	0	0	17	0	**17**
2008	Wild	472	0	0	5,118	124	**5,714**
	Hatchery	4	0	0	14	1	**19**
2009	Wild	80	0	0	3,084	103	**3,267**
	Hatchery	4	0	0	19	0	**23**
2010	Wild	210	0	0	7,711	69	**7,990**
	Hatchery	7	0	0	121	1	**129**
2011	Wild	266	0	0	3,079	43	**3,388**
	Hatchery	106	0	0	243	5	**354**
2012	Wild	1,270	0	21	7,368	30	**8,689**
	Hatchery	39	0	3	87	1	**130**
2013	Wild	174	0	1	2,936	26	**3,137**
	Hatchery	3	0	0	56	1	**60**
Average	***Wild***	***270***	***0***	***1***	***2,941***	***35***	***3,248***
	Hatchery	***18***	***0***	***0***	***61***	***2***	***81***
Median	***Wild***	***112***	***0***	***0***	***2,936***	***21***	***3,137***
	Hatchery	***4***	***0***	***0***	***22***	***0***	***32***

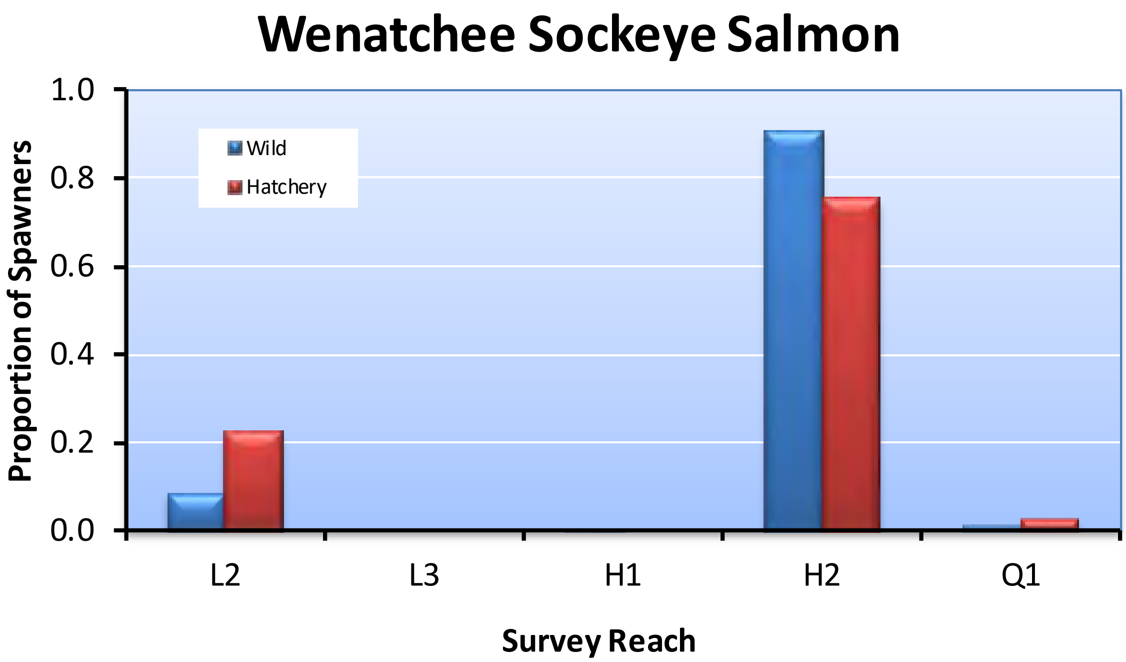


Figure 4.2. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, pooled data from 1993-2013. Reach codes are described in Table 2.9; L = Little Wenatchee, H = White River, and Q = Napeequa River.

4.7 Life History Monitoring

Life history characteristics of Wenatchee sockeye were assessed by examining carcasses on spawning grounds and fish sampled at broodstock collection sites or during stock assessment, and by reviewing tagging data and fisheries statistics.

Migration Timing

There was little difference in migration timing of hatchery and wild sockeye past Tumwater Dam (Table 4.20a and b; Figure 4.3). On average, early in the run, hatchery and wild sockeye arrived at the dam at about the same time. Toward the end of the migration period, hatchery sockeye tended to arrive at the dam slightly later than did wild sockeye. Most hatchery and wild sockeye migrated upstream past Tumwater Dam during July through early August. The peak migration time for both hatchery and wild sockeye was the last two weeks of July (Figure 4.3).

Table 4.20a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery sockeye salmon passed Tumwater Dam, 1998-2018. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery sockeye salmon. All sockeye were visually examined during trapping from 2004 to present. The return of Wenatchee hatchery sockeye ended in 2017.

Survey year	Origin	Sockeye Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	195	14-Jul	201	20-Jul	208	27-Jul	202	21-Jul	4,173
	Hatchery	196	15-Jul	204	23-Jul	220	8-Aug	206	25-Jul	31
1999	Wild	226	14-Aug	233	21-Aug	241	29-Aug	234	22-Aug	908
	Hatchery	228	16-Aug	234	22-Aug	242	30-Aug	235	23-Aug	264
2000	Wild	200	18-Jul	206	24-Jul	213	31-Jul	207	25-Jul	18,390
	Hatchery	199	17-Jul	206	24-Jul	213	31-Jul	206	24-Jul	2,589
2001	Wild	189	8-Jul	194	13-Jul	214	2-Aug	198	17-Jul	32,554
	Hatchery	199	18-Jul	212	31-Jul	240	28-Aug	214	2-Aug	79
2002	Wild	204	23-Jul	208	27-Jul	219	7-Aug	210	29-Jul	27,241
	Hatchery	204	23-Jul	209	28-Jul	222	10-Aug	211	30-Jul	580
2003	Wild	194	13-Jul	200	19-Jul	208	27-Jul	201	20-Jul	4,699
	Hatchery	194	13-Jul	201	20-Jul	211	30-Jul	203	22-Jul	375
2004	Wild	191	9-Jul	196	14-Jul	207	25-Jul	198	16-Jul	31,408
	Hatchery	189	7-Jul	194	12-Jul	203	21-Jul	196	14-Jul	1,758
2005	Wild	192	11-Jul	199	18-Jul	227	15-Aug	204	23-Jul	14,176
	Hatchery	187	6-Jul	200	19-Jul	251	8-Sep	212	31-Jul	42
2006	Wild	201	20-Jul	204	23-Jul	214	2-Aug	206	25-Jul	9,151
	Hatchery	202	21-Jul	219	7-Aug	228	16-Aug	215	3-Aug	507
2007	Wild	201	20-Jul	210	29-Jul	227	15-Aug	213	1-Aug	2,542
	Hatchery	205	24-Jul	213	1-Aug	231	19-Aug	216	4-Aug	65
2008	Wild	200	18-Jul	207	25-Jul	219	6-Aug	208	26-Jul	29,229
	Hatchery	201	19-Jul	206	24-Jul	215	2-Aug	208	26-Jul	103
2009	Wild	198	17-Jul	204	23-Jul	213	1-Aug	206	25-Jul	15,552
	Hatchery	199	18-Jul	205	24-Jul	215	3-Aug	207	26-Jul	534
2010	Wild	199	18-Jul	205	24-Jul	220	8-Aug	208	27-Jul	34,519
	Hatchery	200	19-Jul	215	3-Aug	244	1-Sep	218	6-Aug	1,302
2011	Wild	213	1-Aug	216	4-Aug	224	12-Aug	217	5-Aug	17,680
	Hatchery	213	1-Aug	213	1-Aug	231	19-Aug	216	4-Aug	954
2012[a]	Wild	207	25-Jul	212	30-Jul	216	3-Aug	212	30-Jul	21,246
	Hatchery	207	25-Jul	207	25-Jul	228	15-Aug	213	31-Jul	348
2013	Wild	196	15-Jul	200	19-Jul	207	26-Jul	201	20-Jul	28,245
	Hatchery	197	16-Jul	201	20-Jul	211	30-Jul	203	22-Jul	770

Survey year	Origin	Sockeye Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2014	Wild	194	13-Jul	199	18-Jul	210	29-Jul	201	20-Jul	97,670
	Hatchery	196	15-Jul	201	20-Jul	211	30-Jul	203	22-Jul	2,229
2015	Wild	191	10-Jul	199	18-Jul	215	3-Aug	203	22-Jul	49,628
	Hatchery	181	30-Jun	199	18-Jul	212	31-Jul	200	19-Jul	1,782
2016	Wild	190	8-Jul	196	14-Jul	208	26-Jul	198	16-Jul	73,619
	Hatchery	192	10-Jul	195	13-Jul	207	25-Jul	197	15-Jul	78
2017	Wild	198	17-Jul	204	23-Jul	211	30-Jul	204	23-Jul	23,845
	Hatchery	202	21-Jul	205	24-Jul	212	31-Jul	207	26-Jul	9
Average (1998-2017)	***Wild***	***199***	***--***	***205***	***--***	***216***	***--***	***207***	***--***	***26,824***
	Hatchery	***200***	***--***	***207***	***--***	***222***	***--***	***209***	***--***	***720***
Median (1998-2017)	***Wild***	***198***	***--***	***204***	***--***	***214***	***--***	***205***	***--***	***22,546***
	Hatchery	***199***	***--***	***206***	***--***	***218***	***--***	***208***	***--***	***441***
2018	Wild	194	13-Jul	198	17-Jul	207	26-Jul	200	19-Jul	13,960
Average	***Wild***	***194***	***--***	***198***	***--***	***207***	***--***	***208***	***--***	***13,960***
Median	***Wild***	***194***	***--***	***198***	***--***	***207***	***--***	***208***	***--***	***13,960***

[a] The origin of sockeye passing Tumwater Dam during 8 through 11 August 2012 was not assessed. The total number of sockeye passing Tumwater Dam in 2012 was 30,617 adults. Thus, about 9,023 adults of unknown origin passed Tumwater Dam in 2012.

Table 4.20b. The week that 10%, 50% (median), and 90% of the wild and hatchery sockeye salmon passed Tumwater Dam, 1998-2018. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery sockeye salmon. All sockeye were visually examined during trapping from 2004 to present.

Survey year	Origin	Sockeye Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	28	29	30	29	4,173
	Hatchery	28	30	32	30	31
1999	Wild	33	34	35	34	908
	Hatchery	33	34	35	34	264
2000	Wild	29	30	31	30	18,390
	Hatchery	29	30	31	30	2,589
2001	Wild	27	28	31	29	32,554
	Hatchery	29	31	35	31	79
2002	Wild	30	30	32	30	27,241
	Hatchery	30	30	32	31	580
2003	Wild	28	29	30	29	4,699
	Hatchery	28	29	31	29	375
2004	Wild	28	28	28	29	31,408

Survey year	Origin	Sockeye Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	27	28	29	28	1,758
2005	Wild	28	29	33	30	14,176
	Hatchery	27	29	36	31	42
2006	Wild	29	29	31	30	9,151
	Hatchery	29	32	33	31	507
2007	Wild	29	30	33	31	2,542
	Hatchery	30	31	33	31	65
2008	Wild	29	30	32	30	29,229
	Hatchery	29	30	31	30	103
2009	Wild	29	30	31	30	15,552
	Hatchery	29	29	31	30	534
2010	Wild	29	30	32	30	34,519
	Hatchery	29	31	35	32	1,302
2011	Wild	31	31	32	31	17,680
	Hatchery	31	31	33	31	954
2012[a]	Wild	30	31	31	31	21,246
	Hatchery	30	30	33	31	348
2013	Wild	28	29	30	29	28,245
	Hatchery	29	29	31	29	770
2014	Wild	28	29	30	29	97,670
	Hatchery	28	29	29	29	2,229
2015	Wild	28	29	31	30	49,628
	Hatchery	26	29	31	29	1,782
2016	Wild	28	28	30	29	73,619
	Hatchery	28	28	30	29	78
2017	Wild	29	30	31	30	23,845
	Hatchery	29	30	31	30	9
Average (1998-2017)	***Wild***	***29***	***30***	***31***	***30***	***26,824***
	Hatchery	***29***	***30***	***32***	***30***	***720***
Median (1998-2017)	***Wild***	***29***	***30***	***31***	***30***	***22,546***
	Hatchery	***29***	***30***	***32***	***30***	***441***
2018	Wild	28	29	30	29	13,960
Average[b]	***Wild***	***28***	***29***	***30***	***29***	***13,960***
Median[b]	***Wild***	***28***	***29***	***30***	***29***	***13,960***

[a] The origin of sockeye passing Tumwater Dam during 8 through 11 August 2012 was not assessed. The total number of sockeye passing Tumwater Dam in 2012 was 30,617 adults. Thus, about 9,023 adults of unknown origin passed Tumwater Dam in 2012.

[b] Statistics are from 2018 to present.

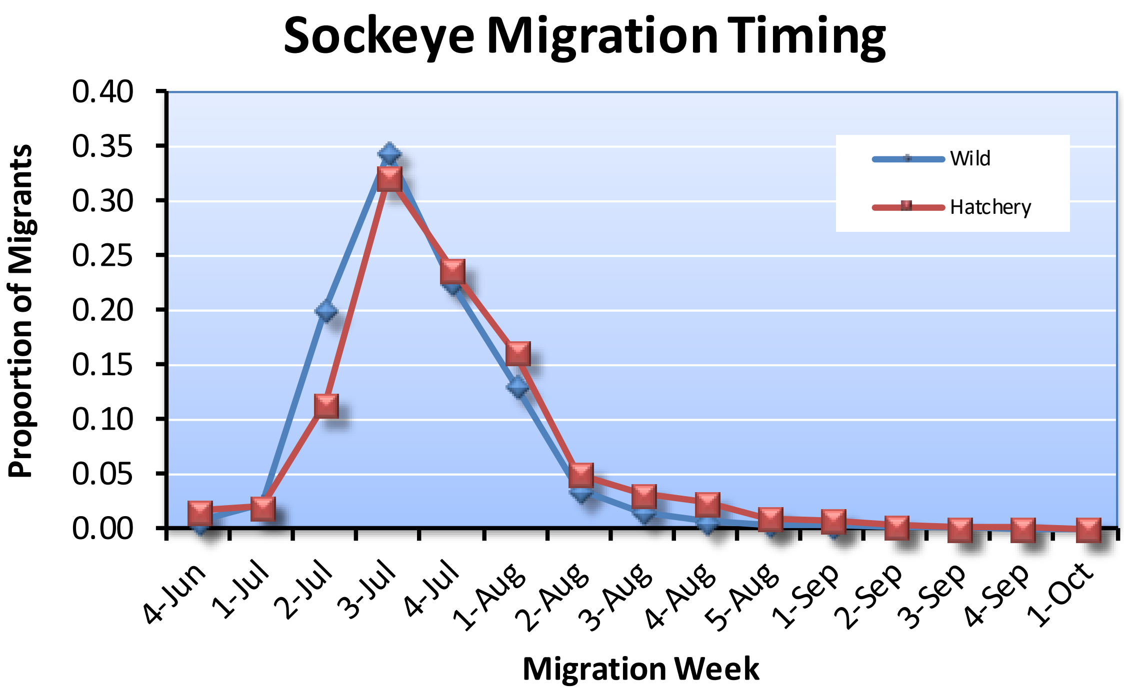


Figure 4.3. Proportion of wild and hatchery sockeye observed (using video) passing Tumwater Dam each week during their migration period late-June through early-October; data were pooled over survey years 1998-2017.

Age at Maturity

Although sample sizes are small, most hatchery sockeye returned as age-4 fish, while most wild sockeye returned as age-4 and 5 fish (Table 4.21; Figure 4.4). Only wild fish have returned at age-6. No hatchery fish were observed in 2018.

Table 4.21. Proportions of wild and hatchery sockeye of different ages (total age) sampled in broodstock (1994-2011), on spawning grounds (1994-2012), and at Tumwater Dam (2013-2018).

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
1994	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.88	0.13	0.00	0.00	16
1995	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.00	1.00	0.00	0.00	1
1996	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	82
1997	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.77	0.23	0.00	0.00	13
1998	Wild	0.00	0.08	0.85	0.08	0.00	0.00	26
	Hatchery	0.00	0.00	0.64	0.36	0.00	0.00	11
1999	Wild	0.00	0.00	0.18	0.73	0.10	0.00	113

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
	Hatchery	0.00	0.00	0.65	0.35	0.00	0.00	31
2000	Wild	0.00	0.00	0.00	1.00	0.00	0.00	1
	Hatchery	0.00	0.00	0.98	0.02	0.00	0.00	359
2001	Wild	0.00	0.00	0.76	0.24	0.00	0.00	29
	Hatchery	0.00	0.00	0.75	0.25	0.00	0.00	171
2002	Wild	0.00	0.00	0.20	0.80	0.00	0.00	5
	Hatchery	0.00	0.00	0.29	0.71	0.00	0.00	63
2003	Wild	0.00	0.00	0.00	1.00	0.00	0.00	5
	Hatchery	0.00	0.33	0.67	0.00	0.00	0.00	6
2004	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.02	0.93	0.05	0.00	0.00	244
2005	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.13	0.75	0.13	0.00	0.00	8
2006	Wild	0.00	0.00	0.34	0.65	0.01	0.00	207
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	65
2007	Wild	0.00	0.00	0.02	0.88	0.10	0.00	206
	Hatchery	0.00	0.00	0.35	0.65	0.00	0.00	17
2008	Wild	0.00	0.00	0.95	0.04	0.01	0.00	258
	Hatchery	0.00	0.08	0.92	0.00	0.00	0.00	12
2009	Wild	0.00	0.00	0.79	0.21	0.00	0.00	251
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	2
2010	Wild	0.00	0.00	0.67	0.33	0.00	0.00	193
	Hatchery	0.00	0.00	0.98	0.02	0.00	0.00	130
2011	Wild	0.00	0.00	0.63	0.36	0.01	0.00	270
	Hatchery	0.00	0.02	0.96	0.02	0.00	0.00	274
2012	Wild	0.00	0.00	0.92	0.08	0.00	0.00	13
	Hatchery	0.00	0.00	0.96	0.03	0.01	0.00	128
2013	Wild	0.00	0.002	0.56	0.44	0.002	0.00	457
	Hatchery	0.00	0.00	0.50	0.50	0.00	0.00	2
2014	Wild	0.00	0.00	0.88	0.12	0.00	0.00	1,332
	Hatchery	0.00	0.03	0.95	0.02	0.00	0.00	40
2015	Wild	0.00	0.00	0.81	0.19	0.00	0.00	882
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	53
2016	Wild	0.00	0.00	0.77	0.23	0.00	0.00	765
	Hatchery	0.00	0.00	0.00	1.00	0.00	0.00	1
2017	Wild	0.00	0.00	0.49	0.47	0.04	0.00	470
	Hatchery	0.00	0.00	0.50	0.00	0.50	0.00	2
	Wild	***0.00***	***0.00***	***0.70***	***0.29***	***0.01***	***0.00***	***229***

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
Average (1994-2017)	***Hatchery***	***0.00***	***0.01***	***0.90***	***0.09***	***0.00***	***0.00***	***72***
Median (1994-2017)	***Wild***	***0.00***	***0.00***	***0.71***	***0.29***	***0.00***	***0.00***	***71***
	Hatchery	***0.00***	***0.00***	***0.91***	***0.09***	***0.00***	***0.00***	***24***
2018	Wild	0.00	0.00	0.65	0.34	0.01	0.00	412
Average[a]	***Wild***	***0.00***	***0.00***	***0.65***	***0.34***	***0.01***	***0.00***	***412***
Median[a]	***Wild***	***0.00***	***0.00***	***0.65***	***0.34***	***0.01***	***0.00***	***412***

[a] Statistics are from 2018 to present.

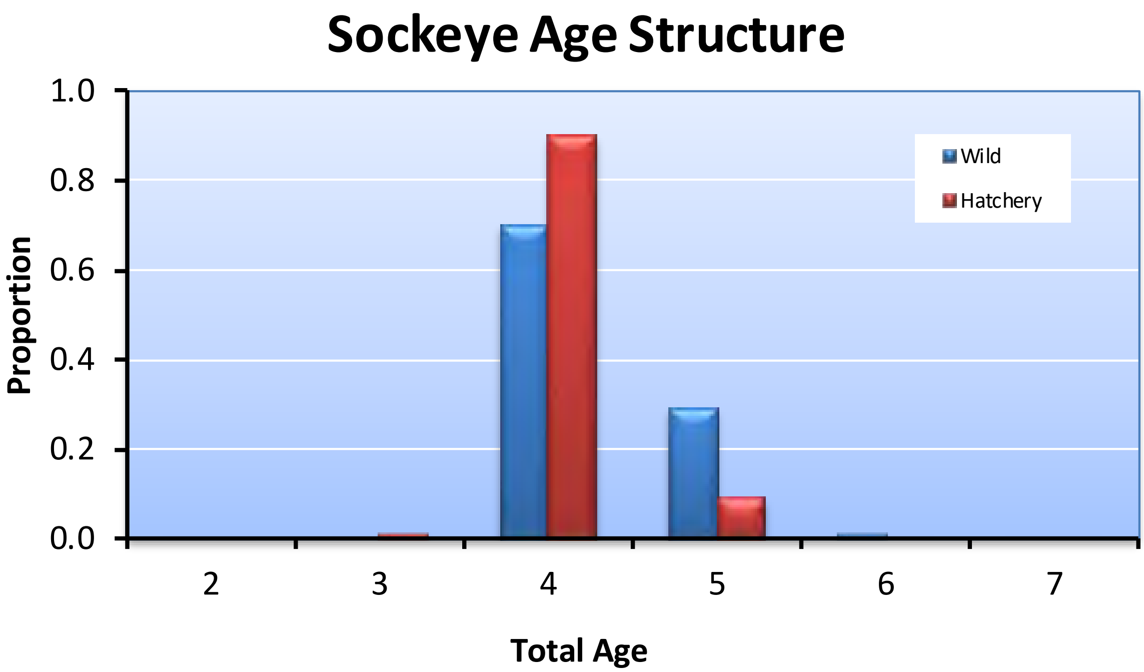


Figure 4.4. Proportions of wild and hatchery sockeye salmon of different total ages sampled at Tumwater Dam and on spawning grounds in the Wenatchee River basin for the combined years 1994-2017.

Size at Maturity

Because no hatchery sockeye returned in 2018, there are no comparisons in sizes between hatchery and wild sockeye in 2018 (Table 4.22). However, for the period 1994-2017, the pooled data indicate that there is little difference in mean sizes of hatchery and wild sockeye salmon, with wild fish slightly greater in length (Table 4.22). Analyses for the five-year statistical reports will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 4.22. Mean lengths (POH; cm) and variability statistics for wild and hatchery sockeye salmon sampled at Dryden Dam (broodstock) and on spawning grounds in the Wenatchee River basin, 1994-2018; SD = 1 standard deviation. From 2014 to present, data are collected from sockeye sampled at Tumwater Dam.

Survey year	Origin	Sample size	Sockeye length (POH; cm)			
			Mean	SD	Minimum	Maximum
1994	Wild	0	-	-	-	-
	Hatchery	14	42	3	37	47
1995	Wild	0	-	-	-	-
	Hatchery	1	53	-	53	53
1996	Wild	0	-	-	-	-
	Hatchery	5	51	3	49	55
1997	Wild	6	40	3	38	45
	Hatchery	17	41	3	37	50
1998	Wild	585	43	3	34	50
	Hatchery	20	43	3	40	51
1999	Wild	99	42	3	36	50
	Hatchery	31	41	3	36	47
2000	Wild	1	48	-	48	48
	Hatchery	377	40	2	30	49
2001	Wild	29	42	2	38	47
	Hatchery	184	43	3	35	51
2002	Wild	5	42	1	40	43
	Hatchery	52	44	3	37	49
2003	Wild	5	44	4	38	47
	Hatchery	13	42	5	30	48
2004	Wild	0	-	-	-	-
	Hatchery	230	40	3	33	49
2005	Wild	0	-	-	-	-
	Hatchery	8	43	9	35	64
2006	Wild	248	45	4	34	52
	Hatchery	17	41	5	31	48
2007	Wild	248	45	3	32	52
	Hatchery	16	41	5	31	48
2008	Wild	261	52	3	44	66
	Hatchery	20	39	3	30	41
2009	Wild	260	43	3	33	53
	Hatchery	22	41	2	36	46
2010	Wild	200	56	3	48	66
	Hatchery	131	41	2	35	45
2011	Wild	277	43	3	35	51

Survey year	Origin	Sample size	Sockeye length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	282	40	3	32	49
2012	Wild	15	40	4	34	48
	Hatchery	130	40	3	31	48
2013	Wild	2	49	3	47	51
	Hatchery	64	50	4	43	65
2014	Wild	1,367	42	2	31	51
	Hatchery	43	41	3	32	45
2015	Wild	920	43	2	37	53
	Hatchery	54	43	2	39	47
2016	Wild	798	43	3	36	51
	Hatchery	1	38	-	38	38
2017	Wild	493	44	3	35	52
	Hatchery	2	44	5	38	49
Pooled (1994-2017)	***Wild***	***5,821***	***45***	***4***	***31***	***66***
	Hatchery	***1,732***	***43***	***4***	***30***	***65***
2018	Wild	429	42	2	35	59
Pooled[a]	***Wild***	***429***	***42***	***2***	***35***	***59***

[a] Statistics are from 2018 to present.

Contribution to Fisheries

The total number of hatchery and wild sockeye captured in different fisheries is provided in Tables 4.23 and 4.24. Harvest on hatchery-origin sockeye has been less than the harvest on wild sockeye.

Table 4.23. Estimated number and percent (in parentheses) of hatchery-origin Wenatchee sockeye captured in different fisheries, brood years 1989-2011. Brood year 2011 was last release of hatchery sockeye salmon into Lake Wenatchee.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1989	0 (0)	279 (30)	4 (0)	639 (69)	922
1990	0 (0)	23 (100)	0 (0)	0 (0)	23
1991	0 (0)	6 (100)	0 (0)	0 (0)	6
1992	0 (0)	38 (97)	1 (3)	0 (0)	39
1993	0 (0)	4 (100)	0 (0)	0 (0)	4
1994	0 (0)	3 (100)	0 (0)	0 (0)	3
1995	0 (0)	10 (100)	0 (0)	0 (0)	10
1996	0 (0)	62 (82)	9 (12)	5 (7)	76
1997	0 (0)	69 (73)	11 (12)	15 (16)	95
1998	0 (0)	7 (100)	0 (0)	0 (0)	7
1999	0 (0)	3 (20)	0 (0)	12 (80)	15

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
2000	0 (0)	59 (12)	9 (2)	414 (86)	482
2001	0 (0)	0 (0)	0 (0)	3 (100)	3
2002	0 (0)	16 (100)	0 (0)	0 (0)	16
2003	0 (0)	3 (100)	0 (0)	0 (0)	3
2004	0 (0)	6 (3)	1 (1)	192 (96)	199
2005	0 (0)	61 (41)	8 (5)	79 (54)	147
2006	0 (0)	124 (23)	2 (0)	409 (76)	535
2007	0 (0)	96 (81)	13 (11)	9 (8)	118
2008	0 (0)	96 (19)	12 (2)	400 (79)	508
2009	0 (0)	20 (16)	2 (2)	104 (83)	126
2010	0 (0)	97 (36)	5 (2)	170 (63)	272
2011	0 (0)	261 (49)	13 (2)	257 (48)	531
Average	***0 (0)***	***58 (60)***	***4 (2)***	***118 (38)***	***180***
Median	***0 (0)***	***23 (73)***	***1 (0)***	***9 (16)***	***76***

[a] Includes the Lake Wenatchee fishery.

Table 4.24. Estimated number and percent (in parentheses) of wild Wenatchee sockeye captured in different fisheries, brood years 1989-2012.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1989	0 (0)	2,192 (31)	26 (0)	4,838 (69)	7,056
1990	0 (0)	191 (100)	0 (0)	0 (0)	191
1991	0 (0)	293 (99)	2 (1)	0 (0)	295
1992	0 (0)	345 (99)	5 (1)	0 (0)	350
1993	0 (0)	661 (99)	4 (1)	0 (0)	665
1994	0 (0)	146 (100)	0 (0)	0 (0)	146
1995	0 (0)	63 (85)	4 (5)	7 (9)	74
1996	0 (0)	1,553 (56)	247 (9)	993 (36)	2,793
1997	0 (0)	3,060 (54)	376 (7)	2,266 (40)	5,702
1998	0 (0)	937 (98)	7 (1)	10 (1)	954
1999	0 (0)	22 (19)	3 (3)	90 (78)	115
2000	0 (0)	1,188 (19)	165 (3)	4,881 (78)	6,234
2001	0 (0)	827 (100)	1 (0)	0 (0)	828
2002	0 (0)	379 (83)	2 (0)	73 (16)	454
2003	0 (0)	129 (24)	14 (3)	383 (73)	526
2004	0 (0)	1,559 (24)	173 (3)	4,825 (74)	6,557
2005	0 (0)	2,498 (44)	197 (3)	2,996 (53)	5,691

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
2006	0 (0)	2,845 (52)	135 (2)	2,505 (46)	5,485
2007	0 (0)	1,534 (57)	216 (8)	976 (36)	2,726
2008	0 (0)	5,069 (26)	596 (3)	13,560 (71)	19,225
2009	0 (0)	1,204 (19)	94 (1)	5,336 (80)	6,670
2010	0 (0)	5,303 (25)	292 (1)	15,615 (74)	21,210
2011	0 (0)	6,691 (40)	369 (2)	9,566 (58)	16,626
2012	0 (0)	4,165 (26)	320 (2)	11,254 (72)	15,739
Average	***0 (0)***	***1,684 (60)***	***127 (3)***	***2,997 (38)***	***4,808***
Median	***0 (0)***	***1,188 (54)***	***26 (2)***	***976 (40)***	***2,726***

[a] Includes the Lake Wenatchee fishery.

Straying

Stray rates of hatchery-origin sockeye were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin for return years 2008-2017. In addition, PIT tagging of hatchery sockeye, which began with brood year 2005, allows estimation of stray rates by return year and brood return. Targets for strays based on return year (recovery year) outside the Wenatchee River basin should be less than 5%.

Based on return year and PIT-tag analysis, hatchery-origin Wenatchee sockeye have strayed into the Methow and Okanogan basins, but these hatchery fish made up less than 1% of the run escapement upstream from Wells Dam (Table 4.25).

Table 4.25. Number and percent of run escapement within other non-target basins that consisted of hatchery-origin Wenatchee sockeye salmon, return years 2008-2017. For example, for return year 2015, 0.46% of the sockeye run escapement upstream of Wells Dam consisted of hatchery-origin Wenatchee sockeye. Percent strays should be less than 5%.

Return year	Methow and Okanogan Run Escapement		
	Run escapement*	Expanded detections	Percent
2008	165,334	0	0.00
2009	134,937	57	0.04
2010	291,764	183	0.06
2011	111,508	51	0.05
2012	326,107	75	0.02
2013	129,993	78	0.06
2014	490,804	0	0.00
2015	187,055	858	0.46
2016	216,036	0	0.00
2017	42,299	0	0.00
Average	***209,584***	***130***	***0.07***
Median	***176,195***	***54***	***0.03***

* Run escapement estimated at Wells Dam.

Based on CWTs and brood-year analysis, virtually no hatchery-origin Wenatchee sockeye strayed into non-target spawning areas or hatchery programs before brood year 2006 (Table 4.26).[13] However, sockeye from brood years 2006 through 2011 strayed into the Entiat River and a few into the Methow River (non-target streams) and non-target hatcheries (Umpqua Trap, Chief Joseph Hatchery, and Entiat National Fish Hatchery) (Table 4.26). The number of returning hatchery sockeye has decreased since brood year 2008. Because carcass surveys in the Wenatchee River basin ended in 2013, the last brood-year homing estimate based on CWTs is 2009.

Table 4.26. Number and percent of hatchery-origin Wenatchee sockeye that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs, by brood years 1990-2009. Hatchery-origin sockeye from brood years 1995-1998 were not tagged because of columnaris disease (NA = not available).

Brood year	Homing				Straying			
	Target streams		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1990	402	99.5	2	0.5	0	0.0	0	0.0
1991	1	100.0	0	0.0	0	0.0	0	0.0
1992	92	98.9	0	0.0	0	0.0	1	1.1
1993	29	96.7	1	3.3	0	0.0	0	0.0
1994	66	94.3	4	5.7	0	0.0	0	0.0
1995	NA	NA	NA	NA	NA	NA	NA	NA
1996	NA	NA	NA	NA	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA	NA	NA	NA
1999	65	100.0	0	0.0	0	0.0	0	0.0
2000	571	100.0	0	0.0	0	0.0	0	0.0
2001	17	100.0	0	0.0	0	0.0	0	0.0
2002	251	100.0	0	0.0	0	0.0	0	0.0
2003	11	100.0	0	0.0	0	0.0	0	0.0
2004	56	100.0	0	0.0	0	0.0	0	0.0
2005	67	97.1	2	2.9	0	0.0	0	0.0
2006	117	41.9	0	0.0	160	57.3	2	0.7
2007	260	82.0	1	0.3	56	17.7	0	0.0
2008	86	90.5	0	0.0	9	9.5	0	0.0
2009	11	73.3	0	0.0	4	26.7	0	0.0
2010	NA	NA	0	0.0	2	100.0	0	0.0
2011	NA	NA	0	0.0	2	8.0	23	92.0
Average	***131***	***92.1***	***1***	***0.7***	***13***	***12.2***	***1***	***5.2***

[13] This is likely because few sockeye surveys were conducted in non-target streams (e.g., Entiat and Methow rivers) before the return of brood year 2016.

Brood year	Homing				Straying			
	Target streams		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
Median	***67***	***99.2***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery sockeye that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish were collected at Tumwater Dam.

Based on PIT-tags and brood-year analyses, on average, about 11% of the hatchery sockeye returns were last detected in streams outside the Wenatchee River basin (Table 4.27). The numbers in Table 4.27 should be considered rough estimates because they are not based on confirmed spawning (only last detections). Nevertheless, these data do indicate that some hatchery sockeye from the Wenatchee program have strayed into the Entiat and Methow rivers and possibly into the Okanogan system (based on sockeye detected at Wells Dam but not in the Methow River).

Table 4.27. Number and percent of hatchery-origin Wenatchee sockeye that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2005-2012. Estimates were based on last detections of PIT-tagged hatchery sockeye.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	1,561	92.2	0	0.0	132	7.8	0	0.0
2006	6,680	94.6	0	0.0	382	5.4	0	0.0
2007	3,239	95.0	0	0.0	169	5.0	0	0.0
2008	1,281	89.1	0	0.0	156	10.9	0	0.0
2009	645	82.0	0	0.0	141	18.0	0	0.0
2010	2,544	100.0	0	0.0	0	0.0	0	0.0
2011	3,331	72.5	0	0.0	1,262	27.5	0	0.0
Average	***2,754***	***89.4***	***0***	***0.0***	***320***	***10.6***	***0***	***0.0***
Median	***2,544***	***92.2***	***0***	***0.0***	***156***	***7.8***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery sockeye that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish were collected at Tumwater Dam.

Genetics

Genetic studies were conducted in 2008 to determine the potential effects of the Wenatchee sockeye supplementation program on natural-origin sockeye in the upper Wenatchee River basin (Blankenship et al. 2008; the entire report is appended as Appendix K). Specifically, the objective of the study was to determine if the genetic composition of the Lake Wenatchee sockeye population had been altered by the supplementation program, which was based on the artificial propagation of a small subset of the Wenatchee population. Microsatellite DNA allele frequencies were used to differentiate between temporally replicated collections of natural and hatchery-origin sockeye in the Wenatchee River basin. A total of 13 collections of Wenatchee sockeye were analyzed; eight temporally replicated collections of natural-origin sockeye (N = 786) and five temporally replicated collections of hatchery-origin sockeye (N = 248). Paired natural-hatchery collections were available from return years 2000, 2001, 2004, 2006, and 2007. All collections were taken at Tumwater Dam and consisted of dried scales and fin clips.

Overall, the study showed that allele frequency distributions were consistent over time, regardless of origin, resulting in small, insignificant measures of genetic differentiation among collections. This indicates that there were no year-to-year differences in allele frequencies between natural and hatchery-origin sockeye. In addition, the analyses found no differences between pre- and post-supplementation collections. Thus, it was concluded that the allele frequencies of the broodstock collections equaled the allele frequency of the natural collections.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

The PNI values for the life of the program (brood years 1989-2011) are shown in Table 4.28. Throughout the program, PNI was consistently greater than 0.67. The hatchery program was terminated in 2012.

Table 4.28. Proportionate Natural Influence (PNI) values for the Wenatchee sockeye supplementation program for brood years 1989-2018. NOS = number of natural-origin sockeye counted at Tumwater Dam; HOS = number of hatchery-origin sockeye counted at Tumwater Dam; NOB = number of natural-origin sockeye collected for broodstock; and HOB = number of hatchery-origin sockeye included in hatchery broodstock. NP = no hatchery program.

Brood year	Escapement[a]			Broodstock			PNI[b]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	21,802	0	0.00	115	0	1.00	1.00
1990	27,325	0	0.00	302	0	1.00	1.00
1991	26,689	0	0.00	199	0	1.00	1.00
1992	16,461	0	0.00	320	0	1.00	1.00
1993	25,064	2,662	0.10	207	0	1.00	0.91
1994	6,934	396	0.05	236	5	0.98	0.95
1995	3,262	186	0.05	194	3	0.98	0.95
1996	6,027	546	0.08	225	0	1.00	0.93
1997	8,376	68	0.01	192	19	0.91	0.99
1998	3,982	32	0.01	122	6	0.95	0.99
1999	961	64	0.06	79	60	0.57	0.91
2000	19,620	1,164	0.06	170	5	0.97	0.94

Brood year	Escapement[a]			Broodstock			PNI[b]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
2001	28,288	815	0.03	200	7	0.97	0.97
2002	27,371	193	0.01	256	0	1.00	0.99
2003	4,797	58	0.01	198	0	1.00	0.99
2004	26,095	1,460	0.05	177	0	1.00	0.95
2005	13,983	28	0.00	166	0	1.00	1.00
2006	9,182	255	0.03	214	0	1.00	0.97
2007	2,320	59	0.02	210	0	1.00	0.98
2008	22,931	92	0.00	243	2	0.99	1.00
2009	13,043	445	0.03	239	0	1.00	0.97
2010	30,357	1,134	0.04	198	0	1.00	0.96
2011	17,490	940	0.05	196	0	1.00	0.95
Average	***15,755***	***461***	***0.03***	***203***	***5***	***0.97***	***0.97***
Median	***16,461***	***186***	***0.03***	***199***	***0***	***1.00***	***0.97***
2012	30,903	502	0.02	NP	NP	NP	NP
2013	22,118	614	0.03	NP	NP	NP	NP
2014	81,804	1840	0.02	NP	NP	NP	NP
2015	42,132	1528	0.03	NP	NP	NP	NP
2016	59,008	59	0.00	NP	NP	NP	NP
2017	23,844	10	0.00	NP	NP	NP	NP
2018	13,960	16	0.00	NP	NP	NP	NP
Average	***39,110***	***653***	***0.01***	***NP***	***NP***	***NP***	***NP***
Median	***30,903***	***502***	***0.02***	***NP***	***NP***	***NP***	***NP***

[a] Proportions of natural-origin and hatchery-origin spawners were determined from reading video tape at Tumwater Dam, adjusted for fish harvested in the Lake Wenatchee recreational fishery.

[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery sockeye salmon from Lake Wenatchee to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 4.29).[14] Over the seven brood years for which PIT-tagged hatchery fish were released, survival rates from Lake Wenatchee to McNary Dam ranged from 0.211 to 0.370; SARs from release to detection at Bonneville Dam ranged from 0.005 to 0.044. Average travel time from Lake Wenatchee to McNary Dam ranged from 176 to 202 days.

[14] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Table 4.29. Total number of hatchery sockeye parr released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2011. Standard errors are shown in parentheses.

Brood year	Number of sockeye released with PIT tags	Survival to McNary Dam	Travel time[1] to McNary Dam (d)	SAR to Bonneville Dam
2005	14,859	0.334 (0.013)	176.4 (61.9)	0.020 (0.001)
2006	14,764	0.370 (0.030)	202.0 (9.1)	0.044 (0.002)
2007	14,947	0.312 (0.013)	199.9 (8.6)	0.024 (0.001)
2008	14,858	0.307 (0.020)	192.9 (35.7)	0.015 (0.001)
2009	14,486	0.211 (0.015)	194.2 (29.1)	0.005 (0.001)
2010	5,039	0.302 (0.048)	191.7 (26.6)	0.014 (0.002)
2011	5,074	0.318 (0.038)	196.7 (7.3)	0.036 (0.003)

[1] Travel time is calculated from the date of release from the net pens in the fall, overwintering in Lake Wenatchee, to spring outmigration.

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population. Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2012, NRR in the Wenatchee averaged 1.64 (range, 0.13-5.72) if harvested fish were not included in the estimate and 1.97 (range, 0.14-6.86) if harvested fish were included in the estimate (Table 4.30).

Hatchery replacement rates (HRR) were estimated as hatchery adult-to-adult returns. These rates should be greater than the NRRs and greater than or equal to 5.4 (the calculated target value in Hillman et al. 2017). The target value of 5.4 includes harvest. HRRs exceeded NRRs in 15 or 16 of the 23 years of data depending on if harvest was or was not included in the estimates (Table 4.30). Hatchery replacement rates for Wenatchee sockeye have equaled or exceeded the estimated target value of 5.4 in six of the 23 years (Table 4.30).

Table 4.30. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for sockeye salmon in the Wenatchee River basin, 1989-2012.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	255	21,802	2,757	23,616	10.81	1.08	3,680	30,672	14.43	1.41
1990	316	27,325	401	3,509	1.27	0.13	423	3,701	1.34	0.14
1991	233	26,689	95	4,820	0.41	0.18	101	5,116	0.43	0.19
1992	343	16,461	576	5,336	1.68	0.32	615	5,685	1.79	0.35
1993	307	27,726	71	11,151	0.23	0.40	75	11,815	0.24	0.43

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1994	265	7,330	47	1,191	0.18	0.16	50	1,337	0.19	0.18
1995	209	3,448	121	840	0.58	0.24	131	913	0.63	0.26
1996	227	6,573	1,351	28,093	5.95	4.27	1,427	30,886	6.29	4.70
1997	226	8,444	739	36,097	3.27	4.27	834	41,798	3.69	4.95
1998	190	4,014	104	16,165	0.55	4.03	111	17,120	0.58	4.27
1999	147	1,025	68	566	0.46	0.55	83	682	0.56	0.67
2000	195	20,784	1,425	29,082	7.31	1.40	1,907	35,316	9.78	1.70
2001	245	29,103	24	17,241	0.10	0.59	28	18,068	0.11	0.62
2002	257	27,564	281	5,752	1.09	0.21	297	6,207	1.16	0.23
2003	219	4,855	32	2,054	0.15	0.42	35	2,590	0.16	0.53
2004	202	27,555	94	23,589	0.47	0.86	293	30,148	1.45	1.09
2005	207	14,011	460	20,793	2.22	1.48	606	26,485	2.93	1.89
2006	220	9,437	1,147	26,966	5.21	2.86	1,682	32,450	7.65	3.44
2007	228	2,379	917	13,619	4.02	5.72	1,037	16,312	4.55	6.86
2008	260	23,023	808	38,327	3.11	1.66	1,314	57,552	5.05	2.50
2009	261	13,488	344	22,202	1.32	1.65	469	28,871	1.80	2.14
2010	201	31,491	1,748	80,037	8.70	2.54	2,020	101,247	10.05	3.22
2011	204	18,430	1,658	48,079	8.13	2.61	2,190	64,659	10.74	3.51
2012	0	31,405	--	55,372	--	1.76	--	71,002	--	2.26
Average	***236***	***16,848***	***664***	***21,437***	***2.92***	***1.64***	***844***	***26,693***	***3.72***	***1.97***
Median	***227***	***17,446***	***401***	***19,017***	***1.32***	***1.24***	***469***	***22,277***	***1.79***	***1.41***

Juvenile-to-Adult Survivals

When possible, both parr-to-adult ratios (PAR) and smolt-to-adult ratios (SAR) were calculated for hatchery sockeye salmon. Ratios were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery parr released or the estimated number of smolts emigrating from Lake Wenatchee. Here, survival ratios were based on CWT returns, when available, or on the estimated number of hatchery adults recovered on the spawning grounds, in broodstock, and harvested. For the available brood years, PARs have ranged from 0.0001 to 0.0339 for hatchery sockeye salmon and SARs have ranged from 0.0002 to 0.0255 (Table 4.31).

Table 4.31. Parr-to-adult ratios (PAR) and smolt-to-adult ratios (SAR) for Wenatchee hatchery sockeye salmon, brood years 1990-2011; NA = not available.

Brood year	Number of parr released	Number of smolts	Estimated adult recaptures	PAR	SAR
1989	108,400	NA	3,680	0.0339	NA
1990	270,802	NA	423	0.0016	NA
1991	167,523	NA	101	0.0006	NA
1992	340,597	NA	615	0.0018	NA
1993	190,443	NA	75	0.0004	NA
1994	252,859	NA	50	0.0002	NA
1995	150,808	28,828	131	0.0009	0.0045

Brood year	Number of parr released	Number of smolts	Estimated adult recaptures	PAR	SAR
1996	284,630	55,985	1,427	0.0050	0.0255
1997	197,195	112,524	834	0.0042	0.0074
1998	121,344	24,684	111	0.0009	0.0045
1999	167,955	94,046	83	0.0005	0.0009
2000	190,174	121,511	1,907	0.0100	0.0157
2001	200,938	140,322	28	0.0001	0.0002
2002	315,783	216,023	297	0.0009	0.0014
2003	240,459	122,399	35	0.0001	0.0003
2004	172,923	159,500	293	0.0017	0.0018
2005	140,542	140,542	606	0.0043	0.0043
2006	225,670	121,843	1,682	0.0075	0.0138
2007	252,133	119,908	1,037	0.0041	0.0086
2008	154,772	126,326	1,314	0.0085	0.0104
2009	227,743	159,089	469	0.0021	0.0027
2010	241,918	NA	2,020	0.0083	NA
2011	256,120	NA	2,190	0.0086	NA
Average	***211,814***	***116,235***	***844***	***0.0046***	***0.0068***
Median	***200,938***	***121,843***	***469***	***0.0018***	***0.0045***

4.8 ESA/HCP Compliance

Smolt and Emigrant Trapping

ESA-listed spring Chinook and steelhead were encountered during operation of the Lower Wenatchee trap. ESA takes are reported in the steelhead (Section 3.8) and spring Chinook (Section 5.8) sections and will not be repeated here.

SECTION 5: WENATCHEE (CHIWAWA) SPRING CHINOOK

The goal of Chiwawa spring Chinook salmon supplementation is to achieve “No Net Impact” to the productivity of spring Chinook caused by the operation of the Rock Island Hydroelectric Project. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Rock Island and Rocky Reach Anadromous Fish Agreement and Habitat Conservation Plans.

Adult spring Chinook are collected for broodstock at the Chiwawa Weir and Tumwater Dam. From 2011 through 2013, all spring Chinook broodstock were collected at the Chiwawa Weir in order to reduce passage delays caused by trapping at Tumwater Dam. Before 2009, the goal was to collect up to 379 adult spring Chinook for the program with natural-origin fish making up not less than 33% of the broodstock. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (beginning with brood year 2013) is to collect 74 natural-origin spring Chinook. The number collected cannot exceed 33% of the natural-origin spring Chinook returns to Tumwater. Beginning in 2014, previously PIT-tagged natural-origin Chiwawa spring Chinook are collected at Tumwater Dam, while the Chiwawa Weir is used to collect the remaining natural-origin brood required for the Chiwawa spring Chinook program. Broodstock collection occurs from May through 15 July at Tumwater with trapping occurring up to 24 hours per day, seven days a week and at the Chiwawa Weir with trapping occurring from 15 June to 1 August (not to exceed 15 cumulative trapping days) on a 24-hour-up/24-hour-down schedule consistent with annual broodstock collection protocols.

Adult spring Chinook are spawned and reared at Eastbank Fish Hatchery. Juvenile spring Chinook are transferred from the hatchery to the Chiwawa Acclimation Facility in late September or early October. Volitional releases are initiated in April of the following spring and any fish that remain are forced out by early May.

The production goal for the Chiwawa spring Chinook supplementation program up to brood year 2009 was to release 672,000 yearling smolts into the Chiwawa River at 12 fish per pound. Brood years 2010-2011, and 2012 were transition years to a reduced program of 298,000 smolts and 205,000 smolts, respectively. Beginning with the 2013 brood, the revised production goal is to release 144,026 smolts as part of a conservation program at 18 fish per pound. Targets for fork length and weight are 155 mm (CV = 9.0) and 37.8 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2006, juvenile spring Chinook have been PIT tagged annually.

With issuance of ESA Section 10 permits in 2013, adult management (i.e., removal of excess hatchery-origin adults at dams, traps, and weirs, and in conservation fisheries) was implemented in 2014 to achieve pHOS and PNI goals for the Chiwawa spring Chinook program.

Although this section of the report focuses on results from monitoring the Chiwawa spring Chinook program, information on spring Chinook collected throughout the Wenatchee River basin is also provided. Information specific to the Nason Creek spring Chinook conservation program is presented in Section 6 and the White River Captive Broodstock Program is presented in Section 7.

5.1 Broodstock Sampling

This section focuses on results from sampling 2016-2018 Chiwawa spring Chinook broodstock, which were collected at the Chiwawa Weir and at Tumwater Dam, consistent with methods in the broodstock collections protocols (Tonseth 2018). Some information for the 2018 return is not available at this time (e.g., age structure and final origin determination). This information will be provided in the 2019 annual report.

Origin of Broodstock

Natural-origin adults made up between 31.0% and 73.5% of the Chiwawa spring Chinook broodstock spawned for brood years 2016-2018 (Table 5.1). Natural and hatchery-origin adults were collected at Tumwater Dam and the Chiwawa Weir for return year 2018. Broodstock were trapped at Tumwater Dam from end of-May through mid-July 2018, and at the Chiwawa Weir from mid-June through early August. Hatchery-origin broodstock were collected at Tumwater Dam in 2018 to meet the Nason Creek Conservation and Safety Net broodstock requirements and to fill potential shortfalls of natural-origin broodstock requirements for the Chiwawa River Conservation program. Additional hatchery-origin broodstock were collected to ensure production obligations were achieved in the event that insufficient natural-origin collections could be made. A total of 21 hatchery-origin fish collected in 2018 were surplused at Eastbank Fish Hatchery.

Table 5.1. Numbers of wild and hatchery Chiwawa spring Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, 1989-2018. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced.

Brood year	Wild spring Chinook					Hatchery spring Chinook						Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Number surplused	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	28	0	0	28	0	0	0	0	0	0	0	28
1990	19	1	0	18	0	0	0	0	0	0	0	18
1991	32	0	5	27	0	0	0	0	0	0	0	27
1992	113	0	0	78	35	0	0	0	0	0	0	78
1993	100	3	3	94	0	0	0	0	0	0	0	94
1994	9	0	1	8	0	4	0	0	0	4	0	12
1995	No Program											
1996	8	0	0	8	0	10	0	0	0	10	0	18
1997	37	0	5	32	0	83	0	1	3	79	0	111
1998	13	0	0	13	0	35	0	1	0	34	0	47
1999	No Program											
2000	10	0	1	9	0	38	0	1	16	21	0	30
2001	115	2	0	113	0	267	0	8	0	259	0	372
2002	21	0	1	20	0	63	0	1	11	51	0	71
2003	44	1	2	41	0	75	0	2	20	53	0	94
2004	100	1	16	83	0	196	0	30	34	132	0	215
2005	98	1	6	91	0	185	0	3	1	181	0	279
2006	95	0	4	91	0	303	0	0	29	224	50	315
2007	45	1	1	43	0	124	0	2	18	104	0	147
2008	88	2	3	83	0	241	0	5	16	220	0	303
2009	113	6	11	96	0	151	0	3	37	111	0	207
2010	83	0	6	77	0	103	0	0	5	98	0	175
2011	80	0	0	80	0	101	0	2	6	93	0	173
Average[b]	***60***	***1***	***3***	***54***	***2***	***94***	***0***	***3***	***9***	***80***	***2***	***134***

Brood year	Wild spring Chinook					Hatchery spring Chinook						Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Number surplused	Prespawn loss[a]	Mortality	Number spawned	Number released	
Median[b]	***45***	***0***	***1***	***43***	***0***	***75***	***0***	***1***	***3***	***53***	***0***	***94***
2012	75	1	1	73	0	41	1	3	0	38	0	111
2013	170	5	0	70	95	52	296	1	50	0	1	70
2014[d]	61	0	0	61	0	203	1,145	1	68	134	0	195
2015[e]	81	1	7	72	1	47	291	0	3	37	7	109
2016	62	0	0	62	0	61	788	2	24	37	0	99
2017	50	0	0	50	0	66	383	0	25	18	23	68
2018	37	2	0	31	4	70	211	0	1	69	0	100
Average[c]	***76.6***	***1.3***	***1.1***	***59.9***	***14.3***	***77.1***	***416***	***1.0***	***24.4***	***47.4***	***4.4***	***107.4***
Median[c]	***62.0***	***1.0***	***0***	***62.0***	***0***	***61.0***	***294***	***1.0***	***24.0***	***37.0***	***0.0***	***100***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] The average and median represent the program before recalculation in 2011.
[c] The average and median represent the current program, which began in 2012. Origin determinations should be considered preliminary pending scale analyses.
[d] HOR Chiwawa spring Chinook were collected to meet both Chiwawa and Nason Creek obligations; broodstock and subsequent progeny were pooled together in the hatchery. About 12 Chiwawa HOR's were used to fulfill the Chiwawa Program; about 122 Chiwawa HOR's were used to fulfill the Nason Creek safety net obligation.
[e] For the Chiwawa program, 36 hatchery-origin returns were collected in case the program fell short on natural-origin returns. After eye-up, all of the hatchery-origin recruit eggs were culled because fecundity of natural-origin recruits was high enough to meet the WxW program.

Age/Length Data

Ages were determined from scales and/or coded wire tags (CWT) collected from broodstock. For both the 2017 and 2018 returns, most adults, regardless of origin, were age-4 Chinook (Table 5.2). All age-5 Chinook were natural-origin fish. There were no age-3 natural- or hatchery-origin Chinook collected for broodstock in 2018.

Table 5.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 1991-2018.

Return year	Origin	Total age			
		2	3	4	5
1991	Wild	0.0	0.0	22.0	78.0
	Hatchery	0.0	0.0	0.0	0.0
1992	Wild	0.0	0.0	28.6	71.4
	Hatchery	0.0	0.0	50.0	50.0
1993	Wild	0.0	0.0	22.0	78.0
	Hatchery	0.0	0.0	0.0	0.0
1994	Wild	0.0	0.0	28.6	71.4
	Hatchery	0.0	0.0	50.0	50.0
1995	Wild	No program			
	Hatchery				
1996	Wild	0.0	28.6	71.4	0.0
	Hatchery	0.0	50.0	50.0	0.0
1997	Wild	0.0	0.0	87.5	12.5

Return year	Origin	Total age			
		2	3	4	5
	Hatchery	0.0	1.2	98.8	0.0
1998	Wild	0.0	0.0	63.6	36.4
	Hatchery	0.0	0.0	62.9	37.1
1999	Wild	No program			
	Hatchery				
2000	Wild	0.0	20.0	70.0	10.0
	Hatchery	0.0	59.1	40.9	0.0
2001	Wild	0.0	2.8	94.4	2.8
	Hatchery	0.0	1.5	98.5	0.0
2002	Wild	0.0	0.0	66.7	33.3
	Hatchery	0.0	0.0	93.4	6.6
2003	Wild	0.0	27.0	2.7	70.3
	Hatchery	0.0	21.3	5.3	73.3
2004	Wild	1.0	6.1	88.8	4.1
	Hatchery	0.0	40.4	59.6	0.0
2005	Wild	0.0	1.0	85.0	14.0
	Hatchery	0.0	4.4	95.6	0.0
2006	Wild	0.0	2.0	70.4	27.6
	Hatchery	0.0	1.3	81.2	17.4
2007	Wild	0.0	15.6	53.3	31.1
	Hatchery	0.0	27.4	60.5	12.1
2008	Wild	0.0	6.3	78.8	15.0
	Hatchery	0.0	8.2	86.8	4.9
2009	Wild	0.0	8.6	79.0	12.4
	Hatchery	0.0	18.5	79.5	2.0
2010	Wild	0.0	5.3	94.7	0.0
	Hatchery	0.0	0.0	99.0	1.0
2011	Wild	0.0	2.7	52.7	44.6
	Hatchery	0.0	20.4	60.2	19.4
2012	Wild	0.0	0.0	79.0	21.0
	Hatchery	0.0	4.3	95.7	0.0
2013	Wild	0.0	0.0	65.7	34.3
	Hatchery	0.0	2.2	86.7	11.1
2014	Wild	0.0	0.0	91.2	8.8
	Hatchery[a]	0.0	0.0	98.5	1.5
2015	Wild	0.0	0.0	88	11.0
	Hatchery[a]	0.0	0.0	100	0.0
2016	Wild	0.0	0.0	82.6	17.4

Return year	Origin	Total age			
		2	3	4	5
	Hatchery[a]	0.0	0.0	85.0	15.0
2017	Wild	0.0	4.3	87.2	8.5
	Hatchery[a]	0.0	9.5	88.1	2.4
2018	Wild	0.0	0.0	83.3	16.7
	Hatchery[a]	0.0	0.0	100	0
Average	***Wild***	***0***	***5.0***	***66.8***	***28.1***
	Hatchery	***0***	***10.4***	***70.2***	***11.7***
Median	***Wild***	***0***	***0.5***	***75.1***	***17.1***
	Hatchery	***0***	***1.4***	***83.1***	***1.8***

[a] Comprised of age results for both Chiwawa and Nason Creek obligations.

There was a small difference in mean lengths between hatchery and natural-origin broodstock of age-4 and age-5 Chinook in 2017. Age-4 hatchery-origin Chinook were slightly larger than natural-origin fish, whereas age-5 natural-origin Chinook were slightly larger than hatchery-origin fish. In 2018, no age-3 fish were included in natural or hatchery-origin broodstock. Additionally, there were no age-5 hatchery-origin fish included in broodstock in 2018 (Table 5.3).

Table 5.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 1991-2018; N = sample size and SD = 1 standard deviation.

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	-	0	-	-	5	-	-	19	-	-	8	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1992	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	-	0	-	79	4	3	92	8	4
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1994	Wild	-	0	-	-	0	-	79	2	3	96	5	6
	Hatchery	-	0	-	-	0	-	82	2	11	92	2	2
1995	Wild	No program											
	Hatchery												
1996	Wild	-	0	-	51	2	1	79	5	7	-	0	-
	Hatchery	-	0	-	56	5	4	74	5	6	-	0	-
1997	Wild	-	0	-	-	0	-	80	28	5	99	4	8
	Hatchery	-	0	-	56	1	-	82	82	4	-	0	-
1998	Wild	-	0	-	-	0	-	78	7	13	83	4	18
	Hatchery	-	0	-	-	0	-	77	22	8	93	13	7
1999	Wild	No program											
	Hatchery												

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2000	Wild	-	0	-	51	2	3	82	7	4	98	1	-
	Hatchery	-	0	-	59	13	4	79	9	8	-	0	-
2001	Wild	-	0	-	49	3	6	82	101	6	95	3	3
	Hatchery	-	0	-	56	4	7	83	261	5	-	0	-
2002	Wild	-	0	-	-	0	-	79	12	4	96	6	10
	Hatchery	-	0	-	-	0	-	81	57	6	94	4	9
2003	Wild	-	0	-	55	10	5	83	1	-	99	26	6
	Hatchery	-	0	-	59	16	5	86	4	18	96	55	6
2004	Wild	47	1	-	60	6	6	80	87	5	99	4	3
	Hatchery	-	0	-	51	80	7	80	118	5	-	0	-
2005	Wild	-	0	-	49	1	-	80	85	6	96	14	8
	Hatchery	-	0	-	56	8	5	82	175	6	-	0	-
2006	Wild	-	0	-	50	2	2	79	69	7	97	27	5
	Hatchery	-	0	-	46	1	-	80	205	6	95	43	7
2007	Wild	-	0	-	54	7	3	79	24	6	93	14	7
	Hatchery	-	0	-	59	34	8	81	75	5	93	15	7
2008	Wild	-	0	-	54	5	9	83	63	5	93	12	6
	Hatchery	-	0	-	56	20	10	82	211	6	96	12	7
2009	Wild	-	0	-	52	9	6	81	83	5	94	13	6
	Hatchery	-	0	-	56	28	6	82	120	5	87	3	11
2010	Wild	-	0	-	58	4	9	80	72	6	-	0	-
	Hatchery	-	0	-	-	0	-	82	102	6	101	1	-
2011	Wild	-	0	-	56	2	3	79	39	5	95	33	7
	Hatchery	-	0	-	63	21	7	80	62	6	95	20	6
2012	Wild	-	0	-	-	0	-	81	49	6	97	13	8
	Hatchery	-	0	-	51	2	0	80	41	5	-	0	-
2013	Wild	-	0	-	-	1	-	74	44	6	92	23	8
	Hatchery	-	0	-	60	1	-	78	39	6	88	5	7
2014	Wild	-	0	-	-	0	-	82	52	7	93	5	6
	Hatchery[a]	-	0	-	-	0	-	81	192	6	85	3	2
2015	Wild	-	0	-	-	0	-	83	45	4	93	10	5
	Hatchery	-	0	-	-	0	-	80	35	6	-	0	-
2016	Wild	-	0	-	-	-	-	80	38	6	97	8	5
	Hatchery	-	0	-	-	-	-	83	51	6	94	9	4
2017	Wild	-	0	-	65	2	1	82	41	6	98	4	6
	Hatchery	-	0	-	65	4	1	85	37	7	95	1	-
2018	Wild	-	0	-	-	0	-	80	27	8	95	6	13

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	81	70	5	-	0	-
Average	***Wild***	***47***	***0***	***-***	***54***	***2***	***5***	***80***	***39***	***6***	***95***	***10***	***7***
	Hatchery	***-***	***0***	***-***	***57***	***10***	***6***	***81***	***76***	***7***	***93***	***7***	***6***

[a] Comprised of age results from HOR's used for both Chiwawa and Nason Creek obligations.

Sex Ratios

Male spring Chinook in the 2016-2018 return years made up 47.2%, 50.9%, and 50.5%, respectively, of the adults collected. This resulted in overall male to female ratios of 0.89:1.00, 1.04:1.00, and 1.02:1.00, respectively (Table 5.4). For the 2018 return year, there was a higher proportion of natural-origin males collected, whereas hatchery-origin fish consisted of a slightly lower proportion of males than females (Table 5.4).

Table 5.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 1989-2018. Ratios of males to females are also provided.

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	11	17	0.65:1.00	-	-	-	0.65:1.00
1990	7	12	0.58:1.00	-	-	-	0.58:1.00
1991	13	19	0.68:1.00	-	-	-	0.68:1.00
1992	39	39	1.00:1.00	-	-	-	1.00:1.00
1993	50	50	1.00:1.00	-	-	-	1.00:1.00
1994	5	4	1.25:1.00	2	2	1.00:1.00	1.17:1.00
1995	No program						
1996	6	2	3.00:1.00	8	2	4.00:1.00	3.50:1.00
1997	14	23	0.61:1.00	34	49	0.69:1.00	0.67:1.00
1998	9	4	2.25:1.00	18	17	1.06:1.00	1.29:1.00
1999	No program						
2000	5	5	1.00:1.00	32	6	5.33:1.00	3.36:1.00
2001	45	70	0.64:1.00	90	177	0.51:1.00	0.55:1.00
2002	9	12	0.75:1.00	30	33	0.91:1.00	0.87:1.00
2003	28	16	1.75:1.00	42	33	1.27:1.00	1.43:1.00
2004	58	42	1.38:1.00	102	94	1.09:1.00	1.18:1.00
2005	58	40	1.45:1.00	89	96	0.93:1.00	1.08:1.00
2006	49	46	1.07:1.00	123	179	0.69:1.00	0.77:1.00
2007	20	25	0.80:1.00	66	58	1.14:1.00	1.04:1.00
2008	41	47	0.87:1.00	109	132	0.83:1.00	0.84:1.00
2009	53	60	0.88:1.00	79	72	1.10:1.00	1.00:1.00
2010	41	42	0.98:1.00	53	50	1.06:1.00	1.02:1.00
2011	38	42	0.90:1.00	53	48	1.10:1.00	1.01:1.00

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2012	35	40	0.87:1.00	20	21	0.95:1.00	0.90:1.00
2013	83	87	0.95:1.00	26	26	1.00:1.00	0.96:1.00
2014[a]	29	32	0.91:1.00	101	102	0.99:1.00	0.97:100
2015	44	36	1.22:1.00	24	23	1.04:1.00	1.15:1.00
2016	29	33	0.88:1.00	29	32	0.90:1.00	0.89:1.00
2017	24	26	0.92:1.00	35	31	1.13:1.00	1.04:1.00
2018	22	15	1.46:1.00	32	38	0.84:1.00	1.02:1.00
Total	***865***	***886***	***0.98:1.00***	***1197***	***1321***	***0.91:1.00***	***0.93:1.00***

[a] Comprised of HOR's used for both Chiwawa and Nason Creek obligations.

Fecundity

Mean fecundities for the 2016-2018 returns of spring Chinook ranged from 4,166 to 4,467 eggs per female (Table 5.5). These fecundities were slightly lower than the overall average of 4,635 eggs per female and near the expected fecundity of 4,272 to 4,429 eggs per female assumed in the broodstock protocols. For the 2018 return year, natural-origin Chinook produced less eggs per female than did hatchery-origin fish. This could be attributed to differences in size, age, and sample size of hatchery and natural-origin fish as described above (Tables 5.2 and 5.3).

Table 5.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 1989-2018; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	2,832
1990*	NA	NA	5,024
1991*	NA	NA	4,600
1992*	NA	NA	5,199[a]
1993*	NA	NA	5,249
1994*	NA	NA	5,923
1995	No program		
1996*	NA	NA	4,645
1997	4,752	4,479	4,570
1998	5,157	5,376	5,325
1999	No program		
2000	5,028	5,019	5,023
2001	4,530	4,663	4,624
2002	5,024	4,506	4,654
2003	6,191	5,651	5,844
2004	4,846	4,775	4,799
2005	4,365	4,312	4,327
2006	4,773	4,151	4,324

Return year	Mean fecundity		
	Wild	Hatchery	Total
2007	4,656	4,351	4,441
2008	4,691	4,560	4,592
2009	4,691	4,487	4,573
2010	4,548	4,114	4,314
2011	4,969	3,884	4,385
2012	4,522	3,682	4,223
2013	4,716	No program	4,716
2014	4,467	3,834	4,045
2015	5,132	4,278	4,847
2016	4,674	4,126	4,467
2017	4,574	4,747	4,615
2018	4,026	4,160	4,166
Average	***4,778***	***4,458***	***4,635***
Median	***4,691***	***4,415***	***4,600***

* Individual fecundities were not tracked with females until 1997.
[a] Estimated as the mean of fecundities two years before and two years after 1992.

To estimate fecundities by length, weight, and age[15], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of spring Chinook females during the spawning of 1997 through 2018 broodstock (complete data for all variables are available for years 2014-2017). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin spring Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

Mean fecundity by total age varied between hatchery and natural-origin spring Chinook and over time (Table 5.6). On average, mean fecundities varied between hatchery-origin and natural-origin spring Chinook by 199 eggs for age-4 fish and 220 eggs for age-5 fish. Too few age-3 fish were collected to evaluate fecundity relationships.

Table 5.6. Mean fecundity by age (total age) for hatchery and wild spring Chinook collected from broodstock for the Chiwawa River program, brood years 1997-2018; N = sample size and SD = 1 standard deviation.

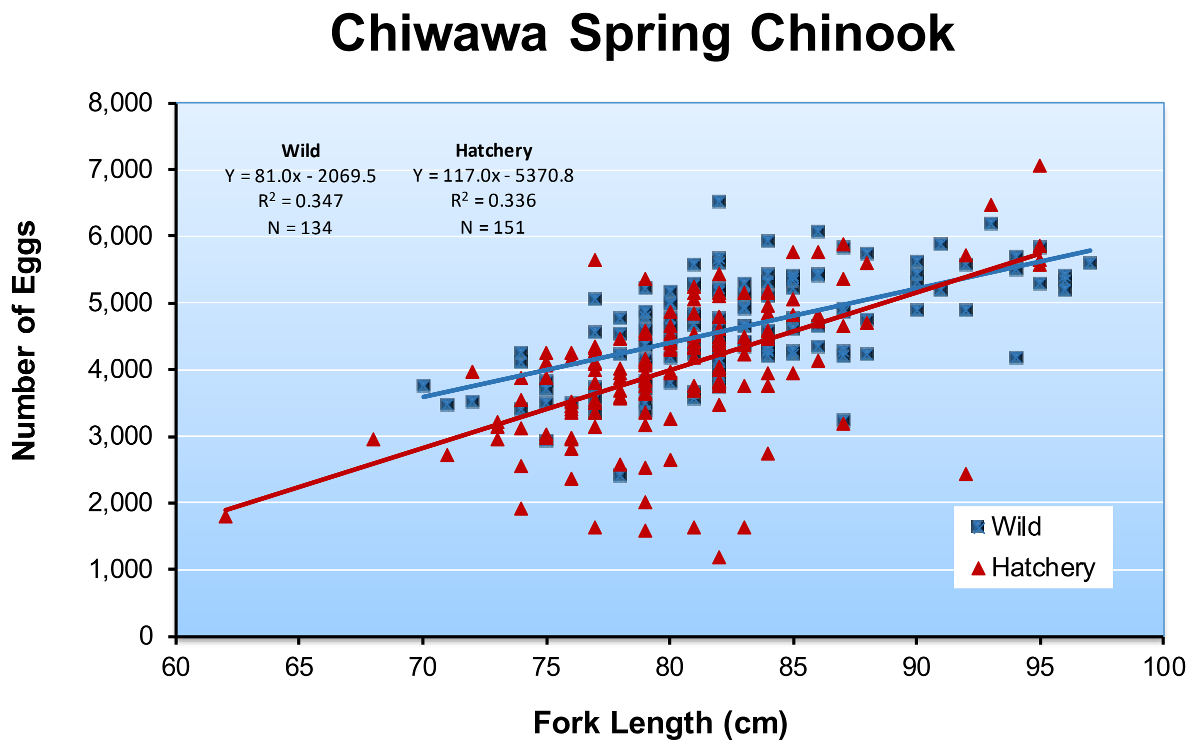
Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1997	Wild	-	0	-	4,663	15	671	5,972	2	1,520
	Hatchery	-	0	-	4,479	44	551	-	0	-
1998	Wild	-	0	-	4,739	1	-	5,153	2	245

[15] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	5,023	9	794	6,171	4	433
1999	Wild	No Program								
	Hatchery									
2000	Wild	-	0	-	4,801.	4	866	5,936	1	-
	Hatchery	-	0	-	5,019	6	611	-	0	-
2001	Wild	-	0	-	4,460	61	712	5,579	3	597
	Hatchery	-	0	-	4,663	164	631	-	0	-
2002	Wild	-	0	-	4,616	9	660	5,614	1	-
	Hatchery	-	0	-	4,444	28	582	5,368	2	583
2003	Wild	-	0	-	4,209	1	-	6,217	12	882
	Hatchery	-	0	-	-	0	-	5,651	27	685
2004	Wild	-	0	-	4,846	40	694	-	0	-
	Hatchery	-	0	-	4,775	81	791	-	0	-
2005	Wild	-	0	-	4,045	28	568	5,642	7	1,327
	Hatchery	-	0	-	4,312	84	590	-	0	-
2006	Wild	-	0	-	4,386	29	716	5,450	18	837
	Hatchery	-	0	-	3,911	90	565	4930	25	711
2007	Wild	-	0	-	4,592	17	690	4,996	8	981
	Hatchery	-	0	-	4,244	48	815	4,746	8	1,217
2008	Wild	-	0	-	4,563	36	996	4,542	9	1,643
	Hatchery	-	0	-	4,381	121	961	5,257	4	1,098
2009	Wild	-	0	-	4,437	42	745	5,929	9	1,146
	Hatchery	-	0	-	4,460	66	4,460	4,905	3	1,241
2010	Wild	-	0	-	4,621	36	758	-	0	-
	Hatchery	-	0	-	4,193	47	783	-	0	-
2011	Wild	-	0	-	4,262	15	430	5,697	16	933
	Hatchery	3,055	1	-	3,793	32	773	4,364	11	679
2012	Wild	-	0	-	4,278	22	586	5,219	9	899
	Hatchery	-	0	-	3,715	23	906	-	0	-
2013	Wild	-	0	-	4,085	17	608	5,574	15	997
	Hatchery	-	0	-	3,614	1	-	-	0	-
2014	Wild	-	0	-	4,329	25	660	5,575	4	233
	Hatchery	-	0	-	3,708	61	981	5,373	1	-
2015	Wild	-	0	-	5,049	23	599	5,561	6	457
	Hatchery	-	0	-	4,149	15	545	-	0	-
2016	Wild	-	0	-	4,313	18	641	5,411	4	143
	Hatchery	-	0	-	4,196	19	805	5,746	5	840

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2017	Wild	-	0	-	4,574	26	620	5,202	1	-
	Hatchery	-	0	-	4,587	7	1,112	5,862	1	-
2018	Wild	-	0	-	3,937	13	570	5,184	1	-
	Hatchery	-	0	-	4,160	32	528	-	0	-
Average	***Wild***	***-***	***0***	***-***	***4,485***	***24***	***688***	***5,515***	***6***	***856***
	Hatchery	***3,055***	***0***	***-***	***4,286***	***48***	***977***	***5,295***	***5***	***850***

We pooled fecundity data from brood years 2014 through 2018 (the only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 5.1, 5.2, and 5.3. All fecundity variables increase linearly with fork length. In addition, except for fish size and mean egg weight, the relationships between fish size and fecundity data were similar for hatchery and natural-origin spring Chinook.



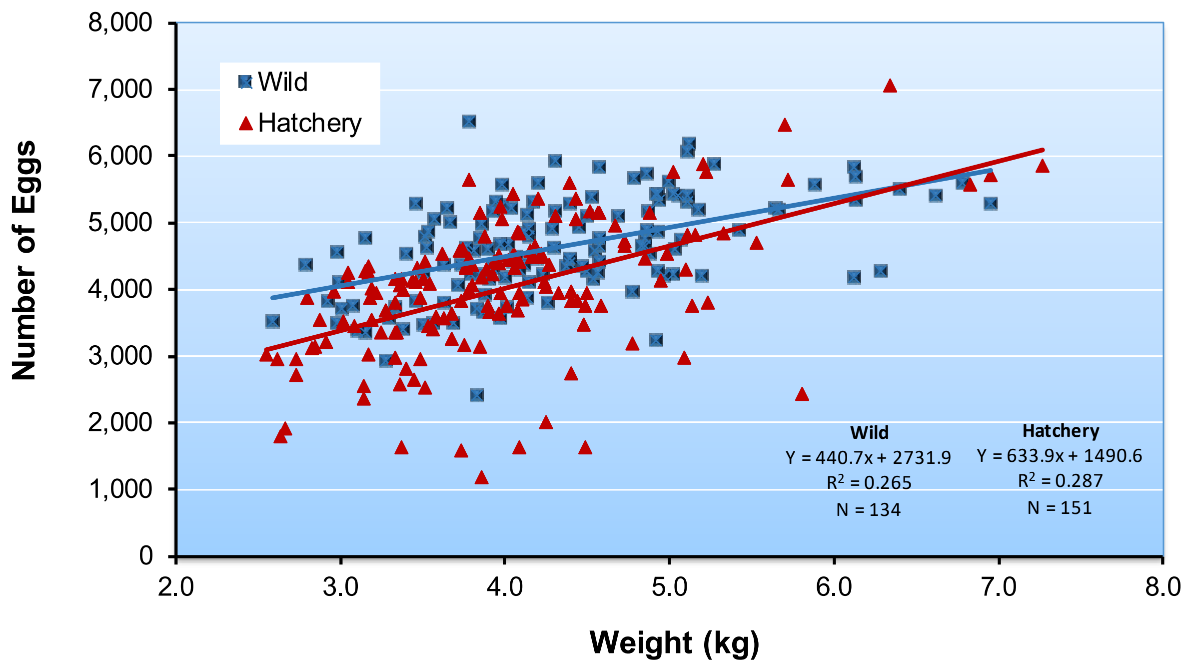


Figure 5.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2018.

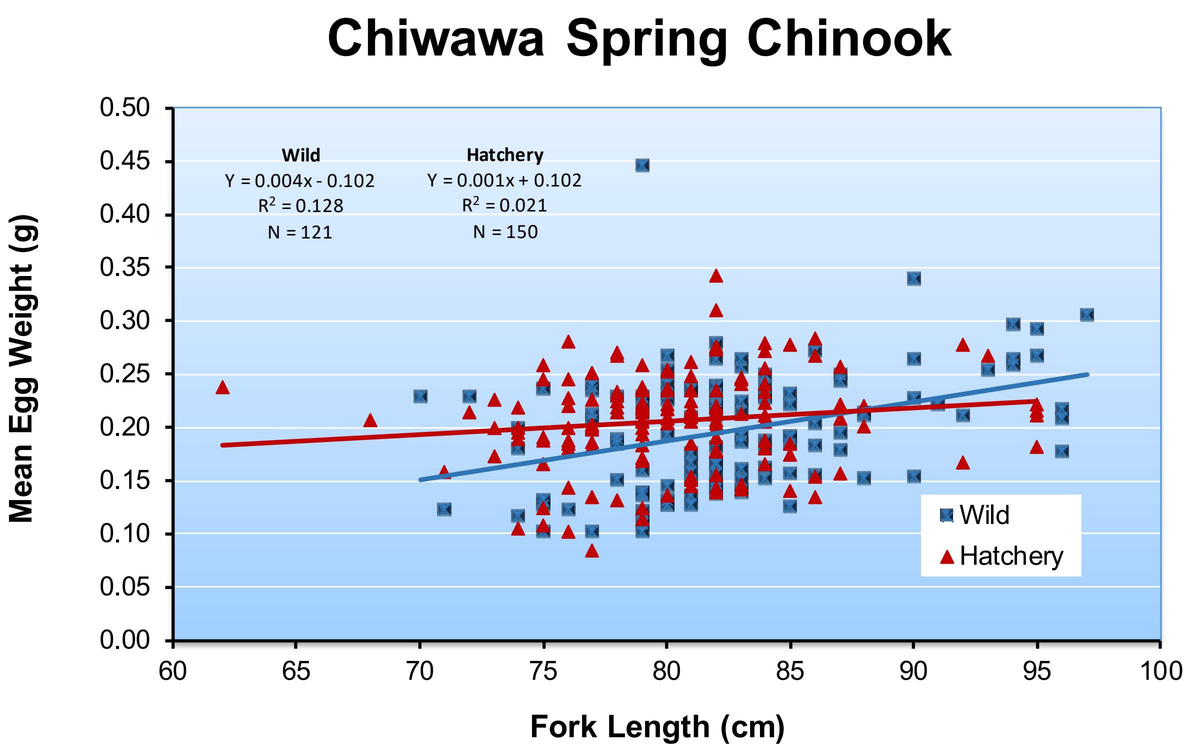


Figure 5.2. Relationships between mean egg weight and fork length for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2018.

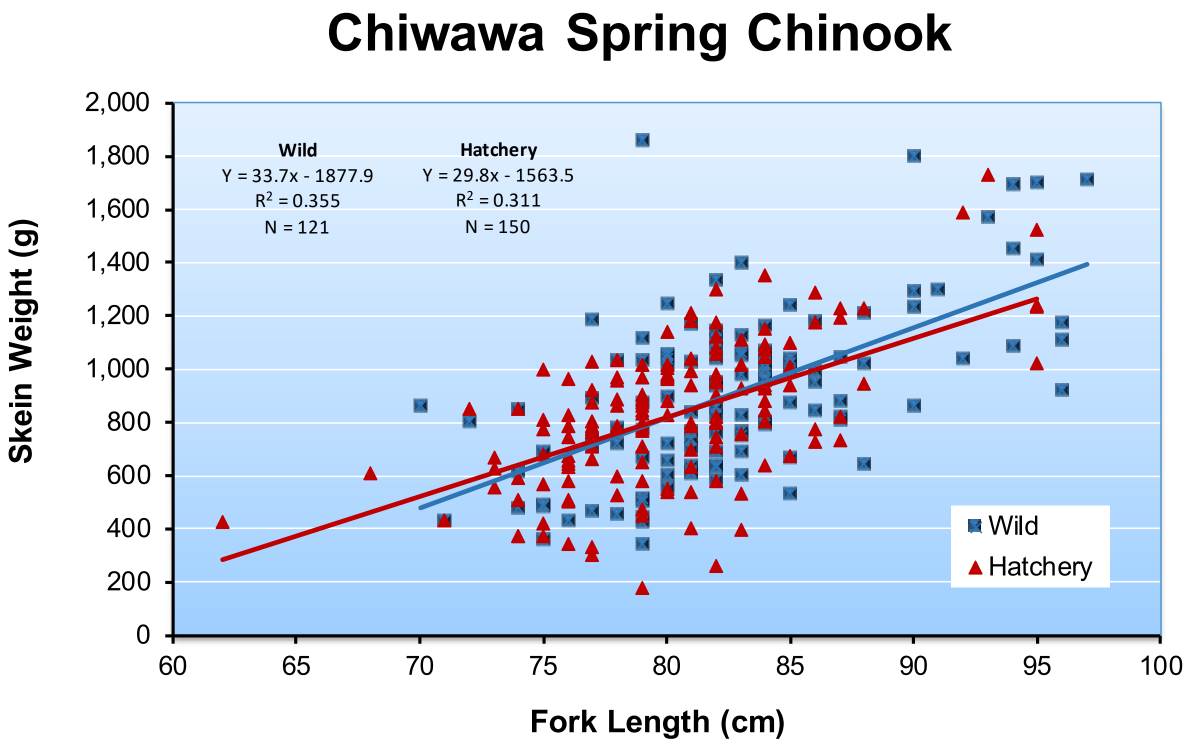


Figure 5.3. Relationships between skein weight and fork length for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2018.

5.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 829,630 eggs were required to meet the program release goal of 672,000 smolts for brood years 1989-2010. For the 2011 and 2012 brood years, a total of 367,536 and 252,410 eggs were required to meet the release goals of 298,000 and 204,452 smolts, respectively. Since 2013, 160,743-177,372 eggs have been required to achieve a release goal of 144,026 smolts for the Chiwawa spring Chinook Program. Between 1989 and 2018, the egg take goal was reached only in 2001, 2015, 2016, and 2018 (Table 5.7). In 2016 and 2018, the natural-origin egg-take goal was not achieved, but the program goal was achieved. The green egg takes for 2016-2018 brood years were 104.1%, 92.1%, and 124.6% of program goals, respectively.

At the beginning of the Chiwawa spring Chinook program, the production level was set at 372,000 smolts. The primary reason for not meeting the egg take requirements included a lack of returning hatchery adults (because of program start up) and low wild fish abundance (along with no weir in the Chiwawa for the first few years). Post-ESA listing and issuance of Section 10(a)(1(A) permit 1196 in 1999, continued low abundance (hatchery and natural origin), as well as the permit limitation requiring a minimum of 33% natural-origin fish in the broodstock further constrained meeting the requisite egg take goal for a 672,000 program. In 2010, it was expected that recalculation of the mitigation obligation beginning with the 2012 brood year was going to result in a significant reduction in the production level and the Hatchery Committees subsequently agreed to reduce the production target to 298,000 in advance of recalculation to increase the likelihood of meeting the overall production goal. In 2011, the Joint Fisheries Parties developed the Wenatchee Basin Spring Chinook Management Plan, which split the program into a conservation and safety-net component; the conservation program using natural-origin fish to meet recovery objectives and the safety net using returning adults from the conservation program to satisfy the balance of the production requirement.

Per amended Section 10(a)(1)(A) permit 18121, natural-origin broodstock is currently collected for the Chiwawa spring Chinook Program using PIT-tagged wild fish (tagged as juveniles) intercepted at Tumwater Dam and natural-origin brood intercepted at the Chiwawa Weir. Operational limitations (e.g., flows, days per season, and bull trout encounters) at the Chiwawa Weir reduce the opportunity to meet the natural-origin broodstock requirement, particularly in years of low adult abundance. Subsequently, to ensure the mitigation obligation is met, a component of hatchery-origin adult returns is trapped and retained from Tumwater Dam during broodstock collection for the Nason Creek Program, which uses a composited broodstock (for the conservation component) identified through genetic analysis. The genetic analysis is used to prioritize those adults assigned with the highest probability to either the Nason or Chiwawa spawning aggregates and excludes those assigned to the White River spawning aggregate.

Table 5.7. Numbers of eggs taken from spring Chinook broodstock, 1989-2018; NP = no program.

Return year	Number of eggs taken for the Chiwawa Program
1989	45,311
1990	60,287
1991	73,601
1992	111,624
1993	257,208
1994	35,539
1995	NP
1996	18,579
1997	312,182
1998	90,521
1999	NP
2000	55,256
2001	1,099,630
2002	196,186
2003	247,501
2004	538,176

Return year	Number of eggs taken for the Chiwawa Program
2005	536,490
2006	744,344
2007	359,739
2008	761,821
2009	564,912
2010	383,944
2011	366,244
Average (1989-2011)	***326,624***
Median (1989-2011)	***257,208***
2012	250,695
2013	165,047
2014	163,358
2015	184,734
2016*	184,712
2017	150,419
2018	211,344
Average (2012-present)	***187,187***
Median (2012-present)	***184,712***

* Although the program egg-take goal was achieved, the natural-origin egg-take goal was not.

Number of acclimation days

Early rearing of the 2016 brood Chiwawa spring Chinook was similar to previous years with fish being held on well water before being transferred to the Chiwawa Acclimation Facility for final acclimation. Beginning in 2006 (2005 brood acclimation), modifications were made to the Chiwawa Acclimation Facility intakes so that Wenatchee River water could be applied to the Chiwawa River intakes during severe cold periods to prevent the formation of frazzle ice. During acclimation of the 2016 brood, fish were acclimated for 200 to 217 days on Chiwawa River water (Table 5.8).

Table 5.8. Number of days spring Chinook broods were acclimated and water source, brood years 1989-2016; NA = not available.

Brood year	Release year	Transfer date	Release date	Number of days and water source		
				Total	Chiwawa	Wenatchee
1989	1991	19-Oct	11-May	204	NA	NA
1990	1992	13-Sep	27-Apr	227	NA	NA
1991	1993	24-Sep	24-Apr	212	NA	NA

Brood year	Release year	Transfer date	Release date	Number of days and water source		
				Total	Chiwawa	Wenatchee
1992	1994	30-Sep	20-Apr	202	NA	NA
1993	1995	28-Sep	20-Apr	204	NA	NA
1994	1996	1-Oct	25-Apr	207	NA	NA
1995	1997	No Program				
1996	1998	25-Sep	29-Apr	216	NA	NA
1997	1999	28-Sep	22-Apr	206	NA	NA
1998	2000	27-Sep	24-Apr	210	NA	NA
1999	2001	No Program				
2000	2002	26-Sep	25-Apr	211	NA	NA
2001	2003	22-Oct	1-May	191	NA	NA
2002	2004	25-Sep	2-May	220	NA	NA
2003	2005	30-Sep	3-May	215	NA	NA
		30-Sep	18-Apr-18-May	200	NA	NA
2004	2006	3-Sep	1-May	240	88-104	124
		3-Sep	17-Apr-17-May	226	NA	NA
2005	2007	25-Sep	1-May	217	217	98[a]
		26-Sep	16-Apr-15-May	202-232	202-232	98[a]
2006	2008	24-27-Sep	14-Apr-13-May	231	231	95[a]
2007	2009	1-Oct	15-Apr-13-May	223	223	103[a]
2008	2010	14-15-Sep	14-Apr-12-May	212-241	212-241	129
2009	2011	14-15-Sep	26-Apr-19-May	225-249	225-249	88
2010	2012	3, 5-6-Oct	17-Apr-1-May	195-212	195-212	132
2011	2013	24-26-Sep	16-22-Apr	202-210	202-210	40
2012	2014	23-25-Sep	14-21-Apr	204-211	204-211	107[a]
2013	2015	29-Sep	13-20-Apr	196-203	196-203	0
2014	2016	5-8-Oct	15-20-Apr	190-198	190-198	0
2015	2017	26-27 Sept	12-19 Apr	198-205	198-205	0
2016	2018	26-28 Sept	16 Apr- 1 May	200-217	200-217	0

[a] Represents the number of days Wenatchee River water was applied to the Chiwawa River intake screen to prevent the formation of frazzle ice.

Release Information

Numbers released

The 2016 brood Chiwawa spring Chinook program achieved 110% of the 144,026 goal with about 130,515 WxW, and 27,674 HxH smolts released volitionally into the Chiwawa River in 2018 (Table 5.9).

Table 5.9. Numbers of spring Chinook smolts tagged and released from the hatchery, brood years 1989-2016. The release target for Chiwawa spring Chinook is 144,026 smolts. For brood years 2012 to present, conservation program fish are not adipose fin clipped (they receive CWT only). All CWT mark rates were adjusted for tag loss before the fish were released.

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
1989	1991	Volitional	0.9932	0	43,000	43,000
1990	1992	Volitional	0.9931	0	53,170	53,170
1991	1993	Volitional	0.9831	0	62,138	62,138
1992	1994	Volitional	0.9747	0	85,113	85,113
1993	1995	Volitional	0.9892	0	223,610	223,610
1994	1996	Volitional	0.9967	0	27,226	27,226
1995	1997	No program				
1996	1998	Forced	0.8413	0	15,176	15,176
1997	1999	Volitional	0.9753	0	266,148	266,148
1998	2000	Volitional	0.9429	0	75,906	75,906
1999	2001	No program				
2000	2002	Volitional	0.9920	0	47,104	47,104
2001	2003	Forced	0.9961	0	192,490[a]	377,544
		Volitional	0.9856	0	185,054[a]	
2002	2004	Volitional	0.9693	0	149,668	149,668
2003	2005	Forced	0.9783	0	69,907	222,131
		Volitional	0.9743	0	152,224	
2004	2006	Forced	0.9533	0	243,505	494,517
		Volitional	0.9493	0	251,012	
2005	2007	Forced	0.9882	4,993	245,406	494,012
		Volitional	0.9864	4,988	248,606	
2006	2007	Direct	0.0000	0	12,977[b]	612,482
	2008	Volitional	0.9795	9,894	612,482	
2007	2008	Direct	0.0000	0	9,494	305,542
	2009	Volitional	0.9948	10,035	296,048	
2008	2010	Volitional	0.9835	10,006	609,789	609,789
2009	2011	Forced	0.9874	0	241,181	438,561

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
		Volitional	0.9874	9,412	197,380	
2010[c]	2012	Volitional	0.9904	5,020	346,248	346,248
2011	2013	Volitional	0.9902	9,945	281,821	281,821
2012[d]	2014	Volitional	0.9841	5,061	222,504	222,504
2013[d]	2015	Volitional	0.9753	10,021	147,480	147,480
2014[d]	2016	Volitional	0.9818	10,179	144,360	341,226[e]
		Volitional	0.9853	0	196,866[f]	
2015[d]	2017	Volitional	0.9571	10,149	163,411	163,411
2016 [d]	2018	Volitional	0.9222	10,089	158,189	158,189

[a] This does not include the 226,456 eyed eggs that were planted in the Chiwawa River.
[b] This high ELISA group was only adipose fin clipped and directly planted into Big Meadow Creek in May.
[c] This does not include 18,480 eyed eggs that were culled because of high ELISA.
[d] For brood years 2013 to present, WxW spring Chinook are not adipose fin clipped (they receive CWT only); HxH Chinook are adipose fin clipped and receive a CWT.
[e] The total number of smolts released includes the HxH Nason Creek program that was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility.
[f] The HxH Nason Creek program that was released from the Chiwawa Acclimation Facility.

Numbers tagged

The 2016 brood Chiwawa spring Chinook were 92.2% CWT based on tag retention determination during quality control[16] (Table 5.9).

On 18-21 April 2019, a total of 10,100 WxW Chiwawa spring Chinook from the 2017 brood were tagged at the Chiwawa Acclimation Facility. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 128 mm in length and 25 g at time of tagging.

Table 5.10 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into the Chiwawa River.

Table 5.10. Summary of PIT-tagging activities for Chiwawa hatchery spring Chinook, brood years 2005-2016.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2005	2007	10,063	74	8	9,981[a]
2006	2008	10,055	134	27	9,894
2007	2009	10,112	61	16	10,035
2008	2010	10,101	81	14	10,006
2009	2011	10,101	655	34	9,412

16 Sixty days after tagging, taggers conduct a quality control procedure, which includes collecting a sample of tagged fish and scanning for tag retention. Thus, the number of tagged fish released is adjusted for tag loss.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2010	2012	5,102	82	0	5,020
2011	2013	10,200	254	1	9,945
2012	2014	5,100	37	2	5,061
2013	2015	10,114	93	0	10,021
2014	2016	10,200	21	0	10,179
2015	2017	10,207	58	0	10,149
2016	2018	10,100	3	8	10,089

[a] This release consisted of 4,988 tagged Chinook that were released volitionally and 4,993 that were forced released.

Fish size and condition at release

Spring Chinook from the 2016 brood were released as yearling smolts between 16 April and 1 May 2018. Size at release (17 fpp) was near the target of 18 fpp established for the program. The CV for fork length was 3% over the target (Table 5.11).

Table 5.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood years 1989-2016. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	147	4.4	37.8	12
1990	1992	137	5.0	32.4	14
1991	1993	135	4.2	30.3	15
1992	1994	133	5.0	28.4	16
1993	1995	136	4.5	30.2	15
1994	1996	139	7.1	34.4	13
1995	1997	No Program			
1996	1998	157	5.3	52.1	9
1997	1999	146	7.2	38.7	12
1998	2000	143	9.1	39.5	12
1999	2001	No Program			
2000	2002	150	6.8	46.7	10
2001	2003	142	7.1	37.6	12
2002	2004	146	8.5	40.3	11
2003	2005	167[a]	5.9	59.4	8
		151[b]	7.4	44.2	10
2004	2006	146[a]	6.4	39.1	12
		139[b]	5.7	34.3	13
2005	2007	136[a]	4.6	30.8	15

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
		129[b]	5.8	26.6	17
2006	2008	124	8.8	23.5	19
2007	2008	70[a]	4.0	3.7	122
	2009	140[b]	11.0	33.6	14
2008	2010	141	10.7	36.0	13
2009	2011	167	12.9	56.8	8
2010	2012	129	8.1	25.8	18
2011	2013	134	6.4	29.5	15
2012	2014	130	6.7	28.5	16
2013	2015	130	8.2	25.3	18
2014[c]	2016	141	16.3	34.8	13
2015	2017	127[b]	10.1	25.4	17.8
2016	2018	131	9.3	26.6	17.1
Average		***140***	***7.4***	***34.4***	***17.2***
Median		***139***	***7.0***	***34.0***	***13.5***
Targets		***155***	***9***	***37.8***	***18.0***

[a] Forced-release group.
[b] Volitional-release group.
[c] This represents the combination of the WxW Chiwawa, HxH Chiwawa, and the HxH Nason Creek programs. The HxH Nason Creek program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility.

Survival Estimates

Overall survival of the 2016 brood Chiwawa spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 5.12). There was higher than expected survivals throughout most stages except unfertilized egg to eyed egg, contributing to increased program performance overall. Pre-spawn survival of adults was also above the standard set for the program.

Table 5.12. Hatchery life-stage survival rates (%) for spring Chinook, brood years 1989-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	100.0	100.0	98.0	99.1	99.1	99.0	96.4	99.3	94.8
1990	100.0	85.7	91.8	98.1	99.5	98.9	97.9	99.2	88.2
1991	100.0	100.0	94.4	96.1	99.6	97.9	93.2	95.0	84.4
1992	100.0	100.0	98.4	96.7	99.9	99.9	80.0	80.6	76.2
1993	96.0	98.0	89.7	98.0	99.7	99.3	98.9	99.7	86.9
1994	100.0	100.0	98.6	100.0	99.8	99.4	77.0	78.9	76.6
1995	No program								
1996	100.0	100.0	88.3	100.0	93.8	93.0	89.9	97.7	81.7

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1997	98.6	100.0	93.2	95.7	98.3	99.6	95.6	99.3	85.3
1998	95.2	100.0	94.5	99.0	98.5	98.3	89.6	99.1	83.9
1999	No program								
2000	100.0	100.0	91.0	98.1	97.2	96.6	95.4	99.3	85.2
2001	97.6	97.0	88.9	98.1	99.7	99.6	51.3	51.8	34.3
2002	97.8	100.0	82.1	98.0	97.4	96.7	94.8	99.1	76.3
2003	93.9	100.0	93.2	97.7	99.5	99.3	98.5	98.1	89.7
2004	97.8	82.5	93.3	98.4	98.8	94.3	93.9	97.2	91.9
2005	97.1	100.0	95.9	98.0	99.2	99.0	97.9	99.1	92.1
2006	100.0	100.0	90.1	98.1	99.2	99.0	95.3	97.7	84.2
2007	98.8	97.7	92.9	97.2	99.4	99.0	98.0	99.4	88.5
2008	96.6	99.3	90.8	93.2	97.4	97.1	95.6	97.6	80.0
2009	94.4	97.6	92.5	88.3	97.6	97.4	89.2	92.8	77.6
2010[a]	98.9	100.0	99.2	100.0	97.9	97.5	95.6	98.2	94.8
2011	98.9	98.9	93.2	88.4	96.8	96.4	93.4	97.1	76.9
2012	98.3	100.0	94.6	98.3	99.7	99.3	98.5	99.4	91.6
2013	91.7	94.6	96.5	97.0	97.9	96.8	95.5	98.9	89.4
2014[b]	100.0	100.0	91.1	98.8	99.6	99.1	98.0	99.3	88.3
2015	98.2	100.0	94.5	97.9	99.0	98.6	97.9	99.6	90.5
2016	98.5	98.3	91.6	98.4	99.3	98.7	97.7	99.2	88.1
Average	***98.0***	***98.1***	***93.0***	***97.2***	***98.6***	***98.1***	***92.5***	***95.1***	***83.7***
Median	***98.6***	***100***	***93.2***	***98.1***	***99.2***	***98.8***	***95.6***	***99.0***	***86.1***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival estimates do not include the 18,840 eyed eggs that were culled because of high ELISA levels.
[b] Survival estimates do not include the HxH Nason Creek program that was transferred to the Chiwawa Acclimation Facility because of water-intake concerns at the Nason Creek Acclimation Facility.

5.3 Disease Monitoring

Results of 2018 adult broodstock bacterial kidney disease (BKD) monitoring indicated that 92% of females had ELISA values less than 0.099. Six percent of females had ELISA values less than 0.119 and 2% had ELISA values higher 0.450 (Table 5.13).

The 2016 brood had no significant health issues during the juvenile rearing period.

Table 5.13. Proportion of bacterial kidney disease (BKD) titer groups for the Chiwawa spring Chinook broodstock, brood years 1996-2018. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1996	0.0000	0.2500	0.2500	0.5000	0.0000	1.0000
1997	0.1176	0.7353	0.0588	0.0882	0.3529	0.6471
1998	0.1176	0.8235	0.0588	0.0000	0.4706	0.5294
1999	No Program					
2000	0.0000	0.9091	0.0909	0.0000	0.1818	0.8182
2001	0.4066	0.5436	0.0373	0.0124	0.6515	0.3485
2002	0.2195	0.6585	0.0732	0.0488	0.5610	0.4390
2003	0.6957	0.1087	0.0652	0.1304	0.7174	0.2826
2004	0.8182	0.1515	0.0227	0.0076	0.8939	0.1061
2005	0.9084	0.0916	0.0000	0.0000	0.9695	0.0305
2006	0.7222	0.2556	0.0000	0.0222	0.8444	0.1556
2007	0.5854	0.3415	0.0244	0.0488	0.7073	0.2927
2008	0.8304	0.1520	0.0058	0.0117	0.9357	0.0643
2009	0.7600	0.1840	0.0080	0.0480	0.8480	0.1520
2010	0.8791	0.0769	0.0000	0.0439	0.9451	0.0549
2011	0.7640	0.2022	0.0000	0.0337	0.8764	0.1236
2012	0.8333	0.1333	0.0167	0.0167	0.9170	0.0830
2013	0.8285	0.1429	0.0286	0.0000	0.8857	0.1143
2014[c]	0.8282	0.1720	0.0000	0.0000	0.8889	0.1111
2015	0.9818	0.0000	0.0000	0.0182	0.9818	0.0182
2016	0.7547	0.2075	0.0189	0.0189	0.8113	0.1887
2017	1.0000	0.0000	0.0000	0.0000	1.000	0.0000
2018	0.9200	0.0600	0.0000	0.0200	0.9400	0.0600
Average	***0.6012***	***0.2818***	***0.0345***	***0.0486***	***0.7446***	***0.2554***
Median	***0.7574***	***0.1780***	***0.0178***	***0.0186***	***0.08622***	***0.1378***

[a] Individual ELISA samples were not collected before the 1996 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.
[c] Comprised of HOR's used for both Chiwawa and Nason Creek obligations.

5.4 Natural Juvenile Productivity

During 2018, juvenile spring Chinook were sampled at the Lower Wenatchee, Nason Creek, White River, and Chiwawa River traps, and counted during snorkel surveys within the Chiwawa River basin. Results from sampling at the Nason Creek Trap are provided in Section 6 and from the White River Trap in Section 7.

Parr Estimates

Based on snorkel surveys, a total of 83,729 (±10%) subyearling and 739 (±36%) yearling spring Chinook were estimated in the Chiwawa River basin in August 2018 (Table 5.14 and 5.15). During the survey period 1992-2017, numbers of subyearling and yearling Chinook have ranged from 5,815 to 149,563 and 5 to 967, respectively, in the Chiwawa River basin (Table 5.14 and 5.15; Figure 5.4). Numbers of all fish counted in the Chiwawa River basin are reported in Appendix B.

Table 5.14. Total numbers of subyearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2018; NS = not sampled.

Sample Year	Number of subyearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	45,483	NS	NS	NS	NS	NS	NS	NS	NS	**45,483**
1993	77,269	0	1,258	586	NS	NS	NS	NS	NS	**79,113**
1994	53,492	0	398	474	68	624	0	0	0	**55,056**
1995	52,775	0	1,346	210	0	683	67	160	0	**55,241**
1996	5,500	0	29	10	0	248	28	0	0	**5,815**
1997	15,438	0	56	92	0	480	0	0	0	**16,066**
1998	65,875	0	1,468	496	57	506	0	13	0	**68,415**
1999	40,051	0	366	592	0	598	22	0	0	**41,629**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	106,753	168	2,077	2,855	354	2,332	78	0	0	**114,617**
2002	117,230	75	8,233	2,953	636	5,021	429	0	297	**134,874**
2003	80,250	4,508	1,570	3,255	118	1,510	22	45	0	**91,278**
2004	43,360	102	717	215	54	637	21	71	0	**45,177**
2005	45,999	71	2,092	660	17	792	0	0	0	**49,631**
2006	73,478	113	2,500	1,681	51	1,890	62	127	0	**79,902**
2007	53,863	125	5,235	870	51	538	20	28	22	**60,752**
2008	72,431	214	3,287	4,730	163	1,221	28	255	22	**82,351**
2009	101,085	125	2,486	1,849	14	1,082	29	18	17	**106,705**
2010	117,499	526	4,571	4,052	0	1,449	56	42	25	**128,220**
2011	136,424	64	2,762	1,330	53	581	42	214	40	**141,510**
2012	96,036	78	4,125	2,227	49	1,322	35	31	37	**103,940**
2013	140,485	120	3,301	3,214	0	2,345	31	21	46	**149,563**
2014	113,869	361	2,384	3,124	28	1,367	11	28	68	**121,240**
2015	103,710	285	1,917	4,158	0	1,013	71	62	8	**111,224**
2016	135,819	107	1,644	991	0	1,508	20	58	25	**140,172**
2017	94,401	120	3,069	2,349	18	2,026	13	96	14	**102,106**
2018	78,449	73	1,995	2,033	17	1,024	32	95	11	**83,729**
Average	***79,501***	***289***	***2,355***	***1,800***	***73***	***1,283***	***47***	***57***	***26***	***85,147***
Median	***77,859***	***102***	***2,077***	***1,681***	***23***	***1,053***	***28***	***30***	***10***	***83,040***

Table 5.15. Total numbers of yearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2018; NS = not sampled.

Sample Year	Number of yearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Y Creek	Total
1992	563	NS	NS	NS	NS	NS	NS	NS	NS	**563**
1993	174	0	0	0	NS	NS	NS	NS	NS	**174**
1994	14	0	0	4	0	0	0	0	0	**18**
1995	13	0	0	0	0	0	0	0	0	**13**
1996	22	0	0	0	0	0	0	0	0	**22**
1997	5	0	0	0	0	0	0	0	0	**5**
1998	63	0	0	0	0	0	0	0	0	**63**
1999	41	0	0	0	0	0	0	0	0	**41**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	66	0	3	0	0	0	0	0	0	**69**
2002	32	0	0	0	0	0	0	0	0	**32**
2003	134	0	0	0	0	0	0	0	0	**134**
2004	14	0	0	0	0	7	0	0	0	**21**
2005	62	0	17	0	0	0	0	0	0	**79**
2006	345	0	0	43	0	0	0	0	0	**388**
2007	41	0	0	0	0	0	0	0	0	**41**
2008	144	0	45	0	0	0	0	0	0	**189**
2009	49	0	0	5	0	0	0	0	0	**54**
2010	207	27	19	38	0	0	0	0	0	**291**
2011	645	0	71	194	0	57	0	0	0	**967**
2012	748	0	0	19	0	0	0	0	0	**767**
2013	836	0	0	8	0	8	0	0	0	**852**
2014	867	28	4	38	0	2	0	0	0	**939**
2015	488	0	22	110	0	0	0	0	0	**620**
2016	254	0	0	0	0	28	0	0	0	**282**
2017	483	0	0	43	0	0	0	0	0	**526**
2018	739	0	0	0	0	0	0	0	0	**739**
Average	***271***	***2***	***7***	***20***	***0***	***4***	***0***	***0***	***0***	***303***
Median	***139***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***154***

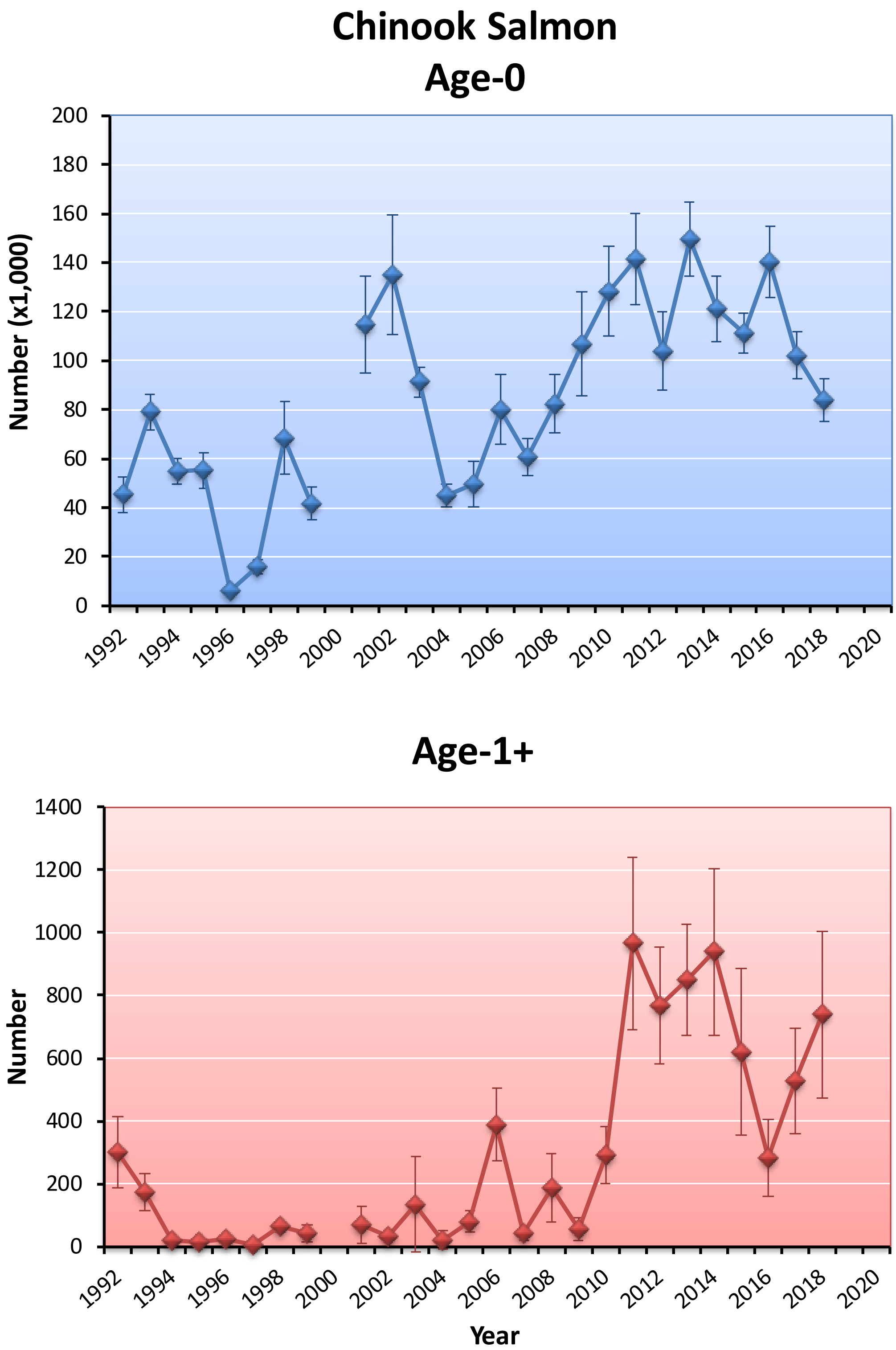


Figure 5.4. Numbers of subyearling and yearling Chinook salmon within the Chiwawa River Basin in August 1992-2018; ND = no data. Vertical bars indicate 95% confidence bounds.

Juvenile Chinook were distributed contagiously among reaches in the Chiwawa River. Their densities were highest in the upper portions of the basin, with the highest densities within tributaries. Juvenile Chinook were most abundant in multiple channels and pools, and least abundant in glides and riffles. Most Chinook associated closely with woody debris in multiple channels. These sites (multiple channels) made up 17% of the total area of the Chiwawa River basin, but they provided habitat for 44% of all subyearling Chinook in the basin in 2018. In contrast, riffles made up 53% of the total area, but provided habitat for only 8% of all juvenile Chinook in the Chiwawa River basin. Pools made up 23% of the total area and provided habitat for 47% of all juvenile Chinook in the basin. Few Chinook used glides that lacked woody debris.

Mean densities of juvenile Chinook in two reaches of the Chiwawa River were generally less than those in corresponding reference areas on the Little Wenatchee River (Figure 5.5). Within both the Chiwawa River and its reference areas, pools and multiple channels consistently had the highest densities of juvenile Chinook.

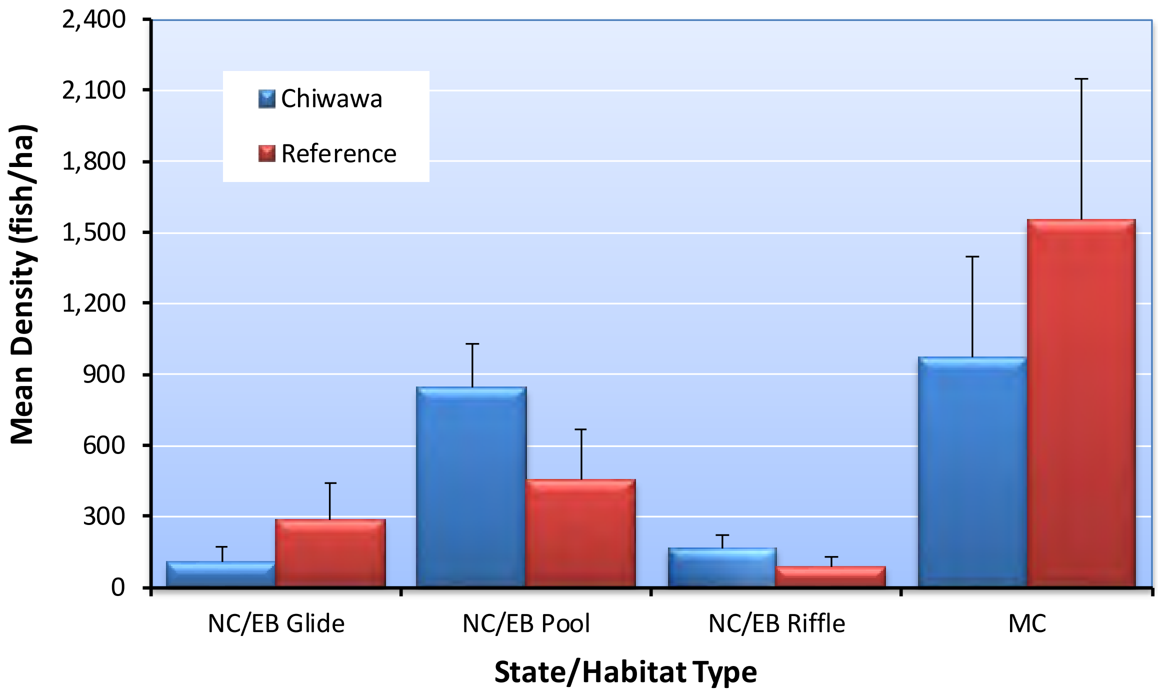


Figure 5.5. Comparison of the 25-year means of subyearling spring Chinook densities within state/habitat types in reaches 3 and 8 of the Chiwawa River and their matched reference areas on the Little Wenatchee River. NC = natural channel; S = straight channel; EB = eroded banks; MC = multiple channel. There was no sampling in 2000 and no sampling within reference areas in 1992.

Smolt and Emigrant Estimates

Numbers of spring Chinook smolts and emigrants were estimated at the Chiwawa and Lower Wenatchee traps in 2018.

Chiwawa Trap

The Chiwawa Trap operated between 6 March and 4 December 2018. During the trapping period, the trap was inoperable for 39 days because of high or low river discharge, debris, major hatchery releases, and mechanical issues. Throughout the trapping season, the trap operated in two positions, the upper position and low-flow position. Daily trap efficiencies were estimated for each age class of fish (e.g., subyearling and yearling). The daily number of fish captured was expanded by the estimated trap efficiency to estimate daily total emigration. Monthly captures of all fish and results of mark-recapture efficiency tests at the Chiwawa Trap are reported in Appendix C.

Wild yearling spring Chinook (2016 brood year) were primarily captured in of April 2018 (Figure 5.6). A significant relationship between trap efficiency and river flow ($R^2 = 0.500$; $P < 0.05$) was developed for the upper cone position. However, a pooled estimate was used for the low-flow cone position due to low R^2 and non-significant P-value. Combining the estimates, the total number of wild yearling Chinook emigrating from the Chiwawa River was estimated at 31,300 (95 CI = ±13,571). Combining the total number of subyearling (fry included) spring Chinook (111,566 ±22,090) that emigrated during the fall of 2017 with the total number of yearling Chinook (31,300 ±13,571) that emigrated during 2018, the total emigrant estimate for brood year 2016 was 142,866 (± 25,926) (Table 5.16). If fry are removed from the estimate, the subyearling estimate becomes 95,063 (95 CI ± 21,247). A non-trapping estimate of 4,305 (95 CI = ± 3,068) was also produced for the 2016 brood year. Adding the non-trapping period estimate to the subyearling and yearling estimates, the complete brood year 2016 estimate is 147,171 (95 CI = ±26,107) if fry are included or 130,668 (95 CI = ± 25,397) if fry are excluded (see Appendix C).

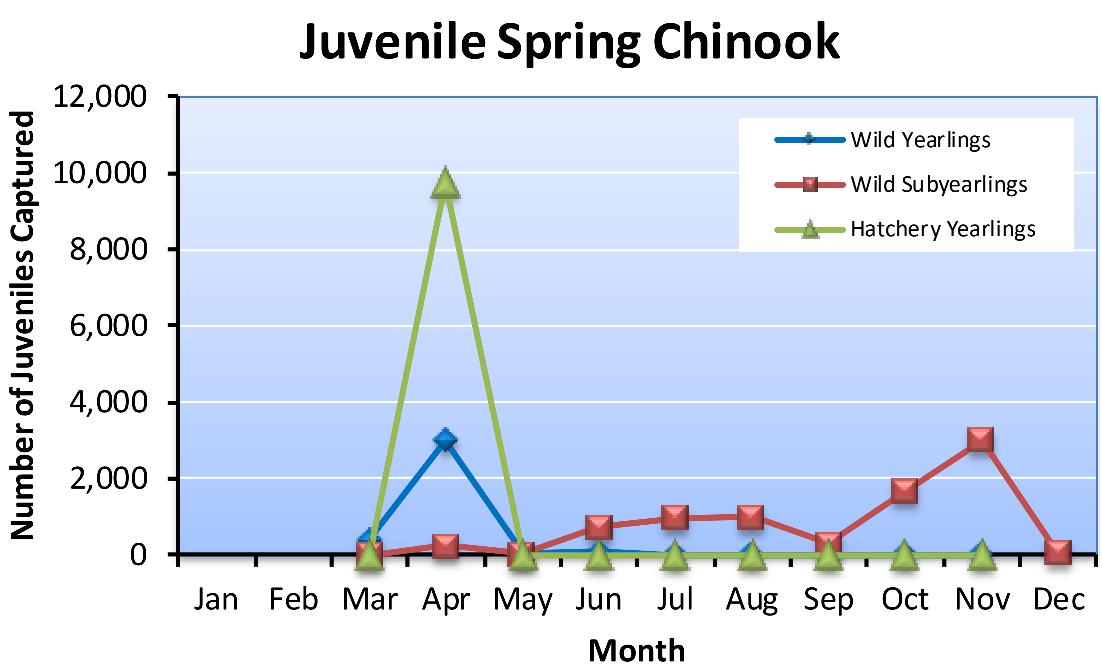


Figure 5.6. Monthly captures of wild subyearling, wild yearling, and hatchery yearling spring Chinook at the Chiwawa Trap, 2018.

Table 5.16. Numbers of redds and juvenile spring Chinook at different life stages in the Chiwawa River basin for brood years 1991-2018; NS = not sampled. Parr were estimated using snorkel techniques, while smolts and total emigrants were estimated using smolt traps.

Brood year	Number of redds	Egg deposition	Number of parr	Number of smolts produced within Chiwawa River basin[a]	Number of emigrants
1991	104	478,400	45,483[b]	42,525	NS
1992	302	1,570,098	79,113	39,723	65,541
1993	106	556,394	55,056	8,662	22,698
1994	82	485,686	55,240	16,472	25,067
1995	13	66,248	5,815	3,830	5,951
1996	23	106,835	16,066	15,475	19,183
1997	82	374,740	68,415	27,555	44,562
1998	41	218,325	41,629	19,257	25,923
1999	34	166,090	NS	10,931	15,649
2000	128	642,944	114,617	39,812	55,685
2001	1,078	4,984,672	134,874	79,814	546,266
2002	345	1,605,630	91,278	82,845	184,279
2003	111	648,684	45,177	16,559	33,637
2004	241	1,156,559	49,631	67,491	116,158
2005	333	1,440,891	79,902	58,833	177,659
2006	297	1,284,228	60,752	41,951	107,972
2007	283	1,256,803	82,351	23,766	86,006
2008	689	3,163,888	106,705	32,849	120,184
2009	421	1,925,233	128,220	32,979	61,955
2010	502	2,165,628	141,510	47,511	101,130
2011	492	2,157,420	103,940	37,185	108,832
2012	880	3,716,240	149,563	37,493	109,413
2013	714	3,367,224	121,240	39,396	113,091
2014	485	1,868,790	111,224	37,245	114,680
2015	543	2,942,129	140,172	53,344	139,863
2016	312	1,581,318	102,106	31,300	130,668
2017	222	1,172,210	83,729	-	-
2018	331	1,595,578	-	-	-
Average	***328***	***1,524,960***	***85,146***	***36,339***	***101,282***
Median	***300***	***1,362,560***	***83,040***	***37,215***	***101,130***

[a] The estimated number of smolts (yearlings) that are produced entirely within the Chiwawa River basin. Smolt estimates for brood years 1992-1996 were calculated with a mark-recapture model; brood years 1997-present were calculated with a flow model.
[b] Estimate only includes numbers of Chinook in the Chiwawa River. Tributaries were not sampled at that time.

Wild subyearling spring Chinook (2017 brood year) were primarily captured in October and November 2018 (Figure 5.6). Based on capture efficiencies, the total number of wild subyearling (fry and parr) Chinook from the Chiwawa River basin was 53,568 (95% CI = ±26,878). Removing fry from the estimate, a total of 43,133 (±26,431) subyearling parr emigrated from the Chiwawa River basin in 2018. Although subyearling parr migrated during all months of sampling, the majority (95%) migrated after 1 July (Figure 5.6).

Yearling spring Chinook sampled in 2018 averaged 93 mm in length, 8.6 g in weight, and had a mean condition of 1.06 (Table 5.17). These size estimates were similar to the overall mean of yearling spring Chinook sampled in previous years (overall means: 93 mm, 9.0 g, and condition of 1.08). Subyearling spring Chinook sampled in 2018 at the Chiwawa Trap averaged 78 mm in length, averaged 5.4 g, and had a mean condition of 1.09 (Table 5.17). In general, subyearlings were similar to previous years (overall means, 76 mm, 5.2 g, and condition of 1.09).

Table 5.17. Mean fork length (mm), weight (g), and condition factor of subyearling (excluding fry) and yearling spring Chinook collected in the Chiwawa Trap, 1996-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
1996	Subyearling	514	78 (25)	6.9 (4.2)	1.11 (0.11)
	Yearling	1,589	94 (9)	9.5 (3.0)	1.11 (0.08)
1997	Subyearling	840	86 (8)	7.5 (2.1)	1.16 (0.08)
	Yearling	1,114	100 (7)	10.2 (2.6)	1.02 (0.10)
1998	Subyearling	3,743	82 (11)	6.2 (2.2)	1.08 (0.09)
	Yearling	2,663	97 (7)	10.3 (2.8)	1.12 (0.23)
1999	Subyearling	569	89 (9)	8.5 (2.4)	1.15 (0.07)
	Yearling	3,664	95 (8)	9.6 (3.4)	1.09 (0.19)
2000	Subyearling	1,810	85 (10)	7.4 (2.4)	1.15 (0.10)
	Yearling	1,891	97 (8)	10.5 (5.2)	1.13 (0.07)
2001	Subyearling	4,657	82 (11)	6.6 (3.4)	1.14 (0.09)
	Yearling	2,935	97 (7)	10.5 (2.4)	1.15 (0.08)
2002	Subyearling	6,130	64 (12)	3.0 (1.6)	1.06 (0.10)
	Yearling	1,735	94 (8)	9.0 (2.3)	1.09 (0.08)
2003	Subyearling	3,679	64 (12)	3.2 (1.7)	1.08 (0.10)
	Yearling	2,657	87 (9)	7.2 (3.5)	1.07 (0.10)
2004	Subyearling	2,278	75 (16)	4.3 (2.1)	0.92 (0.16)
	Yearling	1,032	91 (9)	8.5 (2.7)	1.09 (0.10)
2005	Subyearling	2,702	73 (12)	4.6 (2.2)	1.08 (0.09)
	Yearling	803	96 (9)	9.9 (2.8)	1.08 (0.08)
2006	Subyearling	3,462	76 (11)	5.1 (2.0)	1.12 (0.21)
	Yearling	4,645	95 (7)	9.4 (2.3)	1.10 (0.13)
2007	Subyearling	1,718	72 (12)	4.5 (2.1)	1.13 (0.16)
	Yearling	2,245	91 (8)	8.6 (2.5)	1.10 (0.09)
2008	Subyearling	10,443	79 (12)	5.9 (2.3)	1.15 (0.15)
	Yearling	8,792	93 (7)	8.8 (2.1)	1.08 (0.10)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2009	Subyearling	10,536	75 (10)	5.0 (2.2)	0.91 (0.11)
	Yearling	3,630	92 (7)	8.8 (2.1)	0.89 (0.07)
2010	Subyearling	3,888	77 (12)	5.4 (2.3)	1.11 (0.16)
	Yearling	5,799	91 (8)	8.9 (2.2)	1.15 (0.14)
2011	Subyearling	6,870	73 (11)	4.8 (2.2)	1.15 (0.16)
	Yearling	4,734	94 (8)	8.7 (2.2)	1.04 (0.10)
2012	Subyearling	8,756	75 (10)	4.8 (2.2)	1.13 (0.28)
	Yearling	7,290	90 (7)	8.0 (2.6)	1.06 (0.24)
2013	Subyearling	10,181	71 (10)	4.1 (1.7)	1.09 (0.39)
	Yearling	3,135	88 (9)	7.7 (2.8)	1.09 (0.20)
2014	Subyearling	7,122	71 (10)	3.7 (1.6)	1.08 (0.10)
	Yearling	3,956	89 (8)	7.7 (2.2)	1.05 (0.08)
2015	Subyearling	15,241	71 (11)	4.2 (2.4)	1.10 (0.39)
	Yearling	6,304	93 (9)	8.8 (2.9)	1.09 (0.15)
2016	Subyearling	12,198	71 (13)	4.5 (2.3)	1.08 (0.08)
	Yearling	2,789	91 (9)	8.3 (3.1)	1.06 (0.26)
2017	Subyearling	11,508	74 (12)	4.2 (2.2)	1.09 (0.20)
	Yearling	5,822	93 (7)	8.6 (2.1)	1.06 (0.06)
2018	Subyearling	5,519	78 (12)	5.35 (2.2)	1.09 (0.09)
	Yearling	3,488	93 (7)	8.61 (2.0)	1.06 (0.06)
Average	***Subyearling***	***5,842***	***76***	***5.2***	***1.09***
	Yearling	***3,596***	***93***	***9.0***	***1.08***
Median	***Subyearling***	***4,657***	***75***	***4.8***	***1.10***
	Yearling	***3,135***	***93***	***8.8***	***1.09***

[a] Sample size represents the number of fish that were measured for both length and weight.

Lower Wenatchee Trap

The Lower Wenatchee River Trap operated between 22 March and 24 July 2018. During that time, the trap was inoperable for 18 days because of high or low river discharge, debris, elevated river temperatures, large hatchery releases, and mechanical issues. During the sampling period, a total of 1,418 wild yearling Chinook, 47,283 wild subyearling Chinook (mostly summer Chinook), and 51,068 hatchery yearling Chinook were captured at the Lower Wenatchee Trap. Based on capture efficiencies and river discharge, a significant model was developed ($R^2 = 0.823$, $P < 0.02$) producing an emigrant estimate of 99,045 (95% CI = ±22,234) wild yearling Chinook that emigrated past the Lower Wenatchee Trap (Table 5.18). Monthly captures of all fish collected at the Lower Wenatchee Trap are reported in Appendix C.

Table 5.18. Numbers of redds and wild spring Chinook smolts produced in the Wenatchee River basin for brood years 2000-2018; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere.

Brood year	Number of redds	Egg deposition	Number of smolts produced within Wenatchee River basin
2000	350	1,758,050	76,643
2001	2,109	8,674,624	243,516
2002	1,139	5,300,906	165,116
2003	323	1,887,612	70,738
2004	574	2,663,445	55,619
2005	830	3,587,083	302,116
2006	588	2,542,512	85,558
2007	466	2,069,506	60,219
2008	1,411	6,479,312	82,137
2009	733	NS	NS
2010	968	NS	NS
2011	872	3,823,720	89,917
2012	1,704	7,195,992	67,973
2013	1,159	5,512,204	58,595
2014	677	2,698,015	36,752
2015	905	4,386,535	130,426
2016	638	2,849,946	99,045
2017	430	1,984,450	-
2018	549	2,287,134	-
Average	***864***	***3,864,767***	***108,291***
Median	***733***	***2,849,946***	***82,137***

Yearling spring Chinook sampled in 2018 at the Lower Wenatchee Trap averaged 98 mm in length, 10.3 g in weight, and had a mean condition of 1.05 (Table 5.19). These size estimates were similar to the overall mean of yearling spring Chinook sampled in previous years (overall means: 98 mm, 10.5 g, and condition of 1.10).

Table 5.19. Mean fork length (mm), weight (g), and condition factor of yearling spring Chinook collected in the Lower Wenatchee Trap, 2000-2018. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2000	29	111 (15.1)	15.6 (7.4)	1.15 (0.1)
2001	204	106 (9.6)	13.0 (3.6)	1.10 (0.1)
2002	301	99 (10.0)	10.7 (3.3)	1.11 (0.1)
2003	1,427	96 (9.4)	9.7 (10.0)	1.11 (0.1)
2004	1,046	97 (10.3)	10.0 (3.4)	1.11 (0.1)

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2005	325	101 (10.5)	11.3 (3.7)	1.08 (0.1)
2006	642	99 (9.5)	10.6 (4.9)	1.08 (0.1)
2007	1,902	94 (8.4)	9.4 (2.5)	1.12 (0.1)
2008	615	97 (9.3)	10.5 (3.1)	1.14 (0.1)
2009	483	98 (10.8)	10.8 (3.9)	1.16 (0.1)
2010	1,057	98 (9.4)	10.5 (3.1)	1.10 (0.1)
2011	ND	ND	ND	ND
2012	ND	ND	ND	ND
2013	1729	94 (9.6)	9.0 (2.9)	1.07 (0.1)
2014	1,643	94 (9.8)	8.7 (2.8)	1.04 (0.1)
2015	1,491	96 (9.8)	9.4 (3.7)	1.06 (0.1)
2016	598	94 (9.4)	9.0 (2.9)	1.08 (0.1)
2017	1,320	97 (8.4)	9.7 (2.6)	1.05 (0.1)
2018	1,355	98 (8.7)	10.3 (2.8)	1.05 (0.1)
Average	***951***	***98 (9.9)***	***10.5 (3.9)***	***1.10 (0.1***
Median	***1046***	***97 (9.6)***	***10.3 (3.3)***	***1.10 (0.1)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 17,950 wild juvenile Chinook (12,858 subyearling and 5,092 yearlings) were PIT tagged and released in 2018 in the Wenatchee River basin (Table 5.20). Most of these (51%) were tagged at the Chiwawa trap. See Appendix D for a complete list of all fish captured, tagged, lost, and released.

Table 5.20. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2018. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	7,948	285	5,692	20	6	5,686	0.25
	Yearling	3,539	57	3,448	8	1	3,447	0.22
	Total	**11,487**	**342**	**9,140**	**28**	**7**	**9,133**	**0.24**
Chiwawa River (Electrofishing)	Subyearling	3,800	39	3,737	15	0	3,737	0.39
	Yearling	0	0	0	0	0	0	0
	Total	**3,800**	**39**	**3,737**	**15**	**0**	**3,737**	**0.39**
Nason Creek Trap	Subyearling	1,651	51	686	8	0	686	0.48
	Yearling	301	13	296	5	0	296	1.66
	Total	**1,952**	**64**	**982**	**13**	**0**	**982**	**0.67**
Nason Creek (Electrofishing)	Subyearling	2,648	88	2,524	17	0	2,524	0.64
	Yearling	0	0	0	0	0	0	0

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
	Total	**2,648**	**88**	**2,524**	**17**	**0**	**2,524**	**0.64**
White River Trap	Subyearling	131	0	220	0	0	220	0
	Yearling	225	2	106	0	0	106	0
	Total	**356**	**2**	**326**	**0**	**0**	**326**	**0.00**
Lower Wenatchee Trap	Subyearling	47,283	54	5	347	0	5	0.73
	Yearling	1,418	1	1,243	7	0	1,243	0.49
	Total	**48,701**	**55**	**1,248**	**354**	**0**	**1,248**	**0.73**
Total:	**Subyearling**	**63,461**	**517**	**12,864**	**407**	**6**	**12,858**	**0.64**
	Yearling	**5,483**	**73**	**5,093**	**20**	**1**	**5,092**	**0.36**
Grand Total:		**68,944**	**590**	**17,957**	**427**	**7**	**17,950**	**0.62**

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2007-2018 are shown in Table 5.21.

Table 5.21. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2007-2018.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Chiwawa Trap	Subyearling	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241	5,686
	Yearling	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711	3,447
	Total	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**	**9,133**
Chiwawa River (Angling or Electro-fishing)	Subyearling	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703	3,737
	Yearling	0	0	3	4	0	0	0	0	0	0	0	0
	Total	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**	**3,737**
Upper Wenatchee Trap	Subyearling	15	0	37	3	1	1	0	--	--	--	--	--
	Yearling	1,434	159	296	486	714	75	94	--	--	--	--	--
	Total	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877	686
	Yearling	577	894	185	364	147	357	237	456	142	61	346	296
	Total	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**	**982**
Nason Creek (Angling or Electro-fishing)	Subyearling	6	4	701	595	0	0	0	1,816	1,089	802	3,240	2,524
	Yearling	7	0	13	3	0	0	0	0	0	0	0	0
	Total	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**	**2,524**
White River Trap	Subyearling	0	0	441	143	144	285	374	156	149	136	507	220
	Yearling	0	0	265	359	65	180	22	49	34	3	41	106
	Total	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**	**326**
Upper Wenatchee (Angling or	Subyearling	61	1	0	2	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Electro-fishing)	**Total**	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electro-fishing)	Subyearling	0	65	284	233	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electro-fishing)	Subyearling	0	0	0	1	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	2	0	0	0	0	0	36	0	18	0	5
	Yearling	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220	1,243
	Total	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**	**1,248**
Total:	**Subyearling**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**	**12,858**
	Yearling	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**	**5,092**
Grand Total:		***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***	***17,950***

Freshwater Productivity

Both productivity and survival estimates for different life stages of spring Chinook in the Chiwawa River basin are provided in Table 5.22. Estimates for brood year 2016 fall within the ranges estimated over the period of brood years 1991-2016. During that period, freshwater productivities ranged from 125-1,015 parr/redd, 39-673 smolts/redd, and 124-834 emigrants/redd. Survivals during the same period ranged from 2.7-19.1% for egg-parr, 0.9-14.5% for egg-smolt, and 2.9-18.0% for egg-emigrants. Overwinter survival rates for juvenile spring Chinook within the Chiwawa River basin have ranged from 15.7-100.0%.

Table 5.22. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Chiwawa River basin for brood years 1991-2016; ND = no data. These estimates were derived from data in Table 5.16.

Brood year	Parr/Redd	Smolts/Redd[a]	Emigrants/ Redd	Egg-Parr (%)	Parr-Smolt[b] (%)	Egg-Smolt[a] (%)	Egg-Emigrant (%)
1991	437	409	ND	9.5	93.5	8.9	ND
1992	262	132	217	5.0	50.2	2.5	4.2
1993	519	82	214	9.9	15.7	1.6	4.1
1994	674	201	306	11.4	29.8	3.4	5.2
1995	447	295	458	8.8	65.9	5.8	9.0
1996	699	673	834	15.0	96.3	14.5	18.0
1997	834	346	543	18.3	41.4	7.6	11.9

Brood year	Parr/Redd	Smolts/Redd[a]	Emigrants/ Redd	Egg-Parr (%)	Parr-Smolt[b] (%)	Egg-Smolt[a] (%)	Egg-Emigrant (%)
1998	1,015	563	632	19.1	55.4	10.6	11.9
1999	ND	314	460	ND	ND	6.4	9.4
2000	895	319	435	17.8	35.6	6.4	8.7
2001	125	80	507	2.7	64.1	1.7	11.0
2002	265	264	534	5.7	99.6	5.7	11.5
2003	407	151	303	7.0	37.1	2.6	5.2
2004	206	299	482	4.3	100.0	6.2	10.0
2005	240	207	534	5.5	86.4	4.8	12.3
2006	205	152	364	4.7	74.2	3.5	8.4
2007	291	91	304	6.6	31.3	2.1	6.8
2008	155	51	174	3.4	32.8	1.1	3.8
2009	305	74	147	6.7	24.1	1.6	3.2
2010	282	95	201	6.5	33.6	2.2	4.7
2011	211	76	221	4.8	35.8	1.7	5.0
2012	170	39	124	4.0	23.0	0.9	2.9
2013	170	55	158	3.6	32.5	1.2	3.4
2014	229	77	236	5.7	33.4	1.9	5.8
2015	258	98	358	5.3	38.1	2.0	5.3
2016	327	100	419	7.3	30.7	2.2	9.4
Average	***385***	***202***	***363***	***7.9***	***50.4***	***4.2***	***7.6***
Median	***282***	***141***	***306***	***6.5***	***37.1***	***2.6***	***6.8***

[a] These estimates include Chiwawa smolts produced only within the Chiwawa River basin.
[b] These estimates represent overwinter survival within the Chiwawa River basin. It does not include Chiwawa smolts produced outside the Chiwawa River basin.

Seeding level (egg deposition) explained most of the variability in productivity and survival of juvenile spring Chinook in the Chiwawa River basin. That is, for estimates based on "within-Chiwawa-Basin" life stages (e.g., parr and smolts), survival and productivity decreased as seeding levels increased (Figure 5.7). This suggests that density dependence regulates juvenile productivity and survival within the Chiwawa River basin. This form of population regulation is less apparent with total emigrants. However, one would expect the number of emigrants to increase as seeding levels exceed the rearing capacity of the Chiwawa River basin.

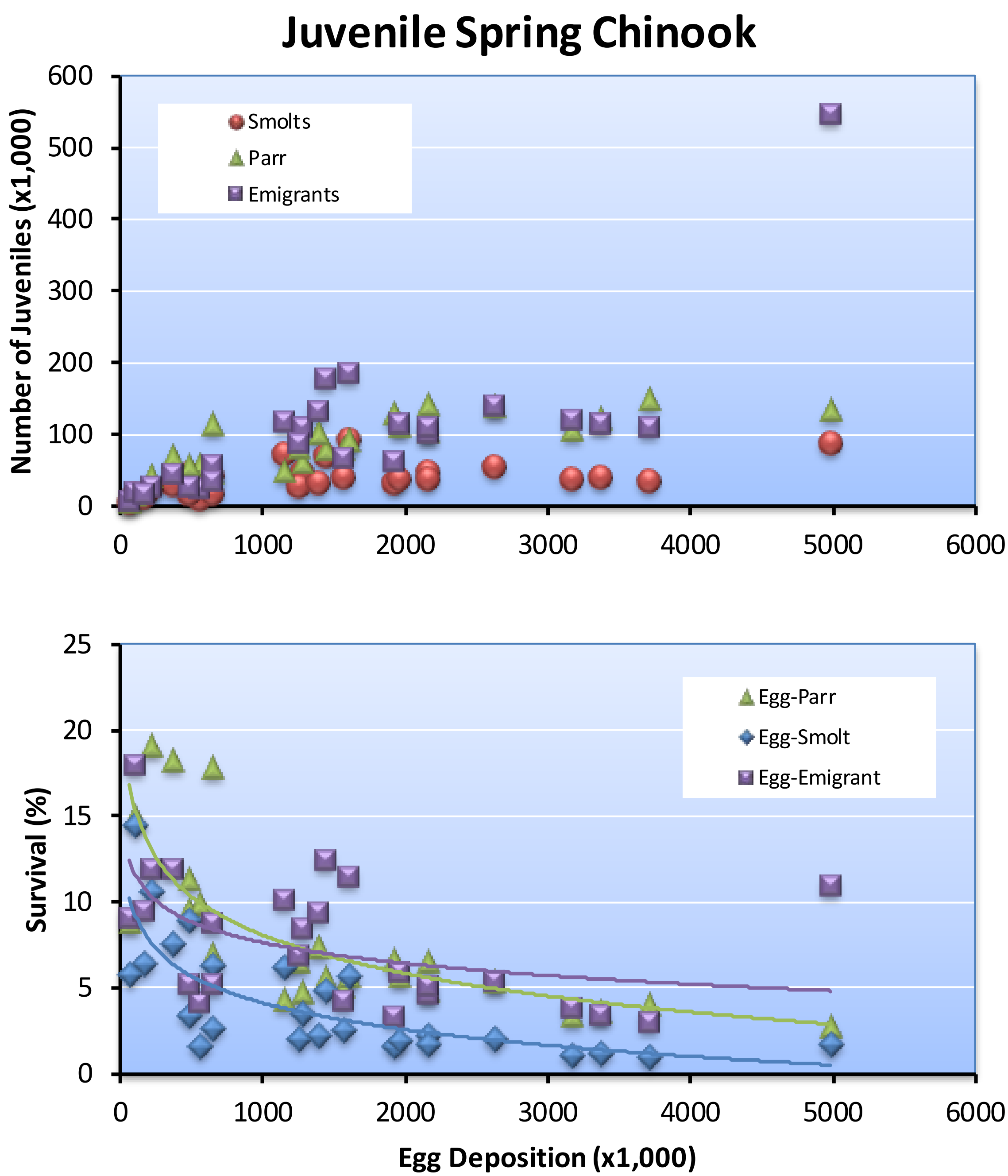


Figure 5.7. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Chiwawa spring Chinook, brood years 1991-2016. Smolts represent yearling Chinook produced within the Chiwawa River basin.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[17] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate parr and smolt carrying capacities using the smooth hockey stick stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). This model explains most of the information contained in the juvenile spring Chinook data (see Appendix B).

Based on the smooth hockey stick model, the population carrying capacity for spring Chinook parr in the Chiwawa River basin is 114,419 parr (95% CI: 95,041 – 138,496) (Figure 5.8). The capacity for spring Chinook smolts is 44,206 (95% CI: 34,857 – 52,934) (Figure 5.9). Here, smolts are defined as the number of yearling spring Chinook produced entirely within the Chiwawa River basin. These estimates reflect current conditions (most recent two decades) within the Chiwawa River basin. Land use activities such as logging, mining, roads, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook parr and smolts in the Chiwawa River basin.

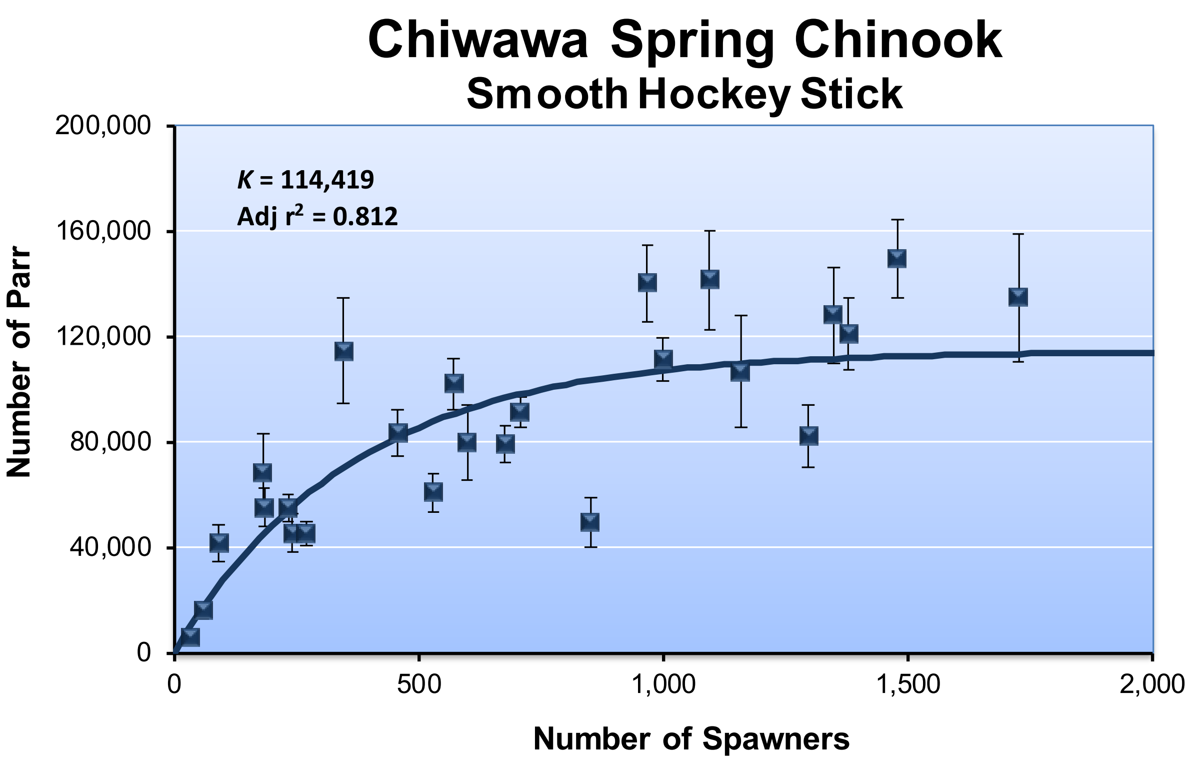


Figure 5.8. Relationship between spawners and number of parr produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data. Vertical bars represent 95% confidence intervals on parr estimates.

[17] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

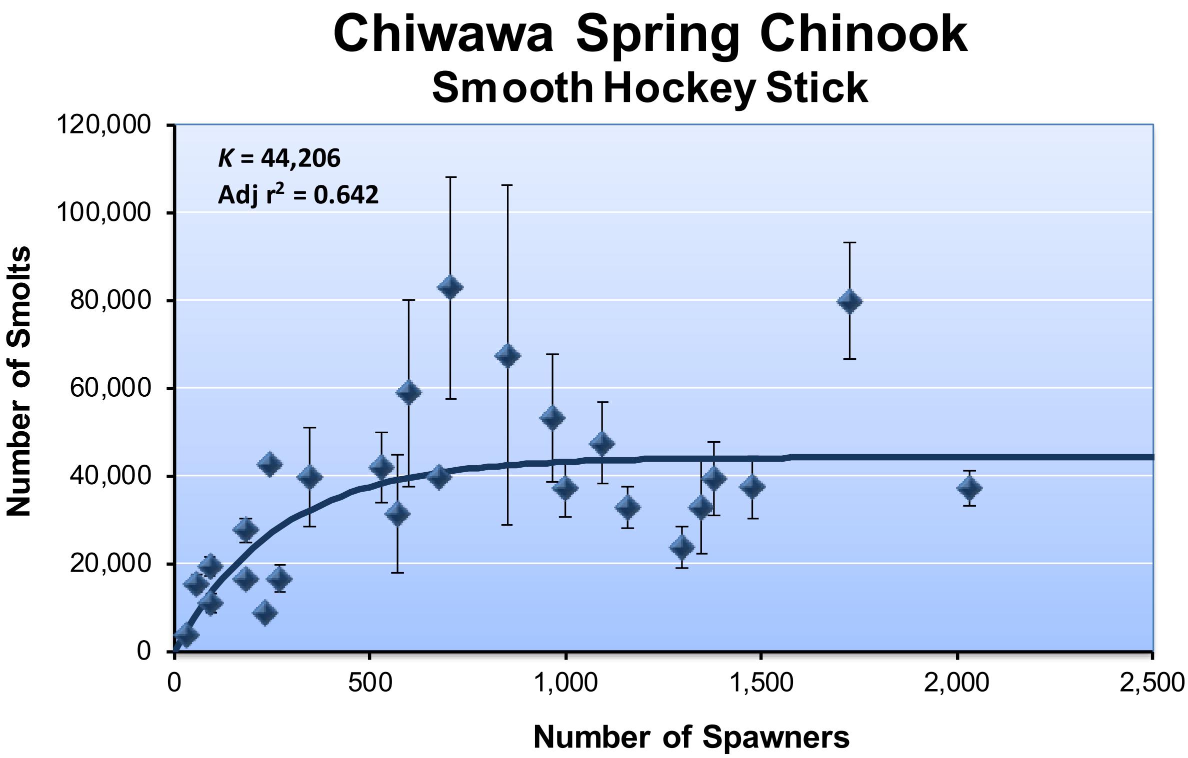


Figure 5.9. Relationship between spawners and number of yearling smolts produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data. At this time, 95% confidence intervals have only been calculated for the most recent six years of smolt data.

We tracked the precision of the smooth hockey stick parameters for Chiwawa spring Chinook smolts over time to see if precision improves with additional years of data, and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the smooth hockey stick model and their associated standard errors and confidence intervals indicates that the parameters appear to stabilize after 19 years of smolt and spawning escapement data (Table 5.23; Figure 5.10). This was also apparent in the estimates of population carrying capacity (Figure 5.11). That is, after 19 years of data, additional years of data had relatively little effect on the parameters of the smooth hockey stick model and its statistics. This observation will change if more extreme spawning escapements occur in the future or density independent factors overwhelm the influence of density dependent factors.

Table 5.23. Estimated parameters and statistics associated with fitting the smooth hockey stick model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the Chiwawa River basin. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	10.80	11.51	110.23	942.46	49,257	110	1,339	0.706
6	10.43	30.61	163.03	28,174.86	34,022	163	625	0.562
7	10.47	70.66	173.00	1,918.57	35,362	173	613	0.567
8	10.40	13.26	206.97	41,705.63	32,750	207	474	0.513
9	10.43	16.70	190.98	96,463.71	33,727	191	529	0.518
10	10.56	41.60	184.83	719.39	38,590	185	625	0.564
11	11.10	8.98	154.07	246,309.06	66,371	154	1,291	0.653
12	11.31	71.48	150.98	2,254.06	81,605	151	1,620	0.701
13	11.28	43.85	142.41	236.06	79,572	142	1,674	0.664
14	11.34	5.26	141.43	118.39	84,292	141	1,786	0.699
15	11.40	15.61	141.76	35.71	89,256	142	1,887	0.718
16	11.38	2.77	141.35	37.66	87,522	141	1,856	0.723
17	11.02	3.10	155.71	38.89	60,965	156	1,173	0.651
18	10.92	0.79	160.92	38.85	55,020	161	1,023	0.635
19	10.82	0.25	166.78	39.68	50,150	167	901	0.614
20	10.82	0.20	166.99	39.58	49,972	167	897	0.622
21	10.78	0.17	169.82	38.50	48,142	170	849	0.618
22	10.75	0.15	172.32	39.35	46,494	172	809	0.611
23	10.73	0.13	173.36	40.07	45,815	173	792	0.612
24	10.73	0.13	173.36	39.82	45,815	173	792	0.612
25	10.72	0.12	174.08	41.00	45,161	174	777	0.610
26	10.72	0.12	174.08	41.29	45,161	174	777	0.610
27	10.73	0.12	173.45	38.05	45,780	173	791	0.617
28	10.70	0.11	166.90	35.17	44,205	167	793	0.642

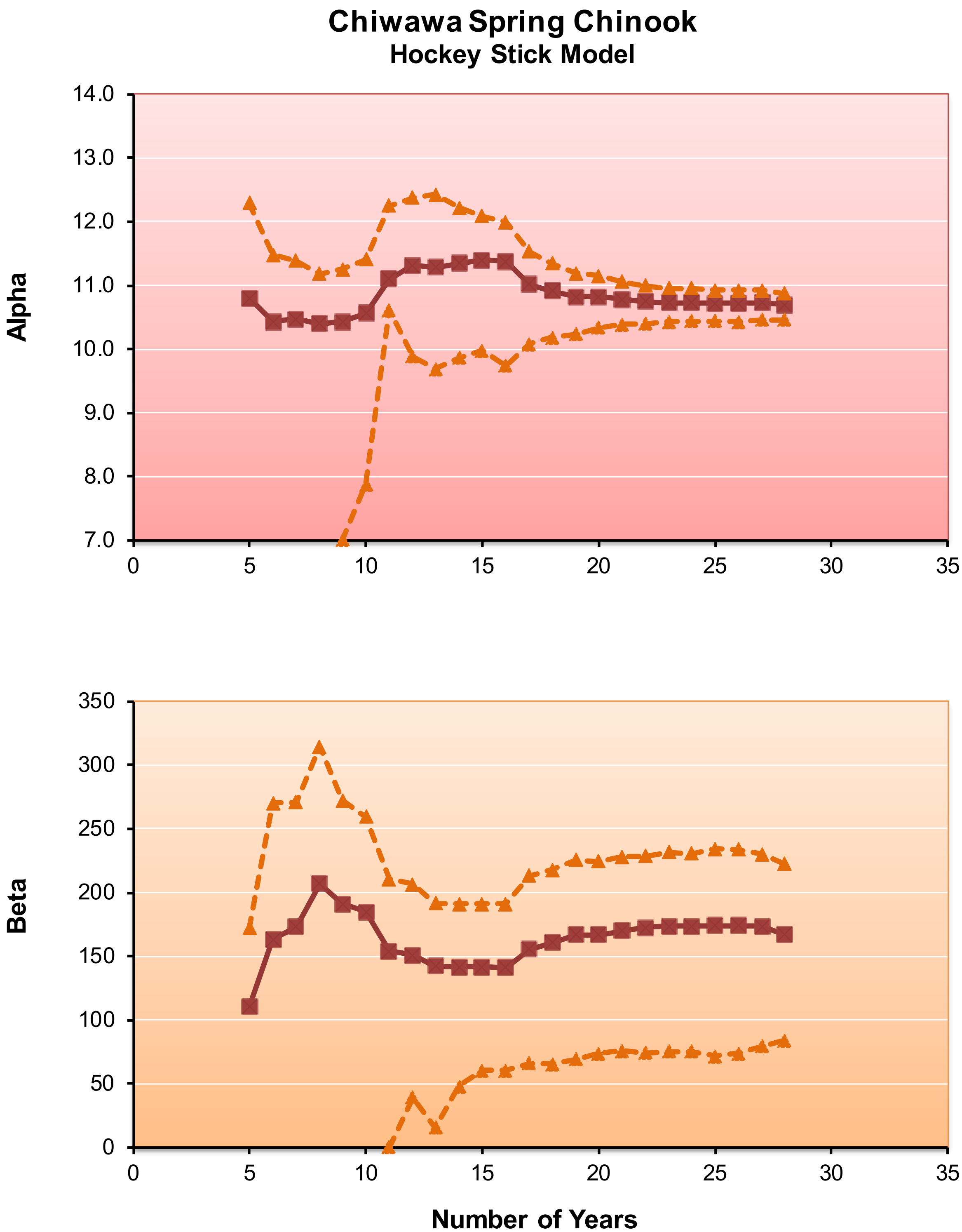


Figure 5.10. Time series of alpha and beta parameters and 95% confidence intervals for the smooth hockey stick model that was fit to Chiwawa spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

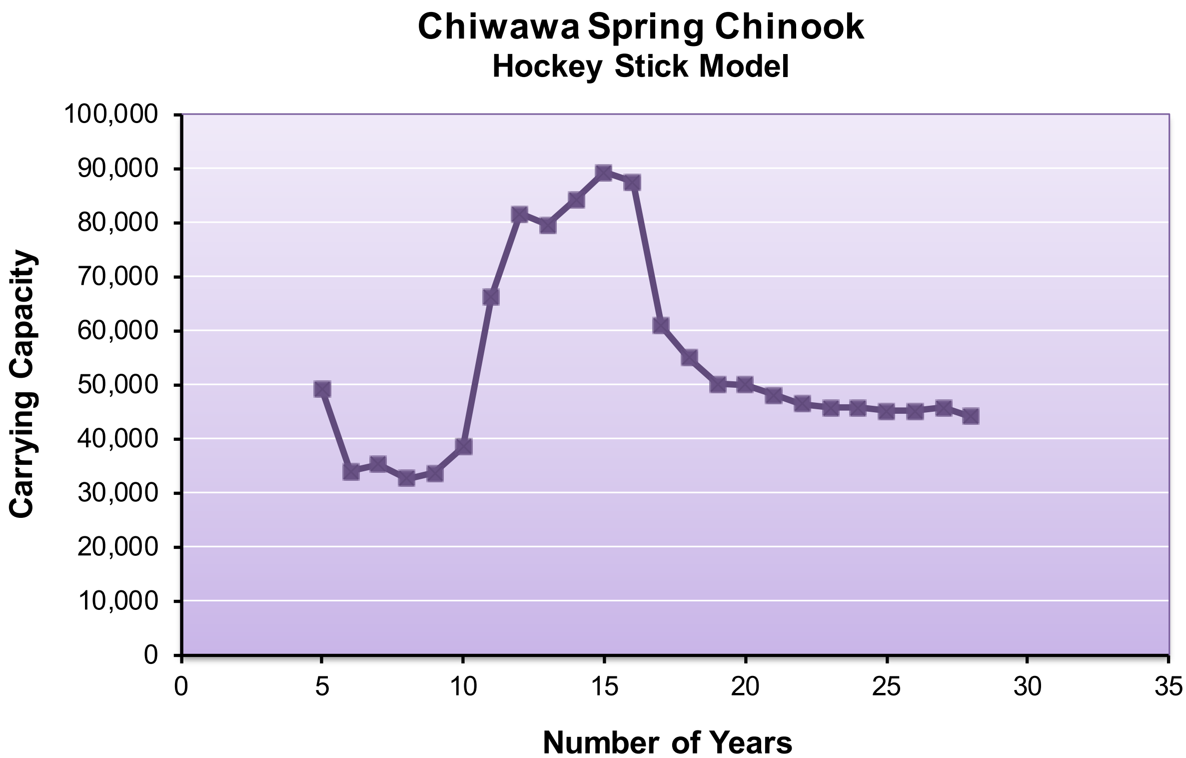


Figure 5.11. Time series of population carrying capacity estimates derived from fitting the smooth hockey stick model to Chiwawa spring Chinook smolt and spawning escapement data.

5.5 Spawning Surveys

Surveys for spring Chinook redds were conducted from mid-July through September 2018 in the Chiwawa River (including Rock, Chikamin, and Phelps creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), Upper Wenatchee River (including Chiwaukum Creek), Little Wenatchee River, and the White River (including the Napeequa River and Panther Creek).

Spawning escapement for spring Chinook was calculated as the total number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[18] Beginning with return year 2015, WDFW used the Gaussian area-under-the-curve (AUC) method (Millar et al. 2012) to estimate the number of redds within survey reaches (see Appendix L). The number of redds within each reach were then divided by the mean net error (ratio of observed redds to the estimated number of redds) to calculate the "adjusted" or "estimated" number of redds within each reach. The mean net error was modeled based on covariates such as surveyor experience, channel complexity (mean thalweg CV), and observed redd density (number of redds per km).

[18] Expansion factor = (1 + (number of males/number of females)).

Redd Counts

A total of 474 spring Chinook redds were counted in the Wenatchee River basin in 2018 (Table 5.24). This is lower than the average of 660 redds counted during the period 1989-2017 in the Wenatchee River basin. Most spawning occurred in the Chiwawa River (69.8% or 331 redds) (Table 5.24; Figure 5.12). Nason Creek contained 19.0% (90 redds), Upper Wenatchee River contained 4.2% (20 redds), White River contained 4.2% (20 redds), Little Wenatchee contained 1.7% (8 redds), Icicle Creek contained 0.6% (3 redds), and Peshastin Creek contained 0.4% (2 redds).

Table 5.24. Numbers of spring Chinook redds counted (not "adjusted" estimates) within different streams or watersheds within the Wenatchee River basin, 1989-2018. WDFW began full implementation of adult management in 2014.

Survey year	Number of spring Chinook redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
1989	314	98	45	64	94	24	NS	**639**
1990	255	103	30	22	36	50	4	**500**
1991	104	67	18	21	41	40	1	**292**
1992	302	81	35	35	38	37	0	**528**
1993	106	223	61	66	86	53	5	**600**
1994	82	27	7	3	6	15	0	**140**
1995	13	7	0	2	1	9	0	**32**
1996	23	33	3	12	1	12	1	**85**
1997	82	55	8	15	15	33	1	**209**
1998	41	29	8	5	0	11	0	**94**
1999	34	8	3	1	2	6	0	**54**
2000	128	100	9	8	37	68	0	**350**
2001	1,078	374	74	104	218	88	173*	**2,109**
2002	345	294	42	42	64	245	107*	**1,139**
2003	111	83	12	15	24	18	60	**323**
2004	241	169	13	22	46	30	55	**576**
2005	333	193	64	86	143	8	3	**830**
2006	297	152	21	31	27	50	10	**588**
2007	283	101	22	20	12	17	11	**466**
2008	689	336	38	31	180	116	21	**1,411**
2009	421	167	39	54	5	32	15	**733**
2010	502	188	38	33	47	155	5	**968**
2011	492	170	30	20	12	122	26	**872**
2012	880	413	43	86	73	199	10	**1,704**
2013	714	212	51	54	17	107	4	**1,159**
2014	485	115	25	26	23	211	0	**885**
2015	543	85	28	70	55	132	10	**923**
2016	312	85	22	44	17	72	2	**554**

Survey year	Number of spring Chinook redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
2017	222	68	10	15	9	40	3	**367**
2018	331	90	8	20	20	3	2	**474**
Average	***328***	***138***	***27***	***34***	***45***	***67***	***9***	***653***
Median	***300***	***101***	***24***	***24***	***26***	***40***	***3***	***564***

* Redd counts in Peshastin Creek in 2001 and 2002 were elevated because the U.S. Fish and Wildlife Service planted 487 and 350 spring Chinook adults, respectively, into the stream. These counts were not included in the average and median calculations.

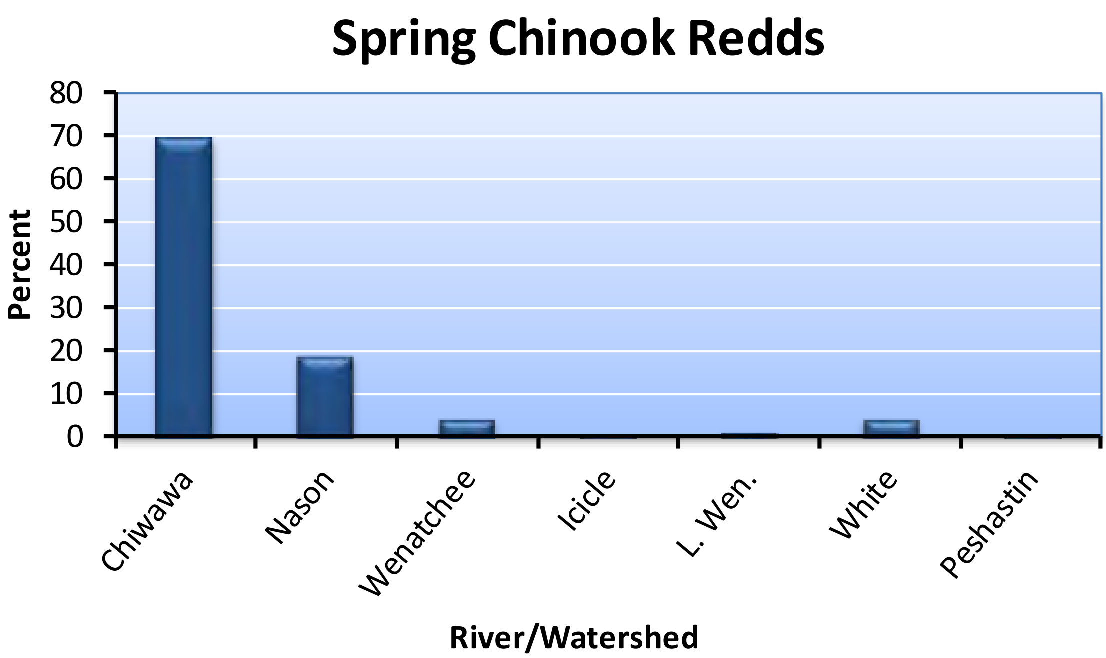


Figure 5.12. Percent of the total number of spring Chinook redds counted in different streams/watersheds within the Wenatchee River basin during August through September 2018.

As noted above, since 2015, WDFW has calculated the "adjusted" or "estimated" number of redds within survey areas in the Wenatchee River basin using the Gaussian area-under-the-curve method. Based on four years of data, the average difference between the observed (counted) and adjusted estimate is about 87 redds (Table 5.25).

Table 5.25. Comparison of the observed number and estimated number of spring Chinook redds within different streams/watersheds within the Wenatchee River basin, 2015-2018.

Survey year	Calculation	Survey stream							Total
		Chiwawa	Nason	Little Wenatchee	White	Wenatchee	Peshastin	Icicle	
2015	Observed	543	85	28	70	55	--	--	781
	Estimated	607	103	38	91	66	--	--	905
2016	Observed	312	85	22	44	17	2	72	554

Survey year	Calculation	Survey stream							Total
		Chiwawa	Nason	Little Wenatchee	White	Wenatchee	Peshastin	Icicle	
	Estimated	354	100	35	53	22	2	72	638
2017	Observed	222	68	10	15	9	3	40	367
	Estimated	254	87	16	19	11	3	40	430
2018	Observed	331	90	8	20	20	2	3	474
	Estimated	383	106	8	22	25	2	3	549

Redd Distribution

Spring Chinook redds were not evenly distributed among reaches within survey streams in 2018 (Table 5.26). Based on "estimated" redd counts, most of the spawning in the Chiwawa River basin occurred in Reaches 1 through 2. About 70% of the spawning in the Chiwawa River basin occurred in the lower two reaches (RKM 0.0-36.97; from the mouth to Rock Creek). Relatively few fish spawned in Rock and Chikamin creeks. The spatial distribution of redds in Nason Creek was weighted towards Reach 3 having 36% of the Nason Creek redds while Reaches 1, 2, and 4 had 19%, 13%, and 32%, respectively. In the Little Wenatchee River, about 88% of all spawning occurred in Reach 3 (RKM 9.2-14.0; Lost Creek to Falls). On the White River, 82% of the spawning occurred in Reach 3 (RKM 20.3-23.3; Napeequa River to Grasshopper Meadows). In the Wenatchee River about 36% of the fish spawned downstream from the mouth of the Chiwawa River (Reach 9) and 64% spawned upstream from the mouth (Reach 10). In Icicle Creek, about 67% of spawning occurred in Reach 2 (RKM 4.9-6.7; Hatchery to Sleeping Lady). All the spawning in Peshastin Creek occurred downstream from the mouth of Scotty Creek in Reach 1.

Table 5.26. Numbers (both observed and estimated) and proportions of spring Chinook redds estimated within different streams/watersheds within the Wenatchee River basin during August through September 2018. NS = not surveyed. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Observed number of redds	Estimated number of redds	Proportion of estimated redds within stream/watershed
Chiwawa	Chiwawa 1 (C1)	73	80	0.21
	Chiwawa 2 (C2)	158	191	0.50
	Chiwawa 3 (C3)	8	10	0.03
	Chiwawa 4 (C4)	31	34	0.09
	Chiwawa 5 (C5)	14	17	0.04
	Chiwawa 6 (C6)	30	30	0.08
	Chiwawa 7 (C7)	8	12	0.03
	Phelps 1 (S1)	0	0	0.00
	Rock 1 (R1)	3	3	0.01
	Chikamin 1 (K1)	6	6	0.02
	Total	**331**	**383**	**1.00**
Nason	Nason 1 (N1)	15	20	0.19
	Nason 2 (N2)	14	14	0.13

Stream/watershed	Reach	Observed number of redds	Estimated number of redds	Proportion of estimated redds within stream/watershed
	Nason 3 (N3)	38	38	0.36
	Nason 4 (N4)	23	34	0.32
	Total	**90**	**106**	**1.00**
Little Wenatchee	Little Wen 1 (L1)[a]	0	--	--
	Little Wen 2 (L2)	1	1	0.13
	Little Wen 3 (L3)	7	7	0.88
	Total	**8**	**8**	**1.00**
White	White 1 (H1)[a]	0	--	--
	White 2 (H2)	3	4	0.18
	White 3 (H3)	17	18	0.82
	White 4 (H4)	0	0	--
	Napeequa 1 (Q1)	0	0	--
	Panther 1 (T1)	0	0	--
	Total	**20**	**22**	**1.00**
Wenatchee River	Wen 9 (W9)	5	9	0.36
	Wen 10 (W10)	15	16	0.64
	Chiwaukum (A1)	0	0	--
	Total	**20**	**25**	**1.00**
Icicle	Icicle 1 (I1)	1	1	0.33
	Icicle 2 (I2)	2	2	0.67
	Icicle 3 (I3)	0	0	--
	Total	**3**	**3**	**1.00**
Peshastin	Peshastin 1 (P1)	2	2	1.00
	Peshastin 2 (P2)	0	0	--
	Ingalls (D1)	0	0	--
	Total	**2**	**2**	**1.00**
Grand Total		***367***	***549***	***1.00***

[a] Reaches L1 of the Little Wenatchee River and H1 of the White River were surveyed once during the peak of the season to verify that no spawning was occurring in the lower portion of each river.

Spawn Timing

Spring Chinook began spawning during the third week of August in the Chiwawa River. Spawning began the fourth week of August in the White River and the last week of August in Nason Creek and the Little Wenatchee and Wenatchee rivers. Spawning began the second week of September in Icicle Creek and the third week of September in Peshastin Creek (Figure 5.13). Spawning peaked the last week of August in the Chiwawa River, White River, and Little Wenatchee River. Spawning in Icicle Creek, Nason Creek, Peshastin Creek, and the Wenatchee River all peaked in September. Chinook completed spawning by the end of September.

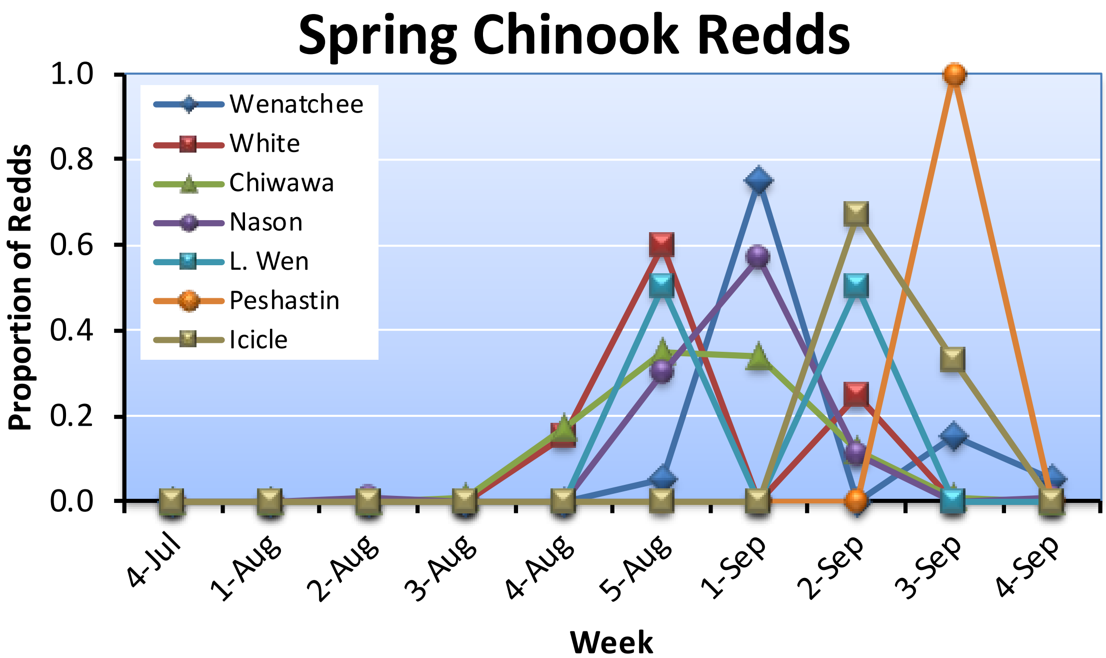


Figure 5.13. Proportion of spring Chinook redds counted during different weeks in different sampling streams within the Wenatchee River basin, August through September 2018.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the observed number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[19] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2018 was 1.88 (based on sex ratios estimated at Tumwater Dam). The estimated fish per redd ratio for spring Chinook downstream from Tumwater (Icicle and Peshastin creeks) was 1.73 (derived from broodstock collected at the Leavenworth National Fish Hatchery). Multiplying these ratios by the number of redds counted in the Wenatchee River basin resulted in a total spawning escapement of 890 spring Chinook (Table 5.27). The Chiwawa River basin had the highest spawning escapement (622 Chinook), while Peshastin Creek had the lowest (3 Chinook).

Table 5.27. Number of observed redds, fish per redd ratios, and total spawning escapement for spring Chinook in the Wenatchee River basin, 2018. Spawning escapement was estimated as the product of redds times fish per redd.

Sampling area	Total number of redds	Fish/redd	Total spawning escapement*
Chiwawa	331	1.88	622
Nason	90	1.88	169
Upper Wenatchee River	20	1.88	38
Icicle	3	1.73	5
Little Wenatchee	8	1.88	15
White	20	1.88	38

[19] Expansion factor = (1 + (number of males/number of females)).

Sampling area	Total number of redds	Fish/redd	Total spawning escapement*
Peshastin	2	1.73	3
Total	***474***	***--***	***890***

* Spawning escapement estimate is based on total number of observed redds by stream. If escapement is calculated at the reach scale, then the total escapement may vary from what is shown here because of rounding errors.

The estimated total spawning escapement of 890 spring Chinook in 2018 was less than the overall average of 1,330 spring Chinook (Table 5.28). The escapement in the Chiwawa River basin in 2018 was 3.7 times the escapement in Nason Creek, the second most abundant escapement in the Wenatchee River basin (Table 5.28).

Table 5.28. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2018; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**
2017	2.06	457	140	21	31	19	1.81	72	5	**745**

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
2018	1.88	622	169	15	38	38	1.73	5	3	**890**
Average	***--***	***717***	***303***	***59***	***73***	***91***	***--***	***120***	***32***	***1,330***
Median	***--***	***611***	***234***	***51***	***61***	***57***	***--***	***72***	***7***	***1,193***

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

5.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2018 in the Chiwawa River (including Rock, Chikamin, and Phelps creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), Upper Wenatchee River (including Chiwaukum Creek), Little Wenatchee River, and White River (including the Napeequa River and Panther Creek).

Number sampled

A total of 350 spring Chinook carcasses were sampled during August through September in the Wenatchee River basin (Table 5.29). Most were sampled in the Chiwawa River basin (61% or 211 carcasses) and Nason Creek (28% or 98 carcasses) (Figure 5.14). A total of 2 carcasses were sampled in Icicle Creek, 23 in the Wenatchee River, 12 in the White River, 3 in the Little Wenatchee River, and 1 in Peshastin Creek.

Table 5.29. Numbers of spring Chinook carcasses sampled within different streams/watersheds within the Wenatchee River basin, 1996-2018.

Survey year	Number of spring Chinook carcasses							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
1996	22	3	0	2	0	1	0	**28**
1997	17	42	3	8	1	28	1	**100**
1998	24	25	3	2	1	6	0	**61**
1999	15	5	0	0	2	1	0	**23**
2000	122	110	8	1	37	52	0	**330**
2001	763	388	68	81	213	163	63	**1,739**
2002	210	292	30	25	34	91	65	**747**
2003	70	100	8	8	11	37	64	**298**
2004	178	186	1	13	29	16	40	**463**
2005	391	217	48	52	120	2	0	**830**
2006	241	190	13	25	15	7	0	**491**
2007	250	201	16	13	24	15	6	**525**
2008	386	243	15	13	94	67	5	**823**
2009	240	128	20	20	1	67	2	**478**
2010	192	141	7	11	29	39	2	**421**
2011	177	98	7	4	3	40	3	**332**

Survey year	Number of spring Chinook carcasses							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
2012	390	332	24	21	23	61	3	**854**
2013	396	142	20	22	8	28	1	**617**
2014	320	68	15	8	19	44	0	**474**
2015	275	43	12	25	25	67	3	**450**
2016	211	95	5	13	13[a]	25	0	**362**
2017	140	78	3	9	5	22	3	**260**
2018	211	98	3	12	23[b]	2	1	**350**
Average	***228***	***140***	***14***	***17***	***32***	***38***	***11***	***481***
Median	***211***	***110***	***8***	***13***	***19***	***28***	***2***	***450***

[a] The number of carcasses sampled in the Wenatchee River in 2016 include two recovered in reach (W6) just downstream from the mouth of Icicle Creek.

[b] The number of carcasses sampled in the Wenatchee River in 2018 include three recovered in reach (W6) just downstream from the mouth of Icicle Creek and two recovered in reach (W8).

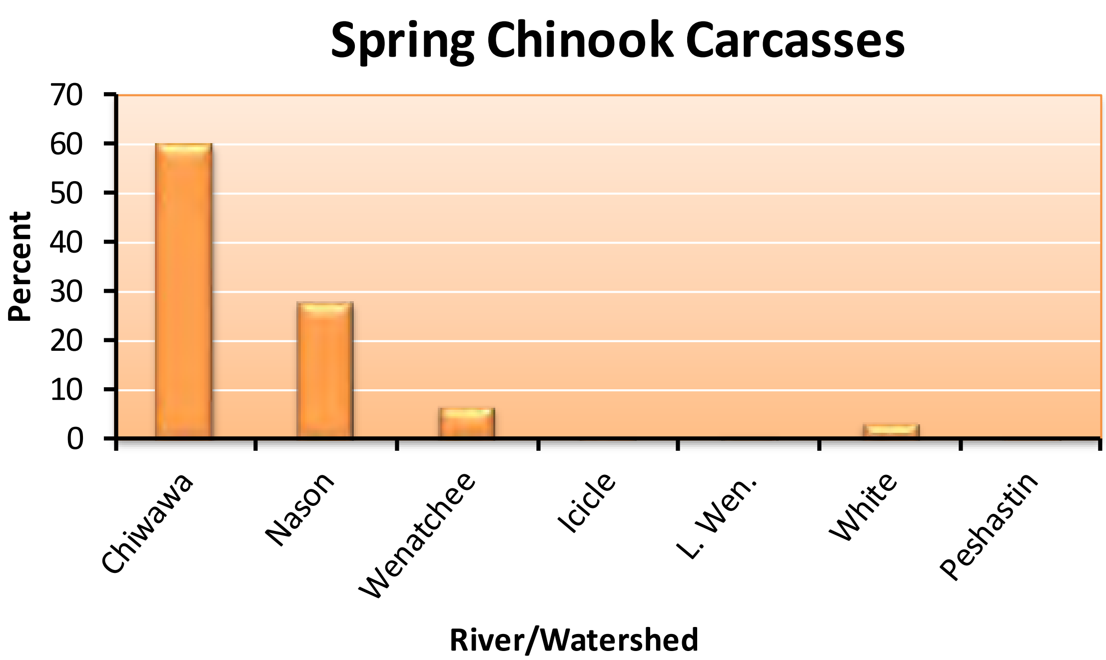


Figure 5.14. Percent of the total number of spring Chinook carcasses sampled in different streams/watersheds within the Wenatchee River basin during August through September 2018.

Carcass Distribution and Origin

Spring Chinook carcasses were not evenly distributed among reaches within survey streams in 2018 (Table 5.30). Most of the carcasses (77%) in the Chiwawa River basin occurred in Reaches 1 and 2 (downstream from Rock Creek). In Nason Creek, most carcasses (47%) were collected in Reach 3 and the fewest (6%) in Reach 1. All carcasses in the Little Wenatchee River were sampled in Reach 3 (Lost Creek to Rainy Creek). On the White River, most (92%) occurred in Reach 3 (Napeequa River to Grasshopper Meadows). On the Wenatchee River, 26% of the carcasses were found upstream from the confluence of the Chiwawa River and 52% were found downstream from the confluence. In Icicle Creek the carcasses were split evenly between Reach 2 (50%) and Reach 3 (50%) with no carcasses found in Reach 1. One carcass was found in Peshastin Creek (between the mouth to Scotty Creek).

Table 5.30. Numbers and proportions of carcasses sampled within different streams/watersheds within the Wenatchee River basin during August through September 2018. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of carcasses	Proportion of carcasses within stream/watershed
Chiwawa	Chiwawa 1 (C1)	37	0.18
	Chiwawa 2 (C2)	125	0.59
	Chiwawa 3 (C3)	7	0.03
	Chiwawa 4 (C4)	14	0.07
	Chiwawa 5 (C5)	9	0.04
	Chiwawa 6 (C6)	12	0.06
	Chiwawa 7 (C7)	1	0.00
	Phelps 1 (S1)	0	0.00
	Rock 1 (R1)	2	0.01
	Chikamin 1 (K1)	4	0.02
	Total	**211**	**1.00**
Nason	Nason 1 (N1)	6	0.06
	Nason 2 (N2)	23	0.23
	Nason 3 (N3)	46	0.47
	Nason 4 (N4)	23	0.23
	Total	**98**	**1.00**
Little Wenatchee	Little Wen 1 (L1)	0	0.00
	Little Wen 2 (L2)	0	0.00
	Little Wen 3 (L3)	3	1.00
	Total	**3**	**1.00**
White	White 1 (H1)	0	0.00
	White 2 (H2)	1	0.08
	White 3 (H3)	11	0.92
	White 4 (H4)	0	0.00
	Napeequa 1 (Q1)	0	0.00
	Panther 1 (T1)	0	0.00
	Total	**12**	**1.00**
Wenatchee River	Wen 6 (W6)	3	0.13
	Wen 8 (W8)	2	0.09
	Wen 9 (W9)	12	0.52
	Wen 10 (W10)	6	0.26
	Chiwaukum 1 (U1)	0	0.00

Stream/watershed	Reach	Number of carcasses	Proportion of carcasses within stream/watershed
	Total	**23**	**1.00**
Icicle	Icicle 1 (I1)	0	0.00
	Icicle 2 (I2)	1	0.50
	Icicle 3 (I3)	1	0.50
	Total	**2**	**1.00**
Peshastin	Peshastin 1 (P1)	1	1.00
	Peshastin 2 (P2)	0	0.00
	Ingalls (D1)	0	0.00
	Total	**1**	**1.00**
Grand Total		**350**	**1.00**

Origin was determined for the 211 carcasses sampled in the Chiwawa River basin in 2018. Of those sampled in the Chiwawa River basin, 75% were hatchery fish (Table 5.31). In the Chiwawa River basin, the spatial distribution of hatchery and wild fish was not equal (Table 5.31). A larger percentage of hatchery fish were found in the lower reaches (C1 and C2; i.e., Mouth to Rock Creek). This general trend was also apparent in the pooled data (Figure 5.15).

Table 5.31. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Chiwawa River basin, 1993-2018. Numbers represent recovered carcasses that had definitive origins. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach									Total
		C-1	C-2	C-3	C-4	C-5	C-6	C-7	Chikamin	Rock	
1993	Wild	0	0	0	0	0	0	--	0	0	**0**
	Hatchery	1	0	0	0	0	0	--	0	0	**1**
1994	Wild	0	6	0	2	0	2	--	0	0	**10**
	Hatchery	1	1	0	2	0	0	--	0	0	**4**
1995	Wild	0	0	0	0	0	0	--	0	0	**0**
	Hatchery	2	3	0	1	0	0	--	0	0	**6**
1996	Wild	13	1	1	1	0	0	--	0	0	**16**
	Hatchery	6	0	0	0	0	0	--	0	0	**6**
1997	Wild	5	2	0	1	0	0	--	0	0	**8**
	Hatchery	3	1	0	0	0	1	--	1	3	**9**
1998	Wild	0	3	6	1	2	4	--	0	0	**16**
	Hatchery	1	3	2	0	1	1	--	0	0	**8**
1999	Wild	1	8	0	5	0	0	--	0	0	**14**
	Hatchery	0	0	0	0	1	0	--	0	0	**1**
2000	Wild	29	29	1	1	1	1	--	0	0	**62**
	Hatchery	42	12	0	0	0	2	--	0	0	**56**
2001	Wild	27	60	15	43	16	21	--	1	3	**186**
	Hatchery	164	284	19	58	14	21	--	8	0	**568**
2002	Wild	22	15	10	6	9	7	--	1	0	**70**

Survey year	Origin	Survey Reach									Total
		C-1	C-2	C-3	C-4	C-5	C-6	C-7	Chikamin	Rock	
	Hatchery	46	41	12	5	1	15	--	15	4	**139**
2003	Wild	7	13	0	12	4	2	--	0	0	**38**
	Hatchery	14	14	0	3	1	0	--	0	0	**32**
2004	Wild	25	50	2	12	7	2	--	0	1	**99**
	Hatchery	48	21	1	1	1	4	--	0	2	**78**
2005	Wild	18	36	3	5	3	2	--	0	0	**67**
	Hatchery	170	132	7	7	4	3	--	0	1	**324**
2006	Wild	10	17	2	8	4	3	--	1	0	**45**
	Hatchery	84	75	5	7	6	13	--	3	3	**196**
2007	Wild	3	15	3	4	2	2	--	0	0	**29**
	Hatchery	42	118	15	14	18	12	--	2	0	**221**
2008	Wild	4	23	0	4	4	8	--	0	0	**43**
	Hatchery	174	122	2	9	15	15	--	4	1	**342**
2009	Wild	3	21	4	8	4	1	--	0	3	**44**
	Hatchery	89	70	6	14	7	5	--	0	5	**196**
2010	Wild	4	30	7	8	10	3	--	0	0	**62**
	Hatchery	64	35	2	10	7	5	--	0	5	**128**
2011	Wild	8	26	10	6	8	6	--	0	1	**65**
	Hatchery	43	40	4	5	5	10	--	1	4	**112**
2012	Wild	11	74	6	21	13	18	0	0	3	**146**
	Hatchery	94	91	9	13	16	16	0	0	6	**245**
2013	Wild	8	38	7	21	16	14	1	0	3	**108**
	Hatchery	101	112	19	23	13	15	0	5	3	**291**
2014	Wild	18	77	9	28	19	21	0	0	0	**172**
	Hatchery	64	48	6	10	6	9	1	2	2	**148**
2015	Wild	14	37	6	12	12	13	0	0	0	**94**
	Hatchery	65	89	7	9	6	5	0	0	0	**181**
2016	Wild	13	73	8	18	15	10	0	2	0	**139**
	Hatchery	25	37	1	4	2	1	1	0	0	**71**
2017	Wild	5	31	2	4	5	1	0	0	0	**48**
	Hatchery	30	36	1	3	3	7	0	8	3	**91**
2018	Wild	6	26	2	8	4	5	0	1	0	**52**
	Hatchery	31	99	5	6	5	7	1	3	2	**159**
Average	***Wild***	***10***	***27***	***4***	***9***	***6***	***6***	***0***	***0***	***1***	***63***
	Hatchery	***54***	***57***	***5***	***8***	***5***	***6***	***0***	***2***	***2***	***139***
Median	***Wild***	***8***	***25***	***3***	***6***	***4***	***3***	***0***	***0***	***0***	***50***
	Hatchery	***43***	***39***	***2***	***5***	***4***	***5***	***0***	***0***	***1***	***120***

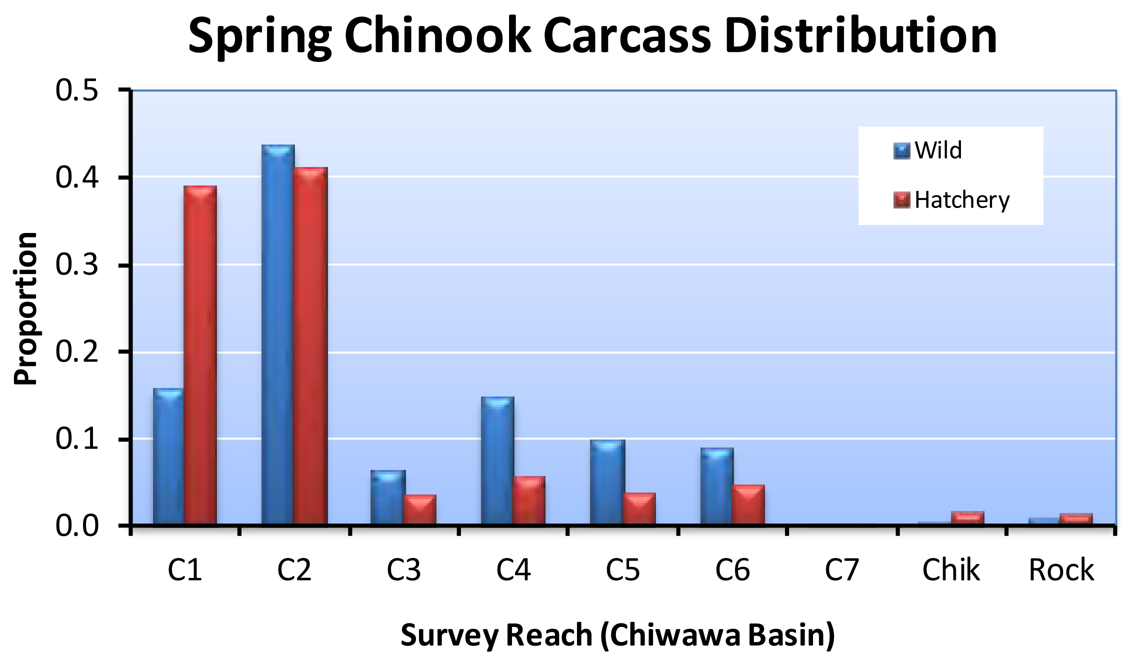


Figure 5.15. Distribution of wild and hatchery produced carcasses in different reaches in the Chiwawa River basin, 1993-2018; Chik = Chikamin Creek and Rock = Rock Creek. Reach codes are described in Table 2.8.

Sampling Rate

Overall, 39% of the estimated total spawning escapement of spring Chinook in the Wenatchee River basin was sampled in 2018 (Table 5.32). Sampling rates among streams/watershed varied from 20 to 61%.

Table 5.32. Number of redds and carcasses, total spawning escapement, and sampling rates for spring Chinook salmon in the Wenatchee River basin, 2018.

Sampling area	Total number of observed redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chiwawa	331	211	622	0.34
Nason	90	98	169	0.58
Upper Wenatchee	20	23	38	0.61
Icicle	3	2	5	0.40
Little Wenatchee	8	3	15	0.20
White	20	12	38	0.32
Peshastin	2	1	3	0.33
Total	***474***	***350***	***890***	***0.39***

Length Data

Mean lengths (POH, cm) of male and female spring Chinook carcasses sampled during surveys in the Wenatchee River basin in 2018 are provided in Table 5.33. The size of both males and females sampled in the Wenatchee River basin in 2018 averaged 60 cm.

Table 5.33. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female spring Chinook carcasses sampled in different streams/watersheds in the Wenatchee River basin, 2018.

Stream/watershed	Mean lengths (cm)	
	Male	Female
Chiwawa	62 (5.9)	60 (4.3)
Nason	57 (9.0)	60 (4.3)
Upper Wenatchee	65 (5.2)	61 (4.5)
Icicle	0	59 (3.5)
Little Wenatchee	0	59 (4.9)
White	51 (14.2)	62 (3.8)
Peshastin	70 (--)	0
Total	***60 (7.7)***	***60 (4.3)***

5.7 Life History Monitoring

Life history characteristics of spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In 2018, there was a small difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 5.34a and b; Figure 5.16). On average, hatchery fish arrived at the dam later and ended their migration later than did wild fish. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 5.16).

Table 5.34a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2018. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	49
	Hatchery	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	25
1999	Wild	192	11-Jul	207	26-Jul	224	12-Aug	207	26-Jul	173
	Hatchery	200	19-Jul	211	30-Jul	229	17-Aug	213	1-Aug	25
2000	Wild	171	19-Jun	186	4-Jul	194	12-Jul	184	2-Jul	651
	Hatchery	179	27-Jun	189	7-Jul	201	19-Jul	190	8-Jul	357

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2001	Wild	154	3-Jun	166	15-Jun	185	4-Jul	167	16-Jun	2,073
	Hatchery	157	6-Jun	169	18-Jun	185	4-Jul	170	19-Jun	4,244
2002	Wild	174	23-Jun	189	8-Jul	204	23-Jul	189	8-Jul	1,033
	Hatchery	178	27-Jun	189	8-Jul	199	18-Jul	189	8-Jul	1,363
2003	Wild	162	11-Jun	181	30-Jun	200	19-Jul	181	30-Jun	919
	Hatchery	157	6-Jun	179	28-Jun	192	11-Jul	178	27-Jun	423
2004	Wild	156	4-Jun	172	20-Jun	189	7-Jul	172	20-Jun	969
	Hatchery	161	9-Jun	177	25-Jun	189	7-Jul	177	25-Jun	1,295
2005	Wild	153	2-Jun	172	21-Jun	193	12-Jul	173	22-Jun	1,038
	Hatchery	153	2-Jun	173	22-Jun	187	6-Jul	172	21-Jun	2,808
2006	Wild	177	26-Jun	184	3-Jul	193	12-Jul	185	4-Jul	577
	Hatchery	178	27-Jun	185	4-Jul	194	13-Jul	186	5-Jul	1601
2007	Wild	169	18-Jun	185	4-Jul	203	22-Jul	185	4-Jul	351
	Hatchery	174	23-Jun	192	11-Jul	209	28-Jul	192	11-Jul	3,232
2008	Wild	173	21-Jun	188	6-Jul	209	27-Jul	189	7-Jul	634
	Hatchery	177	25-Jun	193	11-Jul	210	28-Jul	193	11-Jul	5,368
2009	Wild	174	23-Jun	186	5-Jul	201	20-Jul	187	6-Jul	1,008
	Hatchery	175	24-Jun	187	6-Jul	202	21-Jul	188	7-Jul	4,106
2010	Wild	173	22-Jun	190	9-Jul	214	2-Aug	191	10-Jul	977
	Hatchery	180	29-Jun	194	13-Jul	213	1-Aug	195	14-Jul	4,450
2011	Wild	183	2-Jul	198	17-Jul	213	1-Aug	198	17-Jul	1,433
	Hatchery	187	6-Jul	200	19-Jul	210	29-Jul	199	18-Jul	4,707
2012	Wild	180	28-Jun	191	9-Jul	205	23-Jul	192	10-Jul	1,482
	Hatchery	182	30-Jun	194	12-Jul	206	24-Jul	194	12-Jul	4,449
2013	Wild	163	12-Jun	182	1-Jul	199	18-Jul	183	2-Jul	1,106
	Hatchery	164	13-Jun	181	30-Jun	195	14-Jul	181	30-Jun	3,681
2014	Wild	171	20-Jun	188	7-Jul	202	21-Jul	187	6-Jul	1,329
	Hatchery	167	16-Jun	182	1-Jul	195	14-Jul	181	30-Jun	2,510
2015	Wild	150	30-May	170	19-Jun	184	3-Jul	170	19-Jun	1,370
	Hatchery	148	28-May	168	17-Jun	180	29-Jun	167	16-Jun	1,773
2016	Wild	158	6-Jun	180	28-Jun	200	18-Jul	181	29-Jun	1,252
	Hatchery	160	8-Jun	179	27-Jun	191	9-Jul	178	26-Jun	1,284
2017	Wild	175	24-Jun	184	3-Jul	195	14-Jul	184	3-Jul	483
	Hatchery	177	26-Jun	185	4-Jul	196	15-Jul	187	6-Jul	1,035
2018	Wild	165	14-Jun	175	24-Jun	188	7-Jul	177	26-Jun	684
	Hatchery	161	10-Jun	172	21-Jun	188	7-Jul	175	24-Jun	1,437
Average	Wild	***168***	*--*	***182***	*--*	***198***	*--*	***183***	*--*	***919***
	Hatchery	***170***	*--*	***184***	*--*	***197***	*--*	***184***	*--*	***2,389***
Median	Wild	***171***	*--*	***184***	*--*	***200***	*--*	***184***	*--*	***977***
	Hatchery	***174***	*--*	***185***	*--*	***195***	*--*	***186***	*--*	***1,773***

Table 5.34b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2018. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	23	23	23	23	49
	Hatchery	23	23	23	23	25
1999	Wild	28	30	32	30	173
	Hatchery	29	31	34	31	25
2000	Wild	24	27	27	27	651
	Hatchery	26	27	29	28	357
2001	Wild	22	24	27	24	2,073
	Hatchery	23	25	27	25	4,244
2002	Wild	25	27	30	27	1,033
	Hatchery	26	27	29	27	1,363
2003	Wild	24	26	29	26	919
	Hatchery	23	26	28	26	423
2004	Wild	23	25	27	25	969
	Hatchery	23	26	27	26	1,295
2005	Wild	22	25	28	25	1,038
	Hatchery	22	25	27	25	2,808
2006	Wild	26	27	28	27	577
	Hatchery	26	27	28	27	1,601
2007	Wild	25	27	29	27	351
	Hatchery	25	28	30	28	3,232
2008	Wild	25	27	30	27	634
	Hatchery	26	28	30	28	5,368
2009	Wild	25	27	29	27	1,008
	Hatchery	25	27	29	27	4,106
2010	Wild	25	28	31	28	977
	Hatchery	26	28	31	28	4,450
2011	Wild	27	29	31	29	1,433
	Hatchery	27	29	30	29	4,707
2012	Wild	26	28	30	28	1,482
	Hatchery	26	28	30	28	4,449
2013	Wild	24	26	29	27	1,106
	Hatchery	24	26	28	26	3,681
2014	Wild	25	27	29	27	1,329

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	24	26	28	26	2,510
2015	Wild	22	25	27	25	1,370
	Hatchery	22	24	26	24	1,773
2016	Wild	23	26	29	26	1,252
	Hatchery	23	26	28	26	1,284
2017	Wild	25	27	28	27	483
	Hatchery	26	27	28	27	1,035
2018	Wild	24	25	27	26	384
	Hatchery	23	25	27	25	1,437
Average	Wild	***24***	***26***	***29***	***27***	***919***
	Hatchery	***25***	***27***	***28***	***27***	***2,389***
Median	Wild	***25***	***27***	***29***	***27***	***977***
	Hatchery	***25***	***27***	***28***	***27***	***1,773***

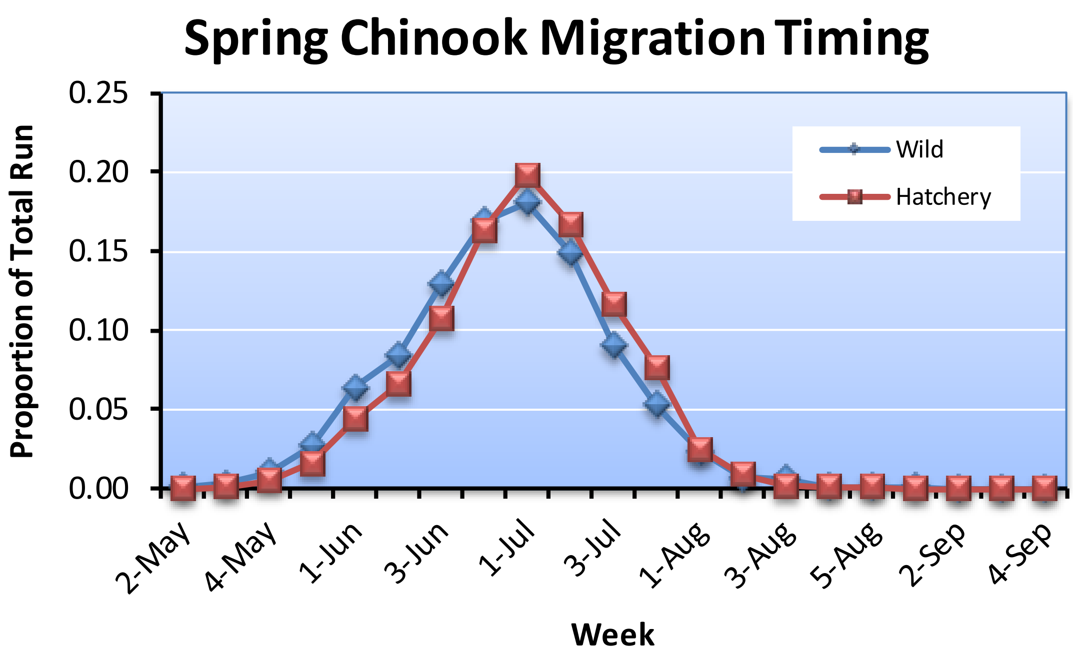


Figure 5.16. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2018.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1994-2018 in the Chiwawa River basin were age-4 fish (total age) (Table 5.35; Figure 5.17). On average, a higher proportion of age-5 wild fish returned than did age-5 hatchery fish. This follows the trend observed across most years where wild fish tended to return at an older age than hatchery fish.

Table 5.35. Proportions of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Chiwawa River basin, 1994-2018.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
1994	Wild	0.00	0.00	0.33	0.67	0.00	9
	Hatchery	0.00	0.20	0.00	0.80	0.00	5
1995	Wild	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	1.00	0.00	0.00	5
1996	Wild	0.00	0.36	0.64	0.00	0.00	14
	Hatchery	0.00	0.83	0.17	0.00	0.00	6
1997	Wild	0.00	0.00	0.75	0.25	0.00	8
	Hatchery	0.00	0.00	1.00	0.00	0.00	9
1998	Wild	0.00	0.00	0.00	1.00	0.00	15
	Hatchery	0.00	0.00	0.13	0.88	0.00	8
1999	Wild	0.00	0.07	0.50	0.43	0.00	14
	Hatchery	0.00	0.00	0.00	1.00	0.00	1
2000	Wild	0.00	0.02	0.95	0.04	0.00	56
	Hatchery	0.00	0.50	0.50	0.00	0.00	52
2001	Wild	0.00	0.01	0.95	0.04	0.00	176
	Hatchery	0.00	0.02	0.98	0.00	0.00	571
2002	Wild	0.00	0.00	0.56	0.44	0.00	54
	Hatchery	0.00	0.00	0.91	0.09	0.00	129
2003	Wild	0.00	0.08	0.00	0.92	0.00	36
	Hatchery	0.00	0.19	0.03	0.78	0.00	32
2004	Wild	0.00	0.05	0.94	0.01	0.00	99
	Hatchery	0.00	0.42	0.58	0.00	0.00	78
2005	Wild	0.00	0.02	0.78	0.21	0.00	67
	Hatchery	0.00	0.04	0.96	0.00	0.00	324
2006	Wild	0.02	0.02	0.51	0.44	0.00	45
	Hatchery	0.01	0.04	0.78	0.18	0.00	196
2007	Wild	0.00	0.10	0.24	0.67	0.00	29
	Hatchery	0.00	0.35	0.59	0.06	0.00	221
2008	Wild	0.02	0.02	0.81	0.14	0.00	43
	Hatchery	0.00	0.07	0.89	0.05	0.00	340
2009	Wild	0.00	0.09	0.86	0.05	0.00	44
	Hatchery	0.00	0.24	0.75	0.02	0.00	196
2010	Wild	0.00	0.00	0.90	0.10	0.00	63
	Hatchery	0.00	0.07	0.91	0.02	0.00	127

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2011	Wild	0.00	0.08	0.38	0.54	0.00	65
	Hatchery	0.00	0.26	0.45	0.30	0.00	112
2012	Wild	0.00	0.01	0.80	0.19	0.00	141
	Hatchery	0.00	0.03	0.96	0.02	0.00	243
2013	Wild	0.00	0.09	0.60	0.31	0.00	105
	Hatchery	0.00	0.13	0.78	0.09	0.00	275
2014	Wild	0.00	0.04	0.89	0.07	0.00	169
	Hatchery	0.00	0.08	0.90	0.02	0.00	148
2015	Wild	0.00	0.01	0.83	0.16	0.00	96
	Hatchery	0.00	0.06	0.93	0.01	0.00	185
2016	Wild	0.00	0.04	0.67	0.29	0.00	138
	Hatchery	0.00	0.04	0.80	0.16	0.00	71
2017	Wild	0.00	0.02	0.85	0.13	0.00	48
	Hatchery	0.00	0.03	0.90	0.07	0.00	91
2018	Wild	0.00	0.00	0.92	0.08	0.00	52
	Hatchery	0.00	0.00	0.99	0.01	0.00	157
Average	***Wild***	***0.00***	***0.04***	***0.75***	***0.21***	***0.00***	***63***
	Hatchery	***0.00***	***0.10***	***0.84***	***0.06***	***0.00***	***144***
Median	***Wild***	***0.00***	***0.02***	***0.82***	***0.15***	***0.00***	***52***
	Hatchery	***0.00***	***0.06***	***0.91***	***0.03***	***0.00***	***127***

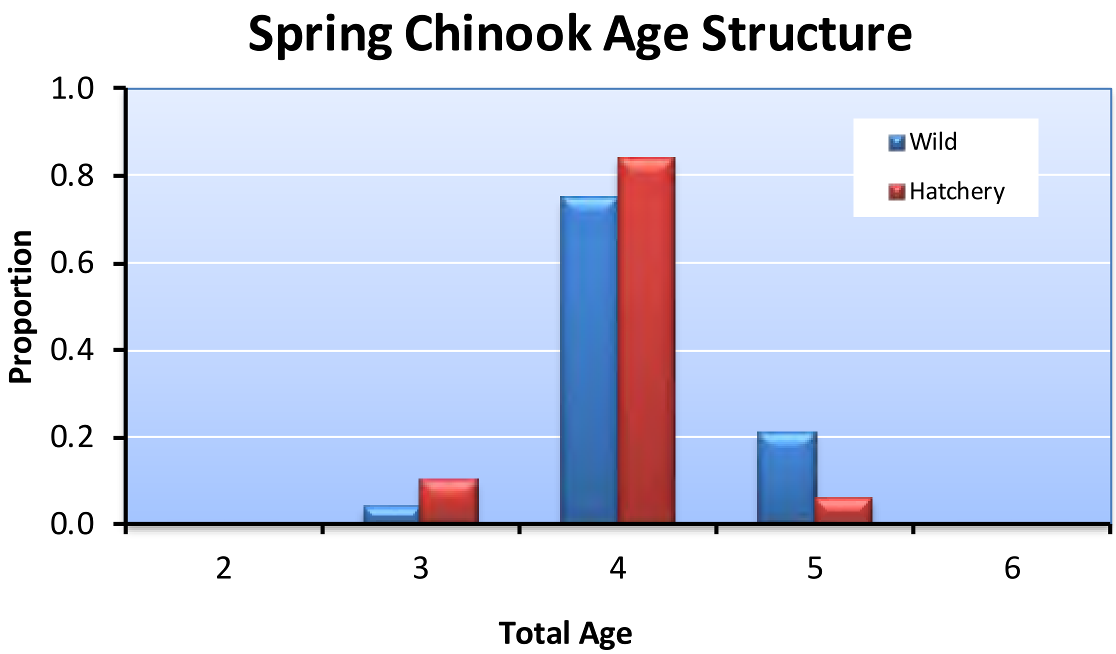


Figure 5.17. Proportions of wild and hatchery spring Chinook of different total ages sampled at the Chiwawa Weir and on spawning grounds in the Chiwawa River basin for the combined years 1994-2018.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed slightly in length (Table 5.36). Differences were usually no more than 4 cm between hatchery and wild fish of the same age.

Table 5.36. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild and hatchery-origin sampled in the Chiwawa River basin, 1994-2018. Return years 2004-2018 include carcasses and live fish PIT-tag detections. In addition, 2005 and 2006 include fish released at the weir.

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
1994	3				43 ±0 (1)
	4			62 ±3 (3)	
	5	76 ±0 (1)		73 ±2 (5)	
	6				
1995	3				
	4		61 ±5 (5)		
	5				
	6				
1996	3	45 ±3 (5)	49 ±7 (10)		
	4	69 ±4 (6)	69 ±0 (1)	67 ±8 (2)	
	5				

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	6				
1997	3				
	4	61 ±1 (2)	68 ±0 (1)	67 ±5 (3)	63 ±3 (8)
	5	67 ±5 (2)			
	6				
1998	3				
	4				54 ±0 (1)
	5	77 ±7 (8)	75 ±4 (4)	74 ±4 (7)	76 ±4 (3)
	6				
1999	3	44 ±0 (1)			
	4	61 ±0 (1)		64 ±3 (6)	
	5	76 ±5 (3)		72 ±5 (3)	66 ±0 (1)
	6				
2000	3		46 ±3 (17)		50 ±7 (3)
	4	60 ±8 (23)	62 ±5 (5)	61 ±5 (26)	62 ±3 (20)
	5	77 ±1 (2)			
	6				
2001	3	37 ±0 (1)	42 ±4 (11)	41 ±0 (1)	60 ±0 (1)
	4	63 ±5 (57)	65 ±5 (151)	62 ±4 (110)	63 ±4 (407)
	5	75 ±5 (2)	83 ±0 (1)	76 ±1 (5)	
	6				
2002	3				
	4	64 ±4 (14)	66 ±5 (46)	60 ±4 (15)	63 ±4 (71)
	5	80 ±6 (13)	75 ±5 (4)	72 ±3 (12)	73 ±6 (6)
	6				
2003	3	45 ±2 (3)	45 ±1 (6)		
	4		63 ±0 (1)		
	5	78 ±5 (12)	74 ±8 (11)	75 ±3 (19)	72 ±5 (14)
	6				
2004	3	42 ±3 (3)	44 ±5 (33)		
	4	63 ±7 (60)	66 ±5 (9)	63 ±4 (59)	63 ±6 (36)
	5			74 ±0 (1)	
	6				
2005	3		43 ±5 (48)		
	4	61 ±5 (32)	65 ±5 (224)	62 ±4 (61)	62 ±4 (382)
	5	74 ±5 (6)	54±0 (1)	71 ±3 (11)	
	6				
2006	3	45 ±3 (3)	43 ±3 (73)		
	4	64 ±3 (7)	62 ±6 (91)	63 ±5 (41)	60 ±4 (227)
	5	74 ±6 (8)	75 ±6 (17)	71 ±4 (26)	71± 4 (37)
	6				

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
2007	3	39 ±3 (5)	45 ±6 (90)		50 ±3 (7)
	4	60 ±4 (4)	66 ±5 (45)	61 ±4 (10)	63 ±3 (142)
	5	78 ±6 (15)	76 ±5 (8)	74 ±3 (20)	73 ±5 (12)
	6				
2008	3	43 ±0 (1)	44 ±5 (22)		
	4	65 ±4 (9)	64 ±6 (73)	62 ±4 (26)	64 ±4 (229)
	5	65 ±5 (3)	79 ±5 (10)	73 ±3 (4)	72 ±3 (5)
	6				
2009	3	45 ±3 (8)	46 ±6 (68)		65 ±0 (1)
	4	64 ±4 (38)	65 ±5 (136)	63 ±3 (67)	64 ±4 (202)
	5	79 ±0 (1)		72 ±2 (4)	71 ±4 (10)
	6				
2010	3		46 ±4 (11)		65 ±3 (3)
	4	64 ±5 (31)	66 ±5 (74)	64 ±4 (82)	65 ±3 (196)
	5	77 ±4 (6)		73 ±5 (9)	73 ±6 (4)
	6				
2011	3	43 ±4 (133)	44 ±4 (1374)		53 ±4 (17)
	4	62 ±5 (137)	64 ±5 (169)	64 ±3 (94)	64 ±3 (258)
	5	80 ±5 (78)	79 ±4 (85)	75 ±3 (116)	75 ±3 (63)
	6				
2012	3	56 ±0 (1)	52 ±7 (7)		
	4	79 ± 6 (37)	80 ±6 (49)	79 ±3 (76)	78 ±4 (180)
	5	97 ±7 (11)	96 ±3 (4)	93 ±4 (16)	87 ±0 (1)
	6				
2013	3	45 ±4 (8)	43 ±4 (32)	35 ±0 (1)	49 ±12 (3)
	4	60 ±6 (29)	63 ±7 (41)	61 ±6 (34)	61 ±4 (171)
	5	75 ±5 (9)	71 ±2 (7)	71 ±3 (24)	69 ±4 (18)
	6				
2014	3	45 ±7 (5)	45±4 (11)	50±0 (1)	47±0 (1)
	4	64 ±7 (60)	62 ±7 (30)	63 ±4 (91)	61 ±4 (99)
	5	81 ±4 (4)		72 ±6 (8)	69 ±4 (3)
	6				
2015	3	56±0 (1)	48±4 (11)		52±0 (1)
	4	65±5 (23)	65±6 (42)	63±5 (57)	63±4 (126)
	5	75±7 (6)	71±0 (1)	69±6 (9)	73±0 (1)
	6				
2016	3	41±5 (5)	43±4 (3)		
	4	63±7 (30)	64±7 (12)	63±5 (62)	61±5 (45)
	5	76±7 (13)	75±0 (1)	73±5 (27)	67±4 (10)
	6				
2017	3	41±0 (1)	47±7 (3)		

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	4	67±6 (21)	65±5 (20)	63±5 (19)	62±4 (62)
	5	71±1 (2)	80±3 (3)	72±5 (4)	70±8 (3)
	6				
2018	3				
	4	62±6 (21)	61±6 (55)	61±3 (27)	60±4 (100)
	5	70±0 (1)		65±7 (3)	68±1 (2)
	6				

Contribution to Fisheries

Nearly all the harvest on hatchery-origin Chiwawa spring Chinook occurs within the Columbia River basin. Ocean catch records (Pacific Fishery Management Council) indicate that very few Upper Columbia spring Chinook are taken in ocean fisheries. Most of the harvest on hatchery-origin Chiwawa spring Chinook occurs in the Lower Columbia River fisheries, which are managed by the states and tribes pursuant to management plans developed in *U.S. v Oregon*. The Lower Columbia River fisheries occur during what is referred to in *U.S. v Oregon* as the winter, spring, and summer seasons, which begin in February and ends 31 July of each year. The Tribal fishery occurs upstream from Bonneville Dam, but primarily in Zone 6, the area between Bonneville and McNary dams; the non-treaty commercial fisheries occur in Zones 1-5, which are downstream from Bonneville Dam. The non-treaty recreational (sport) fishery occurs in the lower mainstem.

The total number of hatchery-origin spring Chinook captured in different fisheries has been relatively low (Table 5.37). The largest harvest occurred on the 2008 brood year.

Table 5.37. Estimated number and percent (in parentheses) of hatchery-origin Chiwawa spring Chinook captured in different fisheries, brood years 1989-2013; NP = no hatchery program.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[b]
		Tribal[a]	Commercial (Zones 1-5)	Recreational (sport)		
1989	3 (13)	5 (21)	0 (0)	16 (67)	24	11.8
1990	0 (0)	0 (0)	0 (0)	18 (100)	18	94.7
1991	0 (0)	3 (100)	0 (0)	0 (0)	3	8.6
1992	0 (0)	1 (100)	0 (0)	0 (0)	1	3.1
1993	3 (75)	1 (25)	0 (0)	0 (0)	4	1.4
1994	0 (0)	0 (0)	0 (0)	0 (0)	0	0.0
1995	NP	NP	NP	NP	NP	NP
1996	0 (0)	2 (100)	0 (0)	0 (0)	2	2.5
1997	1 (0)	193 (51)	68 (18)	115 (31)	377	14.4
1998	10 (5)	47 (24)	12 (6)	126 (65)	195	16.4
1999	NP	NP	NP	NP	NP	NP
2000	0 (0)	17 (74)	0 (0)	6 (26)	23	6.1

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[b]
		Tribal[a]	Commercial (Zones 1-5)	Recreational (sport)		
2001	36 (64)	8 (14)	1 (2)	11 (20)	56	3.0
2002	12 (17)	11 (15)	22 (31)	26 (37)	71	9.1
2003	18 (21)	29 (35)	11 (13)	26 (31)	84	10.6
2004	3 (1)	188 (40)	31 (7)	253 (53)	475	15.8
2005	6 (5)	31 (24)	18 (14)	74 (57)	129	8.5
2006	25 (3)	469 (60)	85 (11)	201 (26)	780	29.8
2007	14 (3)	180 (43)	75 (18)	151 (36)	420	32.2
2008	8 (1)	298 (21)	41 (3)	1,047 (75)	1,394	36.1
2009	6 (2)	92 (23)	73 (18)	228 (57)	399	25.2
2010	0 (0)	372 (57)	45 (7)	231 (36)	648	32.1
2011	3 (0)	393 (56)	138 (20)	168 (24)	702	40.0
2012	1 (0)	87 (41)	43 (20)	82 (38)	213	25.8
2013	0 (0)	19 (31)	3 (5)	40 (65)	62	12.7
Average	***6 (9)***	***106 (42)***	***29 (8)***	***128 (37)***	***264***	***19.1***
Median	***3 (1)***	***29 (35)***	***12 (6)***	***40 (36)***	***84***	***12.7***

[a] Includes the Wanapum fishery and the Icicle and Wenatchee fisheries when they occurred.

[b] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%.

The percentage of the spawning escapement in non-target spawning areas within the Wenatchee River basin made up of hatchery-origin Chiwawa spring Chinook has been high in some years and exceeded the target of 10% (Table 5.38). Over the years of sampling, Chiwawa spring Chinook have strayed into all non-target spawning areas, but, on average, have contributed most to the Nason Creek and Upper Wenatchee spawning escapements.

Table 5.38. Number (No.) and percent (%) of the spawning escapement in other non-target spawning streams within the Wenatchee River basin that consisted of hatchery-origin Chiwawa spring Chinook, return years 1992-2017. For example, for return year 2001, 35.3% of the spring Chinook spawning escapement in Nason Creek consisted of hatchery-origin Chiwawa spring Chinook. Percent strays should be less than 10%.

Return year	Nason Creek		Icicle Creek		Peshastin Creek		Upper Wenatchee		White River		Little Wenatchee	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1992	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1993	61	12.4	0	0.0	0	0.0	34	18.0	7	4.8	0	0.0
1994	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Return year	Nason Creek		Icicle Creek		Peshastin Creek		Upper Wenatchee		White River		Little Wenatchee	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1995	0	0.0	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
1996	25	30.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1997	55	45.1	8	11.0	0	0.0	0	0.0	0	0.0	0	0.0
1998	3	4.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	45	16.7	0	0.0	0	0.0	31	31.0	0	0.0	6	25.0
2001	211	35.3	0	0.0	0	0.0	271	77.7	46	27.7	52	44.1
2002	188	31.2	10	2.0	0	0.0	60	45.8	14	16.3	21	24.4
2003	14	6.9	0	0.0	0	0.0	30	51.7	0	0.0	0	0.0
2004	139	27.4	0	0.0	0	0.0	54	39.1	6	9.1	0	0.0
2005	252	72.6	7	50.0	0	0.0	256	99.6	106	68.4	65	56.5
2006	131	48.3	13	14.4	0	0.0	28	58.3	9	16.4	12	32.4
2007	303	65.4	0	0.0	0	0.0	37	67.3	7	7.6	6	5.9
2008	381	67.4	48	23.4	15	40.5	258	85.4	30	57.7	52	81.3
2009	289	54.1	8	9.2	0	0.0	16	100.0	63	36.4	56	44.8
2010	272	66.3	58	13.7	11	78.6	86	84.3	23	31.9	59	71.1
2011	397	56.6	61	18.8	0	0.0	41	82.0	0	0.0	53	42.7
2012	398	57.3	49	13.0	7	36.8	98	79.7	45	31.3	15	20.8
2013	281	68.7	15	8.0	0	0.0	24	72.7	5	4.8	10	10.2
2014	154	65.0	19	4.5	0	0.0	35	74.5	0	0.0	1	1.9
2015	11	7.3	12	4.7	0	0.0	50	51.0	8	6.4	0	0.0
2016	17	10.9	0	0.0	0	0.0	25	80.6	0	0.0	62	100.0
2017	51	36.4	0	0.0	0	0.0	8	42.1	9	29.0	0	0.0
Average	***142***	***34.3***	***12***	***6.6***	***1***	***6.0***	***56***	***50.3***	***15***	***13.4***	***18***	***21.6***
Median	***96***	***33.2***	***0***	***0.0***	***0***	***0.0***	***31***	***55.0***	***6***	***4.8***	***4***	***3.9***

Hatchery-origin Chiwawa spring Chinook have strayed into the Methow and Entiat basins (Table 5.39). Based on return year analyses, rates of hatchery-origin Chiwawa spring Chinook straying into these populations have been low in recent years; stray rates have ranged from 0.0% to 5.9% from 2014 to 2017.

Table 5.39. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Chiwawa spring Chinook, return years 1992-2017. For example, for return year 2002, 9.2% of the spring Chinook spawning escapement in the Entiat River basin consisted of hatchery-origin Chiwawa spring Chinook. Percent strays should be less than 5%. NS = not sampled.

Return year	Methow River basin		Entiat River basin	
	Number	%	Number	%
1992	0	0.0	0	0.0
1993	0	0.0	0	0.0
1994	0	0.0	0	0.0
1995	0	0.0	0	0.0

Return year	Methow River basin		Entiat River basin	
	Number	%	Number	%
1996	NS	NS	0	0.0
1997	0	0.0	0	0.0
1998	NS	NS	0	0.0
1999	0	0.0	0	0.0
2000	0	0.0	1	0.8
2001	0	0.0	1	0.3
2002	0	0.0	34	18.3
2003	0	0.0	6	3.6
2004	0	0.0	0	0.0
2005	10	0.7	15	5.9
2006	8	0.5	30	18.9
2007	9	0.8	24	12.4
2008	12	1.2	61	26.8
2009	7	0.3	15	7.6
2010	10	0.4	18	5.2
2011	51	1.7	190	37.6
2012	13	1.0	133	33.0
2013	9	0.8	18	9.5
2014	0	0.0	0	0.0
2015	7	0.5	24	5.9
2016	0	0.0	1	0.3
2017	1	0.2	2	2.0
Average	***5***	***0.3***	***22***	***7.2***
Median	***0***	***0.0***	***2***	***1.4***

Based on brood year analyses, on average, about 29% of the hatchery returns have strayed into non-target spawning areas (Table 5.40). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-81%. In most years, few (<2%) have strayed into non-target hatchery programs.

Table 5.40. Number and percent of hatchery-origin Chiwawa spring Chinook that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and non-target hatchery programs, by brood years 1989-2013.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	74	41.1	1	0.6	102	56.7	3	1.7
1990	0	0.0	1	100.0	0	0.0	0	0.0
1991	29	90.6	0	0.0	2	6.3	1	3.1

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1992	2	6.5	4	12.9	25	80.6	0	0.0
1993	134	47.5	82	29.1	63	22.3	3	1.1
1994	4	19.0	14	66.7	3	14.3	0	0.0
1995	No program							
1996	58	75.3	7	9.1	12	15.6	0	0.0
1997	1,242	55.6	298	13.4	687	30.8	5	0.2
1998	553	55.8	109	11.0	329	33.2	0	0.0
1999	No program							
2000	149	42	115	32	90	25	0	0.0
2001	647	35.8	276	15.3	881	48.7	4	0.2
2002	314	44.3	238	33.6	156	22.0	1	0.1
2003	556	78.6	11	1.6	133	18.8	7	1.0
2004	1,198	47.4	203	8.0	1,104	43.7	23	0.9
2005	822	59.3	139	10.0	415	29.9	10	0.7
2006	1,007	54.8	147	8.0	669	36.4	14	0.8
2007	510	57.8	60	6.8	294	33.3	19	2.2
2008	1,160	47.0	62	2.5	1,144	46.4	101	4.1
2009	745	62.9	53	4.5	356	30.0	31	2.6
2010	744	54.4	360	26.3	235	17.2	29	2.1
2011	570	54.1	289	27.4	188	17.8	7	0.7
2012	200	32.7	256	41.8	129	21.1	27	4.4
2013	271	63.5	93	21.8	63	14.8	0	0.0
Average	**478**	**49.0**	**123**	**21.0**	**308**	**28.9**	**12**	**1.1**
Median	**510**	**54.1**	**93**	**12.9**	**156**	**25.4**	**4**	**0.7**

* Homing to the target hatchery includes Chiwawa hatchery spring Chinook that are captured and included as broodstock in the Chiwawa Hatchery program. These hatchery fish are typically collected at the Chiwawa weir and Tumwater Dam.

Ford et al. (2015) used parentage analysis to estimate rates of straying and homing of spring Chinook within the Wenatchee River basin. They found that stray rates of hatchery spring Chinook based on parentage analysis were consistent with rates estimated using physical tag recoveries (the latter estimates are shown in the tables above). They also found that stray rates among the major spawning tributaries were higher than stray rates of tagged fish to areas outside of the Wenatchee River basin (e.g., Entiat and Methow basins), which is consistent with the results shown in the tables above. Finally, the researchers noted that hatchery spring Chinook homed at a far lower rate than natural-origin fish and stray rates of natural-origin fish ranged from about 0-100%. Rates of straying of natural-origin spring Chinook were affected by spawning tributary and by parental origin (i.e., progeny of naturally spawning hatchery-produced fish strayed at higher rates than progeny whose parents were of natural origin).

Genetics

Genetic studies were conducted in 2007 to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix M). A total of 32 population collections of adult spring Chinook were obtained from the Wenatchee River basin between 1989 and 2006. This included nine collections of natural-origin Chinook adults from the Chiwawa River (N = 501) and nine collections of Chiwawa hatchery-origin Chinook (N = 595) at the Chiwawa weir. Collections in 1993 and 1994 included hatchery-origin smolts. Additional samples were collected from the White River, Little Wenatchee River, and Nason Creek; six collections of natural-origin Chinook from the White River (N = 179), one collection from the Little Wenatchee (N = 19), and six collections from Nason Creek (N = 268). A single collection was obtained for Chinook spawning in the mainstem Wenatchee River and from the Leavenworth National Fish Hatchery. Finally, an out-of-basin collection from the Entiat River was included in the analysis. Scale, fin clips, or operculum punches were collected from each sample. Microsatellite DNA allele frequencies were used to statistically assign individual fish to specific demes (locations) within the Wenatchee population. In addition, genetic effects of the hatchery program were assessed by examining relationships between census and effective population sizes (N_e) from samples collected before and after supplementation.

Overall, this work showed that although allele frequencies within and between natural and hatchery-origin spring Chinook were significantly different, there was no evidence (i.e., robust signal) that the difference was the result of the hatchery program. Rather, the differences were more likely the result of life history characteristics. However, there was an increasing trend toward homogenization of the allele frequencies of the natural and hatchery-origin fish that comprised the broodstock, even though there was consistent year-to-year variation in allele frequencies among hatchery and natural-origin fish. In addition, there were no robust signals indicating that hatchery-origin hatchery broodstock, hatchery-origin natural spawners, natural-origin hatchery broodstock, and natural-origin natural spawners were substantially different from each other. Finally, the N_e estimate of 387 was only slightly larger than the pre-hatchery N_e (based on demographic data from 1989-1992), which means that the Chiwawa hatchery program has not reduced the N_e of the Wenatchee spring Chinook population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in Nason Creek and the White River, despite the presence of hatchery-origin spawners in both systems.

It is important to note that no new information will be reported on genetics until the next comprehensive report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[20] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-1994, PNI values were greater than or equal to 0.67 (Table 5.41). Since brood year 1994, PNI has been less than 0.67, except for brood year 2016, which was 0.70.

Table 5.41. Proportionate Natural Influence (PNI) values for the Chiwawa spring Chinook supplementation program for brood years 1989-2018. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	713	0	0.00	28	0	1.00	1.00
1990	571	0	0.00	18	0	1.00	1.00
1991	242	0	0.00	27	0	1.00	1.00
1992	676	0	0.00	78	0	1.00	1.00
1993	231	2	0.01	94	0	1.00	0.99
1994	123	61	0.33	8	4	0.67	0.68
1995	0	33	1.00	No Program			
1996	41	17	0.29	8	10	0.44	0.62
1997	60	122	0.67	32	79	0.29	0.32
1998	59	32	0.35	13	34	0.28	0.47
1999	87	7	0.07	No Program			
2000	233	113	0.33	9	21	0.30	0.50
2001	506	1219	0.71	113	259	0.30	0.32
2002	254	453	0.64	20	51	0.28	0.33
2003	168	102	0.38	41	53	0.44	0.55
2004	575	276	0.32	83	132	0.39	0.57
2005	139	460	0.77	91	181	0.33	0.32
2006	114	415	0.78	91	224	0.29	0.29
2007	155	1141	0.88	43	104	0.29	0.27
2008	190	968	0.84	83	220	0.27	0.26
2009	297	1050	0.78	96	111	0.46	0.39
2010	419	675	0.62	77	98	0.44	0.43
2011	801	1231	0.61	80	93	0.46	0.45

[20] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
2012	574	904	0.61	73	38	0.66	0.53
2013	422	956	0.69	70	0	1.00	0.60
2014	538	461	0.46	61	12	0.84	0.65
2015	337	630	0.65	72	0	1.00	0.61
2016	407	164	0.29	62	37	0.63	0.70
2017	171	288	0.63	50	18	0.74	0.55
2018	166	456	0.73	37	69	0.35	0.34
Average	***309***	***408***	***0.48***	***56***	***66***	***0.58***	***0.56***
Median	***238***	***282***	***0.61***	***62***	***38***	***0.45***	***0.54***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery spring Chinook from the Chiwawa River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 5.42).[21] Over the 12 brood years for which PIT-tagged hatchery fish were released, survival rates from the Chiwawa River to McNary Dam ranged from 0.435 to 0.662; SARs from release to detection at Bonneville Dam ranged from 0.003 to 0.018. Average travel time from the Chiwawa River to McNary Dam ranged from 14 to 44 days. Although there is only one year in which a forced release was compared to a volitional release (brood year 2005), hatchery spring Chinook that were forced out of the Chiwawa Acclimation Facility had slightly higher survival rates and SARs, and a faster travel time to McNary Dam, than did the volitional release.

Table 5.42. Total number of Chiwawa hatchery spring Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2016. Standard errors are shown in parentheses. NA = not available (i.e., not all the adults from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2005	4,993 (forced)	0.662 (0.027)	22.9 (6.6)	0.008 (0.001)
	4,988 (volitional)	0.638 (0.027)	43.6 (6.9)	0.003 (0.001)
2006	9,894	0.619 (0.038)	30.6 (7.6)	0.011 (0.001)
2007	10,031	0.435 (0.019)	32.9 (7.7)	0.007 (0.001)
2008	10,006	0.631 (0.038)	39.9 (10.3)	0.018 (0.001)
2009	9,412	0.547 (0.044)	30.2 (6.7)	0.006 (0.001)
2010	5,020	0.547 (0.038)	18.9 (7.3)	0.008 (0.001)

[21] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2011	9,987	0.458 (0.029)	14.2 (7.5)	0.009 (0.001)
2012	5,061	0.478 (0.043)	30.9 (6.5)	0.008 (0.001)
2013	10,021	0.438 (0.041)	29.5 (5.9)	0.006 (0.001)
2014	10,179	0.628 (0.029)	24.9 (6.2)	NA
2015	10,148	0.463 (0.030)	32.7 (7.0)	NA
2016	10,089	0.574 (0.056)	23.9 (7.5)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2012, NRR for spring Chinook in the Chiwawa averaged 0.99 (range, 0.01-4.40) if harvested fish were not included in the estimate and 1.11 (range, 0.01-4.81) if harvested fish were included in the estimate (Table 5.43). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.7 (the calculated target value in Hillman et al. 2017). The target value of 6.7 includes harvest. In nearly all years, HRRs were greater than NRRs, regardless if harvest was or was not included (Table 5.43). HRRs exceeded the estimated target value of 6.7 in 11 of the 22 years.

Table 5.43. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for spring Chinook in the Chiwawa River basin, brood years 1989-2012; NP = no hatchery program.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	28	713	180	194	6.43	0.27	204	282	7.29	0.40
1990	19	571	1	34	0.05	0.06	19	40	1.00	0.07
1991	32	242	32	2	1.00	0.01	35	2	1.09	0.01
1992	78	676	31	46	0.40	0.07	32	48	0.41	0.07
1993	100	233	282	159	2.82	0.68	286	163	2.86	0.70
1994	13	184	21	37	1.62	0.20	21	38	1.62	0.21
1995	NP	33	NP	66	NP	2.00	NP	69	NP	2.09

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1996	18	58	77	255	4.28	4.40	79	279	4.39	4.81
1997	120	182	2,232	714	18.60	3.92	2,609	795	21.74	4.37
1998	48	91	991	349	20.65	3.84	1,186	409	24.71	4.49
1999	NP	94	NP	10	NP	0.11	NP	11	NP	0.12
2000	48	346	354	695	7.38	2.01	377	740	7.85	2.14
2001	382	1,725	1,808	309	4.73	0.18	1,864	319	4.88	0.18
2002	84	707	709	244	8.44	0.35	780	254	9.29	0.36
2003	119	270	707	107	5.94	0.40	791	115	6.65	0.43
2004	296	858	2,528	276	8.54	0.32	3,003	298	10.15	0.35
2005	283	599	1,386	396	4.90	0.66	1,515	409	5.35	0.68
2006	398	529	1,837	967	4.62	1.83	2,617	1,215	6.58	2.30
2007	169	1,296	883	478	5.22	0.37	1,303	571	7.71	0.44
2008	329	1,158	2,467	740	7.50	0.64	3,861	830	11.74	0.72
2009	264	1,347	1,185	349	4.49	0.26	1,584	378	6.00	0.28
2010	186	1,094	1,368	633	7.35	0.58	2,016	781	10.84	0.71
2011	181	2,032	1,054	502	5.82	0.25	1,756	673	9.70	0.33
2012	116	1,478	612	385	5.28	0.26	825	441	7.11	0.30
Average	***151***	***688***	***943***	***331***	***6.18***	***0.99***	***1,217***	***382***	***7.68***	***1.11***
Median	***118***	***585***	***796***	***293***	***5.25***	***0.36***	***1,006***	***309***	***6.88***	***0.41***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00036 to 0.01563 for hatchery spring Chinook (Table 5.44).

Table 5.44. Smolt-to-adult ratios (SARs) for Chiwawa hatchery spring Chinook, brood years 1989-2013.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	42,707	204	0.00478
1990	52,798	19	0.00036
1991	61,088	35	0.00057
1992	82,976	31	0.00037
1993	221,316	284	0.00128
1994	27,135	21	0.00077
1995	No hatchery program		
1996	12,767	67	0.00525
1997	259,585	2,549	0.00982

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1998	71,571	1,119	0.01563
1999	No hatchery program		
2000	46,726	375	0.00803
2001	374,129	1,849	0.00494
2002	145,074	760	0.00524
2003	216,702	775	0.00358
2004	491,987	2,992	0.00608
2005	489,664	1,506	0.00308
2006	548,777	2,605	0.00475
2007	292,682	1,301	0.00445
2008	609,286	3,861	0.00634
2009	433,608	1,570	0.00362
2010	342,778	2,002	0.00584
2011	278,801	1,743	0.00625
2012	218,968	817	0.00373
2013	143,837	480	0.00334
Average	***237,607***	***1,172***	***0.00470***
Median	***218,968***	***817***	***0.00475***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

5.8 ESA/HCP Compliance

Broodstock Collection

The collection of 2016 Brood Chiwawa River spring Chinook broodstock was consistent with the 2016 Upper Columbia River salmon and steelhead broodstock objectives and site-based broodstock collection protocols. Specifically, broodstock collection targeted previously PIT-tagged natural-origin fish at Tumwater Dam and operation of the Chiwawa Weir. In-season adjustments were made to the natural-origin spring Chinook collected for broodstock as needed and were based on in-season escapement monitoring at Tumwater Dam and estimated Chiwawa run-escapement.

Trapping at Tumwater Dam began on 27 May 2016 and concluded on 15 July 2016. Operation of the Chiwawa Weir was limited to 15 days between 1 June and 15 August and was further constrained by flows and total available bull trout effects. Broodstock collection targeted natural-origin spring Chinook and hatchery-origin spring Chinook as needed to attain a 100% natural-origin broodstock and a maximum 33% extraction of the estimated natural-origin return to the Chiwawa River.

The 2016 brood collection spawned a total of 62 natural-origin and 37 hatchery –origin spring Chinook. All spring Chinook, steelhead, and bull trout that were captured were anesthetized with tricaine methanesulfonate (MS-222) and subject to water-to-water transfers during handling. All fish were allowed to fully recover before release. Additionally, a total of 101 and 77 bull trout were encountered at the Chiwawa Weir and Tumwater Dam, respectively.

The estimated broodstock extraction rate of natural-origin Chiwawa spring Chinook and overall extraction of spring Chinook upstream from Tumwater Dam comply with provisions of ESA Permit 18121.

Hatchery Rearing and Release

The rearing and release of 2016 brood Chiwawa spring Chinook was completed without incident. No mortality events occurred that exceeded 10% of the population. Fish were acclimated on Chiwawa River water with regulated amounts of Wenatchee River water to prevent frazzle ice formation during the winter months (see Section 5.2).

The release of 2016 brood Chiwawa spring Chinook smolts totaled 158,189 fish, representing 109.8% of the program objective of 144,023 smolts, which was compliant with the ESA Section 10 Permit 18121 program not to exceed the maximum level of 158,425 smolts.

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or the Chiwawa Acclimation Facility in 2018. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit Nos. 18118, 18120, and 18121, the permit holders are authorized a direct take of up to 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2013). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2018 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 5.45. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permits 18118, 18120, and 18121, Section B.

Table 5.45. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2018.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	31,300	158,189	43,133	3,539	9,750	7,948	21,237	
Encounter rate	NA	NA	NA	0.1131	0.0616	0.1843	0.0957	0.20

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Mortality[e]	NA	NA	NA	8	37	20	65	
Mortality rate	NA	NA	NA	0.0023	0.0038	0.0025	0.0031	0.02
White River Trap								
Population	11,170	NA	1,679	234	NA	131	365	
Encounter rate	NA	NA	NA	0.0209	NA	0.0780	0.0284	0.20
Mortality[d]	NA	NA	NA	0	NA	0	0	
Mortality rate	NA	NA	NA	0.0000	NA	0.0000	0.0000	0.02
Nason Creek Trap								
Population	5,082	233,471	17,066	301	367	1,651	2,319	
Encounter rate	NA	NA	NA	0.0592	0.0016	0.0967	0.0091	0.20
Mortality[d]	NA	NA	NA	5	0	8	13	
Mortality rate	NA	NA	NA	0.0166	0.0000	0.0048	0.0056	0.02
Lower Wenatchee Trap								
Population	99,045	391,660	5,823,795	1,418	51,069	47,283	99,770	
Encounter rate	NA	NA	NA	0.0143	0.1304	0.0081	0.0162	0.2
Mortality[d]	NA	NA	NA	7	7	347	361	
Mortality rate	NA	NA	NA	0.0049	0.0001	0.0073	0.0036	0.02
Wenatchee River Basin Total								
Population	146,597	391,660	5,885,673	5,492	61,186	57,013	123,691	
Encounter rate	NA	NA	NA	0.0375	0.1562	0.0097	0.0193	0.20
Mortality[d]	NA	NA	NA	20	44	375	439	
Mortality rate	NA	NA	NA	0.0036	0.0007	0.0066	0.0035	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2016 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Precocity Monitoring

For the purpose of addressing permit requirements, we used the PIT Tag Information System (PTAGIS) to identify probable hatchery-origin mini-jack spring Chinook salmon from the Chiwawa River from 2015 through 2018. The query results returned fish that were last detected after 1 July of the year in which they were released. Fish that remained in freshwater during this time period were likely precocious males. We looked for detections in three regions: lower Columbia River mainstem dams (Bonneville, The Dalles, and McNary dams), mid-Columbia mainstem dams (Priest Rapids and Rock Island dams), and within the Wenatchee River basin. The occurrence of mini-jacks was rare, ranging from less than 0.14% to 0.26% of the tagged population (Table 5.46).

Table 5.46. Numbers of Chiwawa River hatchery spring Chinook with final PIT-tag detections after 1 July of the release year. These fish are likely mini-jacks. Lower Columbia River detections occurred at Bonneville, The Dalles, and McNary dams, while Mid-Columbia River detections occurred at Priest Rapids and Rock Island dams.

Year	Number of PIT tags released	Number of tags detected in Lower Columbia River	Number of tags detected in Mid-Columbia River	Number of tags detected within the Wenatchee River basin	Percent of tagged population
2015	10,021	9	0	6	0.15
2016	10,179	22	1	3	0.26
2017	10,148	11	0	3	0.14
2018	10,089	15	3	7	0.25

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2018, as authorized by ESA Section 10 Permits 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permit Numbers 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2018, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin Chinook retained for broodstock) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2018.

Bull Trout

Bull trout encounters associated with implementation of hatchery production and monitoring and evaluation activities for Chinook and steelhead programs in the Wenatchee sub-basin are required to be reported as outlined in the Biological Opinion 01EWF00-2013-0444. The 2018 report for bull trout encounters was compiled under provisions of ESA Section 10 Permit 18118, 18120, 18121, and 18583. Data and reporting information are included in Appendix I.

SECTION 6: NASON CREEK SPRING CHINOOK

The goals of the Nason Creek spring Chinook salmon supplementation program are to conserve, aid in the recovery, and prevent the extinction of naturally spawning spring Chinook in Nason Creek, and to meet the mitigation responsibilities of Grant County PUD. In 1998, a spring Chinook captive-broodstock program was initiated for the Nason Creek population to reduce the risk of extinction.[22] Improvements in adult escapement in Nason Creek have reduced the near-term risk of extinction and therefore the captive-broodstock program was discontinued in 1999. An adult-based supplementation program began with the collection of broodstock in 2013. The first releases of the program occurred from the Nason Creek Acclimation Facility in the spring of 2015.

In 2013, natural-origin adult spring Chinook were collected for broodstock at Tumwater Dam and from Nason Creek using tangle and dip nets. In 2014, all natural-origin broodstock were collected from Nason Creek using tangle and dip nets. While these brood collection methods were successful at collecting adults from the Nason Creek spawning aggregate, they were unable to collect the necessary number of adults to meet mitigation production goals in 2013 and 2014. The PRCC Hatchery Subcommittee decided to implement the Nason Creek conservation program using a composite of Nason and Chiwawa natural-origin broodstock beginning with brood year 2015 in order to be able to consistently meet program goals. The decision was also made to collect all the brood at Tumwater Dam.

The production goal for the Nason Creek program requires collection of 126 adult spring Chinook (64 natural-origin fish and 66 hatchery-origin fish). However, the Section 10 permit requirements restrict the number of natural-origin adults collected and collection cannot exceed 33% of the natural-origin spring Chinook estimates to Tumwater Dam.

Adult spring Chinook broodstock are spawned and reared at Eastbank Fish Hatchery. Juvenile spring Chinook are transferred from the hatchery to the Nason Creek Acclimation Facility in late September or early October. Fish are reared in 30-foot dual-drain circular tanks throughout winter at the Nason Creek Acclimation Facility. Yearling Chinook were released volitionally during April and May the following year up until 2015. Beginning in 2016, all fish are force released at night to improve survival.

The current production goal is to release 223,670 smolts (125,000 for conservation and 98,670 for safety net). Juveniles released from the Nason facility are 100% marked with CWTs and a minimum of 5,000 fish are PIT tagged annually.

The following information focuses on results from monitoring the Nason Creek spring Chinook program. Information on spring Chinook collected throughout the Wenatchee River basin is presented in Section 5.

[22] A total of 1,054 and 235 eggs or alevins were collected directly from redds in 1988 and 1989, respectively. This resulted in some fish being released in 2003 and 8,986 smolts released in 2004. There is no evidence that any of these fish returned as adults.

6.1 Broodstock Sampling

This section focuses on results from sampling 2016-2018 Nason Creek spring Chinook broodstock, which were collected at Tumwater Dam in 2016, 2017, and 2018.

Origin of Broodstock

Natural-origin adults made up between 50% and 60% of the Nason Creek spring Chinook broodstock for return years 2016-2018 (Table 6.1). Beginning with brood year 2015, natural-origin adults were targeted for collection at Tumwater Dam during trapping operations. Natural-origin fish collected at Tumwater Dam were used for broodstock if genotyping confirmed they were natural-origin fish from the Nason or Chiwawa subpopulation and they were not White River Chinook. Fish that were genotyped to the White River were returned to the upper Wenatchee River basin to spawn naturally.

Table 6.1. Numbers of wild and hatchery Nason Creek spring Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, brood years 2013-2018. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program or were surplus fish killed at spawning.

Brood year	Wild spring Chinook					Hatchery spring Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2013	22	0	1	21	0	4	0	0	4	0	25
2014[b]	28	2	5	21	0	0	0	0	0	0	21
2015	78	1	6	59	12	63	0	0	63	0	122
2016	82	0	1	70	11	68	1	1	66	0	136
2017	71	1	0	70	0	70	3	3	67	0	141
2018	72	0	0	54	18	57	2	1	54	0	108
Average[c]	***58.8***	***0.7***	***2***	***49.2***	***6.8***	***44***	***1.0***	***0.8***	***42.3***	***0***	***92***
Median[c]	***71.5***	***0.5***	***1***	***56.5***	***5.5***	***60***	***0.5***	***0.5***	***58.5***	***0***	***115***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] Until sufficient Nason Creek Spring Chinook HOR's are collected to meet broodstock objectives, Chiwawa Spring Chinook HOR's are utilized to fulfill program goals (see table 5.1 and the 2014 Broodstock Protocols). About 12 Chiwawa HORs were used to fulfill the Chiwawa Program; about 122 Chiwawa HORs were used to fulfill the Nason Creek safety-net obligation.
[c] Origin determinations should be considered preliminary pending scale analyses.

Age/Length Data

Ages were determined from scales and/or coded wire tags (CWT) collected from broodstock. For both the 2017 and 2018 returns, most adults, regardless of origin, were age-4 Chinook (Table 6.2). All age-3 fish and the majority of age-5 Chinook were natural-origin.

Table 6.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 2013-2018.

Return year	Origin	Total age			
		2	3	4	5
2013	Wild	0.0	14.3	85.7	0.0
	Hatchery	0.0	0.0	100.0	0.0
2014	Wild	0.0	18.2	68.2	13.6

Return year	Origin	Total age			
		2	3	4	5
	Hatchery[a]	0.0	0.0	98.5	1.5
2015	Wild	0.0	0.0	92.0	8.0
	Hatchery	0.0	0.0	100.0	0.0
2016	Wild	0.0	0.0	69.6	30.4
	Hatchery	0.0	0.0	93.4	6.6
2017	Wild	0.0	0.0	84.5	15.5
	Hatchery	0.0	25.7	72.9	1.4
2018	Wild	0.0	1.4	88.9	9.7
	Hatchery	0.0	0.0	94.7	5.3
Average	***Wild***	***0.0***	***5.65***	***81.5***	***12.9***
	Hatchery	***0.0***	***25.7***	***93.3***	***2.5***
Median	***Wild***	***0.0***	***0.0***	***85.1***	***11.7***
	Hatchery	***0.0***	***0.0***	***96.6***	***1.5***

[a] Data are from Table 5.2.

Age-4 natural-origin Chinook were larger in length than hatchery-origin broodstock in 2017; however, in 2018, age-4 hatchery-origin broodstock were larger than natural-origin broodstock (Table 6.3). In 2017, age-5 hatchery-origin Chinook were larger than natural-origin Chinook. In 2018, age-5 natural-origin Chinook were larger than hatchery-origin Chinook.

Table 6.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 2013-2018; N = sample size and SD = 1 standard deviation.

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	-	0	-	56	3	2	75	16	6	-	0	-
	Hatchery	-	0	-	-	0	-	79	5	6	-	0	-
2014	Wild	-	0	-	57	4	6	82	15	7	86	3	8
	Hatchery[a]	-	0	-	-	0	-	81	192	6	85	3	2
2015	Wild	-	0	-	-	0	-	82	43	5	97	8	6
	Hatchery	-	0	-	-	0	-	82	55	5	-	0	-
2016	Wild	-	0	-	-	0	-	81	39	5	94	17	6
	Hatchery	-	0	-	-	0	-	84	57	6	89	4	9
2017	Wild	-	0	-	-	0	-	83	60	6	95.8	11	7
	Hatchery	-	0	-	67	18	4	81	51	6	106	1	-
2018	Wild	-	0	-	55	1	-	80	49	6	94	5	2
	Hatchery	-	0	-	-	0	-	81	54	5	80	3	8
Average	***Wild***	***-***	***0***	***-***	***56***	***3***	***4***	***79***	***27***	***6***	***90***	***3***	***5***
	Hatchery	***-***	***0***	***-***	***67***	***3***	***4***	***81***	***69***	***6***	***90***	***2***	***6***

[a] Data are from Table 5.3.

Sex Ratios

Male spring Chinook in the 2016-2018 return years made up 49%, 50%, and 46%, respectively, of the adults collected. This resulted in overall male to female ratios of 0.95:1.00, 1.00:1.00, and 0.84:1.00, respectively (Table 6.4).

Table 6.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 2013-2018. Ratios of males to females are also provided.

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2013	12	10	1.20:1:00	1	3	0.33:1.00	1.00:1.00
2014[a]	18	12	1.50:1.00	0	0	-	1.50:1.00
2015	40	38	1.05:1.00	31	32	0.97:1.00	1.01:1.00
2016	40	42	0.95:1.00	33	35	0.94:1.00	0.95:1.00
2017	35	37	0.95:1.00	36	34	1.06:1.00	1.00:1.00
2018	35	37	0.95:1.00	24	33	0.73:1.00	0.84:1.00
Total	***180***	***176***	***1.02:1.00***	***125***	***137***	***0.91:1.00***	***0.97:1.00***

[a] Data for HOR brood are in Table 5.4.

Fecundity

The mean fecundities for the 2016-2018 returns of Nason Creek spring Chinook ranged from 4,108 to 4,731 eggs per female (Table 6.5). Fecundities in the 2018 natural-origin brood, and in the 2016, and 2018 hatchery-origin brood were less than the expected fecundity assumed in the broodstock protocol.

Table 6.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 2016-2018. The first hatchery-origin fish from the Nason Creek spring Chinook program returned in 2016.

Return year	Mean fecundity		
	Wild	Hatchery	Total
2016	4,688	4,274	4,487
2017	4,930	4,513	4,731
2018	4,217	4,009	4,108
Average	***4,458***	***4,206***	***4,271***

[a] Average fecundities are from Table 5.5.

To estimate fecundities by length, weight, and age[23], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of spring Chinook females during the spawning of 2016 through 2018 broodstock. For those brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin spring Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

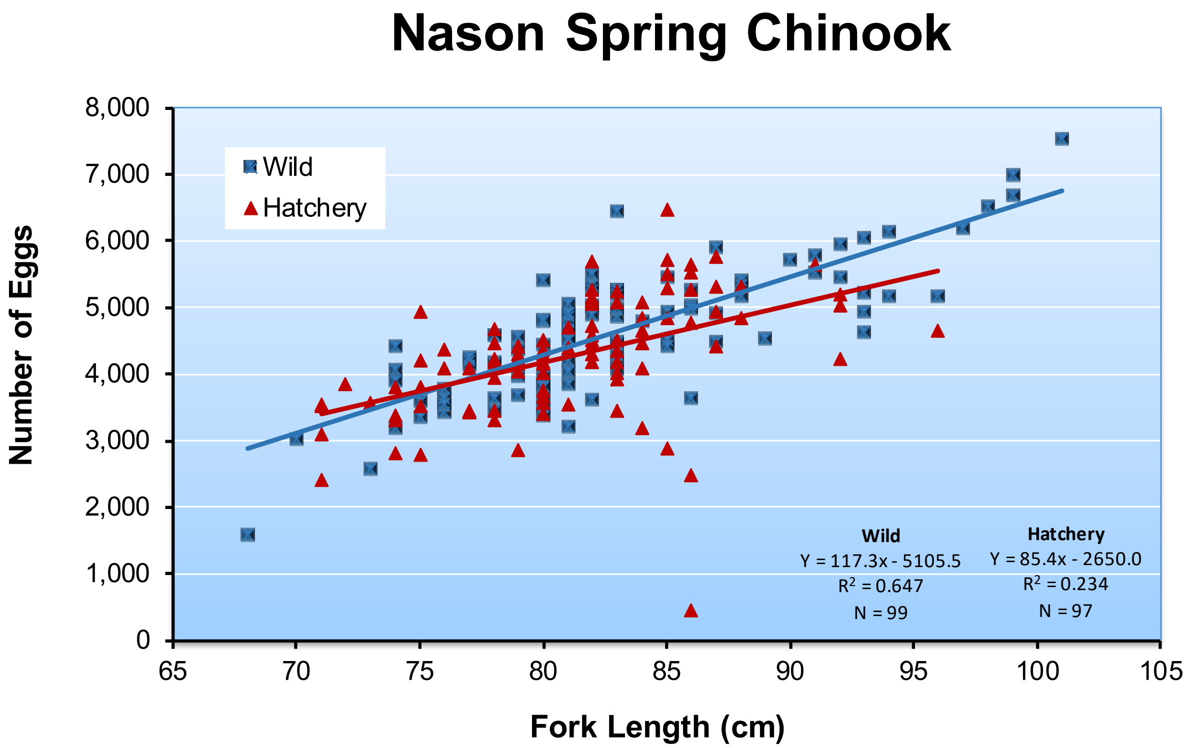
[23] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Mean fecundity by total age varied between hatchery and natural-origin spring Chinook and over time (Table 6.6). On average, mean fecundities varied between hatchery and natural-origin spring Chinook by 121 eggs for age-4 fish and 1,301 eggs for age-5 fish. No eggs from age-3 fish were collected.

Table 6.6. Mean fecundity by age (total age) for hatchery and wild spring Chinook collected from broodstock for the Nason Creek program, brood years 2016-2018; N = sample size and SD = 1 standard deviation. The first hatchery-origin fish from the Nason Creek spring Chinook program returned in 2016.

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2016	Wild	-	0	-	4,262	18	795	5,377	10	552
	Hatchery	-	0	-	4,284	29	815	4,414	4	1,113
2017	Wild	-	0	-	4,633	29	589	6,365	6	871
	Hatchery	-	0	-	4,513	32	1,064	-	0	-
2018	Wild	-	0	-	4,103	26	929	5,703	2	341
	Hatchery	-	0	-	3,982	29	658	4,402	2	1,223
Average	***Wild***	***-***	***0***	***-***	***4,215***	***19***	***887***	***5,741***	***4***	***610***
	Hatchery	***-***	***0***	***-***	***4,284***	***29***	***746***	***4,408***	***0***	***1,168***

We pooled fecundity data from brood years 2016 through 2018 to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 6.1, 6.2, and 6.3. All fecundity variables increase linearly with fork length. In addition, the relationships between fish size and fecundity data were similar for hatchery and natural-origin spring Chinook.



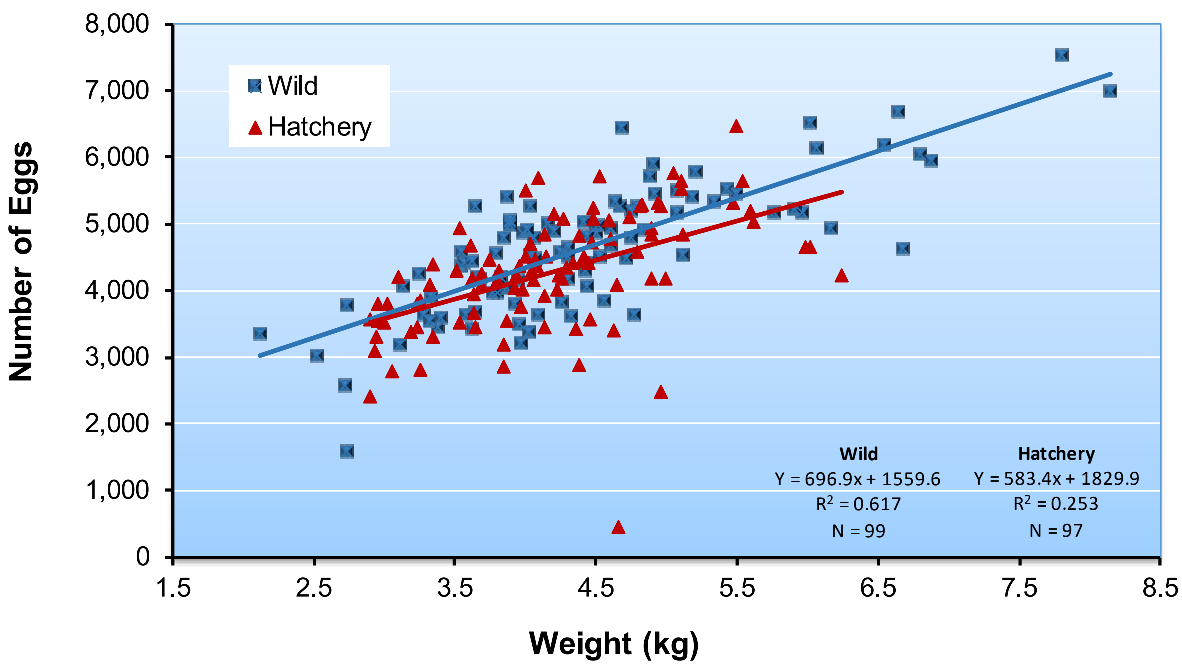


Figure 6.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2016-2018.

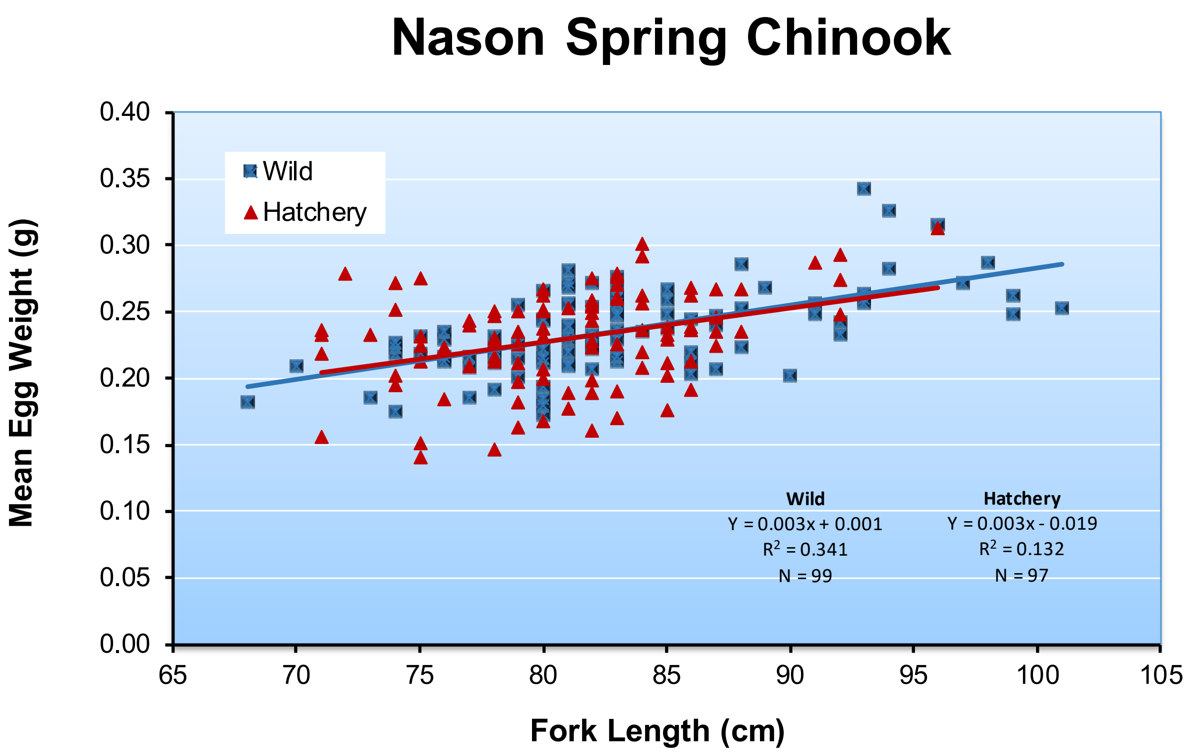


Figure 6.2. Relationships between mean egg weight and fork length for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2016-2018.

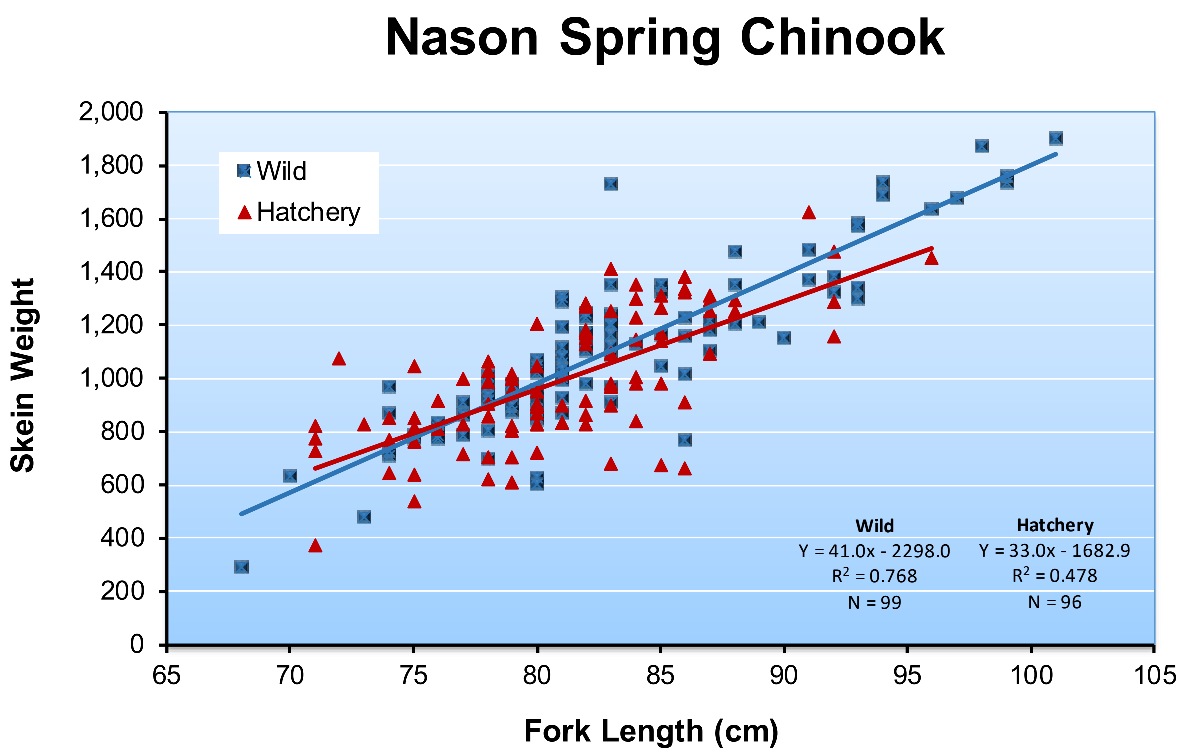


Figure 6.3. Relationships between skein weight and fork length for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2016-2018.

6.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 85%, a total of 263,141 eggs are required to meet the program release goal of 223,670 smolts (Table 6.7). The green egg take for the 2016-2018 brood years was 119%, 114%, and 92% of program goal, respectively.

Table 6.7. Numbers of eggs taken from spring Chinook broodstock, 2013-2018.

Return year	Number of eggs taken
2013[a]	49,720
2014[b]	267,783
2015	268,247
2016	314,090
2017	299,392
2018	242,372
Average	***240,267***

Return year	Number of eggs taken
Median	***268,015***

[a] Safety-net obligation met through the White River Program. Conservation egg take goal was 116,082.
[b] Includes surrogate Chiwawa HxH egg take calculated from tagging proportions.

Number of acclimation days

Fish from the 2016 brood were acclimated for 171-174 days on Nason Creek water and zero days on well water with oxygen (Table 6.8).

Table 6.8. Number of days spring Chinook broods were acclimated on Nason Creek water and well water, brood years 2013-2016.

Brood year	Release year	Transfer date	Release date	Number of acclimation days
2013	2015	13 Oct	13 Apr – 1 May	182-200
2014[a]	2016	21-23 Oct	15-20 Apr	119-122 Nason, 12 Well
2015	2017	2 Nov	17-18 Apr	166-167
2016	2018	25-27 Oct	16-17 Apr	171-174

[a] Because of water-intake concerns at the Nason Creek Acclimation Facility, the HxH Chinook were transferred to the Chiwawa Acclimation Facility on 2-3 March for final acclimation and release. The WxW fish were on Nason Creek water for 166 days. The HxH fish were on Nason Creek water for 119-122 days and on Chiwawa River water for 43-49 days. WxW and HxH fish were on well water and oxygen for 12 days while rearing at the Nason Creek Acclimation Facility.

Release Information

Numbers released

The 2016 brood Nason Creek spring Chinook program achieved 104.1% of the 125,000 target goal with about 130,095 WxW smolts released into Nason Creek in 2018 (Table 6.9). A total of 103,376 HxH smolts were released from the Nason Creek Acclimation Facility for the Nason spring Chinook program.

Table 6.9. Numbers of spring Chinook smolts tagged and released from the hatchery, brood years 2013-2016. The release target for Nason Creek spring Chinook is 223,670 smolts. CWT marking rates were adjusted for tag loss before the fish were released.

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
2013	2015	Volitional	0.9303	20,139	43,082	43,082
2014[a]	2016	Forced	0.9650	5,009	32,215	32,215
2015	2017	Forced	0.9681	10,009	243,127	243,127
2016	2018	Forced	0.9675	10,094	233,471	233,471

[a] Only the WxW Nason program was released from the Nason Creek Acclimation Facility because of water-intake concerns. The HxH Nason program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 (see Table 5.9).

Numbers tagged

The 2016 brood Nason spring Chinook were 96.8% CWT[24] and blank CWT adipose tagged (Table 6.9).

On 11-14 April 2019, a total of 10,100 Nason Creek spring Chinook from the 2017 brood were tagged at the Nason Creek Acclimation Facility. Chinook tagged in Ponds 1-3 were HxH fish, while Chinook tagged in Ponds 4-8 were WxW fish. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 109-113 mm in length and 15-19 g at time of tagging.

Table 6.10 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into Nason Creek.

Table 6.10. Summary of PIT-tagging activities for Nason Creek hatchery spring Chinook, brood years 2013-2016.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2013	2015	20,234	94	1	20,139
2014	2016	5,010	1	0	5,009
2015	2017	10,104	5	0	10,099
2016	2018	10,104	10	0	10,094

Fish size and condition at release

The WxW spring Chinook from the 2016 brood were force released as yearling smolts from 16-17 April 2018. Size at release (22 fpp) was smaller than the approximate target of 18 fpp established for the program. The CV for fork length was lower than the target (Table 6.11).

The HxH spring Chinook were force released as yearling smolts from 16-17 April 2018 into Nason Creek. Size at release (22 fpp) was smaller than the approximate target of 18 fpp established for the program. The CV for fork length was short of the target (Table 6.11).

Table 6.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood years 2013-2016. Size targets are provided in the last row of the table.

Brood year	Release year	Origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2013	2015	WxW	129	8.3	27.6	16
		HxH	-	-	-	-
2014[a]	2016	WxW	124	7.7	21.7	21
		HxH	134	13	29	16
2015	2017	WxW	120	6.7	21.3	21
		HxH	118	7.7	20	23

[24] Sixty days after tagging, taggers conduct a quality control procedure, which includes collecting a sample of tagged fish and scanning for tag retention. Thus, the number of tagged fish released is adjusted for tag loss.

Brood year	Release year	Origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2016	2018	WxW	120	6.6	20.8	22
		HxH	120	5.8	20.3	22
Average		***WxW***	***123***	***7.3***	***22.9***	***20***
		HxH	***124***	***8.8***	***23.1***	***20***
Median		***WxW***	***122***	***7.2***	***21.5***	***21***
		HxH	***120***	***7.7***	***20.3***	***22***
Targets		***WxW***	***155***	***9.0***	***37.8***	***18***
		HxH	***155***	***9.0***	***37.8***	***18***

[a] This represents only the WxW Nason program released from the Nason Creek Acclimation Facility. The HxH program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 for release because of water-intake concerns at the Nason Creek Acclimation Facility. Statistics on the 2014 brood HxH program pre-release sample at the Chiwawa Acclimation Facility were 134 mean length, 17.5 length CV, 28.6g mean wt., and 16 fpp.

Survival Estimates

Overall survival of Nason Creek spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 6.12). There was higher than expected survivals throughout most stages (except unfertilized egg to ponding) contributing to increased program performance. Pre-spawn survival of adults was also above the standard set for the program.

Table 6.12. Hatchery life-stage survival rates (%) for spring Chinook, brood years 2013-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2013	100.0	100.0	93.5	98.8	99.4	98.2	93.8	99.1	86.6
2014[a]	97.3	100.0	91.3	97.6	99.5	99.0	98.1	99.5	87.4
2015	91.9	97.1	94.5	97.9	99.5	99.2	97.9	99.4	90.6
2016	98.6	100	92.2	97.9	99.6	98.9	98.0	99.5	88.4
Average	***97.0***	***99.3***	***92.9***	***98.1***	***99.5***	***98.8***	***97.0***	***99.4***	***88.3***
Median	***98.0***	***100***	***92.9***	***97.9***	***99.5***	***99.0***	***98.0***	***99.5***	***87.9***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] The survival estimates are a combination of the WxW and HxH Nason programs. The WxW program was reared at the Nason Creek Acclimation Facility until release. The HxH Chinook that were reared at the Nason Creek Acclimation Facility until transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility. The HxH fish were released from the Chiwawa Acclimation Facility on 15-20 April 2016.

6.3 Disease Monitoring

Results of 2018 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females had ELISA values less than 0.199. (Table 6.13).

Table 6.13. Proportion of bacterial kidney disease (BKD) titer groups for the Nason Creek spring Chinook broodstock by origin, brood years 2013-2018. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year	Optical density values by titer group								Proportion at rearing densities (fish per pound, fpp)[b]			
	Very Low (≤ 0.099)		Low (0.1-0.199)		Moderate (0.2-0.449)		High (≥ 0.450)		≤ 0.125 fpp (<0.119)		≤ 0.060 fpp (>0.120)	
	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch
2013	0.7000	0.3333	0.3000	0.6666	0.0000	0.0000	0.0000	0.0000	0.9231	0.1000	0.0769	0.0000
2014	0.5000	--	0.3000	--	0.0000	--	0.2000	--	0.8000	--	0.2000	--
2015[a]	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.000	0.0000	0.0000
2016	0.8888	0.9118	0.1111	0.0882	0.0000	0.0000	0.0000	0.0000	0.8888	0.9118	0.1111	0.0882
2017	0.9429	0.9375	0.0571	0.0625	0.0000	0.0000	0.0000	0.0000	0.9714	0.9375	0.0286	0.0625
2018	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.000	1.0000	0.0000	0.0000
Average	***0.8386***	***0.8365***	***0.1280***	***0.1635***	***0.0000***	***0.0000***	***0.0333***	***0.0000***	***0.9110***	***0.7452***	***0.0833***	***0.0299***
Median	***0.9159***	***0.9375***	***0.0841***	***0.0625***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.9231***	***0.9403***	***0.0769***	***0.0156***

[a] Determination of origin should be considered preliminary pending scale analyses.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

6.4 Natural Juvenile Productivity

During 2018, juvenile spring Chinook were sampled at the Nason Creek trap.

Smolt and Emigrant Estimates

Numbers of spring Chinook smolts and emigrants were estimated at the Nason Creek trap in 2018. A complete description of trapping operations on Nason Creek can be found in Appendix N.

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2018. During that time, the trap was inoperable for 99 days because of low stream discharge or flooding. Daily trap efficiencies were estimated from a flow-efficiency regression model. The daily number of fish captured was expanded by the estimated trap efficiency to estimate total emigration. If a viable flow-efficiency regression model could not be developed, a pooled efficiency was used to expand daily catch. All pooled estimates will be recalculated as flow-efficiency models are developed.

Wild yearling spring Chinook (2016 brood year) were captured primarily from March through June 2018 (Figure 6.4). Because a viable yearling emigrant flow-efficiency regression model could not be established at the downstream trap location, a pooled estimate was employed as a temporary method of expansion. The estimated wild yearling Chinook emigration from the Nason Creek basin was 5,082 (±3,580). Combining the number of subyearling spring Chinook (26,785) that emigrated during the fall of 2017 with the total number of yearling Chinook (5,082) that emigrated during 2018 resulted in an emigrant estimate of 31,867 (±5,794) spring Chinook (Table 6.14).

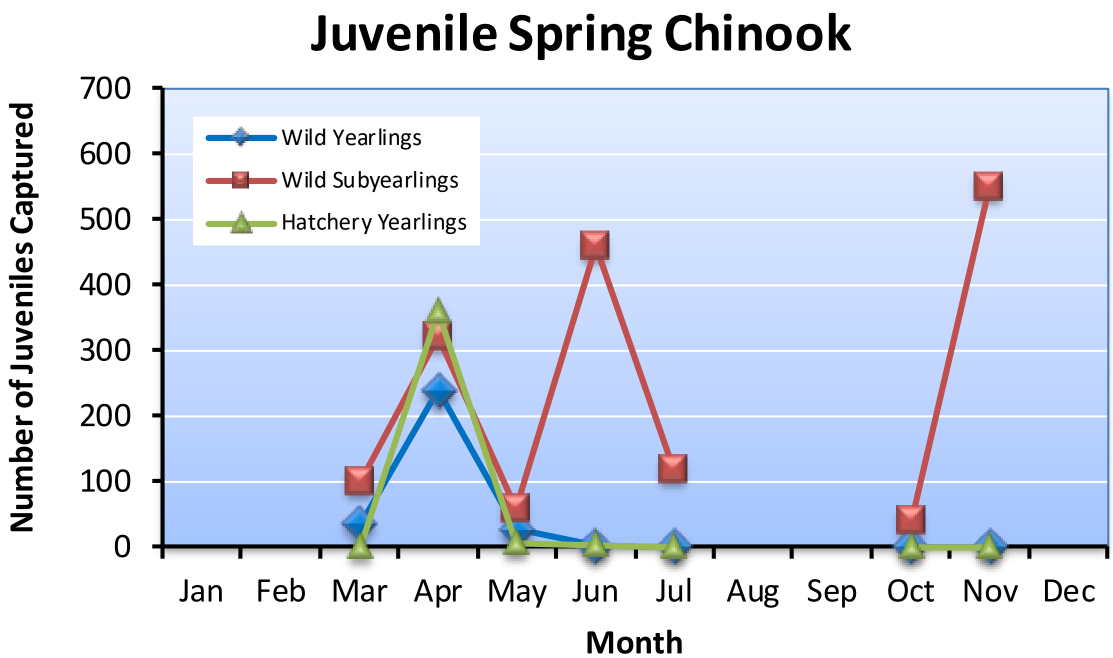


Figure 6.4. Monthly captures of wild subyearling and wild and hatchery yearling spring Chinook at the Nason Creek Trap, 2018.

Table 6.14. Numbers of redds and juvenile spring Chinook at different life stages in the Nason Creek basin for brood years 2002-2017; ND = no data.

Brood year	Number of redds	Egg deposition[a]	Number of subyearling emigrants[b]	Number of smolts produced within Nason Creek basin	Number of emigrants[c]
2002	294	1,368,276	ND	4,683	ND
2003	83	485,052	13,076	6,358	19,425
2004	169	811,031	12,111	2,597	14,708
2005	193	835,111	14,565	8,696	23,261
2006	152	657,248	4,144	7,798	11,942
2007	101	448,541	17,097	5,679	22,776
2008	336	1,542,912	26,284	3,611	29,895
2009	167	763,691	27,720	1,705	29,425
2010	188	811,032	8,685	3,535	12,220
2011	170	745,450	18,457	2,422	20,879
2012	413	1,744,099	34,961	4,561	39,522
2013	212	859,024	21,697	13,814[d]	35,511[d]
2014	115	435,505	7,020	2,372[d]	9,392[d]
2015	85	379,355	6,528	11,654[d]	18,182[d]
2016	85	381,395	25,384	6,483[d]	31,867[d]
2017	68	321,708	17,066	--	--
Average	***177***	***786,839***	***16,986***	***5,731***	***22,786***

Brood year	Number of redds	Egg deposition[a]	Number of subyearling emigrants[b]	Number of smolts produced within Nason Creek basin	Number of emigrants[c]
Median	***168***	***754,571***	***17,066***	***4,683***	***21,828***

[a] Egg deposition is calculated as the number of redds times the fecundity of both wild and hatchery spring Chinook salmon (from Table 5.5).
[b] Subyearling emigrants does not include fry that left the watershed before 1 July.
[c] Brood years 2002-2012 do not include estimates of numbers of juvenile spring Chinook that emigrated during non-trapping periods (1 Dec to 28 Feb). Brood years 2013 to present include estimates of numbers of juvenile spring Chinook that emigrated during non-trapping periods.
[d] Smolt numbers expanded based on mark-recapture studies during non-trapping periods.

Wild subyearling spring Chinook (2017 brood year) were captured between 1 July and 30 November 2018 (Figure 6.1). Based on capture efficiencies estimated from the flow model, the total number of wild subyearling Chinook emigrating from Nason Creek was 17,066 (±1,611).

Yearling spring Chinook sampled in 2018 averaged 95 mm in length, 9.5 g in weight, and had a mean condition of 1.09 (Table 6.15). Estimated length, weight, and condition for these fish were greater than the overall means of yearling spring Chinook sampled in previous years (overall means, 93 mm, 8.7 g, and 1.06). Subyearling spring Chinook sampled in 2018 at the Nason Creek Trap averaged 83 mm in length, 6.5 g in weight, and had a mean condition of 1.09 (Table 6.15). Fork length and weight estimates were greater than the overall means of subyearling spring Chinook sampled in previous years (overall means, 77 mm, 5.2 g, and 1.07).

Table 6.15. Mean fork length (mm), weight (g), and condition factor of subyearling and yearling spring Chinook collected in the Nason Creek Trap, 2004-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2004	Subyearling	656	82 (7)	5.9 (1.7)	1.04 (0.11)
	Yearling	323	92 (8)	8.2 (2.3)	1.04 (0.08)
2005	Subyearling	872	76 (9)	4.8 (1.7)	1.02 (0.13)
	Yearling	276	94 (7)	8.7 (2.0)	1.04 (0.12)
2006	Subyearling	1422	73 (9)	3.9 (1.9)	0.92 (0.16)
	Yearling	362	91 (7)	7.5 (1.8)	0.98 (0.11)
2007	Subyearling	609	78 (14)	5.9 (2.6)	1.15 (0.16)
	Yearling	678	88 (9)	7.4 (2.4)	1.05 (0.13)
2008	Subyearling	1,001	75 (14)	5.0 (2.5)	1.10 (0.11)
	Yearling	881	96 (6)	9.5 (2.0)	1.06 (0.09)
2009	Subyearling	2,147	72 (11)	4.4 (2.1)	1.08 (0.08)
	Yearling	162	96 (8)	9.6 (2.4)	1.08 (0.09)
2010	Subyearling	3,032	81 (11)	6.2 (2.3)	1.13 (0.10)
	Yearling	366	97 (7)	10.2 (2.3)	1.10 (0.09)
2011	Subyearling	1,064	72 (13)	4.7 (2.5)	1.13 (0.12)
	Yearling	150	89 (10)	7.7 (1.8)	1.09 (0.12)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2012	Subyearling	2,141	78 (11)	5.3 (2.0)	1.05 (0.09)
	Yearling	363	93 (6)	9.3 (2.2)	1.11 (0.08)
2013	Subyearling	4,408	70 (11)	3.8 (1.7)	1.03 (0.10)
	Yearling	239	91 (7)	7.9 (2.1)	1.03 (0.07)
2014	Subyearling	1,543	69 (12)	3.8 (2.3)	1.05 (0.06)
	Yearling	464	90 (7)	7.5 (1.8)	1.03 (0.06)
2015	Subyearling	209	84 (8)	6.5 (1.7)	1.08 (0.08)
	Yearling	152	93 (7)	8.4 (2.1)	1.03 (0.09)
2016	Subyearling	490	85 (13)	6.9 (2.5)	1.07 (0.09)
	Yearling	61	96 (6)	9.0 (1.7)	1.01 (0.06)
2017	Subyearling	1,864	74 (12)	4.7 (2.1)	1.10 (0.08)
	Yearling	357	96 (7)	9.8 (2.1)	1.09 (0.07)
2018	Subyearling	710	83 (12)	6.5 (2.4)	1.09 (0.08)
	Yearling	301	95 (7)	9.5 (2.1)	1.09 (0.07)
Average	***Subyearling***	***1,478***	***77 (5)***	***5.2 (1.0)***	***1.07 (0.06)***
	Yearling	***342***	***93 (3)***	***8.7 (0.9)***	***1.06 (0.04)***
Median	***Subyearling***	***1,064***	***76 (5)***	***5.0 (1.0)***	***1.08 (0.06)***
	Yearling	***323***	***93 (3)***	***8.7 (0.9)***	***1.05 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 17,950 wild juvenile Chinook (12,858 subyearling and 5,092 yearlings) were PIT tagged and released in 2018 in the Wenatchee River basin (Table 6.16). A total of 3,506 juvenile Chinook were PIT tagged in Nason Creek in 2018. See Appendix D for a complete list of all fish captured, tagged, lost, and released.

Table 6.16. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2018. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	7,948	285	5,692	20	6	5,686	0.25
	Yearling	3,539	57	3,448	8	1	3,447	0.22
	Total	**11,487**	**342**	**9,140**	**28**	**7**	**9,133**	**0.24**
Chiwawa River (Electrofishing)	Subyearling	3,800	39	3,737	15	0	3,737	0.39
	Yearling	0	0	0	0	0	0	0
	Total	**3,800**	**39**	**3,737**	**15**	**0**	**3,737**	**0.39**
Nason Creek Trap	Subyearling	1,651	51	686	8	0	686	0.48
	Yearling	301	13	296	5	0	296	1.66
	Total	**1,952**	**64**	**982**	**13**	**0**	**982**	**0.67**

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Nason Creek (Electrofishing)	Subyearling	2,648	88	2,524	17	0	2,524	0.64
	Yearling	0	0	0	0	0	0	0
	Total	**2,648**	**88**	**2,524**	**17**	**0**	**2,524**	**0.64**
White River Trap	Subyearling	131	0	220	0	0	220	0
	Yearling	225	2	106	0	0	106	0
	Total	**356**	**2**	**326**	**0**	**0**	**326**	**0.00**
Lower Wenatchee Trap	Subyearling	47,283	54	5	347	0	5	0.73
	Yearling	1,418	1	1,243	7	0	1,243	0.49
	Total	**48,701**	**55**	**1,248**	**354**	**0**	**1,248**	**0.73**
Total:	**Subyearling**	**63,461**	**517**	**12,864**	**407**	**6**	**12,858**	**0.64**
	Yearling	**5,483**	**73**	**5,093**	**20**	**1**	**5,092**	**0.36**
Grand Total:		**68,944**	**590**	**17,957**	**427**	**7**	**17,950**	**0.62**

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2007-2018 are shown in Table 6.17.

Table 6.17. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2007-2018.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Chiwawa Trap	Subyearling	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241	5,686
	Yearling	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711	3,447
	Total	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**	**9,133**
Chiwawa River (Angling or Electro-fishing)	Subyearling	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703	3,737
	Yearling	0	0	3	4	0	0	0	0	0	0	0	0
	Total	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**	**3,737**
Upper Wenatchee Trap	Subyearling	15	0	37	3	1	1	0	--	--	--	--	--
	Yearling	1,434	159	296	486	714	75	94	--	--	--	--	--
	Total	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877	686
	Yearling	577	894	185	364	147	357	237	456	142	61	346	296
	Total	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**	**982**
Nason Creek (Angling or Electro-fishing)	Subyearling	6	4	701	595	0	0	0	1,816	1,089	802	3,240	2,524
	Yearling	7	0	13	3	0	0	0	0	0	0	0	0
	Total	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**	**2,524**
White River Trap	Subyearling	0	0	441	143	144	285	374	156	149	136	507	220
	Yearling	0	0	265	359	65	180	22	49	34	3	41	106
	Total	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**	**326**

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Upper Wenatchee (Angling or Electro-fishing)	Subyearling	61	1	0	2	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electro-fishing)	Subyearling	0	65	284	233	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electro-fishing)	Subyearling	0	0	0	1	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	2	0	0	0	0	0	36	0	18	0	5
	Yearling	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220	1,243
	Total	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**	**1,248**
Total:	**Subyearling**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**	**12,858**
	Yearling	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**	**5,092**
Grand Total:		***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***	***17,950***

Freshwater Productivity

Productivity and survival estimates for different life stages of spring Chinook in the Nason Creek watershed are provided in Table 6.18. During the period 2002-2016, freshwater productivities ranged from 8-85 smolts/redd and 65-358 emigrants/redd. Survivals during the same period ranged from 0.2-1.9% for egg-smolt and 1.5-8.0% for egg-emigrants.

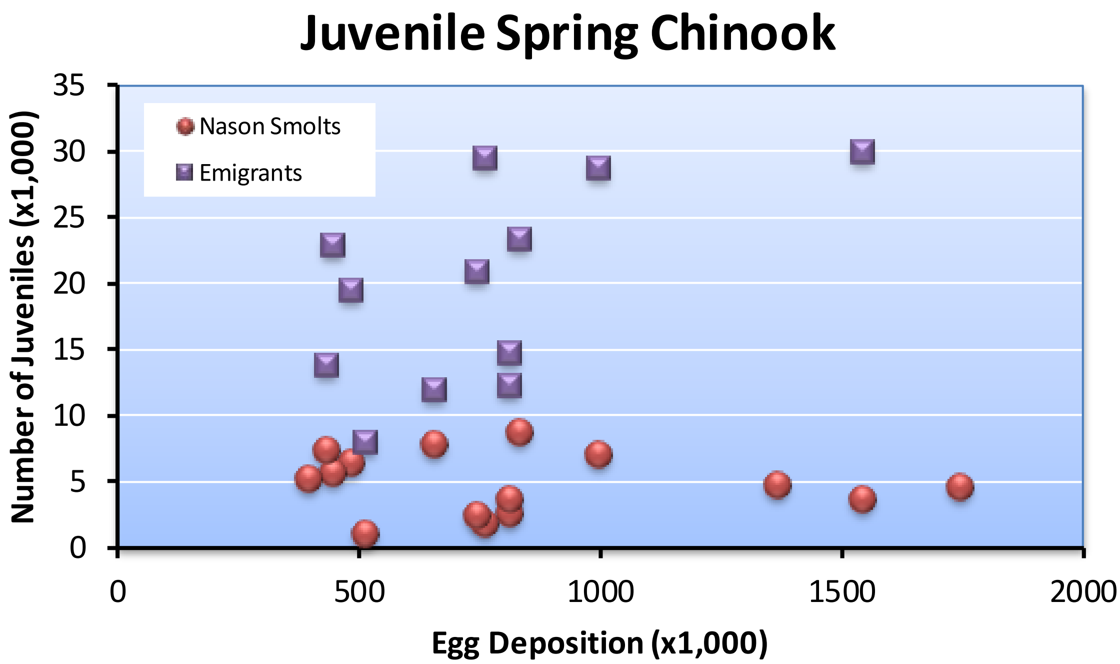
Table 6.18. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Nason Creek watershed for brood years 2002-2016; ND = no data. These estimates were derived from data in Table 6.14. Numbers in parentheses are estimates that have been adjusted based on mark-recapture studies conducted during non-trapping periods (for brood years 2013 to present). Summary statistics do not include adjusted estimates.

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2002	16	ND	0.3	ND
2003	77	234	1.3	4.0
2004	15	87	0.3	1.8
2005	45	121	1.0	2.8
2006	51	79	1.2	1.8
2007	56	226	1.3	5.1
2008	11	89	0.2	1.9

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2009	10	176	0.2	3.9
2010	19	65	0.4	1.5
2011	14	123	0.3	2.8
2012	11	96	0.3	2.3
2013	33 (65)	135 (168)	0.8 (1.4)	3.3 (3.6)
2014	8 (21)	69 (82)	0.2 (0.5)	1.8 (1.8)
2015	85 (137)	162 (214)	1.9 (2.7)	3.6 (4.2)
2016	60 (76)	358 (375)	1.3 (1.7)	8.0 (8.4)
Average	***34***	***144***	***0.7***	***3.2***
Median	***19***	***122***	***0.4***	***2.8***

[a] These estimates include Nason Creek smolts produced only within the Nason Creek basin.

Seeding level (egg deposition) explained most of the variability in productivity and survival of juvenile spring Chinook in the Nason Creek watershed. That is, for estimates based on smolts produced within the Nason Creek watershed (not adjusted for non-trapping periods), survival and productivity decreased as seeding levels increased (Figure 6.5). This suggests that density dependence regulates juvenile productivity and survival within the Nason Creek watershed.



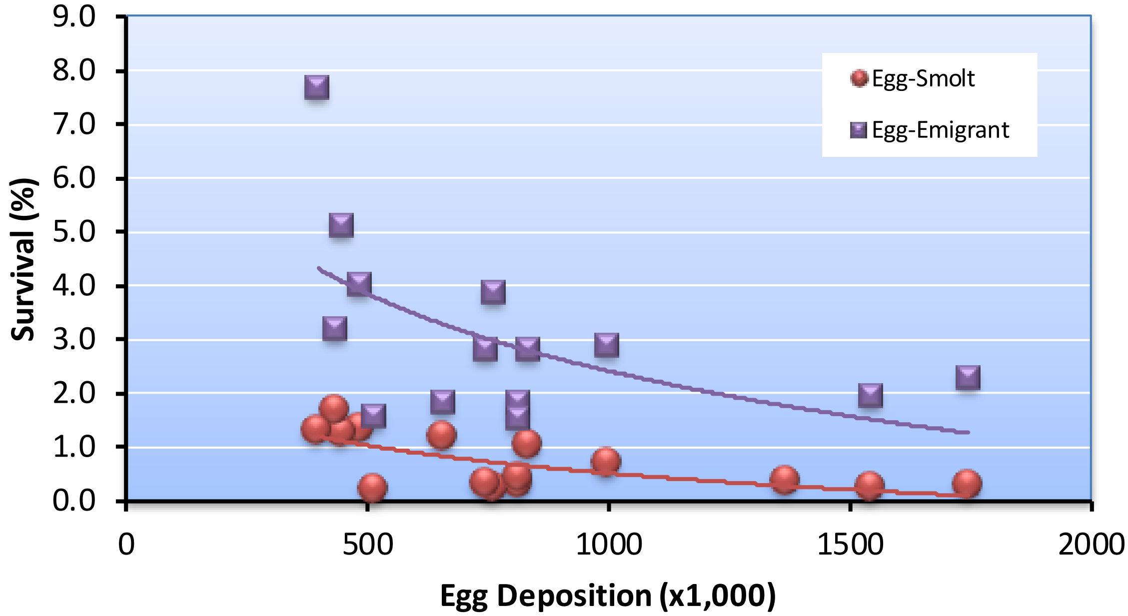


Figure 6.5. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Nason Creek spring Chinook, brood years 2002-2016. Nason Creek smolts are smolts produced only in the Nason Creek watershed.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[25] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate smolt carrying capacities using the Ricker stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). For consistency, only unadjusted smolt estimates were used to model stock-recruitment relationships (i.e., adjusted estimates based on mark-recapture studies conducted for brood years 2015 to present were not included in the analyses). The Ricker model was the only stock-recruitment model that could be fit to the juvenile spring Chinook data.

Based on the Ricker model, the population carrying capacity for spring Chinook smolts in the Nason Creek watershed is 5,088 smolts (95% CI: 0 – 8,467) (Figure 6.6). Here, smolts are defined as the number of yearling spring Chinook produced entirely within Nason Creek. These estimates reflect current environmental conditions (most recent 15 years) within the Nason Creek watershed. Land use activities such as logging, roads, railways, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook smolts in Nason Creek.

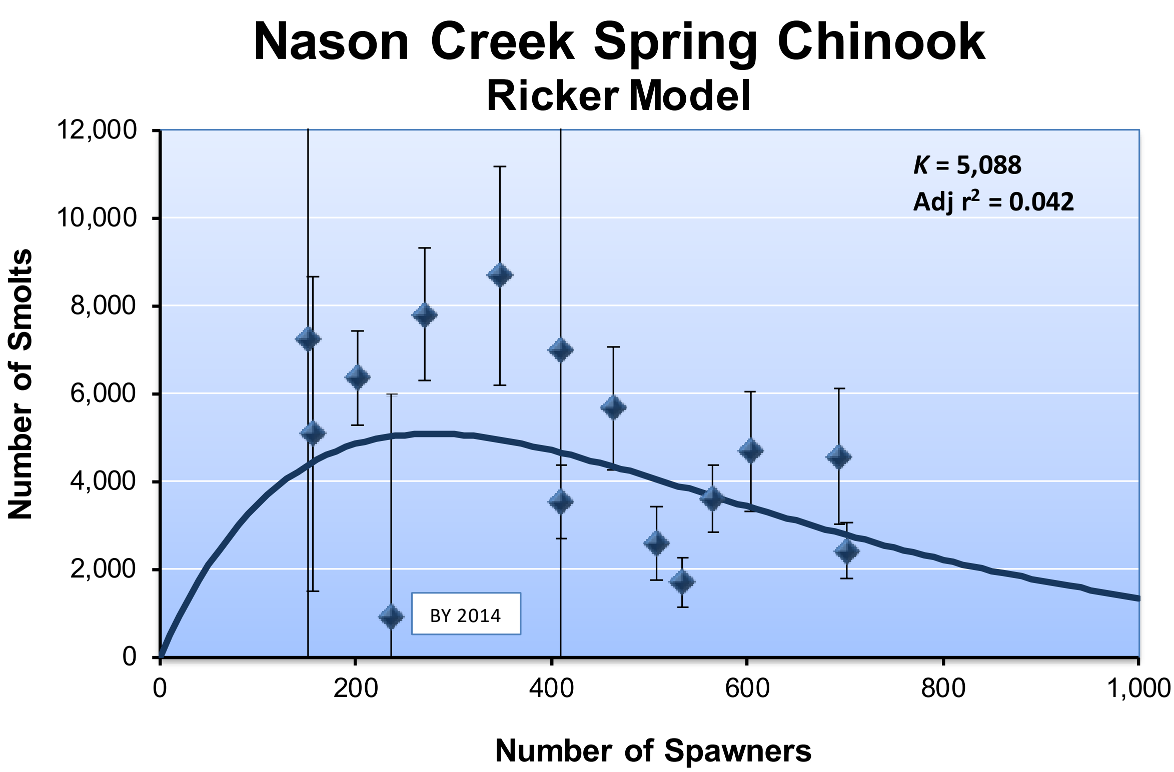


Figure 6.6. Relationship between spawners and number of yearling smolts produced in the Nason Creek watershed. Population carrying capacity (*K*) was estimated using the Ricker model. Vertical bars represent 95% confidence intervals on smolt estimates.

[25] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

We tracked the precision of the Ricker parameters for Nason Creek spring Chinook smolts over time to see if precision improves with additional years of data and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the Ricker model and their associated standard errors and confidence intervals indicates that the parameters have not stabilized, and they lack precision (Table 6.19; Figure 6.7). This was also apparent in the estimates of population carrying capacity (Figure 6.8). Brood year 2014 appeared to have a large effect on the precision of the fit of the stock-recruitment model to the data.

Table 6.19. Estimated parameters and statistics associated with fitting the Ricker model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the Nason Creek watershed. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	90.60	87.13	0.0046	0.0015	7,293	91	219	0.453
6	90.02	5618.57	0.0045	0.0014	7,360	90	222	0.442
7	92.67	1696.44	0.0046	0.0009	7,395	93	217	0.517
8	107.07	1208.15	0.0052	0.0012	7,575	107	192	0.454
9	99.89	1125.42	0.0051	0.0012	7,149	100	195	0.409
10	90.35	50.04	0.0049	0.0008	6,825	90	205	0.470
11	72.26	34.50	0.0043	0.0009	6,240	72	235	0.308
12	76.76	31.24	0.0043	0.0008	6,522	77	231	0.337
13	35.98	32.48	0.0030	0.0013	4,412	36	333	0.049
14	47.48	29.79	0.0035	0.0011	4,962	47	284	0.038
15	49.93	24.34	0.0036	0.0009	5,088	50	277	0.042

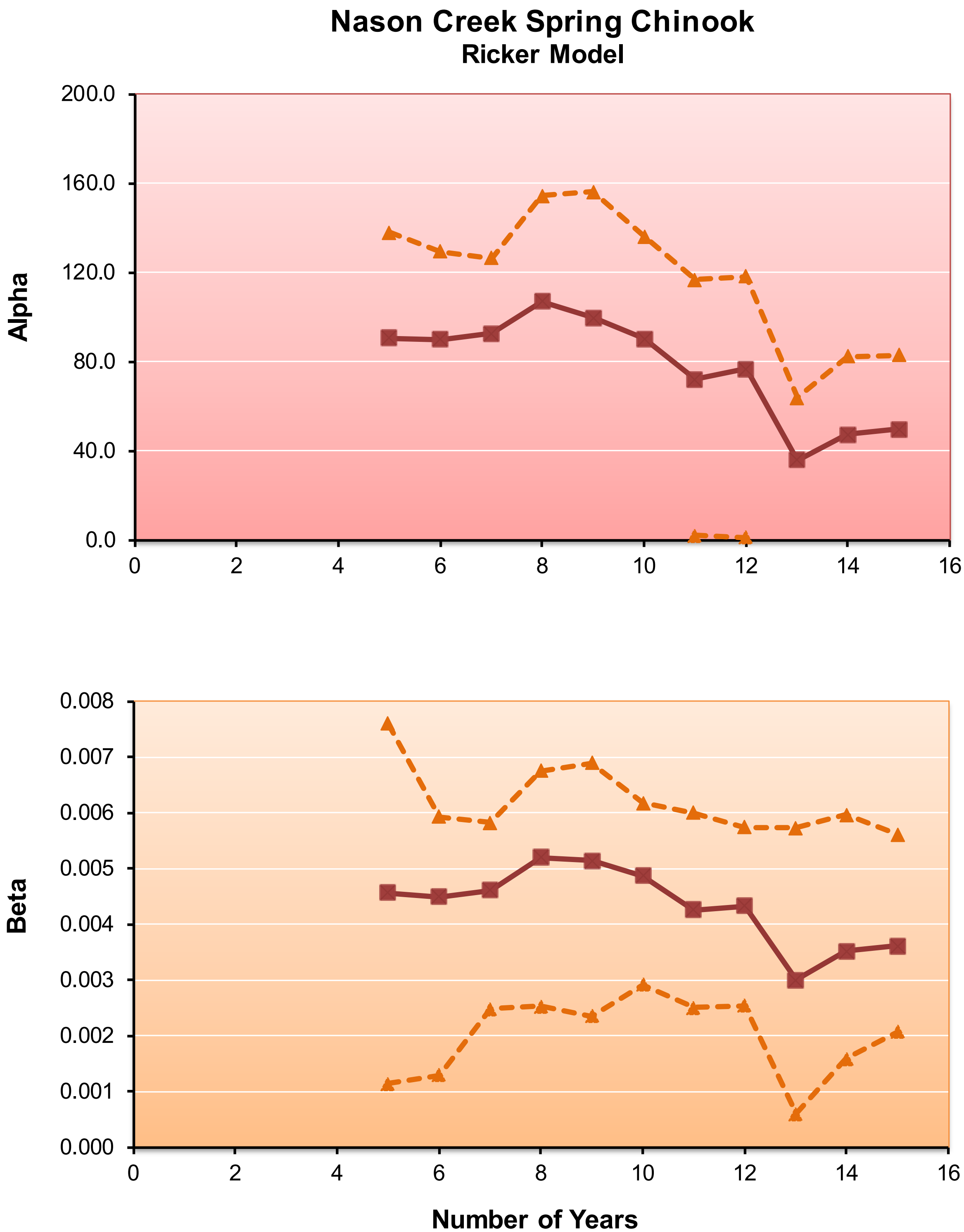


Figure 6.7. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to Nason Creek spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

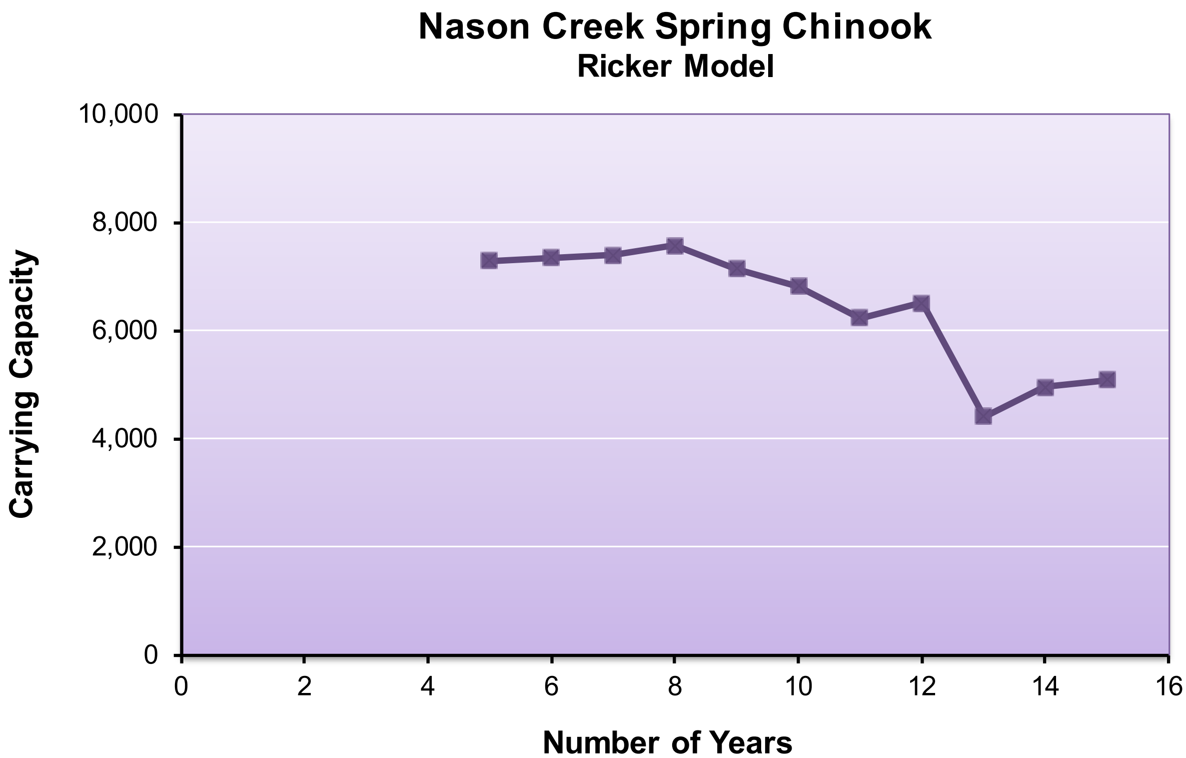


Figure 6.8. Time series of population carrying capacity estimates derived from fitting the Ricker model to Nason Creek spring Chinook smolt and spawning escapement data.

6.5 Spawning Surveys

Surveys for spring Chinook redds were conducted from August through September 2018 in Nason Creek. In the following section, we describe the number and distribution of redds within the Nason Creek basin.

Redd Counts and Distribution

A total of 106 spring Chinook redds were estimated in Nason Creek in 2018 (Table 6.20). This is lower than the average of 139 redds counted during the period 1989-2017 in Nason Creek. Redds were not distributed evenly among the four reaches in Nason Creek. Most redds (68%) were located in Reaches 3 and 4 (Table 6.20).

Table 6.20. Numbers (both counted and estimated) and proportions of spring Chinook redds counted within different reaches within Nason Creek during August through September 2018. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of observed redds	Estimated number of redds*	Proportion of redds estimated within stream/watershed
Nason	Nason 1 (N1)	15	20	0.19
	Nason 2 (N2)	14	14	0.13

Stream/watershed	Reach	Number of observed redds	Estimated number of redds*	Proportion of redds estimated within stream/watershed
	Nason 3 (N3)	38	38	0.36
	Nason 4 (N4)	23	34	0.32
Total		***90***	***106***	***1.00***

* Estimated redds represent the "adjusted" number of redds based on Guassian area-under-the-curve method (see Appendix L).

Spawn Timing

Spring Chinook began spawning during the last week of August in Nason Creek and peaked the first week of September (Figure 6.9). Spawning in Nason Creek ended the last week of September.

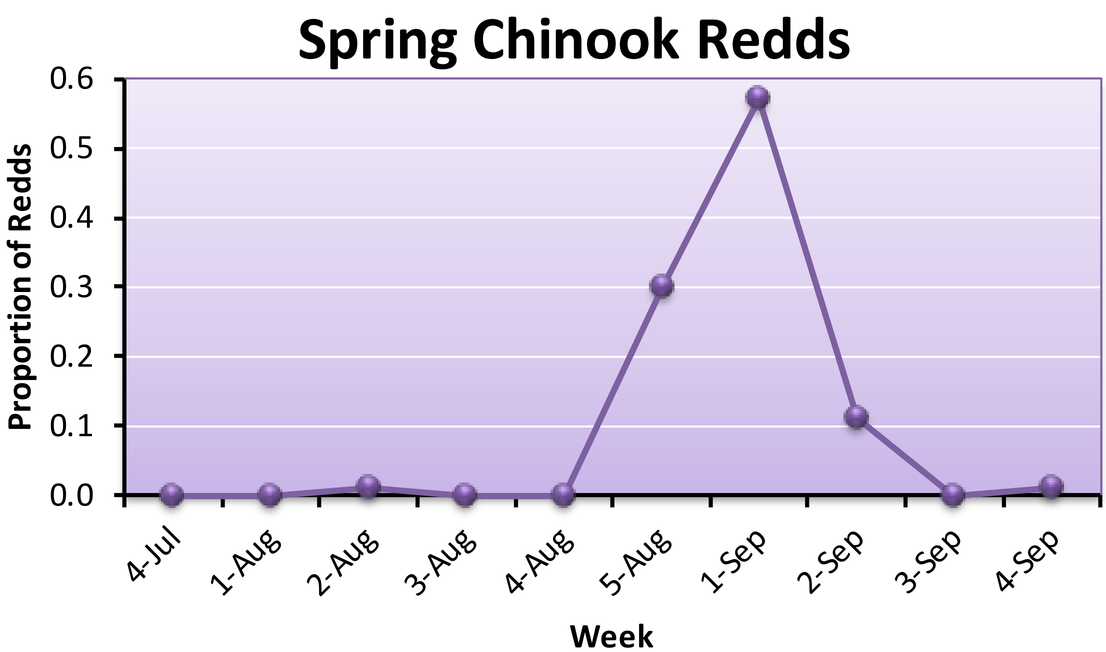


Figure 6.9. Proportion of spring Chinook redds counted during different weeks within Nason Creek, August through September 2018.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[26] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2018 was 1.88 (based on sex ratios estimated at Tumwater Dam). Multiplying this ratio by the number of redds counted in Nason Creek resulted in a total spawning escapement of 169 spring Chinook. The estimated total spawning escapement of spring Chinook in 2018 was less than the overall average of 303 spring Chinook in Nason Creek (Table 6.21).

[26] Expansion factor = (1 + (number of males/number of females)).

Table 6.21. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2018; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**
2017	2.06	457	140	21	31	19	1.81	72	5	**745**
2018	1.88	622	169	15	38	38	1.73	5	3	**890**
Average	***--***	***717***	***303***	***59***	***73***	***91***	***--***	***120***	***32***	***1,330***
Median	***--***	***611***	***234***	***51***	***61***	***57***	***--***	***72***	***7***	***1,193***

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

6.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2018 in Nason Creek. In 2018, 98 spring Chinook carcasses were sampled in Nason Creek. Most of these were sampled in Reach 3 (47%). The number of carcasses sampled in 2018 was less than the overall average of 142 carcasses sampled during the period 1996-2017.

In the Nason Creek watershed, the spatial distribution of hatchery and wild fish was not equal among survey reaches (Table 6.22). In 2018, more hatchery fish were collected during surveys than wild fish. On average, over the survey years, more hatchery fish were collected than wild fish in each of the reaches except Reach 4, where there was no difference on average (Figure 6.10).

Table 6.22. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Nason Creek watershed, 1999-2018. Numbers represent recovered carcasses that had definitive origins. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach				Total
		N-1	N-2	N-3	N-4	
1999	Wild	2	3	0	0	**5**
	Hatchery	0	0	0	0	**0**
2000	Wild	19	21	0	9	**49**
	Hatchery	11	9	0	1	**21**
2001	Wild	25	22	0	41	**88**
	Hatchery	91	54	0	22	**167**
2002	Wild	16	34	0	37	**87**
	Hatchery	33	29	0	35	**97**
2003	Wild	6	19	0	22	**47**
	Hatchery	3	9	0	3	**15**
2004	Wild	29	33	18	24	**104**
	Hatchery	42	26	11	3	**82**
2005	Wild	19	6	11	7	**43**
	Hatchery	130	17	22	4	**173**
2006	Wild	24	17	28	9	**78**
	Hatchery	50	31	17	14	**112**
2007	Wild	2	13	8	6	**29**
	Hatchery	54	77	26	15	**172**
2008	Wild	14	13	16	10	**53**
	Hatchery	102	39	36	13	**190**
2009	Wild	1	12	10	16	**39**
	Hatchery	25	21	20	23	**89**
2010	Wild	3	6	6	4	**19**
	Hatchery	47	29	30	16	**122**
2011	Wild	8	11	11	5	**35**
	Hatchery	22	12	21	8	**63**
2012	Wild	24	11	65	7	**107**
	Hatchery	95	37	70	23	**225**
2013	Wild	4	2	9	8	**23**
	Hatchery	51	12	28	27	**118**
2014	Wild	19	5	13	2	**39**
	Hatchery	25	1	3	0	**29**

Survey year	Origin	Survey Reach				Total
		N-1	N-2	N-3	N-4	
2015	Wild	8	4	20	2	**34**
	Hatchery	2	0	7	0	**9**
2016	Wild	9	8	39	15	**71**
	Hatchery	10	0	9	3	**22**
2017	Wild	4	11	15	5	**35**
	Hatchery	3	13	18	8	**42**
2018	Wild	0	5	6	3	**14**
	Hatchery	6	18	40	20	**84**
Average	***Wild***	***12***	***13***	***14***	***12***	***50***
	Hatchery	***40***	***22***	***18***	***12***	***92***
Median	***Wild***	***9***	***11***	***11***	***8***	***41***
	Hatchery	***29***	***18***	***18***	***11***	***87***

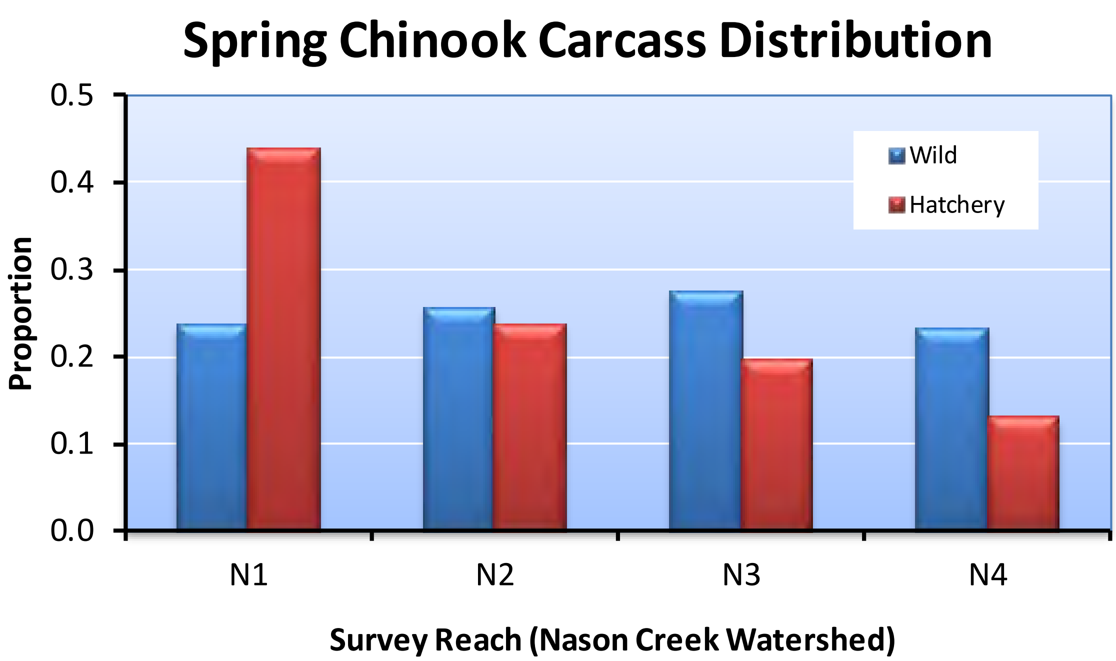


Figure 6.10. Distribution of wild and hatchery produced carcasses in different reaches in the Nason Creek watershed, 1999-2018. Reach codes are described in Table 2.8.

6.7 Life History Monitoring

Life history characteristics of spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In 2018, there was a small difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 6.23a and b; Figure 6.11). On average, hatchery fish arrived at the dam later and ended their migration later than did wild fish. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 6.11).

Table 6.23a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2018. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	49
	Hatchery	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	25
1999	Wild	192	11-Jul	207	26-Jul	224	12-Aug	207	26-Jul	173
	Hatchery	200	19-Jul	211	30-Jul	229	17-Aug	213	1-Aug	25
2000	Wild	171	19-Jun	186	4-Jul	194	12-Jul	184	2-Jul	651
	Hatchery	179	27-Jun	189	7-Jul	201	19-Jul	190	8-Jul	357
2001	Wild	154	3-Jun	166	15-Jun	185	4-Jul	167	16-Jun	2,073
	Hatchery	157	6-Jun	169	18-Jun	185	4-Jul	170	19-Jun	4,244
2002	Wild	174	23-Jun	189	8-Jul	204	23-Jul	189	8-Jul	1,033
	Hatchery	178	27-Jun	189	8-Jul	199	18-Jul	189	8-Jul	1,363
2003	Wild	162	11-Jun	181	30-Jun	200	19-Jul	181	30-Jun	919
	Hatchery	157	6-Jun	179	28-Jun	192	11-Jul	178	27-Jun	423
2004	Wild	156	4-Jun	172	20-Jun	189	7-Jul	172	20-Jun	969
	Hatchery	161	9-Jun	177	25-Jun	189	7-Jul	177	25-Jun	1,295
2005	Wild	153	2-Jun	172	21-Jun	193	12-Jul	173	22-Jun	1,038
	Hatchery	153	2-Jun	173	22-Jun	187	6-Jul	172	21-Jun	2,808
2006	Wild	177	26-Jun	184	3-Jul	193	12-Jul	185	4-Jul	577
	Hatchery	178	27-Jun	185	4-Jul	194	13-Jul	186	5-Jul	1601
2007	Wild	169	18-Jun	185	4-Jul	203	22-Jul	185	4-Jul	351
	Hatchery	174	23-Jun	192	11-Jul	209	28-Jul	192	11-Jul	3,232
2008	Wild	173	21-Jun	188	6-Jul	209	27-Jul	189	7-Jul	634
	Hatchery	177	25-Jun	193	11-Jul	210	28-Jul	193	11-Jul	5,368
2009	Wild	174	23-Jun	186	5-Jul	201	20-Jul	187	6-Jul	1,008
	Hatchery	175	24-Jun	187	6-Jul	202	21-Jul	188	7-Jul	4,106
2010	Wild	173	22-Jun	190	9-Jul	214	2-Aug	191	10-Jul	977
	Hatchery	180	29-Jun	194	13-Jul	213	1-Aug	195	14-Jul	4,450
2011	Wild	183	2-Jul	198	17-Jul	213	1-Aug	198	17-Jul	1,433
	Hatchery	187	6-Jul	200	19-Jul	210	29-Jul	199	18-Jul	4,707
2012	Wild	180	28-Jun	191	9-Jul	205	23-Jul	192	10-Jul	1,482
	Hatchery	182	30-Jun	194	12-Jul	206	24-Jul	194	12-Jul	4,449

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2013	Wild	163	12-Jun	182	1-Jul	199	18-Jul	183	2-Jul	1,106
	Hatchery	164	13-Jun	181	30-Jun	195	14-Jul	181	30-Jun	3,681
2014	Wild	171	20-Jun	188	7-Jul	202	21-Jul	187	6-Jul	1,329
	Hatchery	167	16-Jun	182	1-Jul	195	14-Jul	181	30-Jun	2,510
2015	Wild	150	30-May	170	19-Jun	184	3-Jul	170	19-Jun	1,370
	Hatchery	148	28-May	168	17-Jun	180	29-Jun	167	16-Jun	1,773
2016	Wild	158	6-Jun	180	28-Jun	200	18-Jul	181	29-Jun	1,252
	Hatchery	160	8-Jun	179	27-Jun	191	9-Jul	178	26-Jun	1,284
2017	Wild	175	24-Jun	184	3-Jul	195	14-Jul	184	3-Jul	483
	Hatchery	177	26-Jun	185	4-Jul	196	15-Jul	187	6-Jul	1,035
2018	Wild	165	14-Jun	175	24-Jun	188	7-Jul	177	26-Jun	684
	Hatchery	161	10-Jun	172	21-Jun	188	7-Jul	175	24-Jun	1,437
Average	Wild	***168***	--	***182***	--	***198***	--	***183***	--	***919***
	Hatchery	***170***	--	***184***	--	***197***	--	***184***	--	***2,389***
Median	Wild	***171***	--	***184***	--	***200***	--	***184***	--	***977***
	Hatchery	***174***	--	***185***	--	***195***	--	***186***	--	***1,773***

Table 6.23b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2018. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	23	23	23	23	49
	Hatchery	23	23	23	23	25
1999	Wild	28	30	32	30	173
	Hatchery	29	31	34	31	25
2000	Wild	24	27	27	27	651
	Hatchery	26	27	29	28	357
2001	Wild	22	24	27	24	2,073
	Hatchery	23	25	27	25	4,244
2002	Wild	25	27	30	27	1,033
	Hatchery	26	27	29	27	1,363
2003	Wild	24	26	29	26	919
	Hatchery	23	26	28	26	423
2004	Wild	23	25	27	25	969
	Hatchery	23	26	27	26	1,295
2005	Wild	22	25	28	25	1,038

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	22	25	27	25	2,808
2006	Wild	26	27	28	27	577
	Hatchery	26	27	28	27	1,601
2007	Wild	25	27	29	27	351
	Hatchery	25	28	30	28	3,232
2008	Wild	25	27	30	27	634
	Hatchery	26	28	30	28	5,368
2009	Wild	25	27	29	27	1,008
	Hatchery	25	27	29	27	4,106
2010	Wild	25	28	31	28	977
	Hatchery	26	28	31	28	4,450
2011	Wild	27	29	31	29	1,433
	Hatchery	27	29	30	29	4,707
2012	Wild	26	28	30	28	1,482
	Hatchery	26	28	30	28	4,449
2013	Wild	24	26	29	27	1,106
	Hatchery	24	26	28	26	3,681
2014	Wild	25	27	29	27	1,329
	Hatchery	24	26	28	26	2,510
2015	Wild	22	25	27	25	1,370
	Hatchery	22	24	26	24	1,773
2016	Wild	23	26	29	26	1,252
	Hatchery	23	26	28	26	1,284
2017	Wild	25	27	28	27	483
	Hatchery	26	27	28	27	1,035
2018	Wild	24	25	27	26	384
	Hatchery	23	25	27	25	1,437
Average	Wild	***24***	***26***	***29***	***27***	***919***
	Hatchery	***25***	***27***	***28***	***27***	***2,389***
Median	Wild	***25***	***27***	***29***	***27***	***977***
	Hatchery	***25***	***27***	***28***	***27***	***1,773***

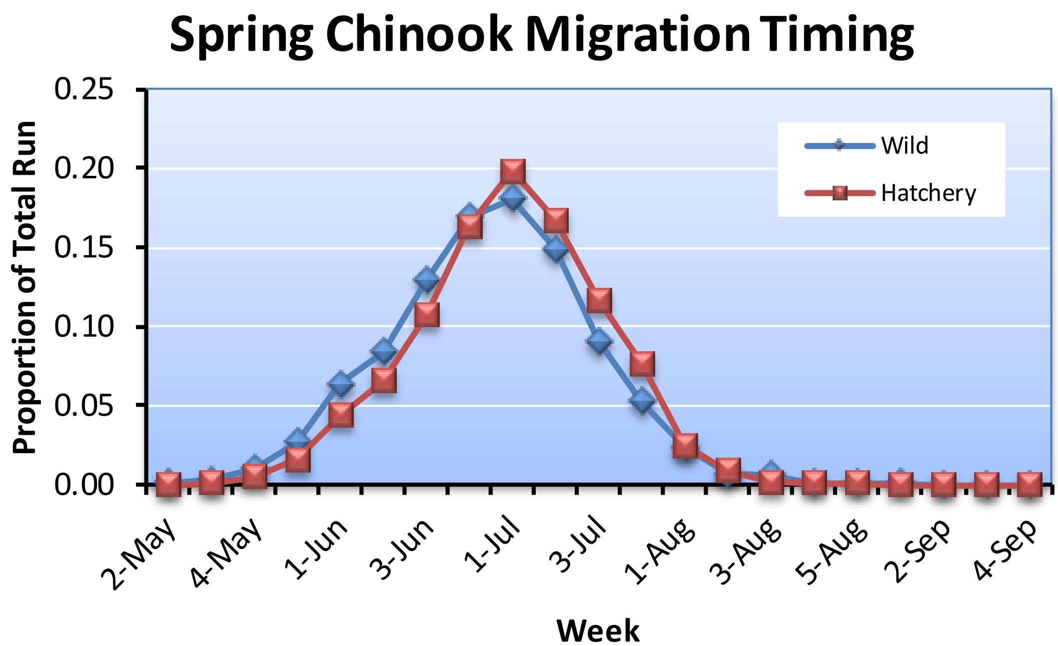


Figure 6.11. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2018.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1999-2018 in the Nason Creek watershed were age-4 fish (total age) (Table 6.24; Figure 6.12). Except for 2014 fish, hatchery fish made up a higher percentage of age-3 Chinook than did wild fish. As in other years, a higher proportion of age-5 wild fish returned than did age-5 hatchery fish. Thus, wild fish tended to return at an older age than hatchery fish.

Table 6.24. Numbers of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Nason Creek watershed, 1999-2018.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
1999	Wild	0	0	5	0	0	**5**
	Hatchery	0	0	0	0	0	**0**
2000	Wild	0	1	45	0	0	**46**
	Hatchery	0	18	3	0	0	**21**
2001	Wild	0	0	63	13	0	**76**
	Hatchery	0	5	159	3	0	**167**
2002	Wild	0	0	58	23	0	**81**
	Hatchery	0	0	85	11	0	**96**
2003	Wild	0	4	3	36	0	**43**
	Hatchery	0	3	1	5	0	**9**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2004	Wild	0	1	101	1	0	**103**
	Hatchery	0	57	23	2	0	**82**
2005	Wild	0	1	25	17	0	**43**
	Hatchery	0	3	170	0	0	**173**
2006	Wild	0	0	60	18	0	**78**
	Hatchery	0	12	78	22	0	**112**
2007	Wild	0	0	18	11	0	**29**
	Hatchery	0	123	40	9	0	**172**
2008	Wild	0	2	46	4	0	**52**
	Hatchery	0	21	163	6	0	**190**
2009	Wild	0	1	36	2	0	**39**
	Hatchery	0	19	65	4	0	**88**
2010	Wild	0	1	18	0	0	**19**
	Hatchery	0	5	116	1	0	**122**
2011	Wild	0	3	24	8	0	**35**
	Hatchery	0	33	17	13	0	**63**
2012	Wild	0	1	89	17	0	**107**
	Hatchery	0	25	198	2	0	**225**
2013	Wild	0	0	16	7	0	**23**
	Hatchery	0	22	92	5	0	**119**
2014	Wild	0	16	19	3	0	**38**
	Hatchery	0	9	20	0	0	**29**
2015	Wild	0	1	25	4	0	**30**
	Hatchery	0	4	9	0	0	**13**
2016	Wild	0	3	61	7	0	**71**
	Hatchery	0	11	10	0	0	**21**
2017	Wild	0	2	22	8	0	**32**
	Hatchery	0	9	30	2	0	**41**
2018	Wild	0	0	12	2	0	**14**
	Hatchery	0	11	70	0	0	**81**
Average	***Wild***	***0***	***2***	***37***	***9***	***0***	***48***
	Hatchery	***0***	***20***	***67***	***4***	***0***	***91***
Median	***Wild***	***0***	***1***	***25***	***7***	***0***	***41***
	Hatchery	***0***	***11***	***53***	***2***	***0***	***85***

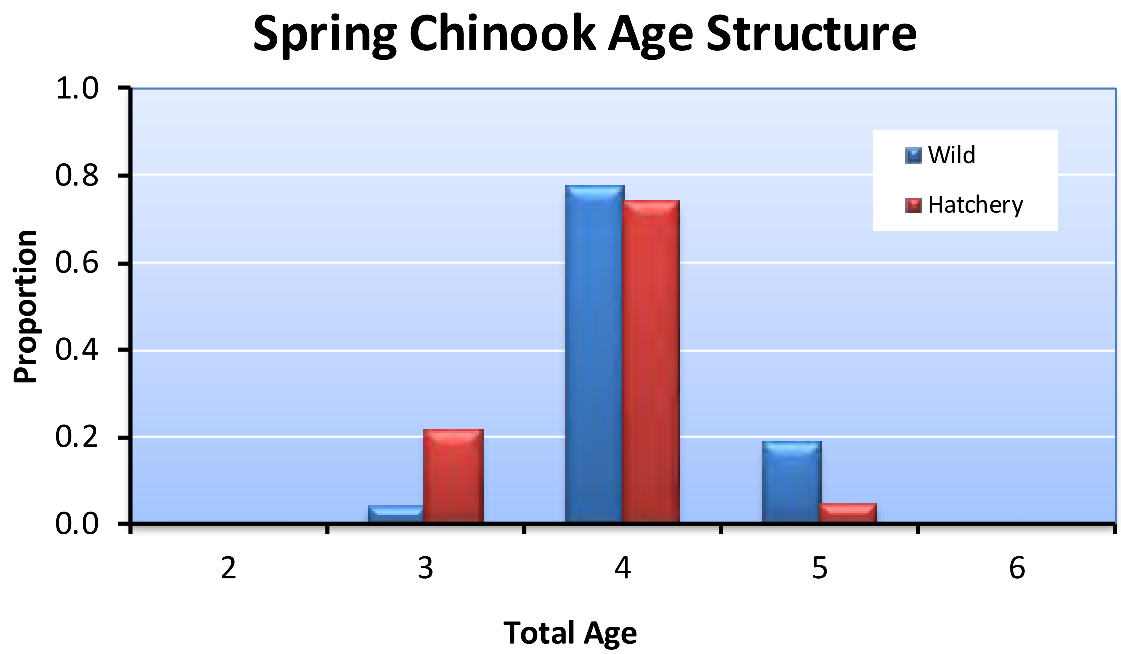


Figure 6.12. Proportions of wild and hatchery spring Chinook of different total ages sampled on spawning grounds in the Nason Creek watershed for the combined years 1999-2018.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed little in length (Table 6.25). Differences were usually no more than 5 cm between hatchery and wild fish of the same age.

Table 6.25. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild and hatchery-origin sampled in the Nason Creek watershed, 1999-2018.

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
1999	3				
	4	71 ±2 (2)		64 ±2 (3)	
	5				
	6				
2000	3	46 ±0 (1)	44 ±4 (14)		52 ±10 (4)
	4	62 ±4 (19)		63 ±3 (25)	60 ±1 (3)
	5				
	6				
2001	3		47 ±12 (5)		
	4	65 ±4 (21)	66 ±5 (36)	63 ±4 (42)	63 ±4 (123)
	5	81 ±5 (3)		72 ±3 (10)	71 ±7 (3)
	6				
2002	3				

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	4	62 ±6 (24)	66 ±5 (35)	63 ±4 (34)	62 ±5 (50)
	5	77 ±4 (12)	81 ±7 (8)	75 ±3 (11)	71 ±5 (3)
	6				
2003	3	44 ±7 (3)	43 ±5 (3)		
	4	58 ±7 (2)	79 ±0 (1)	67 ±0 (1)	
	5	75 ±9 (11)	81 ±6 (2)	72 ±6 (25)	71 ±2 (3)
	6				
2004	3	46 ±0 (1)	43 ±4 (56)		
	4	61 ±4 (35)	60 ±3 (6)	61 ±3 (66)	62 ±4 (17)
	5			81 ±0 (1)	73 ±4 (2)
	6				
2005	3	37 ±0 (1)	41 ±7 (3)		
	4	59 ±6 (8)	63 ±4 (54)	61 ±3 (17)	61 ±3 (116)
	5	73 ±5 (4)		71 ±1 (13)	
	6				
2006	3		41 ±3 (12)		
	4	60 ±5 (26)	62 ±3 (29)	61 ±3 (34)	59 ±4 (49)
	5	72 ±5 (10)	73 ±5 (6)	69 ±4 (8)	70 ±4 (16)
	6				
2007	3		44 ±4 (122)		51 ±0 (1)
	4	62 ±4 (6)	60 ±7 (13)	63 ±4 (12)	61 ±4 (27)
	5	77 ±5 (7)	67 ±5 (3)	68 ±2 (4)	70 ±2 (6)
	6				
2008	3	51 ±21 (2)	45 ±5 (20)		45 ±0 (1)
	4	60 ±5 (15)	63 ±4 (42)	61 ±3 (31)	63 ±3 (121)
	5		77 ±2 (3)	71 ±3 (4)	64 ±7 (3)
	6				
2009	3	41 ±0 (1)	46 ±5 (18)		65 ±0 (1)
	4	60 ±5 (12)	63 ±4 (19)	60 ±3 (24)	61 ±4 (46)
	5		71 ±1 (2)	72 ±4 (2)	73 ±3 (2)
	6				
2010	3	44 ±0 (1)	45 ±5 (5)		
	4	62 ±5 (7)	63 ±4 (42)	61 ±3 (10)	62 ±4 (74)
	5		75 ±0 (1)		
	6				
2011	3	48 ±11 (3)	43 ±4 (31)		48 ±2 (2)
	4	61 ±5 (11)	59 ±11 (6)	60 ±5 (12)	63 ±5 (11)
	5	79 ±2 (3)	73 ±3 (6)	75 ±4 (5)	70 ±3 (7)
	6				
2012	3	41 ±0 (1)	42 ±3 (24)		
	4	61 ±7 (35)	60 ±5 (45)	61 ±4 (54)	60 ±4 (151)

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	5	77 ±4 (6)		66 ±5 (11)	70 ±3 (2)
	6				
2013	3		42 ±4 (21)		
	4	60 ±6 (5)	62 ±4 (23)	60 ±4 (10)	60 ±4 (69)
	5	71 ±0 (1)	75 ±0 (1)	68 ±3 (6)	70 ±4 (4)
	6				
2014	3	44 ±5 (15)	49 ±4 (9)	60 ±0 (1)	
	4	64 ±7 (8)	59 ±4 (8)	63 ±3 (11)	60 ±3 (12)
	5			69 ±8 (3)	
	6				
2015	3	44 ±0 (1)	45 ±1 (4)		
	4	61 ±7 (15)	56 ±4 (3)	63 ±5 (10)	58 ±2 (6)
	5	72 ±7 (3)		65 ±0 (1)	
	6				
2016	3	43 ±2 (3)	46 ±5 (10)		45 ±0 (1)
	4	64 ±6 (32)	65 ±1 (3)	64 ±5 (29)	60 ±2 (7)
	5	67 ±0 (1)		71 ±5 (6)	
	6				
2017	3	44 ±4 (3)	48 ±4 (9)		
	4	63 ±5 (10)	64 ±6 (15)	61 ±4 (17)	63 ±4 (16)
	5	71 ±4 (3)		88 ±0 (1)	68 ±0 (1)
	6				
2018	3		46±3 (11)		
	4	62±7 (9)	60±6 (21)	63±2 (3)	60±4 (49)
	5	70±0 (1)		76±0 (1)	
	6				

Contribution to Fisheries

Based on one brood year, all the harvest on hatchery-origin Nason Creek spring Chinook occurred in the ocean fishery (Table 6.26). No Nason Creek spring Chinook have been captured in the Columbia River fisheries. The Lower Columbia River fisheries are managed by the states and tribes pursuant to management plans developed in *U.S. v Oregon*. The Lower Columbia River fisheries occur during what is referred to in *U.S. v Oregon* as the winter, spring, and summer seasons, which begin in February and ends 31 July of each year. The Tribal fishery occurs upstream from Bonneville Dam, but primarily in Zone 6, the area between Bonneville and McNary dams; the non-treaty commercial fisheries occur in Zones 1-5, which are downstream from Bonneville Dam. The non-treaty recreational (sport) fishery occurs in the lower mainstem.

Table 6.26. Estimated number and percent (in parentheses) of hatchery-origin Nason Creek spring Chinook captured in different fisheries, brood year 2013.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[b]
		Tribal[a]	Commercial (Zones 1-5)	Recreational (sport)		
2013	2 (100)	0 (0)	0 (0)	0 (0)	2	2 (100)
Average	***2 (100)***	***0 (0)***	***0 (0)***	***0 (0)***	***2***	***2 (100)***
Median	***2 (100)***	***0 (0)***	***0 (0)***	***0 (0)***	***2***	***2 (100)***

[a] Includes the Wanapum fishery and the Icicle and Wenatchee fisheries when they occurred.

[b] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Because the Nason Creek program began in 2013, there will be no harvest information on Nason Creek hatchery spring Chinook until 2018, when brood year 2013 fish return.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%.

The percentage of the spawning escapement in non-target spawning areas within the Wenatchee River basin made up of hatchery-origin Nason Creek spring Chinook has been low and has not exceeded the target of 10% (Table 6.27). Over the years of sampling, Nason Creek spring Chinook have strayed only into the Upper Wenatchee spawning area.

Table 6.27. Number (No.) and percent (%) of the spawning escapement in other non-target spawning streams within the Wenatchee River basin that consisted of hatchery-origin Nason Creek spring Chinook, return years 2016-2017. Percent strays should be less than 10%.

Return year	Chiwawa River		Icicle Creek		Peshastin Creek		Upper Wenatchee		White River		Little Wenatchee	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2016	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2017	0	0.0	0	0.0	0	0.0	1	5.3	0	0.0	0	0.0
Average	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***1***	***2.6***	***0***	***0.0***	***0***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***1***	***2.6***	***0***	***0.0***	***0***	***0.0***

Hatchery-origin Nason Creek spring Chinook have strayed into the Entiat basin but not the Methow basin (Table 6.28). Based on return year analyses, rates of hatchery-origin Nason Creek spring Chinook straying into these populations has been low and these fish have not made up more than 5% of the spawning escapement within Entiat or Methow basins.

Table 6.28. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Nason Creek spring Chinook, return years 2016-2017. For example, for return year 2016, 0.3% of the spring Chinook spawning escapement in the Entiat River basin consisted of hatchery-origin Nason Creek spring Chinook. Percent strays should be less than 5%.

Return year	Methow River basin		Entiat River basin	
	Number	%	Number	%
2016	0	0.0	1	0.3
2017	0	0.0	0	0.0
Average	***0***	***0.0***	***1***	***0.1***
Median	***0***	***0.0***	***1***	***0.1***

Based on brood year analyses, on average, about 1% of the hatchery returns have strayed into non-target spawning areas (Table 6.29). Few (0.9%) have strayed into non-target hatchery programs.

Table 6.29. Number and percent of hatchery-origin Nason Creek spring Chinook that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and non-target hatchery programs, by brood year.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2013	46	40.4	66	57.9	1	0.9	1	0.9
Average	***46***	***40.4***	***66***	***57.9***	***1***	***0.9***	***1***	***0.9***
Median	***46***	***40.4***	***66***	***57.9***	***1***	***0.9***	***1***	***0.9***

* Homing to the target hatchery includes Chiwawa hatchery spring Chinook that are captured and included as broodstock in the Chiwawa Hatchery program. These hatchery fish are typically collected at the Chiwawa weir and Tumwater Dam.

Ford et al. (2015) used parentage analysis to estimate rates of straying and homing of spring Chinook within the Wenatchee River basin. They found that stray rates of hatchery spring Chinook based on parentage analysis were consistent with rates estimated using physical tag recoveries (the latter estimates are shown in the tables above). They also found that stray rates among the major spawning tributaries were higher than stray rates of tagged fish to areas outside of the Wenatchee River basin (e.g., Entiat and Methow basins), which is consistent with the results shown in the tables above. Finally, the researchers noted that hatchery spring Chinook homed at a far lower rate than natural-origin fish and stray rates of natural-origin fish ranged from about 0-100%. Rates of straying of natural-origin spring Chinook were affected by spawning tributary and by parental origin (i.e., progeny of naturally spawning hatchery-produced fish strayed at higher rates than progeny whose parents were of natural origin).

Genetics

Because the Nason Creek spring Chinook program began in 2013 with the collection of broodstock, there are no studies that examine the effects of the program on the genetics of natural-origin spring Chinook in the Wenatchee River basin. However, genetic studies were conducted to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix M). This work included the analysis of Nason Creek spring Chinook. Researchers collected microsatellite DNA allele frequencies from temporally replicated natural and hatchery-origin spring Chinook to statistically assign individual fish to specific demes (locations) within the Wenatchee population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in Nason Creek and the White River, despite the presence of hatchery-origin spawners in both systems.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[27] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-2012, when no brood stock was collected for the Nason Creek Program, the PNI values ranged from 0.28 to 1.00 (Table 6.30). During this period, PNI values varied over time because of Chiwawa spring Chinook straying into Nason Creek. For brood years 2013-2018, a period when brood stock was collected for the Nason Creek Program, PNI values for the Nason Creek Program ranged from 0.30 to 0.75 (Table 6.30).

Table 6.30. Proportionate Natural Influence (PNI) Index of hatchery spring Chinook spawning in Nason Creek, brood years 1989-2018. See notes below the table for description of each metric.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_N	HOS_S	$pHOS_N$	$pHOS_{N+S}$	NOB_N	HOB_N	pNOB	
1989	222	0	0	0.00	0.00	0	0	*1.00*	1.00
1990	231	0	0	0.00	0.00	0	0	*1.00*	1.00
1991	156	0	0	0.00	0.00	0	0	*1.00*	1.00
1992	181	0	0	0.00	0.00	0	0	*1.00*	1.00
1993	430	0	61	0.00	0.12	0	0	*1.00*	0.90
1994	60	0	0	0.00	0.00	0	0	*0.67*	1.00
1995	18	0	0	0.00	0.00	0	0	*0.00*	1.00
1996	58	0	25	0.00	0.30	0	0	*0.44*	0.61
1997	67	0	55	0.00	0.45	0	0	*0.29*	0.42

[27] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_N	HOS_S	$pHOS_N$	$pHOS_{N+S}$	NOB_N	HOB_N	pNOB	
1998	61	0	3	0.00	0.05	0	0	*0.28*	0.86
1999	22	0	0	0.00	0.00	0	0	*0.00*	1.00
2000	189	0	81	0.00	0.30	0	0	*0.30*	0.52
2001	257	0	341	0.00	0.57	0	0	*0.30*	0.37
2002	313	0	290	0.00	0.48	0	0	*0.28*	0.39
2003	152	0	50	0.00	0.25	0	0	*0.44*	0.65
2004	297	0	210	0.00	0.41	0	0	*0.39*	0.51
2005	81	0	266	0.00	0.77	0	0	*0.33*	0.32
2006	117	0	154	0.00	0.57	0	0	*0.29*	0.36
2007	83	0	380	0.00	0.82	0	0	*0.29*	0.28
2008	139	0	426	0.00	0.75	0	0	*0.27*	0.29
2009	163	0	371	0.00	0.69	0	0	*0.46*	0.42
2010	59	0	351	0.00	0.86	0	0	*0.44*	0.35
2011	250	0	452	0.00	0.64	0	0	*0.46*	0.43
2012	220	0	474	0.00	0.68	0	0	*0.66*	0.50
Average*	***159***	***0***	***166***	***0.00***	***0.36***	***0***	***0***	***0.48***	***0.63***
Median*	***154***	***0***	***71***	***0.00***	***0.36***	***0***	***0***	***0.42***	***0.52***
2013	70	0	339	0.00	0.83	21	4	0.84	0.51
2014	169	0	68	0.00	0.29	21	0	1.00	0.75
2015	28	0	123	0.00	0.81	59	63	0.48	0.56
2016	125	11	20	0.07	0.20	70	66	0.51	0.75
2017	65	34	41	0.24	0.54	70	67	0.51	0.55
2018	23	NA	176	NA	0.88	54	54	0.5	0.30
Average**	***80***	***9***	***128***	***0.06***	***0.59***	***49***	***42***	***0.64***	***0.57***
Median**	***68***	***0***	***96***	***0.00***	***0.68***	***57***	***59***	***0.51***	***0.56***

HOS_N = hatchery-origin spawners in Nason Creek from the Nason Creek spring Chinook Supplementation Program.
$pHOS_N$ = proportion of hatchery-origin spawners from Nason Creek spring Chinook Supplementation Program.
HOS_S = stray hatchery-origin spawners in Nason Creek.
$pHOS_S$ = proportion of stray hatchery-origin spawners.
NOB_N = natural-origin broodstock spawned in the Nason Creek spring Chinook Supplementation Program.
HOB_N = hatchery-origin broodstock spawned in the Nason Creek spring Chinook Supplementation Program.
pNOB = proportion of hatchery-origin broodstock. Because of the high incidence of strays to Nason Creek from the Chiwawa River spring Chinook program, pNOB values from the Chiwawa program were used to estimate PNI values during the period from 1989 to 2012 (*italicized*). The weighting for those years was 100% based on the Chiwawa program broodstock selection, because there have been no hatchery returns from the Nason Creek spring Chinook program (see Table 5.1 for Chiwawa broodstock selection).
PNI_N = Proportionate Natural Influence for Nason Creek spring Chinook calculated using the gene-flow model for multiple programs.
* Average and median for the period 1989-2012, a period when no brood stock were collected for the Nason Creek Program.
** Average and median for the period 2013-present, a period when brood stock was collected for the Nason Creek Program.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery spring Chinook from the Nason Creek release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 6.31).[28] Over the brood years for which PIT-tagged hatchery fish were released, survival rates from Nason Creek to McNary Dam ranged from 0.346 to 0.572. Average travel time from Nason Creek to McNary Dam ranged from 21 to 38 days. SARs from release to detection at Bonneville Dam for brood year 2013 was 0.005.

Table 6.31. Total number of Nason hatchery spring Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2013-2016. Standard errors are shown in parentheses. NA = not available (i.e., not all the adults from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2013	20,139 (WxW)	0.346 (0.030)	38.1 (5.9)	0.005 (0.000)
2014	5,007 (WxW)	0.572 (0.038)	20.6 (5.3)	NA
2015	5,050 (HxH)	0.482 (0.052)	27.3 (6.8)	NA
	5,047 (WxW)	0.515 (0.055)	27.3 (7.0)	NA
2016	5,050 (HxH)	0.454 (0.064)	24.1 (6.6)	NA
	5,044 (WxW)	0.490 (0.078)	24.7 (6.8)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood-year harvest rates from the Chiwawa Hatchery program. For brood years 1989-2012, NRR for spring Chinook in Nason Creek averaged 0.79 (range, 0.05-5.48) if harvested fish were not included in the estimate and 0.88 (range, 0.05-5.86) if harvested fish were included in the estimate (Table 6.32). The last brood year that exceeded replacement was in 2000 (Table 6.32). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and will be calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.7 (the calculated target value in Hillman et al. 2017). The target value of 6.7 includes harvest and was based on HRRs for Chiwawa spring Chinook salmon. HRRs will be calculated beginning in 2019 with the complete return of 2013 brood fish.

[28] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Table 6.32. Spawning escapements, natural-origin recruits (NOR), and natural replacement rates (NRR; with and without harvest) for spring Chinook in the Nason Creek watershed, brood years 1989-2012.

Brood year	Spawning Escapement	Harvest not included		Harvest included	
		NOR	NRR	NOR	NRR
1989	222	171	0.77	249	1.12
1990	231	15	0.06	18	0.08
1991	156	21	0.13	23	0.15
1992	181	47	0.26	49	0.27
1993	491	133	0.27	137	0.28
1994	60	3	0.05	3	0.05
1995	18	22	1.22	23	1.28
1996	83	229	2.76	250	3.01
1997	122	306	2.51	339	2.78
1998	64	351	5.48	375	5.86
1999	22	14	0.64	15	0.68
2000	270	337	1.25	354	1.31
2001	598	77	0.13	79	0.13
2002	603	123	0.20	128	0.21
2003	202	63	0.31	67	0.33
2004	507	131	0.26	141	0.28
2005	347	155	0.45	160	0.46
2006	271	118	0.44	148	0.55
2007	463	210	0.45	251	0.54
2008	565	244	0.43	274	0.48
2009	534	71	0.13	77	0.14
2010	410	113	0.28	140	0.34
2011	702	195	0.28	261	0.37
2012	694	184	0.27	211	0.30
Average	***326***	***139***	***0.79***	***157***	***0.88***
Median	***271***	***127***	***0.30***	***141***	***0.36***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns, which were adjusted for tag loss before the fish were released. For the available brood year, SAR was 0.00269 for hatchery spring Chinook (Table 6.33).

Table 6.33. Smolt-to-adult ratios (SARs) for Nason Creek hatchery spring Chinook, brood year 2013.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
2013	40,079	108	0.00269
Average	***40,079***	***108***	***0.00269***
Median	***40,079***	***108***	***0.00269***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

6.8 ESA/HCP Compliance

Broodstock Collection

Collection of brood year 2016 broodstock for Nason Creek spring Chinook targeted a combination of 70 natural-origin adults and 72 hatchery-origin adults intercepted at Tumwater Dam. Total broodstock achieved for the 2016 brood Nason Creek spring Chinook program was 71 and 70 natural and hatchery-origin adults, respectively. A total of 77 bull trout were handled and/or observed during broodstock collection at Tumwater Dam in 2016.

Hatchery Rearing and Release

The 2016 brood Nason Creek spring Chinook reared throughout all life stages without significant mortality (defined as >10% population mortality associated with a single event). A total of 130,095 WxW and 103,376 HxH smolts were released (104.1% of the conservation program goal and 104.4% of the aggregate Nason program goal).

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or at the Nason Creek Acclimation Facility during the period 1 January through 31 December 2018. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1196, 18118, 18120, and 18121 the permit holders are authorized a direct take of 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2003). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2018 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 6.29. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 18118, 18120, and

18121, Section B. Table 6.24 includes incidental and direct take associated with the Nason Creek smolt trap operated by the Yakama Nation under separate permits.

Table 6.29. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2018.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	31,300	158,189	43,133	3,539	9,750	7,948	21,237	
Encounter rate	NA	NA	NA	0.1131	0.0616	0.1843	0.0957	0.20
Mortality[e]	NA	NA	NA	8	37	20	65	
Mortality rate	NA	NA	NA	0.0023	0.0038	0.0025	0.0031	0.02
White River Trap								
Population	11,170	NA	1,679	234	NA	131	365	
Encounter rate	NA	NA	NA	0.0209	NA	0.0780	0.0284	0.20
Mortality[d]	NA	NA	NA	0	NA	0	0	
Mortality rate	NA	NA	NA	0.0000	NA	0.0000	0.0000	0.02
Nason Creek Trap								
Population	5,082	233,471	17,066	301	367	1,651	2,319	
Encounter rate	NA	NA	NA	0.0592	0.0016	0.0967	0.0091	0.20
Mortality[d]	NA	NA	NA	5	0	8	13	
Mortality rate	NA	NA	NA	0.0166	0.0000	0.0048	0.0056	0.02
Lower Wenatchee Trap								
Population	99,045	391,660	5,823,795	1,418	51,069	47,283	99,770	
Encounter rate	NA	NA	NA	0.0143	0.1304	0.0081	0.0162	0.20
Mortality[d]	NA	NA	NA	7	7	347	361	
Mortality rate	NA	NA	NA	0.0049	0.0001	0.0073	0.0036	0.02
Wenatchee River Basin Total								
Population	146,597	391,660	5,885,673	5,492	61,186	57,013	123,691	
Encounter rate	NA	NA	NA	0.0375	0.1562	0.0097	0.0193	0.20
Mortality[d]	NA	NA	NA	20	44	375	439	
Mortality rate	NA	NA	NA	0.0036	0.0007	0.0066	0.0035	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2015 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Precocity Monitoring

For the purpose of addressing permit requirements, we used the PIT Tag Information System (PTAGIS) to identify probable hatchery-origin mini-jack spring Chinook from Nason Creek from 2015 through 2018. The query results returned fish that were last detected after 1 July of the year in which they were released. Fish that remained in freshwater during this time period were likely precocious males. We looked for detections in three regions: lower Columbia River mainstem dams (Bonneville, The Dalles, and McNary dams), mid-Columbia mainstem dams (Priest Rapids and Rock Island dams), and within the Wenatchee River basin. The occurrence of mini-jacks was rare, ranging from less than 0.04% to 0.27% of the tagged population (Table 6.30).

Table 6.30. Numbers of Nason Creek hatchery spring Chinook with final PIT-tag detections after 1 July of the release year. These fish are likely mini-jacks. Lower Columbia River detections occurred at Bonneville, The Dalles, and McNary dams, while Mid-Columbia River detections occurred at Priest Rapids and Rock Island dams.

Year	Number of PIT tags released	Number of tags detected in Lower Columbia River	Number of tags detected in Mid-Columbia River	Number of tags detected within the Wenatchee River basin	Percent of tagged population
2015	20,139	6	0	49	0.27
2016	5,017	4	0	0	0.08
2017	10,098	3	0	1	0.04
2018	10,094	6	1	2	0.09

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2018, as authorized by ESA Section 10 Permit Numbers 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permit Numbers 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2018, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin and natural-origin Chinook retained for broodstock) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2018) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2018.

Bull Trout

Bull trout encounters associated with implementation of hatchery production and monitoring and evaluation activities for Chinook and steelhead programs in the Wenatchee sub-basin are required to be reported as outlined in Biological Opinion 01EWF00-2013-0444. The 2018 report for bull trout encounters was compiled under provisions of ESA Section 10 Permit 18118, 18120, 18121, and 18583. Data and reporting information are included in Appendix I.

SECTION 7: WHITE RIVER SPRING CHINOOK

The White River spring Chinook salmon captive brood program began in 1997 with goals to conserve, aid in the recovery, and prevent the extinction of naturally spawning spring Chinook in the White River, and to meet the mitigation responsibilities of Grant County PUD. Collection of eggs or juveniles from the White River (brood years 1997-2009) made up the first-generation (F_1) component of the White River captive brood program. Initially, rearing occurred at AquaSeed in Rochester, Washington, but transitioned to the Little White Salmon National Fish Hatchery near Cook, Washington, in 2006. The F_1 component was reared to maturation and spawned within the hatchery. The resulting progeny (F_2) were then reared in the hatchery until final acclimation and released in the upper Wenatchee Basin. The first large release of F_2 juveniles was in 2008. The last release of juveniles from the captive brood program occurred in 2015 (brood year 2013).

The production goal for the White River captive brood program following the 2013 hatchery recalculation was to release 74,556 yearling smolts into the upper Wenatchee River basin at 18-24 fish per pound. Fish lengths and weights for the recent broods were manipulated to evaluate different approaches for reducing precocious maturation. All fish were marked with CWTs. In addition, from 2008 through 2015, a portion of juvenile spring Chinook were PIT tagged annually.

Since its inception, the captive brood program underwent several adaptive changes designed to improve program success. These changes included: (1) use of a pedigree approach to reduce the use of stray fish in the broodstock, (2) transfer of fish from Aquaseed to the Little White Salmon National Fish Hatchery to improve fish quality, (3) injection of hormones into F_1 females to improve maturation of eggs, (4) manipulation of diet and ration for the F_2 fish to reduce precocious maturation of males, (5) use of temporary tanks and natural enclosures during acclimation to improve homing, and (6) trucking juvenile fish around Lake Wenatchee to improve survival.

The following information focuses on results from monitoring the White River spring Chinook program. More detailed information on the White River program can be found in Lauver et al. (2012).

7.1 Captive Brood Collection

The captive brood program was designed to provide a rapid, short-term demographic boost to the White River spring Chinook spawning aggregate, which was at a high risk of local extinction (Lauver et al. 2012). This section describes the collection of broodstock for the White River program.

Brood Collection and Rearing

A primary objective of the White River program was to collect progeny of naturally spawning spring Chinook in the White River. The progeny (eggs or juveniles) make up the first-generation (F_1) of the captive brood program. However, strays from the Chiwawa supplementation program made this a challenge. As a result, researchers attempted to identify the origin of spawners on redds in the White River and then focused egg and juvenile collection efforts on those redds that had the highest likelihood of being produced from White River parents. During most years, this limited the number of redds from which eggs or juveniles could be collected. Starting with brood year

2006, a pedigree approach was adopted to improve the likelihood that eggs or juveniles used in the captive brood program were of White River origin.

During 1997 to 2009, first-generation broodstock for the captive brood program originated from about 10,353 natural-origin eggs and juveniles collected from 122 redds in the White River. Broodstock from brood year 1997 were trapped as parr with nets in the fall of 1998. Broodstock from brood year 2006 were trapped as fry with nets in the spring of 2007. It was assumed that the parr and fry near known redds were produced from those redds, and origin was confirmed with pedigree analyses. All other brood years were collected as eggs in the fall using redd pumping techniques. Broodstock collection levels were calculated based on the following assumptions and the known number of suitable redds each year (Tonseth and Maitland 2011):

1. 150,000 smolt target/0.70 (green egg to release survival) = 214,000 green eggs
2. 214,000 green eggs/1,500 eggs per female = 143 females/0.50 (sex ratio) = 286 fish
3. 286 fish/0.30 (eyed egg to maturity survival) = 953 eyed eggs
4. 953 eyed eggs/***X*** redds = ***Y*** eyed-eggs per redd

Eyed eggs or juveniles collected in the White River were transported to Aquaseed (brood years 1997-2007) or to the Little White Salmon Hatchery (brood years 2008-2009) and reared to adults. Table 7.1 summarizes the collection of eyed eggs or juveniles for the captive brood program.

Table 7.1. Numbers of eyed eggs or juvenile brood stock collected for the White River captive brood program, brood years 1997-2009 (2009 was the last year for broodstock collection). Also shown are the number of redds that were sampled for eggs or juveniles and the hatchery in which the fish were reared (LWSFH = Little White Salmon Fish Hatchery); NS = no sample.

Brood year	Number of eyed eggs collected	Number of juvenile Chinook collected	Number of redds sampled	Rearing facility
1997	0	527 (parr)	8	Aquaseed
1998	182	0	4	Aquaseed
1999	NS	NS	NS	--
2000	272	0	NS	Aquaseed
2001	NS	NS	NS	--
2002	167	0	3	Aquaseed
2003	250	0	8	Aquaseed
2004	1,216	0	10	Aquaseed
2005	2,733	0	21	Aquaseed/LWSFH[1]
2006	0	1,487 (fry)	29	Aquaseed/ LWSFH[2]
2007	1,153	0	13	Aquaseed/ LWSFH[3]
2008	933	0	11	LWSFH
2009	1,433	0	15	LWSFH
Average	***927***	***1,007***	***12***	

[1] Fish were transferred on 30 June and 2 July 2008 and 20 January 2009.
[2] Fish were transferred on 21 October and 13 November 2008.
[3] Fish were transferred on 26 September and 21 October 2008.

7.2 Hatchery Spawning and Release

Captive Brood Spawning

As noted above, eyed eggs or juveniles collected in the White River were transported to Aquaseed (for brood years 1997-2007) or to the Little White Salmon Hatchery (for brood years 2008-2009) and reared to adults (Lauver et al. 2012). After rearing broodstock to maturity in captivity, adult spring Chinook were spawned and their progeny were grown to smolt size, acclimated to White River water, and ultimately released into the White River, Lake Wenatchee, or trucked and released in the Wenatchee River downstream from Lake Wenatchee.

During spawning, eggs and sperm were collected and those gametes were crossed based on a 2x2 factorial spawning matrix. That is, each female was spawned with two males and each male was spawned with two females. Using pedigree analysis, spawning crosses were arranged to maximize genetic diversity. Because incomplete maturation of ova was an issue in the program, implementation of hormone treatments began in 2011 to facilitate maturation. In addition, following spawning, milt from excess males was collected for cryopreservation. Based on a pilot study, the cryopreserved milt was relatively ineffective at fertilizing eggs, so it was not used widely in the program. There are no plans to use the cryopreserved milt in the future. It is noteworthy that most of the males used in spawning were mini-jacks and there were many females that matured at age 3. Table 7.2 shows the ages of first-generation males and females spawned for the captive brood program.

Table 7.2. Total ages of first-generation (F_1) male and female spring Chinook spawned for the White River captive brood program, spawning years 2001-2011; NA = not available.

Spawning year	Sex	Total age				Total
		2	3	4	5	
2001	Female	0	0	3	0	3
	Male	0	2	0	0	2
2002	Female	0	0	4	4	8
	Male	10	0	0	0	10
2003	Female	0	5	0	0	5
	Male	0	2	0	0	2
2004	Female	0	0	2	0	2
	Male	4	0	0	0	4
2005	Female	0	85*	0	0	85
	Male	90	1	0	0	91
2006	Female	2	104	110	0	216
	Male	104	6	0	0	110
2007	Female	0	21	118	1	140
	Male	113	7	0	0	120
2008	Female	0	58	0	0	58
	Male	NA	NA	NA	NA	NA

Spawning year	Sex	Total age				Total
		2	3	4	5	
2009	Female	0	0	119	0	119
	Male	65	54	0	0	119
2010	Female	0	0	42	0	42
	Male	22	23	0	0	45
2011	Female	0	0	0	150	150
	Male	0	148	2	0	150
Average	***Female***	***0***	***25***	***36***	***14***	***75***
	Male	***41***	***24***	***0***	***0***	***65***
Median	***Female***	***0***	***0***	***3***	***0***	***58***
	Male	***16***	***4***	***0***	***0***	***68***

* Included some unknown number of second-generation females.

Release Information

Numbers released

Several different acclimation and release scenarios were conducted since 1997. Acclimation scenarios have involved naturalized features such as in-channel enclosures, stream-side tanks supplied with pass-through surface water, and net pens in Lake Wenatchee near the mouth of the White River. Release scenarios have included on-site releases from tanks, in-channel enclosures, and net pens in Lake Wenatchee. The low survival of fish released in the lake and White River prompted exploring the release of fish near the mouth of the lake and downstream from the lake. In 2010, acclimated fish were towed in net pens to the mouth of the lake and released there. In 2011, tank and net-pen acclimated fish were loaded into transport trucks and released into the Wenatchee River. In addition, subyearling and yearling Chinook with no acclimation have been released from transport trucks directly into Lake Wenatchee and the White River. A total of 944,591 second-generation (F_2) juvenile spring Chinook have been released from the captive brood program. Table 7.3 summarizes the acclimation and release history of F_2 spring Chinook released into the upper Wenatchee River basin.

Table 7.3. Numbers of White River juvenile spring Chinook released and their acclimation histories for brood years 2002-2013.

Brood year	Acclimation site	Acclimation vessel	Number of smolts released	Release scenario	Release date	Number of acclimation days
2002	WR RM 11.5	Tanks	2,589	White River	4/22/2004	17
2003	WR RM 11.5	Tanks	2,096	White River	5/2/2005	47
2004	WR RM 11.5	Tanks	1,639	White River	4/4/2006	0
2005	Lake Wen	Net Pens	69,032	Lake Wen	5/2/2007	34
2006	NA	NA	139,644*	White River	4/17, 4/25/2007	0
	NA	NA	142,033	White River	3/18, 3/20/2008	0
2007	Lake Wen	Net Pens	87,671	Lake Wen	5/5/2009	35-40

Brood year	Acclimation site	Acclimation vessel	Number of smolts released	Release scenario	Release date	Number of acclimation days
	None	None	44,172	Lake Wen	4/1/2009	0
2008	WR Bridge	Eddy Pen	10,156	Escape	~4/12/2010	~10
	Lake Wen	Net Pens	38,400	Mouth of lake	5/5, 5/6/2010	38-41
2009	WR RM 11.5	Side Channel	12,000	Escape	~3/31/2011	~7
	WR RM 11.5	Tanks	10,000	White River	5/12/2011	49
	WR Bridge	Tanks	28,000	White River	5/14/2011	51
	WR Bridge	Tanks		Wen River	5/13/2011	50
	WR Bridge	Eddy Pen	14,596	Escape	~3/27/2011	~3
	Lake Wen	Net Pens	48,000	Wen River	5/14/2011	46
	Lake Wen	Net Pens		Wen River	5/14/2011	44
2010	WR Bridge	Tanks	18,850	Wen River	5/9/2012	44
2011	WR Bridge	Tanks	42,000	Wen & White R	5/6, 5/7, 5/8/13	49, 50, 51
	Lake Wen	Net Pens	105,000	Wen River	5/8, 5/13, 5/14/13	51, 56, 57
2012	WR Bridge	Tanks	42,000	Wen River	5/6/14	50
	Lake Wen	Net Pens	55,713	Wen River	5/8/14	49
2013	WR Bridge	Tanks	31,000	Wen River	5/4/15	56

* Subyearling release.

Numbers tagged

Brood years 2005 and 2007-2013 spring Chinook were tagged with a CWT in their peduncle. None of these fish were adipose fin clipped.[29] Subyearling fish from the 2006 brood year were tagged with half of a CWT in their snouts. Yearling fish from the 2006 brood year were tagged with CWTs in the peduncle. None of these fish were adipose fin clipped. In addition, beginning in 2008 (brood year 2006), 258,375 juvenile spring Chinook were PIT tagged before release. Table 7.4 identifies the number of second-generation (F_2) juvenile spring Chinook tagged with PIT tags.

Table 7.4. Numbers of second-generation (F2) White River spring Chinook smolts tagged and released in the upper Wenatchee River basin, brood years 2002-2013.

Brood year	Acclimation site	Acclimation vessel	Release scenario	CWT mark rate	Number released that were PIT tagged	Number of smolts released
2002	WR RM 11.5	Tanks	White River	0.00	0	2,589
2003	WR RM 11.5	Tanks	White River	0.00	0	2,096
2004	WR RM 11.5	Tanks	White River	0.00	0	1,639

[29] Given that juvenile spring Chinook were tagged with CWTs in the peduncle and were not ad-clipped, it is possible that field crews missed hatchery-origin adults on the spawning grounds because they did not know they were supposed to sample fish with adipose fins. Thus, this bias in carcass sampling may bias derived metrics such as spawning distribution of hatchery and natural-origin fish, spawn timing of hatchery and natural-origin fish, age at maturity, size at maturity, contributions to fisheries, HOR, NOR, HRR, NRR, PNI, straying, and SARs.

Brood year	Acclimation site	Acclimation vessel	Release scenario	CWT mark rate	Number released that were PIT tagged	Number of smolts released
2005	Lake Wen	Net Pens	Lake Wen	1.00	0	69,032
2006	NA	NA	White River	0.00	29,881	139,644*
	NA	NA	White River	0.00		142,033
2007	Lake Wen	Net Pens	Lake Wen	1.00	29,863	87,671
	None	None	Lake Wen	1.00	9,957	44,172
2008	WR Bridge	Eddy Pen	Escape	1.00	38,148	10,156
	Lake Wen	Net Pens	Lake Mouth	1.00		38,400
2009	WR RM 11.5	Side Channel	Escape	1.00	41,886	12,000
	WR RM 11.5	Tanks	White River	1.00		10,000
	WR Bridge	Tanks	White River	1.00		28,000
	WR Bridge	Tanks	Wen River	1.00		
	WR Bridge	Eddy Pen	Escape	1.00		14,596
	Lake Wen	Net Pens	Wen River	1.00		48,000
	Lake Wen	Net Pens	Wen River	1.00		
2010	WR Bridge	Tanks	Wen River	1.00	12,283	18,850
2011	WR Bridge	Tanks	Wen & White	1.00	2,490	42,000
	Lake Wen	Net Pens	Wen River	1.00	51,697	105,000
2012	WR Bridge	Tanks	Wen River	1.00	52,097	42,000
	Lake Wen	Net Pens	Wen River	1.00		55,713
2013	WR Bridge	Tanks	Wen River	1.00	19,954	31,000

* Subyearling release.

Fish size and condition at release

Table 7.5 summarizes the size and condition of second-generation White River juvenile spring Chinook released in the upper Wenatchee River basin.

Table 7.5. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of second-generation White River (WR) juvenile spring Chinook released in the upper Wenatchee River basin, brood years 2002-2013. Size targets are provided in the last row of the table. NA = not available.

Brood year	Acclimation site	Release scenario	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2002	WR RM 11.5	White River	NA	NA	NA	NA
2003	WR RM 11.5	White River	166	12.4	53.7	8
2004	WR RM 11.5	White River	207	11.6	117.7	4
2005	Lake Wen	Lake Wen	145	9.7	36.9	31
2006	NA	White River	NA	NA	NA	NA
	NA	White River	NA	NA	NA	NA

Brood year	Acclimation site	Release scenario	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2007	Lake Wen	Lake Wen	135	7.8	29.2	29
	None	Lake Wen	NA	NA	NA	NA
2008	WR Bridge	Escape	--	--	--	--
	Lake Wen	Mouth of lake	138	10.0	32.5	14
2009	WR RM 11.5	Escape	--	--	--	--
	WR RM 11.5	White River	134	8.7	29.3	16
	WR Bridge	White River	138	9.3	28.6	16
	WR Bridge	Wen River	NA	NA	NA	NA
	WR Bridge	Escape	--	--	--	--
	Lake Wen	Wen River	140	8.9	31.6	14
	Lake Wen	Wen River	142	9.8	39.3	12
2010	WR Bridge	Wen River	125	8.0	22.8	20
2011	WR Bridge	Wen & White	130	8.4	24.1	19
	Lake Wen	Wen River	128	8.2	24.0	19
2012	WR Bridge	Wen River	131	8.1	24.2	18.8
	Lake Wen	Wen River	NA	NA	NA	NA
2013	WR Bridge	Wen River	132	8.7	24.5	19
Average			142	9.3	37.0	17

Post-Release Survival

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of released second-generation (F_2) White River spring Chinook smolts to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam.[30] Based on the available data, post-release survival has been low for fish released into the White River and Lake Wenatchee (Table 7.6). In contrast, survival of fish released in the Wenatchee River tends to be higher than those released in the White River or in Lake Wenatchee. These results suggest that high mortality in Lake Wenatchee may explain why adult returns of program fish have been consistently poor; however, other factors such as high precocious maturation may also contribute to the estimated low survival (e.g., see Ford et al. 2015).

Average travel time from release to McNary Dam ranged from 21 to 82 days (Table 7.6). Spring Chinook released in the Wenatchee River typically traveled faster to McNary Dam than those released in the White River or in Lake Wenatchee. Because of uncertain release times for several groups, we were unable to estimate travel times for all release groups.

[30] It is important to point out that because of fish size differences among rearing net pens, tanks, or raceways, fish PIT tagged in one pen, tank, or raceway may not represent untagged fish rearing in other pens, tanks, or raceways.

Table 7.6. Survival and travel times (mean days) of second-generation (F2) White River spring Chinook smolts to McNary Dam and SARs to Bonneville Dam for different release scenarios, brood years 2006-2013. Values in parentheses represent the standard error of the estimate. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Release scenario	Number of Chinook released with PIT tags	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2006	White River	29,881	0.037 (0.008)	82.3 (16.1)	0.000 (0.000)
2007	Lake Wen Pens	29,863	0.096 (0.010)	NA	0.000 (--)
	Lake Wenatchee	9,957	0.080 (0.015)	NA	0.000 (--)
2008	Lake Wenatchee	38,146	0.065 (0.010)	65.2 (14.0)	0.001 (0.000)
2009	White and Wenatchee rivers	19,913	0.269 (0.027)	22.9 (9.2)	0.002 (0.000)
	White River	21,829	0.055 (0.013)	45.6 (21.0)	0.000 (0.000)
2010	Wenatchee River	12,283	0.267 (0.017)	NA	0.001 (0.000)
2011	Wenatchee River	2,490	0.385 (0.042)	21.7 (6.2)	0.004 (0.001)
	White and Wenatchee rivers	51,697	0.433 (0.010)	23.4 (12.7)	0.003 (0.000)
2012	Wenatchee River	52,113	0.353 (0.013)	20.9 (6.9)	0.001 (0.000)
2013	Wenatchee River	19,954	0.328 (0.026)	20.6 (5.7)	0.000 (0.000)

7.3 Disease Monitoring

First-Generation Health Maintenance

First-generation (F_1) adults were fed an azithromycin-medicated feed in the spring to prevent bacterial kidney disease (BKD), which is a common affliction of spring Chinook salmon. As needed, fish received a dose of 20 mg/kg of body weight. The fish also received formalin treatments as needed throughout the year to prevent and treat fungus infections. This was especially important during the pre-spawning period when individual fish were maturing in preparation for spawning. Formalin treatments were conducted three times per week and consist of one hour of flow-through at a concentration of 167 parts per million (ppm).

Second-Generation Health Maintenance

Following fertilization and initial incubation in September, second-generation (F_2) eggs were shocked in October. Eggs were treated with a 1,667 ppm formalin solution in a 15-minute flow-through treatment three times a week to prevent fungus growth. Formalin treatments ended after hatching, and water flow was increased from three to five gallons per minute. Dead and deformed fry were removed before relocating the fry to nursery tanks in late January or early February. Fry were then relocated to raceways in July, where they remained until transfer to the White River for acclimation the following March. Coded-wire tagging was typically conducted in July, and PIT tagging occurred the following January or February, just before the fish were transferred to acclimation facilities on the White River in March.

7.4 Natural Juvenile Productivity

Juvenile productivity estimation began with the monitoring of emigration of spring Chinook in the White River in 2007 (Lauver et al. 2012). A five-foot diameter rotary screw trap is operated annually from about 1 March through November. A second screw trap was installed in 2017 to increase catch and improve capture efficiency estimates. The purpose of the program is to estimate the number and timing of subyearlings and yearling spring Chinook emigrating from the White River basin.

Smolt and Emigrant Estimates

In 2018, the White River Trap operated between 1 March and 30 November 2018. During that period, the trap was intentionally pulled for two days during periods of high discharge. Daily trap efficiencies were estimated by conducting mark-recapture trials. The daily number of fish captured was expanded by the estimated trap efficiency to estimate daily total emigration. If trap efficiencies could not be assessed because of low numbers of juvenile Chinook trapped, a composite model based on efficiency trials from previous years was used to calculate abundance. Daily captures of fish and results of mark-recapture efficiency tests at the White River trap are reported in Appendix O.

Wild yearling spring Chinook (2016 brood year) were captured primarily from March through April 2018 (Figure 7.1). Based on a composite regression model, the total number of wild yearling Chinook emigrating from the White River was 11,070 (±13,710). Combining the total number of subyearling spring Chinook (2,430 ±1,373) that emigrated during the fall of 2017 with the total number of yearling Chinook (11,070) that emigrated during 2018 resulted in a total emigrant estimate of 16,201 (±13,779) spring Chinook for the 2016 brood year (Table 7.7).

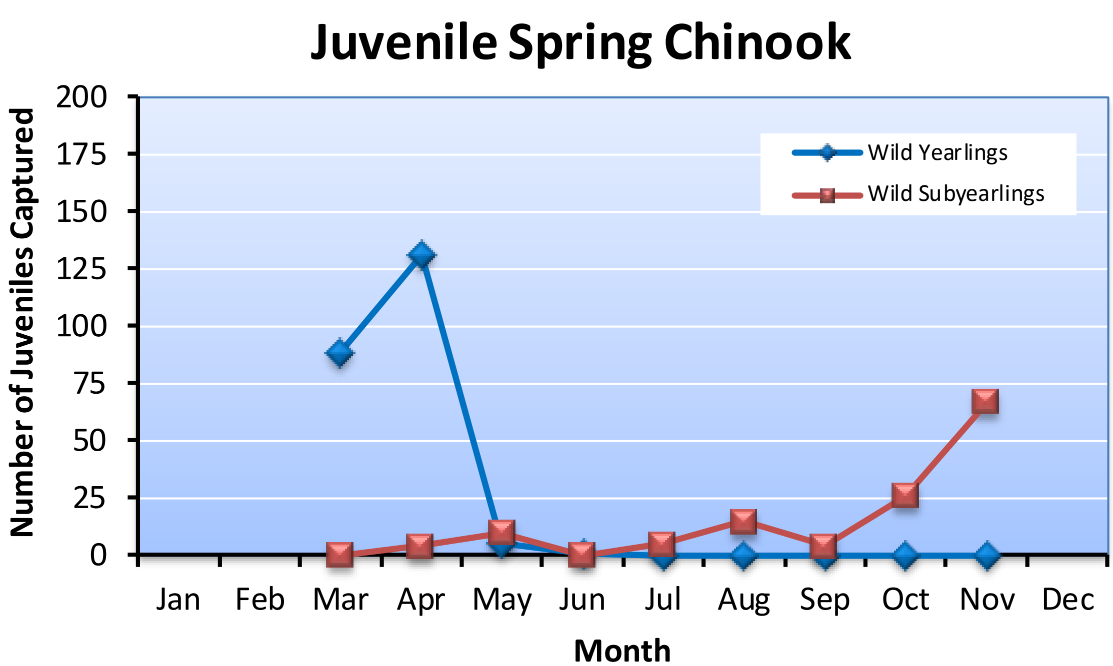


Figure 7.1. Monthly captures of wild subyearling (parr) and yearling spring Chinook at the White River Trap, 2018.

Table 7.7. Numbers of redds and juvenile spring Chinook at different life stages in the White River basin for brood years 2005-2017; ND = no data.

Brood year	Number of redds	Egg deposition[a]	Number of subyearling emigrants[b]	Number of smolts produced within White River basin	Number of emigrants
2005	86	372,122	ND	4,856	ND
2006	31	134,044	652	2,004	2,656
2007	20	88,820	2,309	3,395	5,704
2008	31	142,352	5,560	5,193	10,753
2009	54	246,942	2,428	2,939	5,367
2010	33	142,362	1,859	4,103	5,962
2011	20	87,700	3,128	1,659	4,787
2012	86	363,178	3,816	3,995	7,811
2013	54	254,664	2,461	3,023	5,484
2014	26	105,170	1,950	386	2,336
2015	70	339,290	2,430	2,942	5,372
2016	44	196,548	4,851	11,170	16,021
2017	15	69,225	1,679	--	--
Average[c]	***44***	***195,571***	***2,969***	***5,252***	***8,339***
Median[c]	***33***	***142,361***	***2,584***	***4,919***	***8,244***

[a] Egg deposition is calculated as the number of redds times the fecundity of both wild and hatchery spring Chinook salmon (from Table 5.5.
[b] Subyearling emigrants do not include fry that left the watershed before 1 July.
[c] Average and median are based on the entire time series of data, not just the period 2006 through 2012.

Wild subyearling spring Chinook (2017 brood year) were captured between 3 August and 30 November 2018, with peak catch during November (Figure 7.1). Based on a composite regression model, the total number of wild subyearling Chinook emigrating from the White River was 1,697 (±546).

Yearling spring Chinook sampled in 2018 averaged 98 mm in length, 10.6 g in weight, and had a mean condition of 1.11 (Table 7.8). The average length and weight were less than the overall means of yearling spring Chinook sampled in previous years, while condition factor was higher (overall means, 100 mm, 11.2 g, and 1.10). Subyearling spring Chinook parr sampled in 2018 at the White River Trap averaged 95 mm in length, averaged 9.3 g, and had a mean condition of 1.08 (Table 7.8). Estimated length, weight, and condition were all greater than the overall means of subyearling spring Chinook sampled in previous years (overall means, 90 mm, 8.4 g, and 1.10).

Table 7.8. Mean fork length (mm), weight (g), and condition factor of subyearling (parr) and yearling spring Chinook collected in the White River Trap, 2007-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2007	Subyearling	33	95 (12)	9.8 (4.1)	1.07 (0.11)
	Yearling	173	93 (9)	8.6 (2.2)	1.03 (0.09)
2008	Subyearling	202	95 (9)	9.4 (2.5)	1.08 (0.13)
	Yearling	105	100 (12)	11.3 (3.3)	1.07 (0.13)
2009	Subyearling	499	85 (11)	7.1 (2.6)	1.09 (0.11)
	Yearling	274	104 (6)	12.5 (2.6)	1.11 (0.10)
2010	Subyearling	168	87 (13)	7.8 (3.1)	1.12 (0.11)
	Yearling	346	100 (7)	11.2 (2.4)	1.12 (0.09)
2011	Subyearling	145	94 (9)	9.3 (2.5)	1.10 (0.10)
	Yearling	64	99 (8)	11.3 (2.8)	1.14 (0.09)
2012	Subyearling	285	91 (10)	8.9 (2.7)	1.13 (0.09)
	Yearling	179	98 (8)	10.9 (2.8)	1.14 (0.08)
2013	Subyearling	444	84 (12)	6.6 (2.5)	1.05 (0.09)
	Yearling	20	102 (7)	12.3 (3.0)	1.12 (0.14)
2014	Subyearling	185	86 (14)	7.5 (3.3)	1.10 (0.11)
	Yearling	43	94 (7)	9.4 (2.2)	1.11 (0.13)
2015	Subyearling	148	96 (8)	9.9 (2.3)	1.11 (0.07)
	Yearling	31	104 (7)	13.0 (2.8)	1.14 (0.07)
2016	Subyearling	147	89 (11)	8.3 (2.8)	1.13 (0.10)
	Yearling	3	106 (2)	12.4 (0.3)	1.05 (0.03)
2017	Subyearling	516	85 (10)	7.1 (2.3)	1.09 (0.02)
	Yearling	36	99 (6)	10.7 (2.3)	1.11 (0.08)
2018	Subyearling	94	95 (8)	9.3 (2.3)	1.08 (0.07)
	Yearling	114	98 (7)	10.6 (2.2)	1.11 (0.08)
Average	***Subyearling***	***239***	***90 (5)***	***8.4 (1.2)***	***1.10 (0.02)***
	Yearling	***116***	***100 (4)***	***11.2 (1.3)***	***1.10 (0.04)***
Median	***Subyearling***	***117***	***90 (5)***	***8.6 (1.2)***	***1.10 (0.2)***
	Yearling	***85***	***100 (4)***	***11.3 (1.3)***	***1.11 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 17,950 wild juvenile Chinook (12,858 subyearling and 5,092 yearlings) were PIT tagged and released in 2018 in the Wenatchee River basin (Table 7.9). A total of 326 juvenile Chinook were PIT tagged in the White River in 2018. See Appendix D for a complete list of all fish captured, tagged, lost, and released.

Table 7.9. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2018. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	7,948	285	5,692	20	6	5,686	0.25
	Yearling	3,539	57	3,448	8	1	3,447	0.22
	Total	**11,487**	**342**	**9,140**	**28**	**7**	**9,133**	**0.24**
Chiwawa River (Electrofishing)	Subyearling	3,800	39	3,737	15	0	3,737	0.39
	Yearling	0	0	0	0	0	0	0
	Total	**3,800**	**39**	**3,737**	**15**	**0**	**3,737**	**0.39**
Nason Creek Trap	Subyearling	1,651	51	686	8	0	686	0.48
	Yearling	301	13	296	5	0	296	1.66
	Total	**1,952**	**64**	**982**	**13**	**0**	**982**	**0.67**
Nason Creek (Electrofishing)	Subyearling	2,648	88	2,524	17	0	2,524	0.64
	Yearling	0	0	0	0	0	0	0
	Total	**2,648**	**88**	**2,524**	**17**	**0**	**2,524**	**0.64**
White River Trap	Subyearling	131	0	220	0	0	220	0
	Yearling	225	2	106	0	0	106	0
	Total	**356**	**2**	**326**	**0**	**0**	**326**	**0.00**
Lower Wenatchee Trap	Subyearling	47,283	54	5	347	0	5	0.73
	Yearling	1,418	1	1,243	7	0	1,243	0.49
	Total	**48,701**	**55**	**1,248**	**354**	**0**	**1,248**	**0.73**
Total:	**Subyearling**	**63,461**	**517**	**12,864**	**407**	**6**	**12,858**	**0.64**
	Yearling	**5,483**	**73**	**5,093**	**20**	**1**	**5,092**	**0.36**
Grand Total:		**68,944**	**590**	**17,957**	**427**	**7**	**17,950**	**0.62**

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2007-2018 are shown in Table 7.10.

Table 7.10. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2007-2018.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Chiwawa Trap	Subyearling	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241	5,686
	Yearling	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711	3,447
	Total	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**	**9,133**
Chiwawa River (Angling or Electro-fishing)	Subyearling	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703	3,737
	Yearling	0	0	3	4	0	0	0	0	0	0	0	0
	Total	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**	**3,737**
	Subyearling	15	0	37	3	1	1	0	--	--	--	--	--

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Upper Wenatchee Trap	Yearling	1,434	159	296	486	714	75	94	--	--	--	--	--
	Total	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877	686
	Yearling	577	894	185	364	147	357	237	456	142	61	346	296
	Total	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**	**982**
Nason Creek (Angling or Electro-fishing)	Subyearling	6	4	701	595	0	0	0	1,816	1,089	802	3,240	2,524
	Yearling	7	0	13	3	0	0	0	0	0	0	0	0
	Total	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**	**2,524**
White River Trap	Subyearling	0	0	441	143	144	285	374	156	149	136	507	220
	Yearling	0	0	265	359	65	180	22	49	34	3	41	106
	Total	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**	**326**
Upper Wenatchee (Angling or Electro-fishing)	Subyearling	61	1	0	2	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electro-fishing)	Subyearling	0	65	284	233	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electro-fishing)	Subyearling	0	0	0	1	--	--	--	--	--	--	--	--
	Yearling	0	0	0	0	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	2	0	0	0	0	0	36	0	18	0	5
	Yearling	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220	1,243
	Total	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**	**1,248**
Total:	**Subyearling**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**	**12,858**
	Yearling	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**	**5,092**
Grand Total:		***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***	***17,950***

Freshwater Productivity

Productivity and survival estimates for different life stages of spring Chinook in the White River basin are provided in Table 7.11. Estimates for brood year 2016 were greater than productivity and survival estimates for brood years 2005-2015. Freshwater productivities ranged from 15-254 smolts/redd and 77-364 emigrants/redd. Survivals during the same period ranged from 0.4-5.7% for egg-smolt and 1.6-8.2% for egg-emigrants.

Table 7.11. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the White River basin for brood years 2005-2016. These estimates were derived from data in Table 7.7. ND = no data.

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2005	56	ND	1.3	ND
2006	65	85	1.5	2.0
2007	170	285	3.8	6.4
2008	168	347	3.6	7.6
2009	54	99	1.2	2.2
2010	124	181	2.9	4.2
2011	83	239	1.9	5.5
2012	46	91	1.1	2.2
2013	56	102	1.2	2.2
2014	15	90	0.4	2.2
2015	42	77	0.9	1.6
2016	254	364	5.7	8.2
Average	***94***	***178***	***2.1***	***4.0***
Median	***61***	***102***	***1.4***	***2.2***

[a] These estimates include White River smolts produced only within the White River basin.

Seeding level (egg deposition) explained part of the variability in productivity and survival of juvenile spring Chinook in the White River basin. That is, for estimates based on smolts produced within the White River basin, survival and productivity decreased as seeding levels increased (Figure 7.2). This suggests that density dependence in part regulates juvenile productivity and survival within the White River basin.

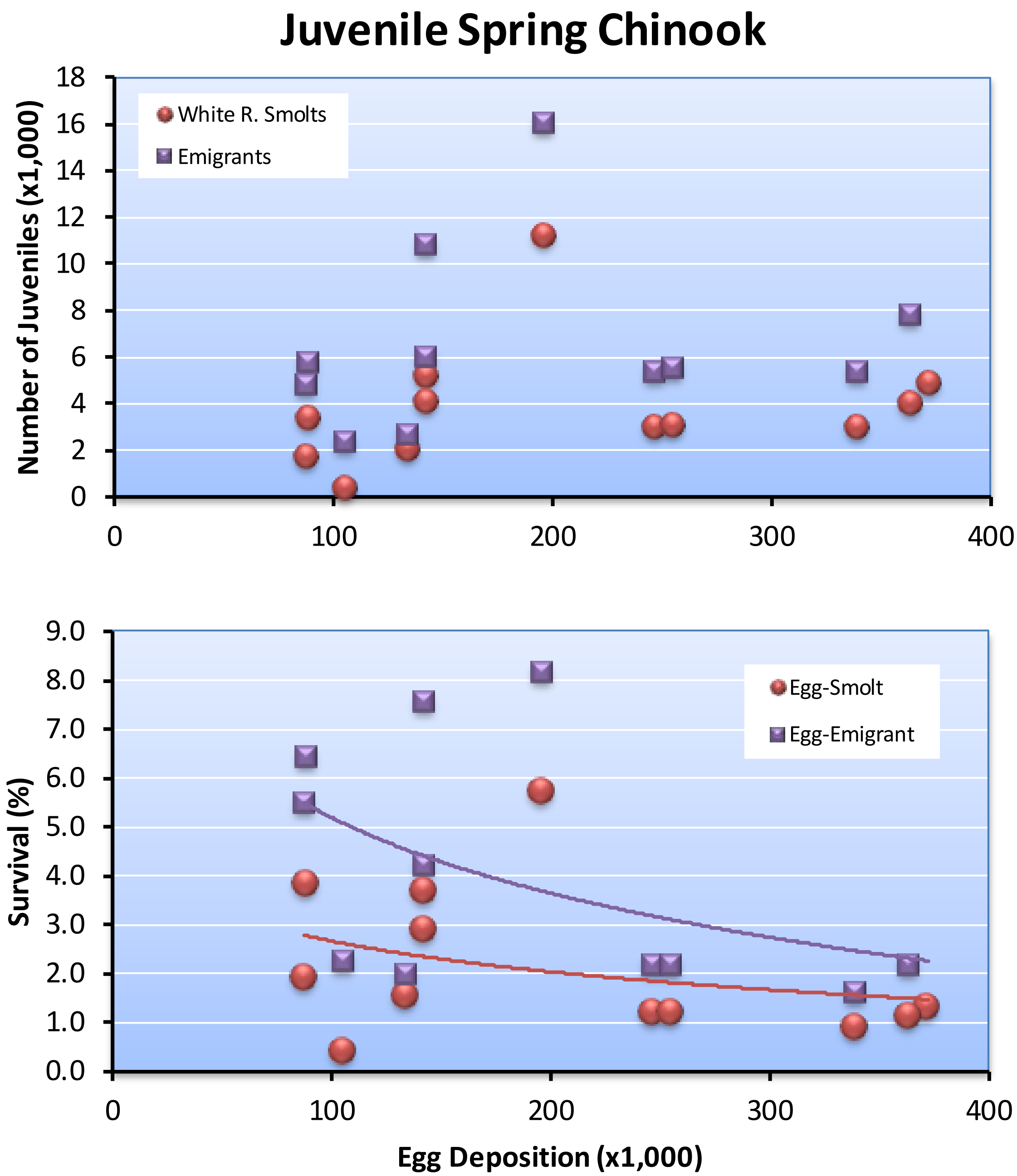


Figure 7.2. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for White River spring Chinook, brood years 2005-2016. White River smolts are smolts produced only within the White River basin.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[31] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate smolt carrying capacities using the Ricker stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). The Ricker model was the best fitting stock-recruitment model to the juvenile spring Chinook data.

Based on the Ricker model, the population carrying capacity for spring Chinook smolts in the White River basin is 4,056 smolts (95% CI: 0 – 6,462) (Figure 7.3). Here, smolts are defined as the number of yearling spring Chinook produced entirely within the White River basin. These estimates reflect current conditions (most recent decades) within the White River basin. Land use activities such as logging, roads, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook smolts in the White River basin.

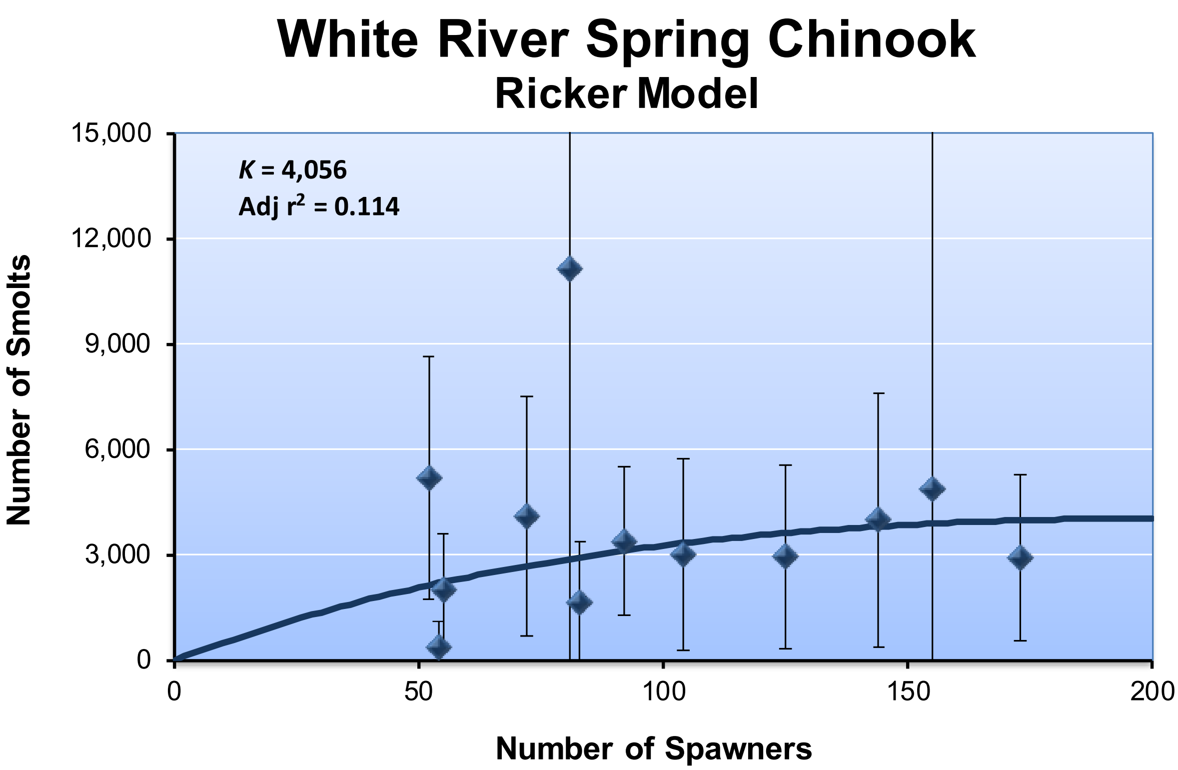


Figure 7.3. Relationship between spawners and number of smolts produced in the White River basin. Population carrying capacity (*K*) was estimated using the Ricker model. Vertical bars represent 95% confidence intervals on smolt estimates.

[31] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

We tracked the precision of the Ricker parameters for White River spring Chinook smolts over time to see if precision improves with additional years of data, and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the Ricker model and their associated standard errors and confidence intervals indicates that the parameters have not stabilized and lack precision (Table 7.12; Figure 7.4). This was also apparent in the estimates of population carrying capacity (Figure 7.5).

Table 7.12. Estimated parameters and statistics associated with fitting the Ricker model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the White River basin. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	95.89	44.84	0.0090	0.0040	3,928	96	111	0.001
6	100.65	37.65	0.0092	0.0034	4,007	101	108	0.019
7	81.75	36.97	0.0084	0.0042	3,602	82	120	0.000
8	80.32	32.78	0.0080	0.0036	3,675	80	124	0.000
9	78.79	42.85	0.0080	0.0037	3,605	79	124	0.000
10	40.02	33.48	0.0032	0.0040	4,659	40	316	0.183
11	40.20	32.47	0.0033	0.0040	4,441	40	300	0.182
12	52.58	49.87	0.0048	0.0045	4,056	53	210	0.114

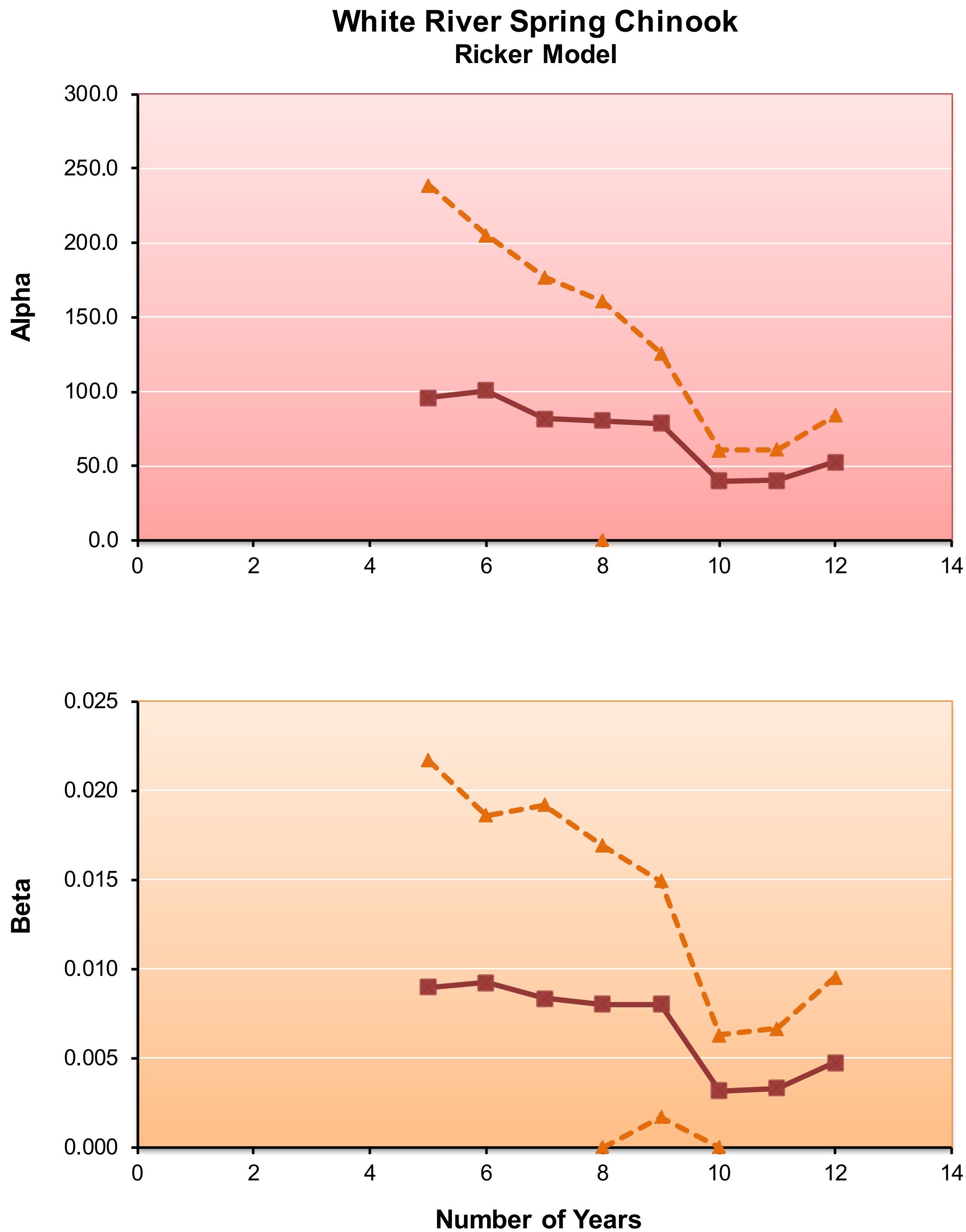


Figure 7.4. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to White River spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

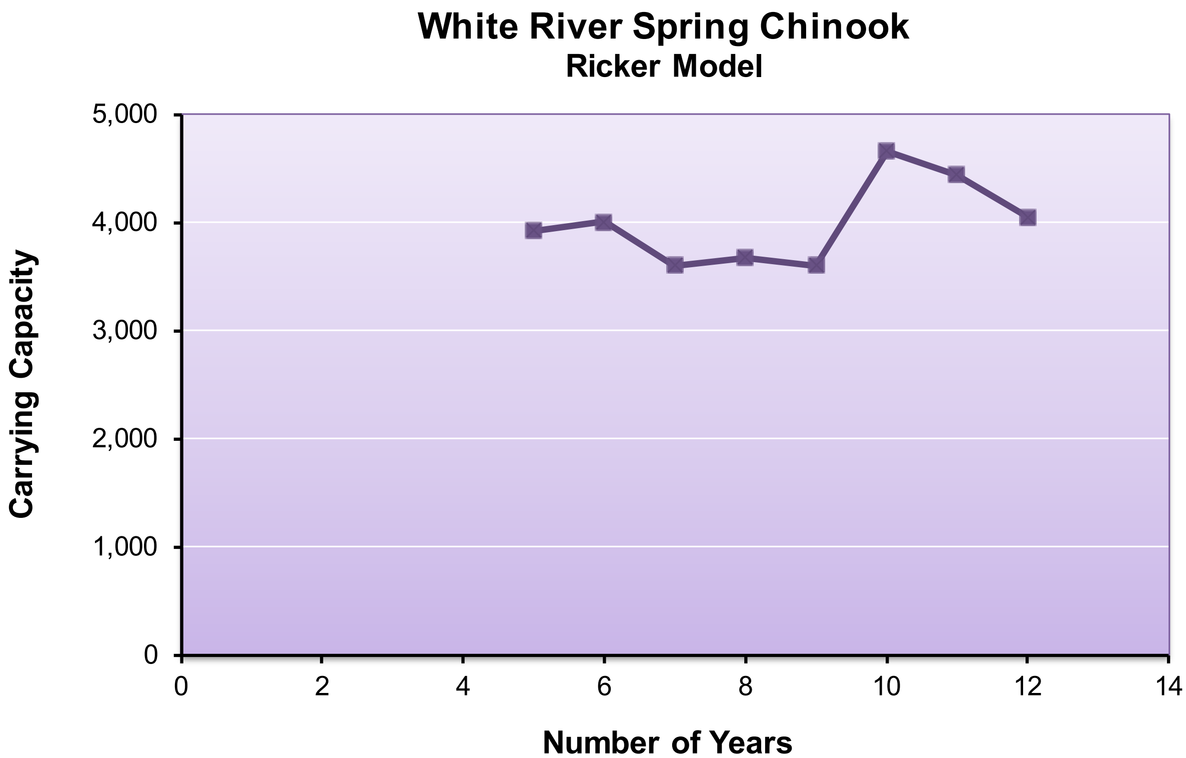


Figure 7.5. Time series of population carrying capacity estimates derived from fitting the Ricker model to White River spring Chinook smolt and spawning escapement data.

7.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during August through September 2018 in the White River (including the Napeequa River and Panther Creek). In the following section, we describe the number and distribution of redds within the White River basin.

Redd Counts and Distribution

A total of 22 spring Chinook redds were estimated in the White River basin in 2018 (Table 7.13). This is lower than the average of 35 redds counted during the period 1989-2017 in the White River. Redds were not distributed evenly among the six survey areas in the White River basin. Most redds (82%) were located in Reach 3 (Napeequa River to Grasshopper Meadows) in the White River (Table 7.13).

Table 7.13. Numbers (both observed and estimated) and proportions of spring Chinook redds counted within different survey areas within the White River basin during August through September 2018. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of observed redds	Estimated number of redds*	Proportion of estimated redds within stream/watershed
White River	White 1 (H1)	0	--	--
	White 2 (H2)	3	4	0.18
	White 3 (H3)	17	18	0.82
	White 4 (H4)	0	0	--
	Napeequa 1 (Q1)	0	0	--
	Panther 1 (T1)	0	0	--
Total		***20***	***22***	***1.00***

* Estimated redds represent the "adjusted" number of redds based on Guassian area-under-the-curve method (see Appendix L).

Spawn Timing

Spring Chinook began spawning during the fourth week of August in the White River and peaked the last week of August (Figure 7.6). Spawning in the White River ended the second week of September.

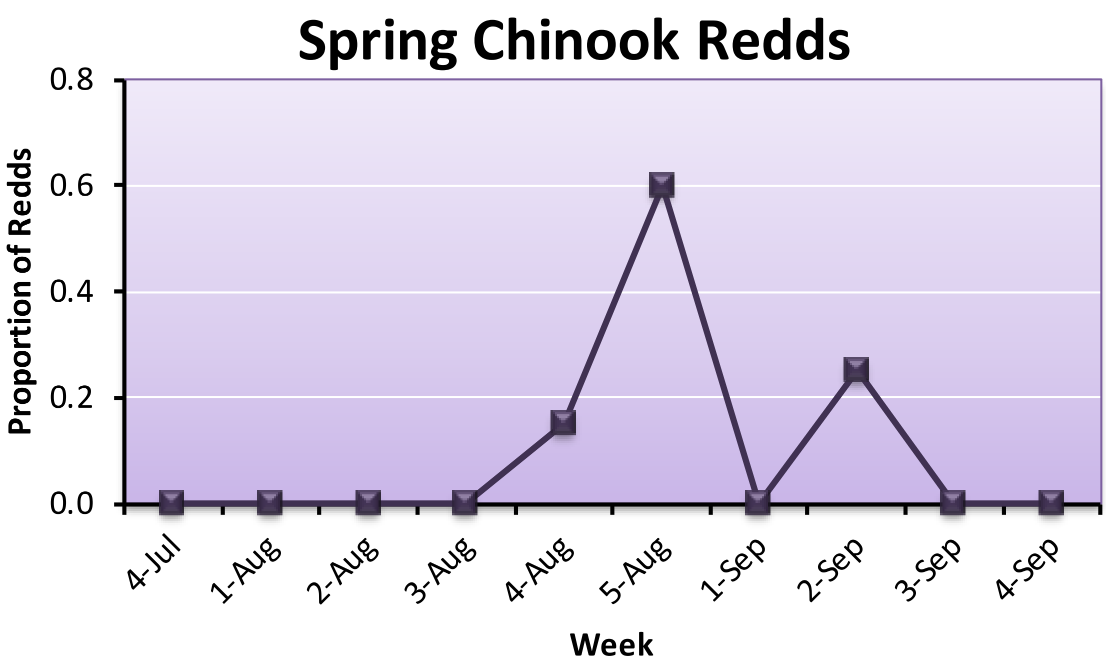


Figure 7.6. Proportion of spring Chinook redds counted during different weeks within the White River basin, August through September 2018.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[32] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2018 was 1.88 (based on sex ratios estimated at Tumwater Dam). Multiplying this ratio by the number of redds counted in the White River basin resulted in a total spawning escapement of 38 spring Chinook. The estimated total spawning escapement of spring Chinook in 2018 was less than the overall average of 73 spring Chinook in the White River basin (Table 7.14).

Table 7.14. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2018; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**
2017	2.06	457	140	21	31	19	1.81	72	5	**745**
2018	1.88	622	169	15	38	38	1.73	5	3	**890**
Average	**--**	***717***	***303***	***59***	***73***	***91***	**--**	***120***	***32***	***1330***

[32] Expansion factor = (1 + (number of males/number of females)).

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
Median	--	*611*	*234*	*51*	*61*	*57*	--	*72*	*7*	*1193*

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

7.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2018 in the White River (including the Napeequa River and Panther Creek). In 2018, 12 spring Chinook carcasses were sampled in the White River basin. Most of these were sampled in Reach 3. The total number of carcasses sampled in 2018 was less than the overall average of 17 carcasses sampled during the period 1996-2017.

In the White River basin in 2018, the spatial distribution of hatchery strays (primarily from the Chiwawa Spring Chinook program) and wild spring Chinook was not equal (Table 7.15). Only one carcass was recovered in Reach 2, which was of wild origin, while Reach 3 had six carcasses of wild origin and 5 of hatchery origin. In 2018, Reach 3 accounted for 92% of the recovered carcasses on the White River (Table 7.15). Over the years, spring Chinook have spawned more often in this reach than in other reaches (Figure 7.7).

Table 7.15. Numbers of wild, hatchery strays, and captive brood spring Chinook carcasses sampled within different reaches in the White River basin, 2000-2018. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach					Total
		H-2	H-3	H-4	Napeequa	Panther	
2000	Wild	1	0	0	0	0	**1**
	Hatchery Strays	0	0	0	0	0	**0**
2001	Wild	5	40	5	3	1	**54**
	Hatchery Strays	1	19	3	1	2	**26**
2002	Wild	3	15	0	0	0	**18**
	Hatchery Strays	0	6	0	0	1	**7**
2003	Wild	0	6	0	0	0	**6**
	Hatchery Strays	0	1	1	0	0	**2**
2004	Wild	1	9	1	0	0	**11**
	Hatchery Strays	0	1	0	0	1	**2**
2005	Wild	1	10	0	1	0	**12**
	Hatchery Strays	3	37	0	0	0	**40**
	Captive Brood	0	0	0	0	0	**0**
2006	Wild	2	16	0	1	0	**19**
	Hatchery Strays	0	6	0	0	0	**6**
	Captive Brood	0	0	0	0	0	**0**
2007	Wild	1	7	0	0	2	**10**
	Hatchery Strays	0	3	0	0	0	**3**
	Captive Brood	0	0	0	0	0	**0**
2008	Wild	1	3	0	0	1	**5**

Survey year	Origin	Survey Reach					Total
		H-2	H-3	H-4	Napeequa	Panther	
	Hatchery Strays	1	4	0	0	1	**6**
	Captive Brood	0	0	0	0	0	**0**
2009	Wild	0	9	0	0	0	**9**
	Hatchery Strays	0	8	0	0	3	**11**
	Captive Brood	0	0	0	0	0	**0**
2010	Wild	0	3	0	0	0	**3**
	Hatchery Strays	0	8	0	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**
2011	Wild	0	4	0	0	0	**4**
	Hatchery Strays	0	0	0	0	0	**0**
	Captive Brood	0	0	0	0	0	**0**
2012	Wild	0	13	0	0	0	**13**
	Hatchery Strays	0	8	0	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**
2013	Wild	0	9	0	0	0	**9**
	Hatchery Strays	0	7	0	0	3	**10**
	Captive Brood	0	2	0	0	0	**2**
2014	Wild	0	6	0	0	0	**6**
	Hatchery Strays	0	2	0	0	0	**2**
	Captive Brood	0	0	0	0	0	**0**
2015	Wild	1	13	0	0	0	**14**
	Hatchery Strays	2	4	0	0	0	**6**
	Captive Brood	2	3	0	0	0	**5**
2016	Wild	0	10	1	0	0	**11**
	Hatchery Strays	0	1	0	0	0	**1**
	Captive Brood	1	0	0	0	0	**1**
2017	Wild	2	2	0	1	0	**5**
	Hatchery Strays	0	3	0	0	0	**3**
	Captive Brood	0	1	0	0	0	**1**
2018	Wild	1	6	0	0	0	**7**
	Hatchery Strays	0	5	0	0	0	**5**
	Captive Brood	0	0	0	0	0	**0**
Average	***Wild***	***1***	***10***	***0***	***0***	***0***	***11***
	Hatchery Stray	***0***	***6***	***0***	***0***	***1***	***8***
	Captive Brood	***0***	***0***	***0***	***0***	***0***	***1***
Median	***Wild***	***1***	***9***	***0***	***0***	***0***	***9***
	Hatchery Stray	***0***	***4***	***0***	***0***	***0***	***6***
	Captive Brood	***0***	***0***	***0***	***0***	***0***	***0***

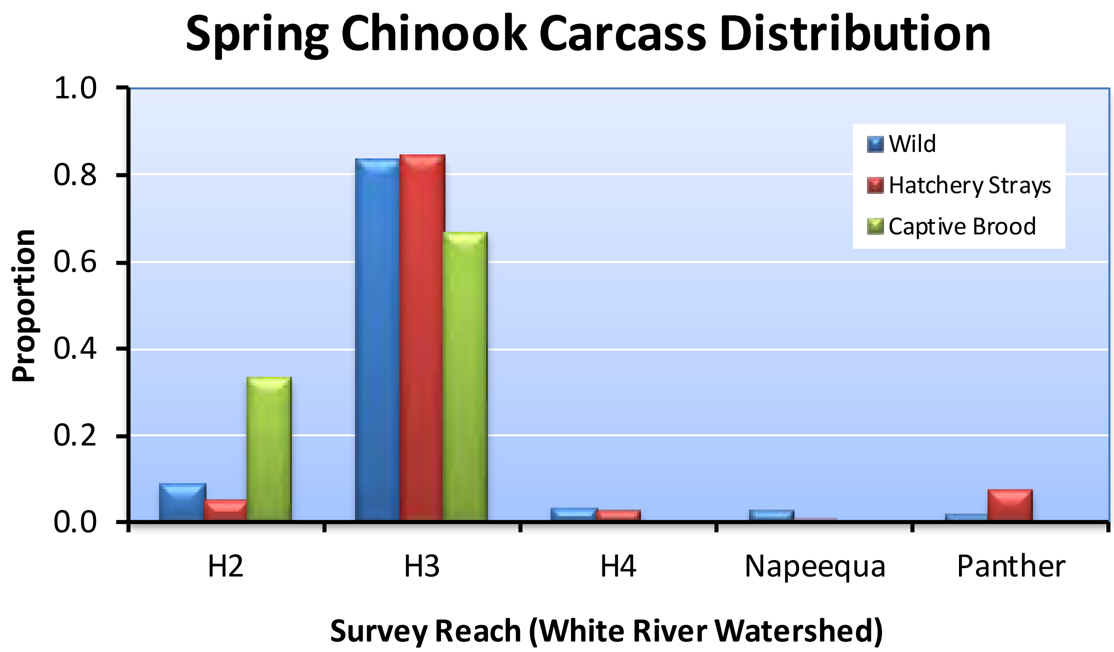


Figure 7.7. Distribution of wild, hatchery strays, and captive brood produced carcasses in different reaches in the White River basin, 2000-2018. Reach codes are described in Table 2.8.

7.7 Life History Monitoring

Life history characteristics of White River spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In general, wild spring Chinook arrived at Tumwater Dam earlier than did White River hatchery spring Chinook (Table 7.16a and b; Figure 7.8). On average, White River hatchery fish arrived at the dam about 12 days later and ended their migration about 3 days later than did wild fish. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 7.8).

Table 7.16a. The Julian day and date that 10%, 50% (median), and 90% of the wild and White River hatchery spring Chinook salmon passed Tumwater Dam, 2009-2018. The average Julian day and date are also provided. Migration timing is based on PIT-tag detections at Tumwater Dam. PIT tag releases of hatchery-origin White River spring Chinook occurred for brood years 2006-2013. Wild fish include all wild spring Chinook sampled at Tumwater Dam.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2009	Wild	171	20-Jun	176	25-Jun	185	4-Jul	177	25-Jun	31
	Hatchery	--	--	--	--	--	--	--	--	0
2010	Wild	175	24-Jun	184	3-Jul	190	9-Jul	184	3-Jul	80
	Hatchery	182	1-Jul	182	1-Jul	182	1-Jul	182	1-Jul	1

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2011	Wild	181	29-Jun	193	12-Jul	207	26-Jul	194	12-Jul	97
	Hatchery	206	25-Jul	207	26-Jul	208	26-Jul	207	26-Jul	2
2012	Wild	181	29-Jun	189	7-Jul	202	19-Jul	190	8-Jul	66
	Hatchery	182	30-Jun	194	12-Jul	207	25-Jul	194	11-Jul	20
2013	Wild	166	15-Jun	179	28-Jun	191	10-Jul	179	27-Jun	32
	Hatchery	159	7-Jun	175	24-Jun	187	5-Jul	175	24-Jun	43
2014	Wild	169	18-Jun	179	27-Jun	195	13-Jul	181	29-Jun	32
	Hatchery	182	1-Jul	194	12-Jul	207	25-Jul	193	12-Jul	52
2015	Wild	149	29-May	170	19-Jun	193	12-Jul	170	19-Jun	45
	Hatchery	160	8-Jun	175	24-Jun	197	16-Jul	176	25-Jun	60
2016	Wild	155	2-Jun	174	22-Jun	188	6-Jul	172	20-Jun	37
	Hatchery	166	14-Jun	182	30-Jun	192	10-Jul	180	28-Jun	21
2017	Wild	172	21-Jun	180	29-Jun	194	13-Jul	183	1-Jul	31
	Hatchery	--	--	--	--	--	--	--	--	0
2018	Wild	135	14-May	170	18-Jun	194	13-Jul	167	16-Jun	40
	Hatchery	--	--	--	--	--	--	--	--	0
Average	Wild	**165**		**179**		**194**		**180**		**49**
	Hatchery	**177**		**187**		**197**		**187**		**20**
Median	Wild	**170**		**179**		**194**		**180**		**39**
	Hatchery	**182**		**182**		**197**		**182**		**11**

Table 7.16b. The week that 10%, 50% (median), and 90% of the wild and White River hatchery spring Chinook salmon passed Tumwater Dam, 2009-2018. The average week is also provided. Migration timing is based on PIT-tag detections at Tumwater Dam. PIT tag releases of hatchery-origin White River spring Chinook occurred for brood years 2006-2013. Wild fish include all wild spring Chinook sampled at Tumwater Dam.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2009	Wild	25	26	27	26	31
	Hatchery	--	--	--	--	0
2010	Wild	25	27	28	27	80
	Hatchery	26	26	26	26	1
2011	Wild	26	28	30	28	97
	Hatchery	30	30	30	30	2
2012	Wild	26	27	29	28	66
	Hatchery	27	28	30	28	20
2013	Wild	24	26	28	26	32
	Hatchery	23	25	27	25	43
2014	Wild	25	26	28	26	32

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	26	28	30	28	52
2015	Wild	22	25	28	25	45
	Hatchery	23	25	29	26	60
2016	Wild	23	25	27	25	37
	Hatchery	24	26	28	26	21
2017	Wild	25	26	28	27	31
	Hatchery	--	--	--	--	0
2018	Wild	20	25	28	24	40
	Hatchery	--	--	--	--	0
Average	Wild	**24**	**26**	**28**	**26**	**49**
	Hatchery	**26**	**27**	**29**	**27**	**20**
Median	Wild	**25**	**26**	**28**	**26**	**39**
	Hatchery	**26**	**26**	**29**	**26**	**11**

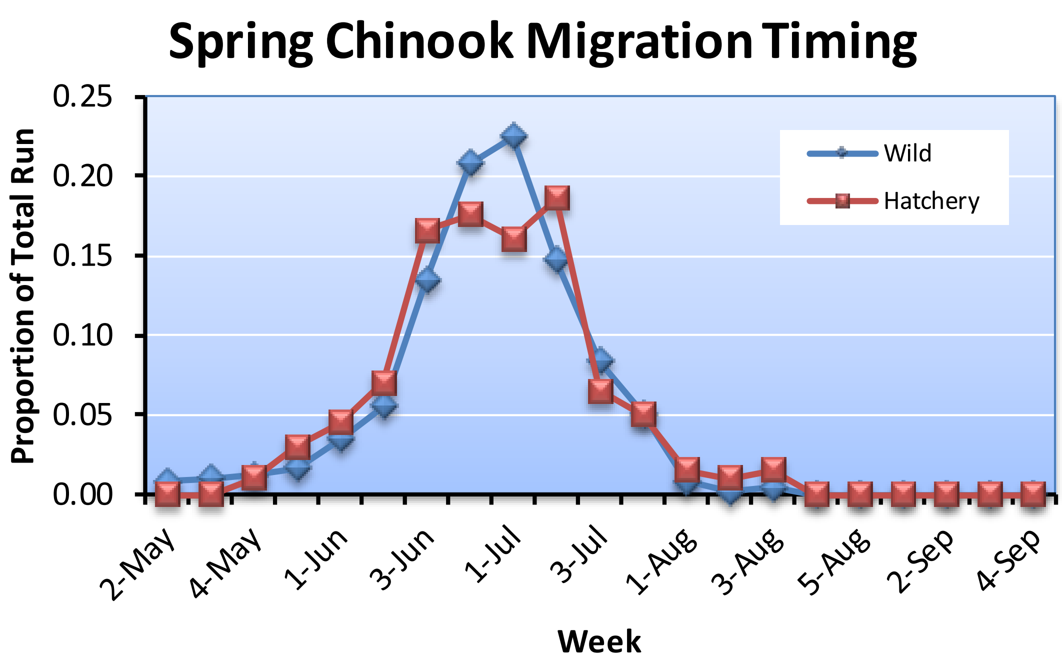


Figure 7.8. Proportion of wild and White River hatchery spring Chinook observed passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 2009-2018. Wild fish include all wild spring Chinook sampled at Tumwater Dam.

Age at Maturity

Most of the wild and hatchery stray spring Chinook sampled during the period 2001-2018 in the White River basin were age-4 fish (total age) (Table 7.17; Figure 7.9). A higher proportion of age-

5 wild fish returned than did age-5 hatchery strays. Thus, wild fish tended to return at an older age than hatchery strays. Currently, few captive brood carcasses have been identified on the spawning grounds; most were age-4 and one was age-5. There has been a conspicuous absence of age-3 fish recovered as carcasses. In all years except 2007, no age-3 carcasses have been recovered.

Table 7.17. Numbers of wild, hatchery strays, and captive brood spring Chinook of different ages (total age) sampled on spawning grounds in the White River basin, 2001-2018.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2001	Wild	0	0	47	0	0	**47**
	Hatchery Strays	0	0	27	0	0	**27**
2002	Wild	0	0	7	11	0	**18**
	Hatchery Strays	0	0	6	1	0	**7**
2003	Wild	0	0	0	6	0	**6**
	Hatchery Strays	0	0	0	1	0	**1**
2004	Wild	0	0	9	0	0	**9**
	Hatchery Stray	0	0	2	0	0	**2**
2005	Wild	0	0	12	0	0	**12**
	Hatchery Strays	0	0	40	0	0	**40**
	Captive Brood	0	0	0	0	0	**0**
2006	Wild	0	0	7	12	0	**19**
	Hatchery Strays	0	0	3	3	0	**6**
	Captive Brood	0	0	0	0	0	**0**
2007	Wild	0	0	2	8	0	**10**
	Hatchery Strays	0	2	1	0	0	**3**
	Captive Brood	0	0	0	0	0	**0**
2008	Wild	0	0	4	1	0	**5**
	Hatchery Strays	0	0	6	0	0	**6**
	Captive Brood	0	0	0	0	0	**0**
2009	Wild	0	0	8	1	0	**9**
	Hatchery Strays	1	0	10	0	0	**11**
	Captive Brood	0	0	0	0	0	**0**
2010	Wild	0	0	3	0	0	**3**
	Hatchery Strays	0	0	8	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**
2011	Wild	0	0	0	4	0	**4**
	Hatchery Strays	0	0	0	0	0	**0**
	Captive Brood	0	0	0	0	0	**0**
2012	Wild	0	0	13	0	0	**13**
	Hatchery Strays	0	0	8	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2013	Wild	0	0	7	2	0	**9**
	Hatchery Strays	0	0	9	0	0	**9**
	Captive Brood	0	0	1	1	0	**2**
2014	Wild	0	0	5	1	0	**6**
	Hatchery Strays	0	0	2	0	0	**2**
	Captive Brood	0	0	0	0	0	**0**
2015	Wild	0	0	13	1	0	**14**
	Hatchery Strays	0	0	6	0	0	**6**
	Captive Brood	0	0	5	0	0	**5**
2016	Wild	0	0	5	6	0	**11**
	Hatchery Strays	0	0	1	0	0	**1**
	Captive Brood	0	0	1	0	0	**1**
2017	Wild	0	0	4	1	0	**5**
	Hatchery Strays	0	0	3	0	0	**3**
	Captive Brood	0	0	1	0	0	**1**
2018	Wild	0	2	5	0	0	**7**
	Hatchery Strays	0	0	5	0	0	**5**
	Captive Brood	0	0	0	0	0	**0**
Average	***Wild***	***0***	***0***	***8***	***3***	***0***	***12***
	Hatchery Strays	***0***	***0***	***8***	***0***	***0***	***8***
	Captive Brood	***0***	***0***	***1***	***0***	***0***	***1***
Median	***Wild***	***0***	***0***	***6***	***1***	***0***	***9***
	Hatchery Strays	***0***	***0***	***6***	***0***	***0***	***6***
	Captive Brood	***0***	***0***	***0***	***0***	***0***	***0***

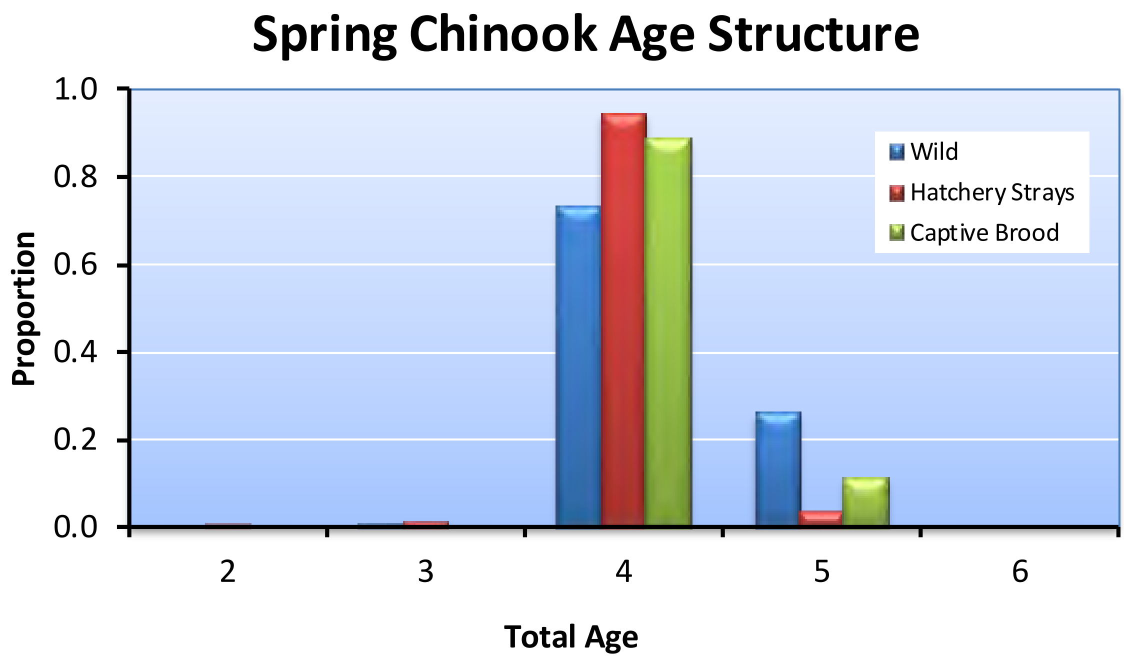


Figure 7.9. Proportions of wild, hatchery strays, and captive brood spring Chinook of different total ages sampled on spawning grounds in the White River basin for the combined years 2000-2018.

For comparison, Table 7.18 and Figure 7.10 show the age structure of spring Chinook carcasses sampled in the Little Wenatchee River. Similar to the White River, most of the wild and hatchery stray spring Chinook sampled during the period 2001-2018 in the Little Wenatchee River basin were age-4 fish (total age). A higher proportion of age-5 wild fish returned than did age-5 hatchery strays. Thus, wild fish tended to return at an older age than hatchery strays. As in the White River, few age-3 fish have been recovered in the Little Wenatchee River.

Table 7.18. Numbers of wild and hatchery stray spring Chinook of different ages (total age) sampled on spawning grounds in the Little Wenatchee River basin, 2001-2018.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2001	Wild	0	0	31	2	0	**33**
	Hatchery Strays	0	0	33	1	0	**34**
2002	Wild	0	0	6	8	0	**14**
	Hatchery Strays	0	0	12	2	0	**14**
2003	Wild	0	0	1	3	0	**4**
	Hatchery Strays	0	0	0	4	0	**4**
2004	Wild	0	0	1	0	0	**1**
	Hatchery Stray	0	0	0	0	0	**0**
2005	Wild	0	0	12	0	0	**12**
	Hatchery Strays	0	0	40	0	0	**40**
2006	Wild	0	0	7	12	0	**19**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
	Hatchery Stray	0	0	3	3	0	**6**
2007	Wild	0	0	2	8	0	**10**
	Hatchery Strays	0	2	1	0	0	**3**
2008	Wild	0	0	4	1	0	**5**
	Hatchery Stray	0	0	6	0	0	**6**
2009	Wild	0	0	8	1	0	**9**
	Hatchery Strays	1	0	10	0	0	**11**
2010	Wild	0	0	3	0	0	**3**
	Hatchery Stray	0	0	7	0	0	**7**
2011	Wild	0	0	0	4	0	**4**
	Hatchery Strays	0	0	0	0	0	**0**
2012	Wild	0	0	13	0	0	**13**
	Hatchery Stray	0	0	8	0	0	**8**
2013	Wild	0	0	7	2	0	**9**
	Hatchery Strays	0	0	9	0	0	**9**
2014	Wild	0	0	5	1	0	**6**
	Hatchery Stray	0	0	2	0	0	**2**
2015	Wild	0	0	13	1	0	**14**
	Hatchery Strays	0	0	6	0	0	**6**
2016	Wild	0	0	5	6	0	**11**
	Hatchery Strays	0	0	1	0	0	**1**
2017	Wild	0	0	4	1	0	**5**
	Hatchery Strays	0	0	3	0	0	**3**
2018	Wild	0	2	5	0	0	**7**
	Hatchery Strays	0	0	5	0	0	**5**
Average	***Wild***	***0***	***0***	***7***	***3***	***0***	***10***
	Hatchery Strays	***0***	***0***	***8***	***1***	***0***	***9***
Median	***Wild***	***0***	***0***	***5***	***1***	***0***	***9***
	Hatchery Strays	***0***	***0***	***6***	***0***	***0***	***6***

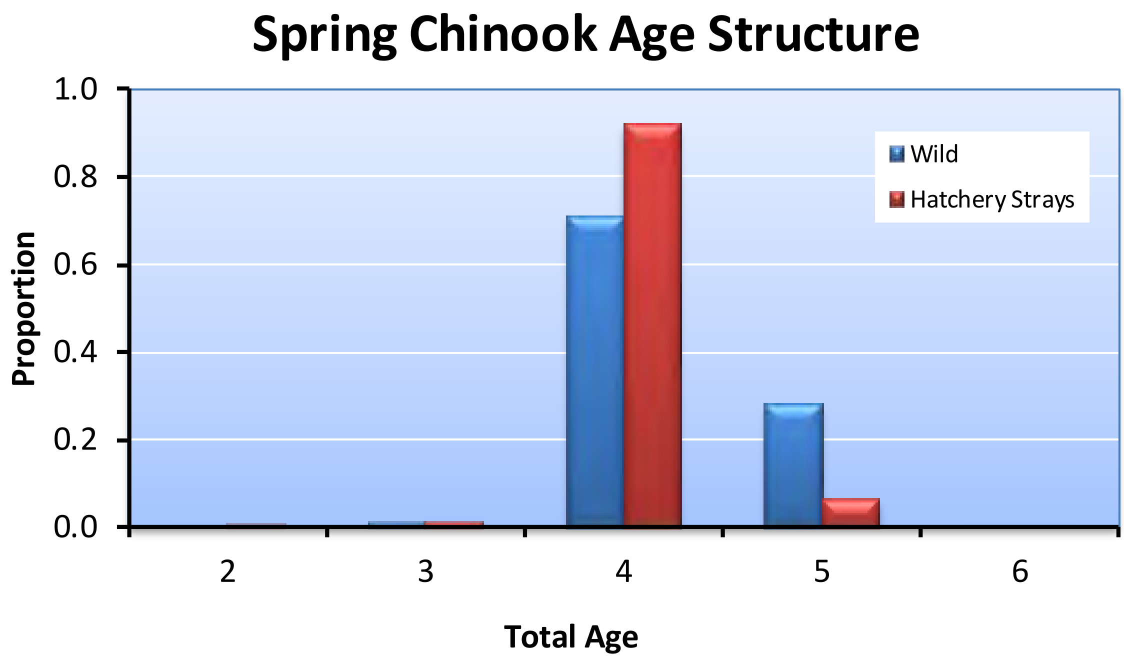


Figure 7.10. Proportions of wild and hatchery stray spring Chinook of different total ages sampled on spawning grounds in the Little Wenatchee River basin for the combined years 2000-2018.

Size at Maturity

On average, hatchery strays and wild spring Chinook of a given age differed little in length (Table 7.19). Differences were generally small (1-2 cm) between hatchery strays and wild fish of the same age. Few captive brood carcasses have been identified on the spawning grounds; most were females. Those fish were about the same size as wild and hatchery strays of the same age.

Table 7.19. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild, hatchery strays, and captive brood origin sampled in the White River basin, 2001-2018.

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
2001	3						
	4	65 ±3 (17)	66 ±4 (5)		63 ±3 (30)	63 ±4 (21)	
	5						
	6						
2002	3						
	4	66 ±0 (1)	69 ±0 (1)		63 ±4 (6)	59 ±6 (5)	
	5	75 ±11 (2)			72 ±3 (9)	72 ±0 (1)	
	6						
2003	3						
	4						

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	5				75 ±5 (6)	73 ±0 (1)	
	6						
2004	3						
	4	68 ±3 (3)			63 ±3 (6)	59 ±2 (2)	
	5						
	6						
2005	3						
	4	64 ±4 (3)	62 ±7 (4)		57 ±5 (8)	62 ±4 (33)	
	5						
	6						
2006	3						
	4	65 ±1 (3)			61 ±3 (4)	60 ±2 (3)	
	5	69 ±3 (4)			67 ±5 (8)	70 ±4 (3)	
	6						
2007	3		49 ±4 (2)				
	4				61 ±3 (2)	67 ±0 (1)	
	5	75 ±4 (3)			75 ±1 (5)		
	6						
2008	3						
	4	56 ±0 (1)	61 ±0 (1)		63 ±6 (2)	61 ±2 (5)	
	5				75 ±0 (1)		
	6						
2009	3						
	4	61 ±4 (3)	68 ±3 (2)		63 ±1 (5)	62 ±2 (8)	
	5				78 ±0 (1)		
	6						
2010	3						
	4		65 ±3 (2)		60 ±5 (3)	61 ±5 (5)	
	5						
	6						
2011	3						
	4						
	5				73 ±4 (5)		
	6						
2012	3						
	4	47 ±0 (1)			62 ±3 (12)	60 ±4 (8)	
	5						
	6						
2013	3						
	4	64 ±3 (3)	60 ±3 (2)		62 ±2 (4)	60 ±3 (5)	63 ±0 (1)

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	5				67 ±1 (2)		71 ±0 (1)
	6						
2014	3						
	4		54 ±0 (1)		60 ±2 (5)	58 ±0 (1)	
	5				74 ±0 (1)		
	6						
2015	3						
	4	60 ±6 (5)	74 ±0 (1)	61 ±0 (1)	64 ±4 (8)	64 ±4 (5)	64 ±4 (4)
	5				75 ±0 (1)		
	6						
2016	3						
	4	65 ±0 (1)			63 ±4 (4)	59 ±4 (2)	
	5	71 ±3 (2)			71 ±5 (4)		
	6						
2017	3						
	4	69 ±0 (1)	68±0 (1)		66 ±2 (3)	62 ±2 (2)	61 ±0 (1)
	5				67 ±0 (1)		
	6						
2018	3	40 ±2 (2)					
	4	63 ±5 (2)			63 ±2 (3)	61 ±4 (5)	
	5						
	6						

Contribution to Fisheries

No White River spring Chinook from the captive brood program tagged with CWTs or PIT tags have been recaptured (or reported) in ocean or Columbia River (tribal, commercial, or recreational) fisheries.

Straying

Stray rates of White River spring Chinook from the captive brood program were determined by examining the locations where PIT-tagged Chinook demonstrating anadromy (based on detections at Bonneville Dam) were last detected. PIT tagging of White River spring Chinook began with release year 2008, which allows estimation of stray rates by brood return. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%.

Based on PIT-tag analyses, on average, about 57% of the brood year returns of White River spring Chinook were last detected in streams outside the White River (Table 7.20). The numbers in Table 7.20 should be considered rough estimates because they are not based on confirmed spawning (only last detections) and they represent small sample sizes. In addition, last detections in adult fishways (i.e., Bonneville, Rock Island, and Tumwater dams) were not included, nor were detections in areas outside the distribution of known spring Chinook spawning (i.e., Lower and Middle Wenatchee River). All fish reported in Table 7.20 are at least age-3 fish (total age) and some of them may not have migrated all the way to the ocean but rather resided completely in freshwater downstream from Bonneville Dam.

Table 7.20. Number and percent of White River spring Chinook from the captive brood program that homed to target spawning areas on the White River and the target hatchery program (Little White Salmon Fish Hatchery), and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2006-2013. Only PIT-tagged fish demonstrating anadromy were included in the analysis. Estimates were based on last detections of PIT-tagged spring Chinook.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2006	9	100.0	0	0.0	0	0.0	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	0	0.0	19	100.0	0	0.0
2009	8	13.8	0	0.0	65	86.2	0	0.0
2010	0	0.0	0	0.0	9	100.0	0	0.0
2011	38	17.1	0	0.0	184	82.9	0	0.0
2012	6	12.0	0	0.0	38	88.0	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0
Average	***8***	***17.9***	***0***	***0.0***	***39***	***57.1***	***0***	***0.0***
Median	***3***	***6.0***	***0***	***0.0***	***14***	***84.6***	***0***	***0.0***

* Homing to the target hatchery includes White River hatchery spring Chinook that are captured and included as broodstock in the White River Hatchery program.

The percentage of the PIT-tagged White River spring Chinook from the captive brood program that were last detected in different watersheds within and outside the Wenatchee River basin are shown in Table 7.21. On average, a small percentage of the PIT-tagged White River spring Chinook homed to the White River. Relatively high percentages of them were last detected in the Little Wenatchee River, Upper Wenatchee River, Nason Creek, and the Chiwawa River.

Few returning adults have strayed into spawning areas outside the Wenatchee River basin. Three were last detected in the Entiat River. No other returning adults were detected outside the Wenatchee River basin. On the other hand, several juveniles were last detected in rivers outside the Wenatchee River basin. Juveniles were last detected in the Deschutes, Walla Walla, Hood, and North Fork Teanaway rivers. Juveniles were also last detected at the Little White Salmon Fish Hatchery. There is no evidence that these fish entered the ocean and returned as adults.

Table 7.21. Number and percent (in parentheses) of PIT-tagged White River spring Chinook from the captive brood program that were last detected in different tributaries within the Wenatchee River basin, return years 2010-2018. Only PIT-tagged fish demonstrating anadromy were included in the analysis.

Return year	Homing	Straying							
	White River	Chiwawa River	Chiwaukum Creek	Icicle Creek	Little Wenatchee	Nason Creek	Peshastin Creek	Upper Wenatchee	Entiat River
2010	9 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2011	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
2012	3 (16.0)	3 (16.0)	0 (0.0)	0 (0.0)	10 (66.7)	1 (7.6)	0 (0.0)	0 (0.0)	0 (0.0)
2013	5 (7.4)	20 (28.0)	3 (3.7)	5 (7.4)	13 (18.1)	20 (28.0)	0 (0.0)	5 (7.4)	0 (0.0)
2014	11 (8.6)	44 (34.9)	0 (0.0)	3 (2.2)	8 (6.5)	44 (34.9)	0 (0.0)	14 (10.8)	3 (2.2)
2015	24 (22.8)	59 (55.2)	3 (2.5)	0 (0.0)	0 (0.0)	3 (2.5)	0 (0.0)	18 (16.9)	0 (0.0)
2016	8 (23.0)	19 (51.7)	0 (0.0)	3 (7.5)	0 (0.0)	2 (5.2)	0 (0.0)	5 (12.6)	0 (0.0)
2017	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2018	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Average	***7 (19.8)***	***16 (20.6)***	***1 (0.7)***	***1(1.9)***	***4 (15.0)***	***8 (14.2)***	***0 (0.0)***	***5 (5.3)***	***0 (0.2)***
Median	***5 (8.6)***	***3 (16.0)***	***0 (0.0)***	***0 (0.0)***	***0 (0.0)***	***1 (5.2)***	***0 (0.0)***	***0 (0.0)***	***0 (0.0)***

Genetics

At this time, there are no studies that examine the effects of the White River captive brood program on the genetics of natural-origin spring Chinook in the Wenatchee River basin. However, genetic studies were conducted to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix M). This work included the analysis of White River spring Chinook. Researchers collected microsatellite DNA allele frequencies from temporally replicated natural and hatchery-origin spring Chinook to statistically assign individual fish to specific demes (locations) within the Wenatchee population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in the White River, despite the presence of hatchery-origin spawners in both systems.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[33] The larger the

[33] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a

PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-2000, PNI values ranged from 0.95 to 1.00 (Table 7.22). For brood years 2001-2013, PNI for the White River Program averaged 0.60 (range, 0.33-1.00) (Table 7.22). The captive brood program ended with brood year 2013.

Table 7.22. Proportionate Natural Influence (PNI) values for hatchery spring Chinook spawning in the White River, brood years 1989-2013. See notes below the table for description of each metric.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_W	HOS_S	$pHOS_W$	$pHOS_S$	NOB_N	HOB_N	pNOB	
1989	145	0	0	0.00	0.00	0	0	*1.00*	1.00
1990	49	0	0	0.00	0.00	0	0	*1.00*	1.00
1991	49	0	0	0.00	0.00	0	0	*1.00*	1.00
1992	78	0	0	0.00	0.00	0	0	*1.00*	1.00
1993	138	0	7	0.00	0.05	0	0	*0.99*	0.95
1994	7	0	0	0.00	0.00	0	0	*0.67*	1.00
1995	5	0	0	0.00	0.00	0	0	*1.00*	1.00
1996	30	0	0	0.00	0.00	0	0	*0.60*	1.00
1997	33	0	0	0.00	0.00	0	0	*0.30*	1.00
1998	11	0	0	0.00	0.00	0	0	*0.44*	1.00
1999	3	0	0	0.00	0.00	0	0	*1.00*	1.00
2000	22	0	0	0.00	0.00	0	0	*0.48*	1.00
Average*	***48***	***0***	***1***	***0.00***	***0.00***	***0***	***0***	***0.79***	***1.00***
Median*	***32***	***0***	***0***	***0.00***	***0.00***	***0***	***0***	***1.00***	***1.00***
2001	111	0	55	0.00	0.33	5	0	1.00	0.50
2002	60	0	26	0.00	0.30	18	0	1.00	0.51
2003	31	0	5	0.00	0.14	7	0	1.00	0.77
2004	54	0	12	0.00	0.18	6	0	1.00	0.70
2005	38	11	106	0.07	0.68	103	73	0.59	0.33
2006	41	5	9	0.09	0.16	191	135	0.59	0.61
2007	62	23	7	0.25	0.08	254	6	0.98	0.67
2008	20	2	30	0.04	0.58	116	0	1.00	0.34
2009	81	29	63	0.17	0.36	238	0	1.00	0.53
2010	27	22	23	0.31	0.32	90	0	1.00	0.50
2011	83	0	0	0.00	0.00	306	0	1.00	1.00
2012	89	10	45	0.07	0.31	390	0	1.00	0.73
2013	44	55	5	0.53	0.05	383	0	1.00	0.64

selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_W	HOS_S	$pHOS_W$	$pHOS_S$	NOB_N	HOB_N	pNOB	
Average**	***57***	***12***	***30***	***0.12***	***0.27***	***162***	***16***	***0.94***	***0.60***
Median**	***54***	***5***	***23***	***0.07***	***0.30***	***116***	***0***	***1.00***	***0.61***

HOS_W = hatchery-origin spawners in White River from the White River spring Chinook Supplementation Program.
$pHOS_W$ = proportion of hatchery-origin spawners from White River spring Chinook Supplementation Program.
HOS_S = stray hatchery-origin spawners in the White River.
$pHOS_S$ = proportion of stray hatchery-origin spawners.
NOB_W = natural origin broodstock spawned for the White River spring Chinook Supplementation Program.
HOB_W = hatchery-origin broodstock spawned in the White River spring Chinook Supplementation Program.
pNOB = proportion of hatchery-origin broodstock. Because of the high incidence of strays to the White River from the Chiwawa River spring Chinook program, pNOB values from the Chiwawa program were used to estimate PNI values during the period from 1989 to 2000 (*italicized*). The weighting for those years was 100% based on the Chiwawa program broodstock selection, because there have been no hatchery returns from the White River spring Chinook program during this period (see Table 5.1 for Chiwawa broodstock selection).
PNI = Proportionate Natural Influence for White River spring Chinook calculated using the gene-flow model for multiple programs.
* Average and median for the period 1989-2000.
** Average and median for the period 2001-2013.

Natural and Hatchery Replacement Rates

In general, natural replacement rates (NRR) are calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs include all returning fish that either returned to the basin or were collected as wild broodstock. For brood years 1989-2012, NRR for spring Chinook in the White River basin averaged 1.01 (range, 0.00-4.91) if harvested fish were not included in the estimate and 1.15 (range, 0.00-5.73) if harvested fish were included in the estimate (Table 7.23a). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and are calculated as the ratio of hatchery-origin recruits (HOR) detected at Tumwater Dam to the parent broodstock collected (the number of eggs or juveniles that were collected, survived, and spawned in the hatchery). For brood years 2006-2012, hatchery replacement rates averaged 0.28 (range, 0.00-0.94) if harvest is not included and 0.34 (range, 0.00-1.26) if harvest is included (Table 7.23a). HRR was greater than the NRR in most years. The HRR values are generally higher when they are calculated using the number of adult equivalents taken from the natural environment to initiate the captive brood program (brood years 2006-2009; Table 7.23b).

Table 7.23a. Numbers of brood stock spawned, spawning escapements, hatchery-origin recruits (HOR), natural-origin recruits (NOR), hatchery replacement rates (HRR), and natural replacement rates (NRR) with and without harvest for spring Chinook in the White River basin, brood years 1989-2012.

Brood year	Brood stock spawned	Spawning Escapement	Harvest not included				Harvest included			
			HOR[1]	NOR[2]	HRR[1]	NRR[2]	HOR[3]	NOR[4]	HRR[3]	NRR[4]
1989	--	145	--	81	--	0.56	--	118	--	0.81
1990	--	49	--	2	--	0.04	--	2	--	0.04
1991	--	49	--	3	--	0.06	--	3	--	0.06
1992	--	78	--	30	--	0.38	--	32	--	0.41

Brood year	Brood stock spawned	Spawning Escapement	Harvest not included				Harvest included			
			HOR[1]	NOR[2]	HRR[1]	NRR[2]	HOR[3]	NOR[4]	HRR[3]	NRR[4]
1993	--	145	--	44	--	0.30	--	45	--	0.31
1994	--	7	--	1	--	0.14	--	1	--	0.14
1995	--	5	--	9	--	1.80	--	9	--	1.80
1996	--	30	--	15	--	0.50	--	16	--	0.53
1997	--	33	--	148	--	4.48	--	173	--	5.24
1998	--	11	--	54	--	4.91	--	65	--	5.91
1999	--	3	--	0	--	0.00	--	0	--	0.00
2000	--	22	--	54	--	2.45	--	58	--	2.64
2001	5	166	--	64	--	0.39	--	66	--	0.40
2002	18	86	--	70	--	0.81	--	73	--	0.85
2003	7	36	--	11	--	0.31	--	12	--	0.33
2004	6	66	--	25	--	0.38	--	27	--	0.41
2005	176	155	--	72	--	0.46	--	74	--	0.48
2006	326	55	0	110	0.00	2.00	0	138	0.00	2.51
2007	260	92	0	0	0.00	0.00	0	0	0.00	0.00
2008	116	52	1	100	0.01	1.92	9	112	0.08	2.15
2009	238	173	1	39	0.00	0.23	13	42	0.05	0.24
2010	90	72	0	40	0.00	0.56	0	49	0.00	0.68
2011	306	83	64	110	0.21	1.33	252	147	0.82	1.77
2012	390	144	12	34	0.03	0.24	95	39	0.24	0.27
Average	***162***	***73***	***10***	***47***	***0.03***	***1.01***	***46***	***54***	***0.15***	***1.15***
Median	***146***	***61***	***1***	***40***	***0.00***	***0.43***	***5***	***44***	***0.03***	***0.44***

[1] HOR and HRR values represented here are based on expanded CWT recoveries.
[2] NOR and NRR values represented here are based on carcasses recovery in the White River adjusted by H:W ratios and age composition and expanded to the escapement in the White River.
[3] Harvest on hatchery-origin White River spring Chinook was estimated based on harvest rates observed for Chiwawa spring Chinook.
[4] Expanded NORs for harvest were based on harvest rates from Chiwawa River spring Chinook.

Table 7.23b. Hatchery-origin recruits (HOR) and hatchery replacement rates (HRR) based on adult equivalents for spring Chinook in the White River basin, brood years 2006-2009. HORs were estimated at Tumwater Dam.

Brood year	Adult equivalents	Harvest not included		Harvest included	
		HOR	HRR	HOR	HRR
2006	1.03	0	0.00	0	0.00
2007	1.21	0	0.00	0	0.00
2008	0.36	1	2.78	9	25.00
2009	1.05	1	0.95	13	12.38
Average	***0.91***	***1***	***0.93***	***6***	***9.35***
Median	***1.04***	***1***	***0.48***	***5***	***6.19***

For comparison, we calculated NRR for spring Chinook within the Little Wenatchee River basin. Spring Chinook from both the White River and Little Wenatchee River must migrate through Lake Wenatchee. Therefore, a comparison between the two subpopulations is appropriate.

NRRs for spring Chinook in the Little Wenatchee River basin were generally less than those for spring Chinook in the White River basin. For brood years 1989-2012, NRR for spring Chinook in the Little Wenatchee River basin averaged 0.79 (range, 0.00-4.50) if harvested fish were not included in the estimate and 0.90 (range, 0.00-5.00) if harvested fish were included in the estimate (Table 7.24). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Table 7.24. Spawning escapements, natural-origin recruits (NOR), and natural replacement rates (NRR) with and without harvest for spring Chinook in the Little Wenatchee River basin, brood years 1989-2012.

Brood year	Spawning Escapement	Harvest not included		Harvest included	
		NOR	NRR	NOR	NRR
1989	102	84	0.82	122	1.20
1990	67	0	0.00	0	0.00
1991	42	0	0.00	0	0.00
1992	78	8	0.10	8	0.10
1993	134	21	0.16	22	0.16
1994	16	11	0.69	11	0.69
1995	0	10	0.00	10	0.00
1996	8	14	1.75	15	1.88
1997	18	81	4.50	90	5.00
1998	18	31	1.72	36	2.00
1999	8	4	0.50	4	0.50
2000	24	39	1.63	42	1.75
2001	118	51	0.43	53	0.45
2002	86	79	0.92	82	0.95
2003	29	13	0.45	14	0.48
2004	39	13	0.33	14	0.36
2005	115	43	0.37	44	0.38
2006	37	49	1.32	62	1.68
2007	101	59	0.58	70	0.69
2008	64	73	1.14	82	1.28
2009	125	52	0.42	56	0.45
2010	83	44	0.53	54	0.77
2011	124	61	0.49	82	0.77
2012	72	15	0.21	17	0.24
Average	**63**	**36**	**0.79**	**41**	**0.90**
Median	**66**	**35**	**0.50**	**39**	**0.58**

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adults detected at Tumwater Dam divided by the number of tagged hatchery smolts released. SARs were based on PIT-tag detections. For the available brood years, SARs have ranged from 0.00000 to 0.00196 (Table 7.25). The captive brood program ended with brood year 2013.

Table 7.25. Smolt-to-adult ratios (SARs) for White River spring Chinook from the captive brood program, brood years 2006-2013. Detections at Tumwater Dam are adjusted for PIT-tag detection efficiency.

Brood year	Number of smolts released	Number of PIT-tagged smolts released	PIT-tags	
			Adjusted Tumwater Detections	SAR
2006	142,033	29,881	1	0.00003
2007	131,843	39,820	0	0.00000
2008	48,556	38,650	23	0.00060
2009	112,596	41,742	42	0.00101
2010	18,850	12,283	6	0.00049
2011	147,000	54,187	106	0.00196
2012	97,713	52,440	25	0.00048
2013	31,000	19,954	2	0.00010
Average	***91,199***	***36,120***	***26***	***0.00058***
Median	***105,155***	***39,235***	***15***	***0.00048***

7.8 ESA/HCP Compliance

Brood Collection

The last collection of eggs or fry for this program occurred in 2010 (brood year 2009). The hatchery program ended with the last release of juveniles in 2015 (brood year 2013).

Hatchery Rearing, Spawning, and Release

The hatchery program ended with the last release of juveniles in 2015 (brood year 2013). No release of juveniles occurred under Section 10(a)(1)(A) Permit 18120 in 2017.

Hatchery Effluent Monitoring

No juveniles were reared or released as part of the White River captive brood program in 2017 due to sun-setting of the program with the 2013 brood. Therefore, no effluent monitoring was required or conducted in 2018.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit Nos. 18118, 18120, and 18121, the permit holders are authorized a direct take of 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2003). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring

Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2018 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 7.26. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permits 18118, 18120, and 18121, Section B. Table 7.26 includes incidental or direct take associated with the White River smolt trap operated by the Yakama Nation under separate permits.

Table 7.26. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2018.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	31,300	158,189	43,133	3,539	9,750	7,948	21,237	
Encounter rate	NA	NA	NA	0.1131	0.0616	0.1843	0.0957	0.20
Mortality[e]	NA	NA	NA	8	37	20	65	
Mortality rate	NA	NA	NA	0.0023	0.0038	0.0025	0.0031	0.02
White River Trap								
Population	11,170	NA	1,679	234	NA	131	365	
Encounter rate	NA	NA	NA	0.0209	NA	0.0780	0.0284	0.20
Mortality[d]	NA	NA	NA	0	NA	0	0	
Mortality rate	NA	NA	NA	0.0000	NA	0.0000	0.0000	0.02
Nason Creek Trap								
Population	5,082	233,471	17,066	301	367	1,651	2,319	
Encounter rate	NA	NA	NA	0.0592	0.0016	0.0967	0.0091	0.20
Mortality[d]	NA	NA	NA	5	0	8	13	
Mortality rate	NA	NA	NA	0.0166	0.0000	0.0048	0.0056	0.02
Lower Wenatchee Trap								
Population	99,045	391,660	5,823,795	1,418	51,069	47,283	99,770	
Encounter rate	NA	NA	NA	0.0143	0.1304	0.0081	0.0162	0.2
Mortality[d]	NA	NA	NA	7	7	347	361	
Mortality rate	NA	NA	NA	0.0049	0.0001	0.0073	0.0036	0.02
Wenatchee River Basin Total								
Population	146,597	391,660	5,885,673	5,492	61,186	57,013	123,691	
Encounter rate	NA	NA	NA	0.0375	0.1562	0.0097	0.0193	0.20
Mortality[d]	NA	NA	NA	20	44	375	439	
Mortality rate	NA	NA	NA	0.0036	0.0007	0.0066	0.0035	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2017 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2018, as authorized by ESA Section 10 Permits Numbers 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permit Numbers 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2018, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin and natural-origin Chinook retained for broodstock or removed as part of adult management activities) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2018.

Bull Trout

Bull trout encounters associated with implementation of hatchery production and monitoring and evaluation activities for Chinook and steelhead programs in the Wenatchee sub-basin are required to be reported as outlined in Biological Opinion 01EWF00-2013-0444. The 2018 report for bull trout encounters was compiled under provisions of ESA Section 10 Permit 18118, 18120, 18121, and 18583. Data and reporting information are included in Appendix I.

SECTION 8: WENATCHEE SUMMER CHINOOK

The goal of summer Chinook salmon supplementation in the Wenatchee Basin is to use artificial production to replace adults lost because of mortality at Priest Rapids, Wanapum, and Rock Island dams, while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD and subsequently Grant PUD began cost-sharing the program in 2012. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans as well as the Priest Rapids Project Salmon and Steelhead Settlement Agreement.

Adult summer Chinook are collected for broodstock from the run-at-large at the right and left-bank traps at Dryden Dam, and at Tumwater Dam if weekly quotas cannot be achieved at Dryden Dam. Before 2012, the goal was to collect up to 492 natural-origin adult summer Chinook for the Wenatchee program for an annual release of 864,000 smolts. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was reduced. The current goal (beginning in 2012) is to collect up to 256 adult natural-origin summer Chinook for an annual release of 500,001 smolts. Broodstock collection occurs from about 1 July through 15 September with trapping occurring up to 24 hours per day, seven days a week. If natural-origin broodstock collection falls short of expectation, hatchery-origin adults can be collected to meet the collection quota.

Adult summer Chinook are spawned at Eastbank Fish Hatchery. At Eastbank, the majority of summer Chinook are reared in raceways, and a portion in re-use circular tanks. Juvenile summer Chinook are transferred from the hatchery to Dryden Acclimation Pond in March. They are released from the pond in late April to early May.

Before 2012, the production goal for the Wenatchee summer Chinook supplementation program was to release 864,000 yearling smolts into the Wenatchee River at ten fish per pound. Beginning with the 2012 brood, the revised production goal is to release 500,001 yearling smolts into the Wenatchee River at 18 fish per pound. Targets for fork length and weight are 163 mm (CV = 9.0) and 45.4 g, respectively. Over 95% of these fish are marked with CWTs. In addition, since 2009, about 10,000 juvenile summer Chinook have been PIT tagged annually.

8.1 Broodstock Sampling

This section focuses on results from sampling 2016-2018 Wenatchee summer Chinook broodstock, which were collected at Dryden and Tumwater dams.

Origin of Broodstock

Consistent with the broodstock collection protocol, the 2016-2018 broodstock consisted primarily of natural-origin (adipose fin present and no CWT) summer Chinook (Table 8.1). Since 2012, less than 1% of the broodstock has consisted of hatchery-origin fish (hatchery-origin was determined by examination of scales and/or CWTs).

Table 8.1. Number of wild and hatchery summer Chinook collected for broodstock, mortality prior to spawning, and number spawned, 1989-2018. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	346	29	27	290	0	0	0	0	0	0	290
1990	87	6	24	57	0	0	0	0	0	0	57
1991	128	9	14	105	0	0	0	0	0	0	105
1992	341	48	19	274	0	0	0	0	0	0	274
1993	480	28	46	406	0	44	0	0	44	0	450
1994	363	29	1	333	0	55	1	0	54	0	387
1995	382	15	4	363	0	16	0	0	16	0	378
1996	331	34	34	263	0	3	0	0	3	0	266
1997	225	14	6	205	0	15	1	1	13	0	218
1998	378	40	39	299	0	94	4	12	78	0	377
1999	250	7	1	242	0	238	1	1	236	0	478
2000	298	18	5	275	0	194	7	7	180	0	455
2001	311	41	60	210	0	182	8	38	136	0	346
2002	469	28	32	409	0	13	1	2	10	0	419
2003	488	90	61	337	0	8	1	0	7	0	344
2004	494	24	46	424	0	2	0	0	2	0	426
2005	491	29	19	397	46	3	0	0	3	0	400
2006	483	29	21	433	0	5	1	0	4	0	437
2007	415	53	99	263	0	4	0	1	3	0	266
2008	400	11	11	378	0	72	2	1	69	0	447
2009	482	22	8	452	0	9	1	0	8	0	460
2010	427	14	25	388	0	7	2	0	5	0	393
2011	398	11	11	376	0	7	0	0	7	0	405
Average[b]	***368***	***27***	***27***	***312***	***2***	***42***	***1***	***3***	***38***	***0***	***351***
Median[b]	***382***	***28***	***21***	***333***	***0***	***8***	***1***	***0***	***7***	***0***	***387***
2012	273	5	1	267	0	1	0	0	1	0	268
2013	256	12	10	234	0	2	0	0	2	0	236
2014	279	18	0	261	0	2	0	0	2	0	263
2015	252	9	0	245	0	0	0	0	0	0	245
2016	271	9	3	259	0	0	0	0	0	0	259
2017	261	8	1	252	0	1	0	0	1	0	253
2018	212	5	0	206	0	4	0	0	4	0	210
Average[c]	***258***	***9***	***2***	***246***	***0***	***1***	***0***	***0***	***1***	***0***	***248***
Median[c]	***261***	***9***	***1***	***252***	***0***	***1***	***0***	***0***	***1***	***0***	***253***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[a] This average represents the program before recalculation in 2011.
[b] This average represents the current program, which began in 2012.

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2016 return consisted primarily of age-4 and age-5 natural-origin Chinook (98.4%). Age-3 and age-6 natural-origin fish made up 1.3% and 0.4% of the broodstock, respectively (Table 8.2). No hatchery Chinook were included in broodstock.

Broodstock collected from the 2017 return consisted primarily of age-4 and age-5 natural-origin Chinook (98.8%). Age-3 and age-6 natural-origin fish made up 0.4% and 0.8% of the broodstock, respectively (Table 8.2). One hatchery Chinook was included in broodstock.

Broodstock collected from the 2018 return consisted primarily of age-4 and age-5 natural-origin Chinook (96.4%). Age-3 and age-6 natural-origin fish made up 3.1% and 0.5% of the broodstock, respectively (Table 8.2). Four hatchery-origin Chinook were included in broodstock.

Table 8.2. Percent of hatchery and wild Wenatchee summer Chinook of different ages (total age) collected from broodstock in the Wenatchee River basin, 1991-2018.

Return Year	Origin	Total age				
		2	3	4	5	6
1991	Wild	0.0	4.6	36.8	57.5	1.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
1992	Wild	0.0	2.6	40.4	50.9	6.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
1993	Wild	0.0	1.5	35.7	60.4	2.3
	Hatchery	0.0	0.0	93.2	6.8	0.0
1994	Wild	0.0	1.0	33.7	64.3	1.0
	Hatchery	0.0	0.0	1.9	98.1	0.0
1995	Wild	0.0	3.3	19.2	76.3	1.2
	Hatchery	0.0	0.0	0.0	0.0	100.0
1996	Wild	0.0	4.6	40.1	53.3	2.0
	Hatchery	0.0	0.0	33.3	66.7	0.0
1997	Wild	0.0	2.3	42.6	53.2	1.9
	Hatchery	0.0	26.7	66.7	6.7	0.0
1998	Wild	0.0	5.5	34.7	58.6	1.2
	Hatchery	0.0	5.3	68.1	20.2	6.4
1999	Wild	0.5	1.9	39.0	56.3	2.3
	Hatchery	0.0	1.3	23.2	72.2	3.4
2000	Wild	2.6	6.3	24.6	66.5	0.0
	Hatchery	0.0	24.2	14.9	42.8	18.0
2001	Wild	0.3	16.6	53.6	27.7	1.7
	Hatchery	0.0	6.1	80.5	10.4	3.0
2002	Wild	0.7	8.4	61.6	28.5	0.7
	Hatchery	0.0	0.0	41.7	58.3	0.0
2003	Wild	0.9	2.8	31.4	64.8	0.0

Return Year	**Origin**	**Total age**				
		2	**3**	**4**	**5**	**6**
	Hatchery	0.0	12.5	25.0	62.5	0.0
2004	Wild	0.2	3.6	10.1	83.9	2.1
	Hatchery	0.0	0.0	50.0	50.0	0.0
2005	Wild	0.0	4.3	53.5	35.1	7.1
	Hatchery	0.0	0.0	0.0	100.0	0.0
2006	Wild	0.9	0.9	14.9	82.1	1.1
	Hatchery	0.0	0.0	0.0	80.0	20.0
2007	Wild	3.1	15.0	18.7	46.6	16.6
	Hatchery	0.0	0.0	0.0	100.0	0.0
2008	Wild	0.5	6.4	65.5	26.0	1.6
	Hatchery	0.0	2.9	13.0	69.6	14.5
2009	Wild	1.1	6.9	45.8	46.8	0.0
	Hatchery	0.0	0.0	11.1	88.9	0.0
2010	Wild	1.0	6.3	66.1	26.6	0.0
	Hatchery	0.0	0.0	62.5	37.5	0.0
2011	Wild	0.8	8.2	50.3	40.4	0.3
	Hatchery	0.0	42.9	14.3	42.9	0.0
2012	Wild	0.0	3.5	47.2	49.2	0.0
	Hatchery	0.0	0.0	0.0	100.0	0.0
2013	Wild	0.0	12.1	57.1	29.1	1.6
	Hatchery	0.0	0.0	50.0	50.0	0.0
2014	Wild	0.0	4.5	74.7	20.0	0.0
	Hatchery	0.0	0.0	100.0	0.0	0.0
2015	Wild	0.0	7.8	33.0	59.1	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
2016	Wild	0.0	1.3	46.1	52.3	0.4
	Hatchery	0.0	0.0	0.0	0.0	0.0
2017	Wild	0.0	0.4	41.2	57.6	0.8
	Hatchery	0.0	0.0	0.0	0.0	100.0
2018	Wild	0.0	3.1	33.3	63.1	0.5
	Hatchery	0.0	0.0	25.0	75.0	0
Average	***Wild***	***0.0***	***5.2***	***41.1***	***51.3***	***1.9***
	Hatchery	***0.0***	***4.5***	***27.7***	***44.2***	***9.5***
Median	***Wild***	***0.0***	***4.3***	***40.1***	***53.3***	***1.1***
	Hatchery	***0.0***	***0.0***	***14.6***	***46.5***	***0.0***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years (Table 8.3).

Table 8.3. Mean fork length (cm) at age (total age) of hatchery and wild Wenatchee summer Chinook collected from broodstock in the Wenatchee River basin, 1991-2018; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	-	0	-	-	4	-	-	32	-	-	50	-	-	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1992	Wild	-	0	-	66	3	10	69	46	5	81	58	3	87	7	1
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	68	6	10	84	138	9	98	235	6	100	9	6
	Hatchery	-	0	-	-	0	-	79	41	8	101	3	8	-	0	-
1994	Wild	-	0	-	74	3	5	86	101	8	96	193	7	106	3	7
	Hatchery	-	0	-	-	0	-	75	1	-	90	53	8	-	0	-
1995	Wild	-	0	-	66	11	8	85	64	7	97	255	6	106	4	7
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	91	16	8
1996	Wild	-	0	-	69	14	5	86	121	6	97	161	6	104	6	5
	Hatchery	-	0	-	-	0	-	63	1	-	96	2	4	-	0	-
1997	Wild	-	0	-	54	5	10	85	92	7	98	115	6	97	4	9
	Hatchery	-	0	-	46	4	2	74	10	4	98	1	-	-	0	-
1998	Wild	-	0	-	66	19	9	85	119	7	99	201	7	106	4	7
	Hatchery	-	0	-	53	5	2	77	64	8	95	19	8	98	6	8
1999	Wild	42	1	-	65	4	6	86	83	6	97	120	7	103	5	8
	Hatchery	-	0	-	52	3	6	79	55	7	90	171	6	100	8	6
2000	Wild	43	7	3	60	17	7	84	67	5	98	181	6	-	0	-
	Hatchery	-	0	-	53	47	7	76	29	8	93	83	7	102	35	9
2001	Wild	48	1	-	66	48	7	88	155	7	97	80	6	102	5	3
	Hatchery	-	0	-	51	10	3	75	132	8	91	17	8	100	5	8
2002	Wild	51	3	3	64	37	8	89	270	7	100	125	7	99	7	5
	Hatchery	-	0	-	-	0	-	78	5	8	95	7	5	-	0	-
2003	Wild	41	4	2	58	13	4	87	144	8	100	297	7	-	0	-
	Hatchery	-	0	-	40	1	-	78	2	4	101	5	8	-	0	-
2004	Wild	51	1	-	69	17	5	84	47	8	99	392	6	109	10	7
	Hatchery	-	0	-	-	0	-	84	1	-	108	1	-	-	0	-
2005	Wild	-	0	-	68	20	7	86	247	8	95	162	6	101	33	6
	Hatchery	-	0	-	-	0	-	-	0	-	90	3	9	-	0	-
2006	Wild	44	4	7	63	4	11	88	66	7	99	363	6	96	5	7
	Hatchery	-	0	-	-	0	-	-	0	-	99	4	7	100	1	-
2007	Wild	44	12	5	65	58	7	89	72	8	99	180	7	102	64	6
	Hatchery	-	0	-	-	0	-	-	0	-	90	4	5	-	0	-
2008	Wild	46	2	3	69	24	7	90	247	6	98	98	7	105	6	9
	Hatchery	-	0	-	63	2	14	81	9	7	93	48	6	99	10	5
2009	Wild	46	5	5	68	31	8	89	207	8	101	209	6	-	0	-

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	61	4	7	81	1	-	98	8	14	-	0	-
2010	Wild	45	4	4	70	26	9	89	273	7	99	110	6	-	0	-
	Hatchery	-	0	-	-	0	-	72	5	8	88	3	7	-	0	-
2011	Wild	49	3	3	66	30	7	88	183	7	98	147	7	114	1	-
	Hatchery	-	0	-	55	3	2	90	1	-	81	3	5	-	0	-
2012	Wild	-	0	-	71	9	4	87	120	7	96	125	7	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	83	1	-	-	0	-
2013	Wild	-	0	-	72	30	3	87	141	7	98	72	7	97	4	6
	Hatchery	-	0	-	-	0	-	79	1	-	96	1	-	-	0	-
2014	Wild	-	0	-	74	12	5	88	198	6	98	53	7	-	0	-
	Hatchery	-	0	-	-	0	-	86	2	6	-	0	-	-	0	-
2015	Wild	-	0	-	72	18	3	86	76	6	98	136	6	-	0	-
	Hatchery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Wild	-	0	-	70	3	8	86	106	7	95	121	7	99	1	-
	Hatchery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	Wild	-	0	-	64	103	5	81	103	7	93	144	7	92	2	4
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	98	1	-
2018	Wild	-	0	-	70	6	3	85	65	6	92	123	7	97	1	-
	Hatchery	-	0	-	-	0	-	64	1	-	90	3	5	-	0	-
Average	***Wild***	***45.8***	***2.1***	***3.9***	***66.9***	***20.5***	***6.7***	***85.8***	***128.0***	***6.9***	***96.9***	***160.9***	***6.4***	***101.1***	***7***	***6.1***
	Hatchery	***-***	***0***	***-***	***52.7***	***4.2***	***5.4***	***77.3***	***15.0***	***6.9***	***93.6***	***17.6***	***7.1***	***98.5***	***4.8***	***7.3***

Sex Ratios

Male summer Chinook in the 2016, 2017, and 2018 broodstock made up about 49.6%, 49.8%, and 44.3% of the adults collected, resulting in overall male to female ratios of 0.99:1.00, 0.99:1.00, and 0.80:1.00, respectively (Table 8.4). The ratios in 2016-2017 were nearly equal to the 1:1 ratio goal in the broodstock protocol.

Table 8.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock in the Wenatchee River basin, 1989-2018. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	166	180	0.92:1.00	0	0	-	0.92:1.00
1990	45	39	1.15:1.00	0	0	-	1.15:1.00
1991	60	68	0.88:1.00	0	0	-	0.88:1.00
1992	154	187	0.82:1.00	0	0	-	0.82:1.00
1993	208	228	0.91:1.00	35	9	3.89:1.00	1.03:1.00
1994	158	179	0.88:1.00	24	31	0.77:1.00	0.87:1.00
1995	169	213	0.79:1.00	1	15	0.07:1.00	0.75:1.00

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1996	150	181	0.83:1.00	2	1	2.00:1.00	0.84:1.00
1997	104	121	0.86:1.00	15	0	-	0.98:1.00
1998	211	167	1.26:1.00	64	30	2.13:1.00	1.40:1.00
1999	130	120	1.08:1.00	108	130	0.83:1.00	0.95:1.00
2000	153	145	1.06:1.00	112	82	1.37:1.00	1.17:1.00
2001	187	124	1.51:1.00	132	50	2.64:1.00	1.83:1.00
2002	266	203	1.31:1.00	5	8	0.63:1.00	1.28:1.00
2003	270	218	1.24:1.00	5	3	1.67:1.00	1.24:1.00
2004	230	264	0.87:1.00	1	1	1.00:1.00	0.87:1.00
2005	291	200	1.46:1.00	2	1	2.00:1.00	1.46:1.00
2006	237	246	0.96:1.00	1	4	0.25:1.00	0.95:1.00
2007	239	176	1.36:1.00	2	2	1.00:1.00	1.35:1.00
2008	208	192	1.08:1.00	29	43	0.67:1.00	1.01:1.00
2009	223	236	0.94:1.00	25	7	3.57:1.00	1.02:1.00
2010	217	198	1.10:1.00	5	2	2.50:1.00	1.12:1.00
2011	198	200	0.99:1.00	4	3	1.33:1.00	0.99:1.00
2012	138	135	1.02:1.00	1	0	-	1.03:1.00
2013	127	130	0.98:1.00	1	1	1.00:1.00	0.98:1.00
2014	140	139	1.01:1.00	0	2	0.00:1.00	0.99:1.00
2015	122	123	0.99:1.00	0	0	--	0.99:1.00
2016	134	136	0.99:1.00	0	0	--	0.99:1.00
2017	130	131	0.99:1.00	0	1	--	0.98:1.00
2018	94	118	0.80:1.00	1	3	0.33:1.00	0.79:1.00
Total	***5,159***	***4,997***	***1.03:1.00***	***575***	***429***	***1.34:1.00***	***1.06:1.00***

Fecundity

Fecundities for the 2016-2018 returns of summer Chinook averaged 4,423, 4,361, and 4,298 eggs per female, respectively (Table 8.5). These values are less than the overall average of 5,047 eggs per female. Mean observed fecundities for the 2016-2018 returns were lower than the expected fecundities of 4,902, 4,834, and 4,697 eggs per female assumed in the broodstock collection protocols, respectively.

Table 8.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock in the Wenatchee River basin, 1989-2018; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	5,280
1990*	NA	NA	5,436
1991*	NA	NA	4,333

Return year	Mean fecundity		
	Wild	Hatchery	Total
1992*	NA	NA	5,307
1993*	NA	NA	5,177
1994*	NA	NA	5,899
1995*	NA	NA	4,402
1996*	NA	NA	4,941
1997	5,385	5,272	5,390
1998	5,393	4,825	5,297
1999	5,036	4,942	4,987
2000	5,464	5,403	5,441
2001	5,280	4,647	5,097
2002	5,502	5,027	5,484
2003	5,357	5,696	5,361
2004	5,372	6,681	5,377
2005	5,045	6,391	5,053
2006	5,126	5,633	5,133
2007	5,124	4,510	5,115
2008	5,147	4,919	5,108
2009	5,308	4,765	5,291
2010	4,971	3,323	4,963
2011	4,943	2,983	4,913
2012	4,801	NA	4,801
2013	4,987	5,272	4,990
2014	4,788	4,429	4,756
2015	4,982	NA	4,982
2016	4,423	NA	4,423
2017	4,351	5,621	4,361
2018	4,303	4,097	4,298
Average	***5,049***	***4,970***	***5,047***
Median	***5,085***	***4,942***	***5,103***

* Individual fecundities were not tracked with females until 1997.

To estimate fecundities by length, weight, and age[34], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2003 through 2018 broodstock (complete data for all variables are available for years 2014-2018). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass for natural-origin summer Chinook (very few hatchery fish were examined because they were not targeted for broodstock). Hatchery staff randomly sampled about fifty females.

[34] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

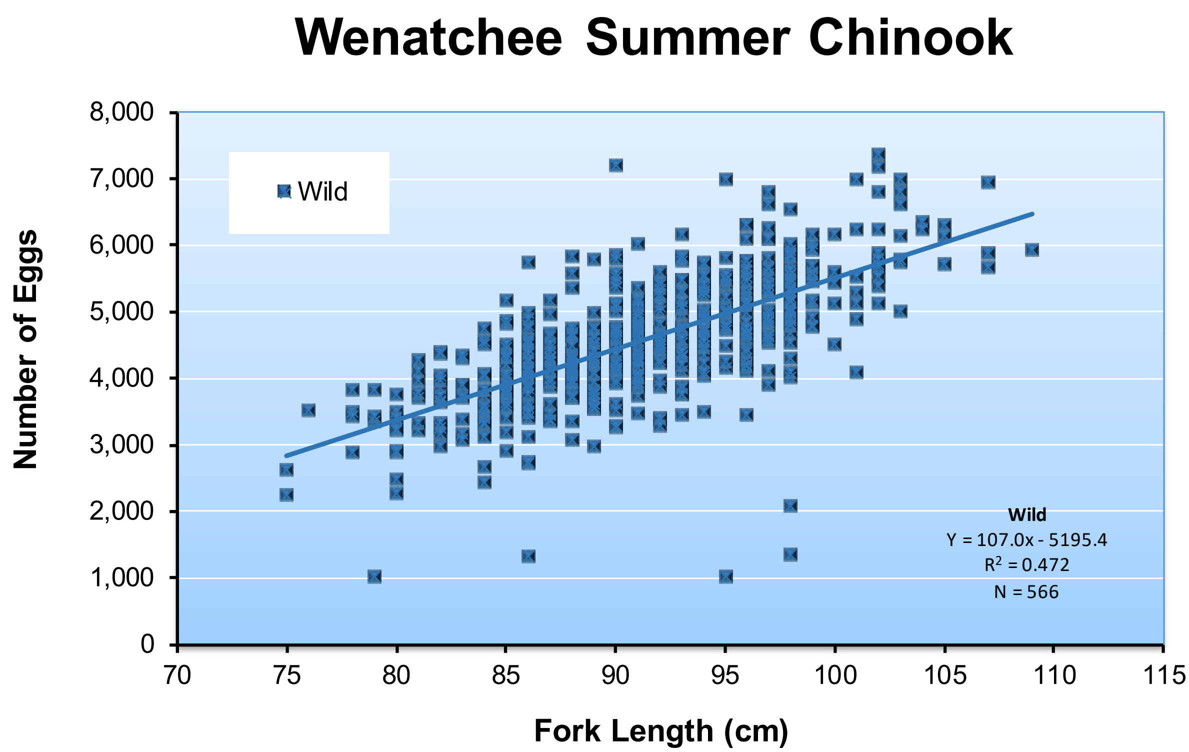
On average, mean fecundities for natural-origin age-3 and age-4 Chinook were 3,897 and 4,494 eggs, respectively. Although hatchery-origin fish were not targeted for inclusion in broodstock, mean fecundity by age varied between natural-origin and the few hatchery-origin summer Chinook over time (Table 8.6).

Table 8.6. Mean fecundity by age (total age) for hatchery and wild summer Chinook collected from broodstock for the Wenatchee River program, brood years 2003-2018; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2003	Wild	-	0	-	4,643	23	601	5,463	126	832	-	0	-
	Hatchery	-	0	-	-	0	-	5,696	2	603	-	0	-
2004	Wild	-	0	-	4,419	6	753	5,387	223	746	6,181	4	877
	Hatchery	-	0	-	-	0	-	6,681	1	-	-	0	-
2005	Wild	-	0	-	4,823	56	716	5,047	85	762	5,846	17	778
	Hatchery	-	0	-	-	0	-	6,391	1	-	-	0	-
2006	Wild	-	0	-	4,503	14	791	5,264	186	889	5,000	4	1,049
	Hatchery	-	0	-	-	0	-	5,633	3	224	-	0	-
2007	Wild	-	0	-	4,829	24	952	5,123	73	911	5,445	18	1,023
	Hatchery	-	0	-	-	0	-	4,510	2	685	-	0	-
2008	Wild	-	0	-	5,019	113	807	5,448	57	658	4,756	2	286
	Hatchery	-	0	-	4,124	3	425	4,841	27	714	5,389	8	1,015
2009	Wild	-	0	-	4,947	98	814	5,612	116	822	-	0	-
	Hatchery	-	0	-	-	0	-	3,944	1	-	-	0	-
2010	Wild	1,631	1	-	4,891	123	756	5,219	59	884	-	0	-
	Hatchery	-	0	-	-	0	-	3,323	1	-	-	0	-
2011	Wild	3,780	1	-	4,727	84	739	5,155	91	818	-	0	-
	Hatchery	-	0	-	-	0	-	2,983	3	761	-	0	-
2012	Wild	-	0	-	4,697	39	680	4,857	83	848	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2013	Wild	-	0	-	4,730	61	887	5,280	45	1,048	5,181	3	767
	Hatchery	-	0	-	-	0	-	5,272	1	-	-	0	-
2014	Wild	-	0	-	4,658	87	893	5,164	31	796	-	0	-
	Hatchery	-	0	-	4,429	2	1,906	-	0	-	-	0	-
2015	Wild	-	0	-	4,332	25	761	5,159	92	827	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2016	Wild	-	0	-	4,198	55	596	4,550	69	870	5,690	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	3,897	34	764	4,494	84	803	5,002	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	5,621	1	-
2018	Wild	-	0	-	4,137	27	737	4,398	75	759	3,897	1	-

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	4,453	3	867	-	0	-
Average	***Wild***	***-***	***0***	***-***	***4,591***	***0***	***-***	***5,101***	***93***	***830***	***5,222***	***3***	***797***
	Hatchery	***-***	***0***	***-***	***4,277***	***0***	***-***	***4,884***	***3***	***642***	***5,505***	***1***	***1,015***

We pooled fecundity data from brood years 2014 through 2018 (years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg mass for natural-origin females are shown in Figures 8.1, 8.2, and 8.3. All fecundity variables increase linearly with fork length.



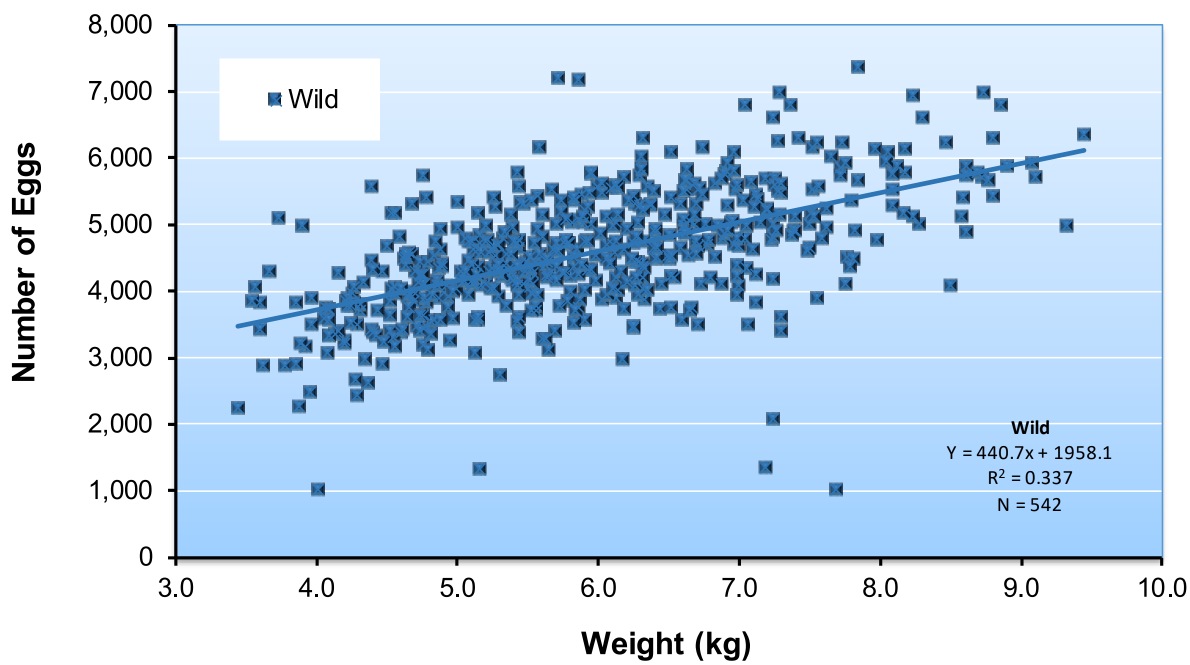


Figure 8.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural-origin summer Chinook for return years 2014-2018.

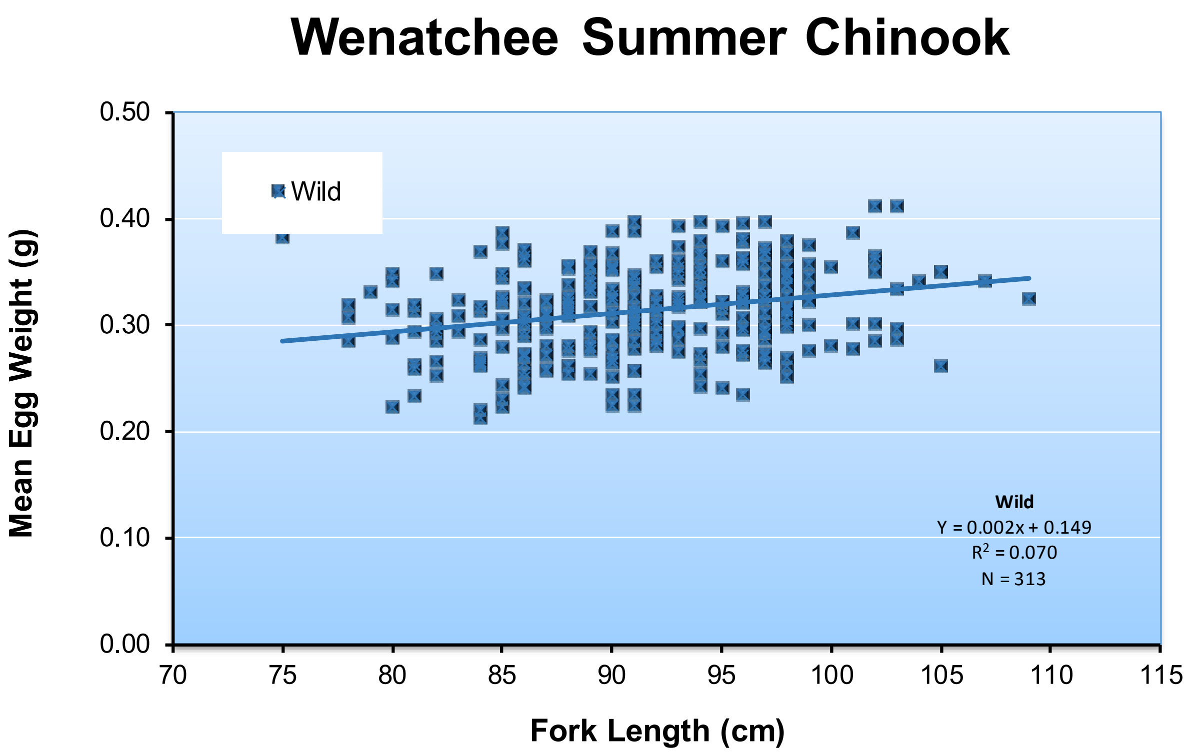


Figure 8.2. Relationships between mean egg weight and fork length for natural-origin summer Chinook for return years 2014-2018.

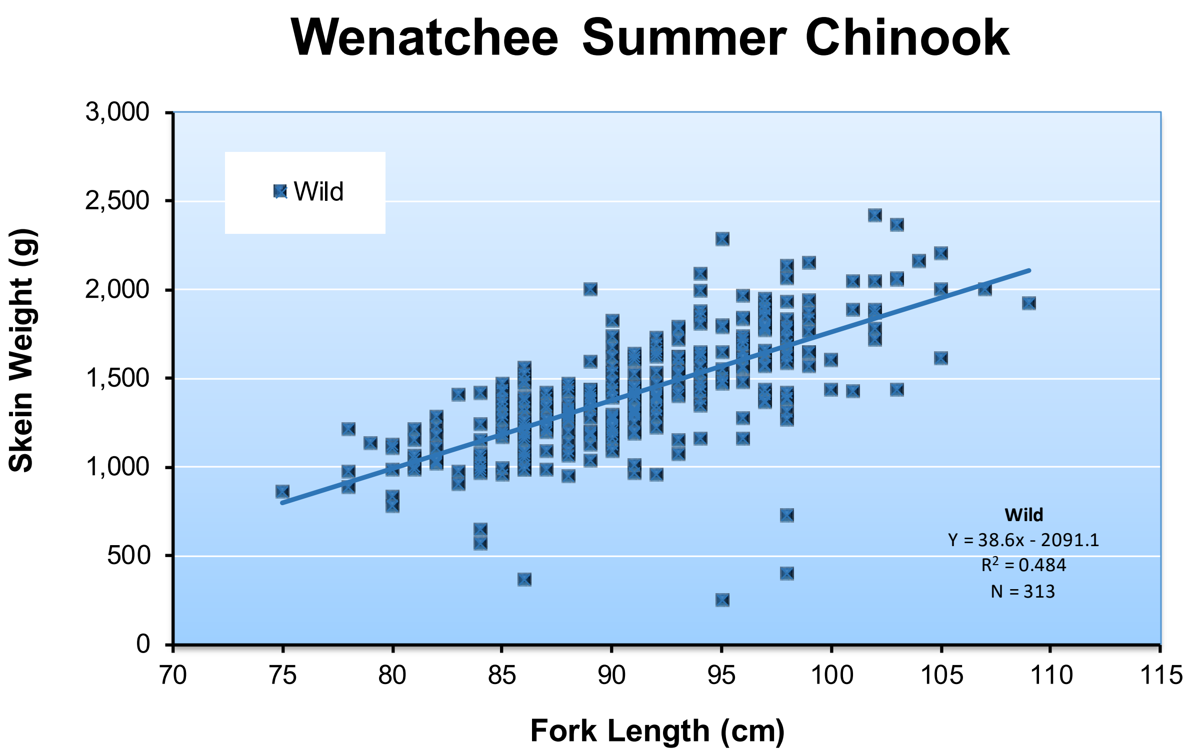


Figure 8.3. Relationships between skein weight and fork length for natural-origin summer Chinook for return years 2014-2018.

8.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 1,066,667 eggs were required to meet the program release goal of 864,000 smolts for brood years 1989-2011. An evaluation of the program in 2011 determined that 617,285 eggs are needed to meet the revised release goal of 500,001 smolts. This revised goal began with brood year 2012. From 1989 to 2011, the egg take goal was reached in seven of those years (Table 8.7). The average egg take goal of 608,700 eggs was achieved twice from 2013-2018.

Table 8.7. Numbers of eggs taken from Wenatchee summer Chinook broodstock, 1989-2018.

Return year	Number of eggs taken
1989	829,012
1990	163,109
1991	247,000
1992	827,911
1993	1,133,852
1994	999,364

Return year	Number of eggs taken
1995	949,531
1996	756,000
1997	554,617
1998	854,997
1999	1,182,130
2000	1,113,159
2001	733,882
2002	1,049,255
2003	901,095
2004	1,311,051
2005	883,669
2006	1,190,757
2007	655,201
2008	1,145,330
2009	1,217,028
2010	947,875
2011	959,202
Average (1989-2011)	***895,871***
Median (1989-2011)	***947,875***
2012	633,677
2013	578,513
2014	612,422
2015	610,718
2016	588,606
2017	550,478
2018	498,527
Average (2012-present)	***581,849***
Median (2012-present)	***588,606***

Number of acclimation days

The 2016 brood Wenatchee summer Chinook were transferred to the Dryden Acclimation Pond between 7-9, 12-14, and 24 March 2018. These fish received 24-83 days of acclimation on Wenatchee River water before being released volitionally from 17-April to 30 May 2018 (Table 8.8).

Table 8.8. Number of days Wenatchee summer Chinook were acclimated at Dryden Acclimation Pond, brood years 1989-2016. Numbers in parenthesis represents the number of days fish reared at Chiwawa Acclimation Facility.

Brood year	Release year	Transfer date	Release date	Number of days
1989	1991	2-Mar	7-May	66
1990	1992	19-Feb	2-May	73
1991	1993	10-Mar	8-May	59
1992	1994	1-Mar	6-May	66
1993	1995	3-Mar	1-May	59
1994	1996	2-Oct	6-May	217 (154)
		5-Mar	6-May	62
1995	1997	16-Oct	8-May	205 (139)
		27-Feb	8-May	70
1996	1998	6-Oct	28-Apr	204 (142)
		25-Feb	28-Apr	62
1997	1999	23-Feb	27-Apr	63
1998	2000	5-Mar	1-May	57
1999	2001	8-Mar	23-Apr	46
2000	2002	1-Mar	6-May	66
2001	2003	19-Feb	23-Apr	63
2002	2004	5-Mar	23-Apr	49
2003	2005	15-Mar	25-Apr	41
2004	2006	25-Mar	27-Apr	33
2005	2007	15-Mar	30-Apr	46
2006	2008	11-14-Mar	28-Apr	45-48
2007	2009	30-31-Mar	29-Apr	29-30
2008	2010	9-12, 15, 22-Mar	28-Apr	38-51
2009	2011	15-18, 21-Mar, 22-Apr	26-Apr	5-43
2010	2012	26-30-Mar	25-Apr	26-30
2011	2013	25-29-Mar	24-Apr	26-30
2012	2014	17-27-Mar	30-Apr	34-44
2013	2015	9-13-Mar, 17-Apr	28-Apr	11-50
2014	2016	21-24-Mar	18-27-Apr	25-37
2015	2017	13-15-Mar	17-26-Apr	33-44
2016	2018	7-9, 12-14, 24 Mar	17 Apr- 30 May	24-83

Release Information

Numbers released

The 2016 Wenatchee summer Chinook program achieved 98.7% of the 500,001 goal with 493,333 fish being released in 2018 (Table 8.9). For brood years 2012-2016, the Wenatchee summer Chinook program has averaged 103% of the smolt obligation.

Table 8.9. Numbers of Wenatchee summer Chinook smolts released from the hatchery, brood years 1989-2016. Up to 2012, the release target for Wenatchee summer Chinook was 864,000 smolts. Beginning in 2012, the release target is 500,001 smolts. CWT marking rates include adjustments for tag loss before the fish were released.

Brood year	Release year	CWT mark rate	Number released with PIT tags	Number of smolts released
1989	1991	0.2013	0	720,000
1990	1992	0.9597	0	124,440
1991	1993	0.9957	0	191,179
1992	1994	0.9645	0	627,331
1993	1995	0.9881	0	900,429
1994	1996	0.9697	0	797,350
1995	1997	0.9725	0	687,439
1996	1998	0.9758	0	600,127
1997	1999	0.9913	0	438,223
1998	2000	0.9869	0	649,612
1999	2001	0.9728	0	1,005,554
2000	2002	0.9723	0	929,496
2001	2003	0.9868	0	604,668
2002	2004	0.9644	0	835,645
2003	2005	0.9778	0	653,764
2004	2006	0.9698	0	892,926
2005	2007	0.9596	0	644,182
2006	2008	0.9676	0	51,550[a]
		0.9676	0	899,107
2007	2009	0.9768	0	456,805
2008	2010	0.9664	10,035	888,811
2009	2011	0.9767	29,930	843,866
2010	2012	0.9964	0	792,746
2011	2013	0.9904	5,020	827,709
Average (1989-2011)		***0.9761***	***1,874***	***667,085***
Median (1989-2011)		***0.9727***	***0***	***720,000***
2012	2014	0.9700	19,911	550,877
2013	2015	0.9872	20,486	470,570

Brood year	Release year	CWT mark rate	Number released with PIT tags	Number of smolts released
2014	2016	0.9639	10,432	535,255
2015	2017	0.9831	20,605	525,366
2016	2018	0.9976	20,677	493,333
Average (2012-present)		***0.9804***	***18,422***	***515,080***
Median (2012-present)		***0.9831***	***20,486***	***525,366***

[a] Represents high ELISA group planted directly in the Wenatchee River at Leavenworth Boat Launch.

Numbers tagged

The 2016 brood Wenatchee summer Chinook were 99.8% CWT[35] and adipose fin-clipped (Table 8.9).

2017 Brood Wenatchee Summer Chinook (Raceway)—A total of 10,500 Wenatchee summer Chinook were tagged at Eastbank Hatchery on 29 October to 1 November 2018. These were tagged and released into raceway #13. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 96 mm in length and 10.2 g at time of tagging.

2017 Brood Wenatchee Summer Chinook (Reuse Circular Ponds)—A total of 10,498 Wenatchee summer Chinook were tagged at Eastbank Hatchery on 22-26 October 2018. These were tagged and released into water-reuse circular ponds #1 and #2. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 92 mm in length and 9.4 g at time of tagging.

Table 8.10 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Wenatchee River.

Table 8.10. Summary of PIT-tagging activities for Wenatchee hatchery summer Chinook, brood years 2008-2016.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	10,100	64	1	10,035
2009	2011	10,108 (Control)	140	3	9,965
		10,100 (R1)	129	0	9,971
		10,099 (R2)	105	0	9,994
2010	2012	0	0	0	0
2011	2013	5,100	80	0	5,020
2012	2014 (Raceway)	5,150 (small-size)	90	12	5,048
		5,153 (big-size)	379	34	4,740
		5,150 (small-size)	109	0	5,041

[35] Sixty days after tagging, taggers conduct a quality control procedure, which includes collecting a sample of tagged fish and scanning for tag retention. Thus, the number of tagged fish released is adjusted for tag loss.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
	2014 (Reuse Circular)	5,151 (big-size)	69	0	5,082
2013	2015 (Raceway)	5,150 (small-size)	44	0	5,116
		5,153 (big-size)	31	0	5,129
	2015 (Reuse Circular)	5,150 (small-size)	41	0	5,120
		5,151 (big-size)	38	1	5,121
2014	2016 (Raceway)	5,250 (small-size)	54	0	5,196
		5,250 (big-size)	92	0	5,158
	2016 (Reuse Circular)	5,250 (small-size)	19	0	5,231
		5,250 (big-size)	49	0	5,201
2015	2017 (Raceway)	10,565	213	0	10,352
	2017 (Reuse Circular)	10,429	176	0	10,253
2016	2018 (Raceway)	10,500	126	3	10,371
	2018 (Reuse Circular)	10,500	188	6	10,306

Fish size and condition at release

About 493,333 summer Chinook from the 2016 brood were released volitionally from Dryden Acclimation Pond on 17 April to 30 May 2018. Assessing size-target achievement from pre-release sampling was not practical because of size-target studies on the 2012 and 2013 brood years. However, since the program began, Wenatchee summer Chinook have not met the target length and CV values (Table 8.11). The target weight (fish/pound or FPP) of juvenile fish has been met in some years. (Table 8.11).

Table 8.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Wenatchee summer Chinook smolts released from the hatchery, brood years 1989-2016; NA = not available. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	158	13.7	45.4	10
1990	1992	155	14.2	45.4	10
1991	1993	156	15.5	42.3	11
1992	1994	152	13.1	40.1	10
1993	1995	149	NA	34.9	13
1994	1996	138	NA	21.7	21
1995	1997	149	12.2	42.5	11
1996	1998	151	16.6	43.2	10

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1997	1999	154	10.1	42.8	11
1998	2000	166	9.7	53.1	9
1999	2001	137	16.1	29.0	16
2000	2002	148	14.6	37.1	12
2001	2003	148	NA	38.9	12
2002	2004	146	15.1	37.3	14
2003	2005	147	13.2	36.5	12
2004	2006	147	10.7	35.4	13
2005	2007	153	16.3	40.6	11
2006	2008	136	21.5	29.2	16
2007	2009	163	21.6	49.7	9
2008	2010	166	15.0	52.0	9
2009	2011	152	15.9	39.0	12
2010	2012	154	17.2	43.1	11
2011	2013	149	13.8	41.4	11
Average (1989-2011)		***151***	***14.8***	***40.0***	***12***
Targets (1989-2011)		***176***	***9.0***	***45.4***	***10***
2012	2014	158	12.6	40.7	11
2013	2015	156	10.1	40.7	11
2014	2016	145	10.2	31.1	15
2015	2017	139	9.5	29.8	15
2016	2018	140	9.2	29.2	16
Average (2012-present)		***148***	***10.3***	***34.0***	***14***
Targets (2012-present)[a]		***163***	***9.0***	***45.4***	***18***

[a] For brood year 2012, the fish per pound (fpp) targets were 10 fpp and 15 fpp.

Survival Estimates

Overall survival of the 2016 brood Wenatchee summer Chinook from green (unfertilized) egg to release was higher than the standard set for the program. This was in part because of a high survival at most stages (Table 8.12).

Table 8.12. Hatchery life-stage survival rates (%) for Wenatchee summer Chinook, brood years 1989-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	90.0	93.4	90.9	97.0	99.7	99.3	98.5	99.4	86.9
1990	89.7	95.6	80.9	96.6	99.6	99.2	97.7	98.8	76.3
1991	88.2	98.3	86.9	96.1	99.3	98.5	94.9	98.1	77.4

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1992	84.3	92.2	79.8	97.8	99.9	99.9	97.1	98.1	75.8
1993	92.4	95.9	84.2	97.5	99.6	99.3	96.7	98.8	79.4
1994	90.7	95.3	83.7	100	99.2	97.0	95.3	98.4	79.8
1995	94.7	98.2	86.0	100	96.7	96.4	74.9	90.8	72.4
1996	84.6	96.1	84.1	100	97.9	97.7	94.4	97.7	79.4
1997	89.3	98.3	82.6	97.3	97.1	96.9	98.3	98.2	79.0
1998	85.3	94.6	80.9	98.3	99.4	98.6	95.6	99.8	76.0
1999	98.4	98.3	90.4	97.9	98.1	97.9	96.2	99.4	85.1
2000	93.0	96.6	88.3	98.0	99.6	99.3	96.5	98.9	83.5
2001	87.4	91.5	90.6	97.7	99.8	99.6	93.1	93.3	82.4
2002	93.8	94.1	85.1	99.8	98.1	97.6	93.7	96.5	79.6
2003	77.4	85.1	80.5	98.1	99.6	99.1	91.9	93.5	72.6
2004	92.8	97.8	85.7	87.8	99.9	99.6	86.6	92.1	65.1
2005	97.3	89.6	83.5	98.0	99.7	99.4	89.1	99.5	72.9
2006	92.4	95.2	85.6	98.4	99.3	98.4	94.8	97.2	79.8
2007	73.6	97.5	73.7	97.9	99.5	98.7	96.6	99.1	69.7
2008	96.6	97.9	90.4	97.3	99.4	98.7	88.2	89.6	77.6
2009	95.1	95.6	92.0	99.6	97.3	97.3	84.8	98.2	78.1
2010	94.7	97.8	96.1	99.3	97.6	97.1	87.2	90.3	83.2
2011	98.0	96.4	92.3	97.9	99.5	98.9	95.9	97.3	86.7
2012	97.8	97.2	92.3	98.1	99.7	99.1	96.1	97.3	86.9
2013	91.5	98.4	87.5	98.8	97.1	96.6	94.1	98.4	81.3
2014	92.2	95.0	92.6	99.4	99.6	98.7	97.8	99.3	90.0
2015	96.2	97.7	89.8	97.8	99.7	99.4	98.2	99.4	86.2
2016	97.1	96.3	88.3	98.4	99.8	99.5	96.4	97.4	83.8
Average	***91.2***	***95.6***	***86.6***	***97.9***	***99.0***	***98.5***	***93.6***	***97.0***	***79.5***
Median	***92.4***	***96.2***	***86.5***	***98.0***	***99.5***	***98.7***	***95.5***	***98.2***	***79.5***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

8.3 Disease Monitoring

Rearing of the 2016 brood Wenatchee summer Chinook was similar to previous years with fish being held on well water before being transferred to Dryden Acclimation Pond for final acclimation in March 2018. Fish were transferred to Dryden Acclimation Pond from 7-9, 12-14, 24 March. A 10-day prophylactic treatment of formalin occurred at Dryden Acclimation Pond at the beginning of acclimation to prevent a possible outbreak of external fungus.

Results of the 2018 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females (100%) had ELISA values less than 0.199. Additionally, all females had ELISA values less than 0.120, which means that none of the progeny needed to be reared at densities less than 0.06 fish per pound (Table 8.13).

Table 8.13. Proportion of bacterial kidney disease (BKD) titer groups for the Wenatchee summer Chinook broodstock, brood years 1997-201. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.7714	0.0857	0.0381	0.1048	0.8095	0.1905
1998	0.3067	0.2393	0.1656	0.2883	0.4479	0.5521
1999	0.9590	0.0123	0.0123	0.0164	0.9713	0.0287
2000	0.6268	0.1053	0.1627	0.1053	0.7321	0.2679
2001	0.6513	0.0263	0.0987	0.2237	0.6776	0.3224
2002	0.7868	0.0457	0.0711	0.0964	0.8325	0.1675
2003	0.9825	0.0000	0.0058	0.0117	0.9825	0.0175
2004	0.9593	0.0081	0.0163	0.0163	0.9675	0.0325
2005	0.9833	0.0056	0.0000	0.0111	0.9833	0.0167
2006	0.9134	0.0563	0.0000	0.0303	0.9351	0.0649
2007	0.9535	0.0078	0.0078	0.0310	0.9535	0.0465
2008	0.9868	0.0088	0.0044	0.0000	0.9868	0.0132
2009	0.9957	0.0000	0.0000	0.0043	0.9957	0.0043
2010	0.9897	0.0025	0.0000	0.0025	0.9949	0.0051
2011	0.9585	0.0363	0.0000	0.0052	0.9896	0.0104
2012	0.9697	0.0303	0.0000	0.0000	1.0000	0.0000
2013	0.8120	0.1790	0.0000	0.0090	0.8890	0.1110
2014	0.9462	0.0154	0.0000	0.0385	0.9462	0.0538
2015	0.9919	0.0000	0.0000	0.0081	0.9919	0.0081
2016	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2017	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2018	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
Average	***0.8883***	***0.0393***	***0.0265***	***0.0456***	***0.9130***	***0.0870***
Median	***0.9592***	***0.0106***	***0.0000***	***0.0114***	***0.9769***	***0.0231***

[a] Individual ELISA samples were not collected before the 1997 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

8.4 Natural Juvenile Productivity

During 2018, juvenile summer Chinook were sampled at the Lower Wenatchee Trap located near the town of Cashmere. The Lower Wenatchee Trap was moved to its present location in 2013 and smolt abundance estimates occur at this location.

Emigrant Estimates

Lower Wenatchee Trap

The Lower Wenatchee River Trap operated between 22 March and 24 July 2018. During that time, the trap was inoperable for 18 days because of high or low river discharge, debris, elevated river temperatures, large hatchery releases, and mechanical issues. During the sampling period, 47,283 wild subyearling Chinook were captured at the Lower Wenatchee Trap. Based on seven capture efficiency trials, a significant relationship between trap efficiency and river discharge was created ($R^2 = 0.72$, $P < 0.02$) and an estimated 5,823,795 (±855,856; 95% CI) wild subyearling Chinook passed the trap within the sampling period (Table 8.14).

Table 8.14. Numbers of redds and juvenile summer Chinook emigrants in the Wenatchee River basin for brood years 1999-2017; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere.

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
1999	2,738	13,654,406	9,572,392	9,685,591
2000	2,540	13,820,140	1,299,476	1,322,383
2001	3,550	18,094,350	8,229,920	8,340,342
2002	6,836	37,488,624	13,167,855	13,475,368
2003	5,268	28,241,748	20,336,968	20,426,149
2004	4,874	26,207,498	14,764,141	14,935,745
2005	3,538	17,877,514	11,612,939	11,695,581
2006	8,896	45,663,168	9,397,044	9,595,512
2007	1,970	10,076,550	4,470,672	4,546,838
2008	2,800	14,302,400	4,309,496	4,405,473
2009	3,441	18,206,331	6,695,977	6,814,805
2010	3,261	16,184,343	NS	NS
2011	3,078	15,122,214	NS	NS
2012	2,504	12,021,704	9,333,214	10,034,508
2013	3,241	16,162,867	11,936,928	12,605,925
2014	3,458	16,556,904	14,157,778	14,763,064
2015	1,804	11,491,325	4,023,310	4,199,697
2016	2,797	12,371,131	7,593,243	8,505,733
2017	3,896	16,951,496	5,823,795	6,254,015
Average	***3,710***	***18,973,406***	***9,219,126***	***9,506,278***
Median	***3,261***	***16,184,343***	***9,333,214***	***9,595,512***

A total of 268 summer Chinook redds were observed downstream from the trap in 2017. Thus, the total number of summer Chinook emigrating from the Wenatchee River in 2018 was expanded using the ratio of the number of redds downstream from the trap to the number upstream from the trap. This resulted in a total summer Chinook emigrant estimate of 6,254,015 fish (Table 8.14). Most of the fish emigrated during April through June (Figure 8.4). Monthly captures and mortalities of all fish collected at the Lower Wenatchee Trap are reported in Appendix C.

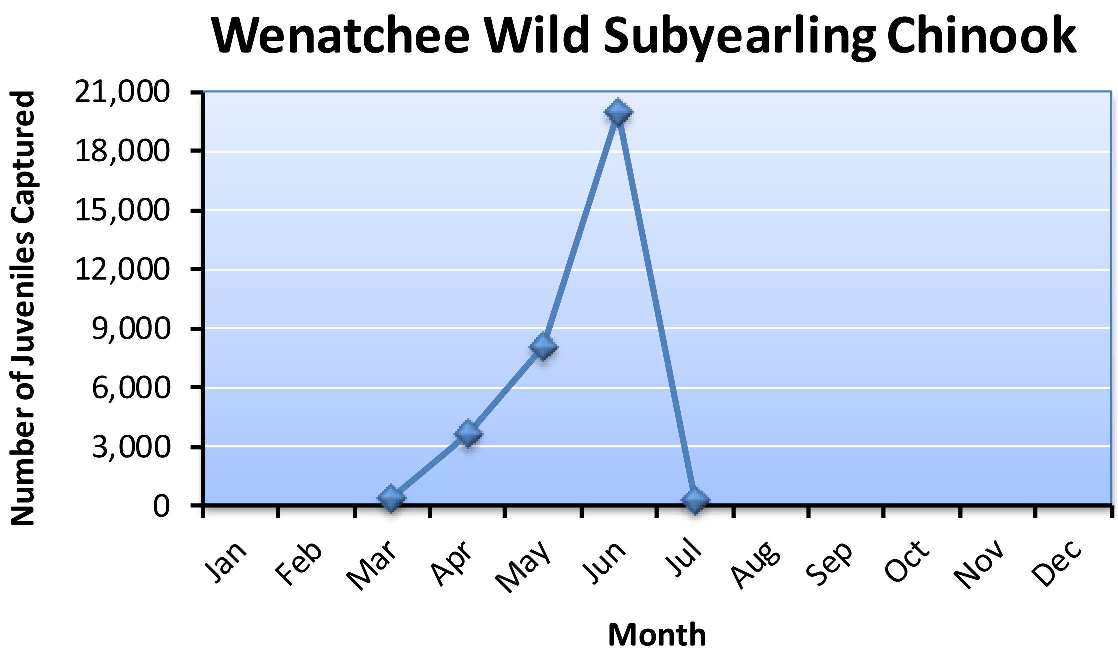


Figure 8.4. Numbers of wild subyearling Chinook captured at the Lower Wenatchee Trap during late January through July 2018.

Subyearling summer Chinook sampled in 2018 averaged 50 mm in length, 1.7 g in weight, and had a mean condition of 0.97 (Table 8.15). These size estimates were similar to the overall mean of subyearling summer Chinook sampled in previous years (overall means: 49 mm, 1.7 g, and condition of 0.98).

Table 8.15. Mean fork length (mm), weight (g), and condition factor of subyearling summer Chinook collected in the Lower Wenatchee Trap, 2000-2018; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2000	1,069	55 (16)	1.7 (2.2)	1.01 (0.29)
2001	402	48 (13)	2.3 (1.9)	1.03 (0.17)
2002	2,259	58 (18)	3.0 (2.7)	1.04 (0.17)
2003	818	47 (14)	2.8 (2.6)	1.09 (0.16)
2004	1,723	46 (11)	1.2 (1.5)	0.91 (0.20)

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2005	2,947	43 (7)	1.0 (1.0)	0.91 (0.21)
2006	2,863	50 (15)	1.8 (2.0)	0.96 (0.23)
2007	3,061	48 (13)	1.4 (1.8)	0.92 (0.21)
2008	2,201	48 (13)	1.5 (1.7)	1.03 (0.27)
2009	2,474	49 (14)	1.6 (2.0)	0.98 (0.21)
2010	2,366	45 (10)	1.0 (1.2)	0.94 (0.23)
2011	NS	NS	NS	NS
2012	NS	NS	NS	NS
2013	4,431	52 (17)	2.0 (2.5)	0.99 (0.30)
2014	5,107	45 (11)	1.1 (1.3)	0.92 (0.20)
2015	4,560	46 (11)	1.5 (1.5)	0.96 (0.24)
2016	5,998	53 (15)	2.0 (1.9)	0.99 (0.17)
2017	3,417	54 (12)	1.8 (1.5)	1.02 (0.16)
2018	3,895	50 (12)	1.7 (1.7)	0.97 (0.17)
Average	***3,074***	***49***	***1.7***	***0.98***
Median	***3,074***	***49***	***1.7***	***0.98***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

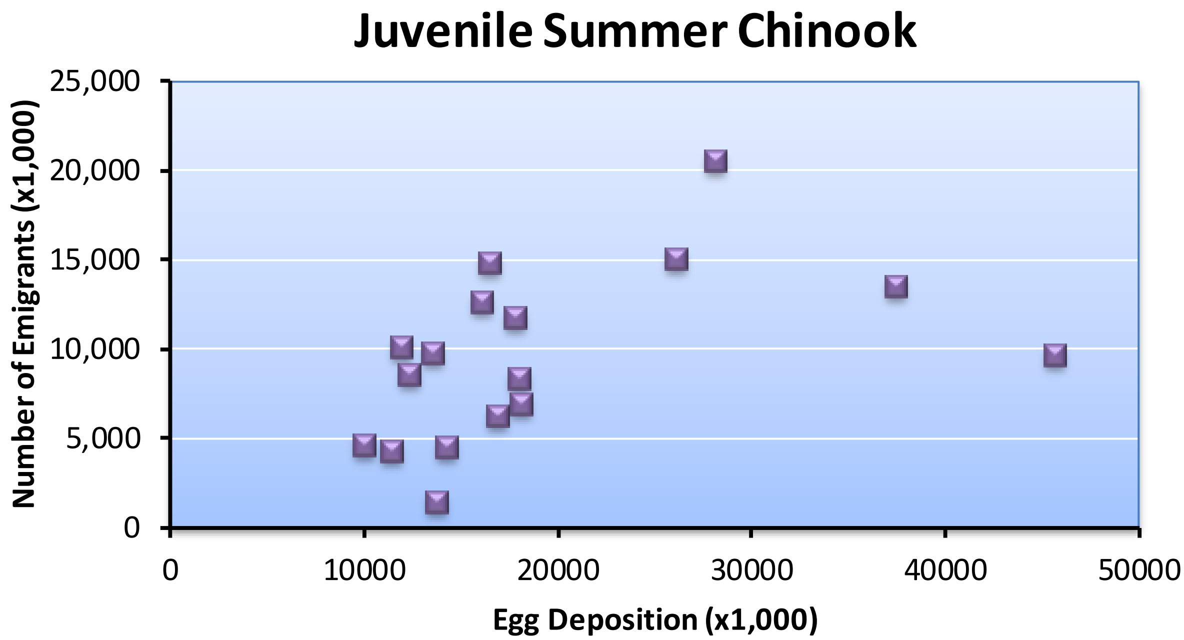
Both productivity and survival estimates for juvenile emigrants of summer Chinook in the Wenatchee River basin are provided in Table 8.16. Estimates for brood year 2017 were within the range of estimates for brood years 1999-2016. During the period 1999-2017, freshwater productivities ranged from 521-4,269 emigrants/redd. Survivals during the same period ranged from 9.6-89.2% for egg-emigrants.

Table 8.16. Productivity (emigrants/redd) and survival (egg-emigrant) estimates for summer Chinook in the Wenatchee River basin for brood years 1999-2017; ND = no data. These estimates were derived from data in Table 8.14.

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
1999	3,537	70.9
2000	521	9.6
2001	2,349	46.1
2002	1,971	36.0
2003	3,877	72.3
2004	3,064	57.0
2005	3,306	65.4
2006	1,079	21.0
2007	2,308	45.1
2008	1,573	30.8
2009	1,980	37.4

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
2010	ND	ND
2011	ND	ND
2012	4,007	83.5
2013	3,890	78.0
2014	4,269	89.2
2015	2,328	36.6
2016	3,041	68.8
2017	1,605	36.9
Average	***2,630***	***52.0***
Median	***2,349***	***46.1***

Numbers of juvenile emigrants increased with increasing egg deposition; however, egg-emigrant survival did not decrease significantly with increasing egg deposition (Figure 8.5). This suggests a density-independent relationship between seeding levels and emigrants within the Wenatchee River basin (see Population Carrying Capacity section below).



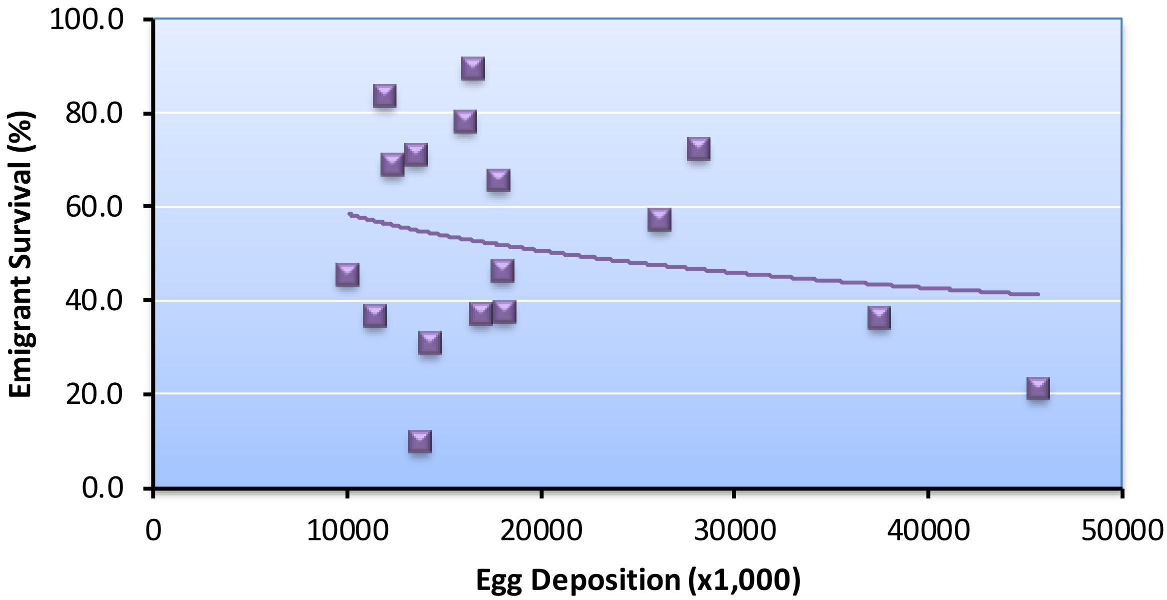


Figure 8.5. Relationships between seeding levels (egg deposition) and juvenile productivity (top figure) and emigrant survival (bottom figure) for Wenatchee summer Chinook, brood years 1999-2017.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the Ricker model).[36] Maximum equilibrium population size is generated from density dependent

[36] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we used population models to estimate juvenile summer Chinook carrying capacities (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods).

Only the density-independent model adequately fit the juvenile emigrant data for Wenatchee summer Chinook (Figure 8.6). This means that under the range of seeding levels examined, there is no estimate of carrying capacity for juvenile emigrants. This implies that spawning habitat is not currently limiting juvenile productivity within the Wenatchee River basin. It does not mean that there is no limit to juvenile rearing within the Wenatchee River basin. Indeed, there is likely a limit to the number of parr that can rear within the basin; however, there are no parr data to estimate rearing capacity.

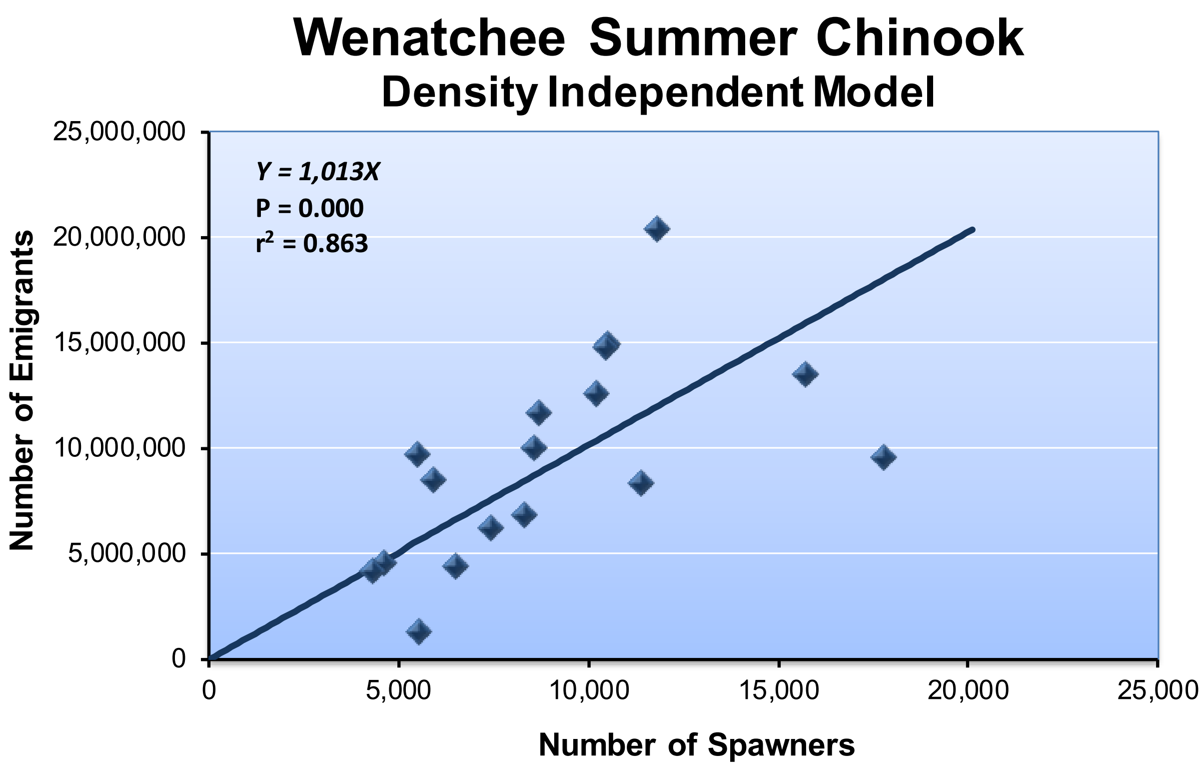


Figure 8.6. Density-independent relationship between spawners and number of juvenile emigrants produced in the Wenatchee River basin.

8.5 Spawning Surveys

Surveys for Wenatchee summer Chinook redds were conducted from 3 September to 5 November 2018 in the Wenatchee River and Icicle Creek.

Redd Counts

A total count of summer Chinook redds was estimated in 2018 based on weekly census surveys conducted in the Wenatchee River. Redds were counted in Icicle Creek when feasible. A total of 1,498 summer Chinook redds were counted in the Wenatchee River basin in 2018 (Table 8.17).

In the future, spawning escapement estimates may be derived using the area-under-the-curve (AUC) method described in Millar et al. (2012). WDFW now has five years of data (2014-2018) to inform model parameters (e.g., observer efficiency of redd counts at variable temporal and spatial scales). Model calibration has begun with existing data. WDFW now have prototype models to generate updated spawning escapements with associated variance. These updated estimates will be incorporated into this report when the models are fully calibrated.

Table 8.17. Numbers of redds counted in the Wenatchee River basin, 1989-2018; ND = no data. From 1989-2013, numbers of redds were based on expanding "peak counts" to generate a Total Count. Since 2014, numbers of redds were based on weekly census surveys that encompass all reaches.

Survey year	Redd counts		Total count
	Wenatchee River	Icicle Creek	
1989	3,331	ND	4,215
1990	2,479	ND	3,103
1991	2,180	ND	2,748
1992	2,328	ND	2,913
1993	2,334	ND	2,953
1994	2,426	ND	3,077
1995	1,872	ND	2,350
1996	1,435	ND	1,814
1997	1,388	ND	1,739
1998	1,660	ND	2,230
1999	2,188	ND	2,738
2000	2,022	ND	2,540
2001	2,857	ND	3,550
2002	5,419	ND	6,836
2003	4,281	ND	5,268
2004	4,003	ND	4,874
2005	2,895	ND	3,538
2006	7,165	68	8,896
2007	1,857	13	1,970
2008	2,338	23	2,800
2009	2,667	21	3,441
2010	2,553	11	3,261
2011	2,583	9	3,078
2012	2,301	2	2,504
2013	2,875	42	3,241
2014	3,383	75	3,458

Survey year	Redd counts		Total count
	Wenatchee River	Icicle Creek	
2015	1,781	23	1,804
2016	2,725	72	2,797
2017	3,872	36	3,908
2018	1,498	12	1,510
Average			***3,305***
Median			***3,015***

Redd Distribution

Summer Chinook redds were not evenly distributed among reaches within the Wenatchee River basin in 2018 (Table 8.18; Figure 8.7). Most of the spawning occurred upstream from the Leavenworth Bridge in Reaches 6, 8, 9, and 10. The highest density of redds occurred in Reach 6 near the confluence of the Icicle River.

Table 8.18. Total numbers of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through mid-November 2018.

Survey reach	Reach description	Total redd count
Wenatchee 1 (W1)	Mouth to Sleepy Hollow Br	4
Wenatchee 2 (W2)	Sleepy Hollow Br to L. Cashmere Br	19
Wenatchee 3 (W3)	L. Cashmere Br to Dryden Dam	90
Wenatchee 4 (W4)	Dryden Dam to Peshastin Br	27
Wenatchee 5 (W5)	Peshastin Br to Leavenworth Br	33
Wenatchee 6 (W6)	Leavenworth Br to Icicle Rd Br	504
Wenatchee 7 (W7)	Icicle Rd Br to Tumwater Dam	83
Wenatchee 8 (W8)	Tumwater Dam to Tumwater Br	219
Wenatchee 9 (W9)	Tumwater Br to Chiwawa River	336
Wenatchee 10 (W10)	Chiwawa River to Lake Wenatchee	183
Icicle Creek (I1)	Mouth to Hatchery	12
Totals		***1,510***

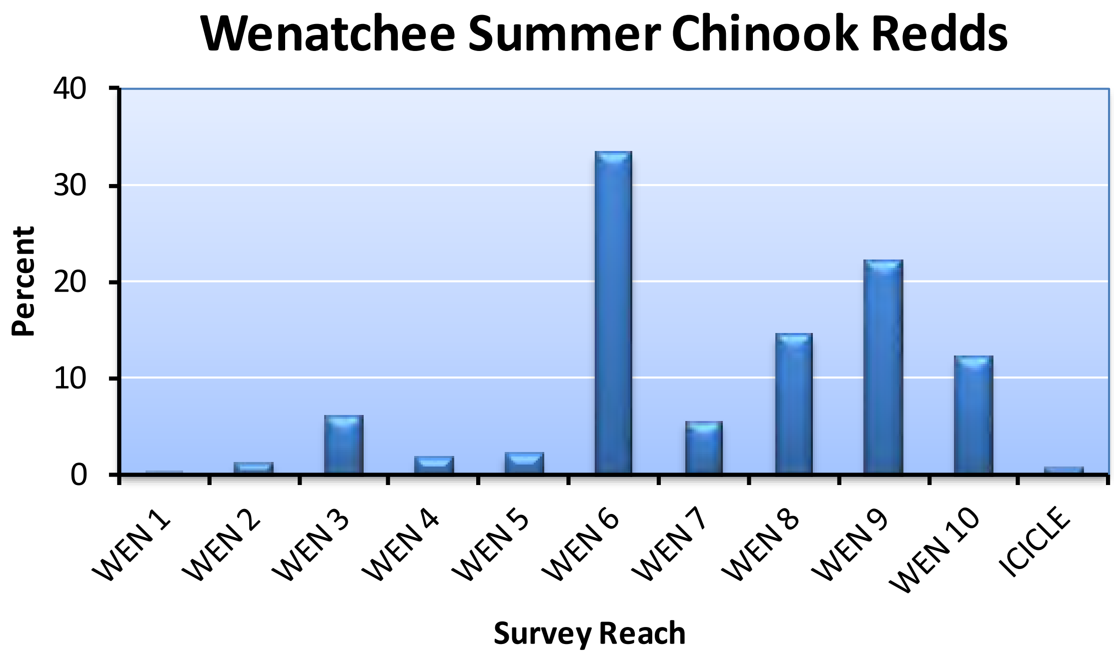


Figure 8.7. Percent of the total number of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through early-November 2018. Reach codes are described in Table 2.10.

Spawn Timing

In 2018, spawning in the Wenatchee River began during the second week of September, peaked the second week of October, and ended the first week of November (Figure 8.8).

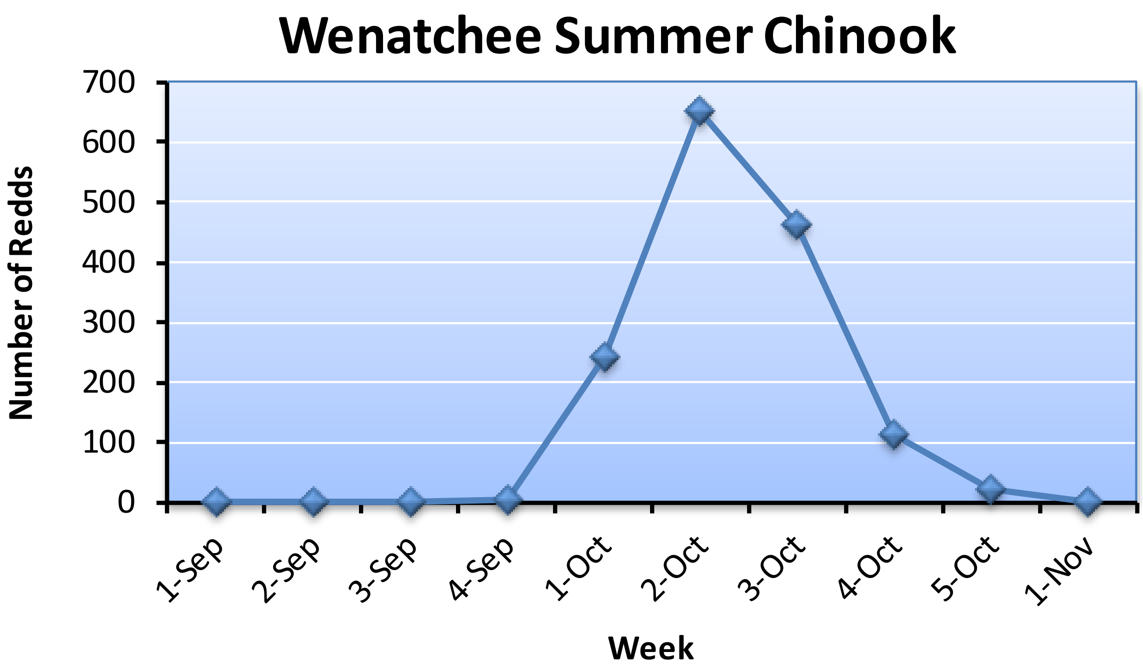


Figure 8.8. Number of new summer Chinook redds counted during different weeks in the Wenatchee River, September through early November 2018.

Spawning Escapement

Spawning escapement for Wenatchee summer Chinook was calculated as the total number of redds (expanded peak counts for return years 1989-2013) times the fish per redd ratio estimated from broodstock and fish sampled at adult trapping sites.[37] The estimated fish per redd ratio for summer Chinook in 2018 was 2.30. Multiplying this ratio by the number of redds counted in the Wenatchee River basin resulted in a total spawning escapement of 3,445 summer Chinook (Table 8.19). This is less than the overall average spawning escapement of 8,837 summer Chinook and is the lowest since redd counts began in 1989.

Table 8.19. Spawning escapements for summer Chinook in the Wenatchee River basin, return years 1989-2018. Number of redds is based on expanded peak redd counts for the period 1989-2013.

Return year	Fish/Redd	Redds	Total spawning escapement
1989	3.40	4,215	14,331
1990	3.50	3,103	10,861
1991	3.70	2,748	10,168
1992	4.00	2,913	11,652
1993	3.20	2,953	9,450
1994	3.30	3,077	10,154
1995	3.30	2,350	7,755
1996	3.40	1,814	6,168

[37] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Redds	Total spawning escapement
1997	3.40	1,739	5,913
1998	2.40	2,230	5,352
1999	2.00	2,738	5,476
2000	2.17	2,540	5,512
2001	3.20	3,550	11,360
2002	2.30	6,836	15,723
2003	2.24	5,268	11,800
2004	2.15	4,874	10,479
2005	2.46	3,538	8,703
2006	2.00	8,896	17,792
2007	2.33	1,970	4,590
2008	2.32	2,800	6,496
2009	2.42	3,441	8,327
2010	2.29	3,261	7,468
2011	3.20	3,078	9,850
2012	3.41	2,504	8,539
2013	3.15	3,241	10,209
2014	3.02	3,458	10,443
2015	2.40	1,804	4,330
2016	2.11	2,797	5,902
2017	1.90	3,908	7,425
2018	2.30	1,510	3,473
Average	***2.77***	***3,305***	***8,857***
Median	***2.44***	***3,015***	***8,621***

8.6 Carcass Surveys

Surveys for Wenatchee summer Chinook carcasses were conducted from early September to early November 2018 in the Wenatchee River and Icicle Creek.

Number sampled

A total of 792 summer Chinook carcasses were sampled during early September through early November in the Wenatchee River basin in 2018 (Table 8.20).

Table 8.20. Numbers of summer Chinook carcasses sampled within each survey reach in the Wenatchee River basin, 1993-2018. Reach codes are described in Table 2.10.

Survey year	Number of summer Chinook carcasses											
	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	Total
1993	68	151	696	13	82	150	215	41	0	0	0	**1,416**
1994	0	6	25	1	21	50	20	49	131	1	0	**304**

Survey year	Number of summer Chinook carcasses											
	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	Total
1995	0	10	14	0	0	117	50	37	20	0	0	**248**
1996	0	5	84	42	10	206	27	37	43	0	0	**454**
1997	1	47	127	5	29	312	8	80	70	13	0	**692**
1998	6	81	159	4	1	270	32	395	354	65	0	**1,367**
1999	0	169	112	16	35	932	68	146	185	79	0	**1,742**
2000	8	118	178	9	85	693	82	121	172	208	0	**1,674**
2001	0	49	138	31	0	338	36	124	101	94	0	**911**
2002	0	249	189	0	205	848	0	341	564	166	6	**2,568**
2003	6	369	195	72	149	768	66	266	537	58	40	**2,526**
2004	8	157	193	177	173	1,086	103	346	493	409	16	**3,161**
2005	8	85	106	39	46	709	70	140	353	258	7	**1,821**
2006	22	140	160	64	112	953	435	343	703	658	18	**3,608**
2007	3	15	49	10	26	475	38	38	96	91	8	**849**
2008	10	34	63	38	36	676	47	42	106	144	8	**1,204**
2009	11	29	43	32	27	389	16	58	240	175	6	**1,026**
2010	3	31	98	57	122	681	135	49	124	194	15	**1,509**
2011	5	88	126	19	38	1,332	77	45	211	289	9	**2,239**
2012	8	82	95	22	40	600	53	62	173	183	0	**1,318**
2013	3	100	149	22	109	767	5	60	353	265	14	**1,847**
2014	3	42	64	18	59	659	89	160	329	282	34	**1,739**
2015	9	7	36	15	19	296	27	110	314	150	5	**988**
2016	7	55	96	33	90	494	27	79	245	178	5	**1,309**
2017	18	74	100	29	47	415	22	122	202	147	4	**1,180**
2018	2	7	48	14	33	283	48	98	187	71	1	**792**
Average	***8***	***85***	***129***	***30***	***61***	***558***	***69***	***130***	***243***	***161***	***8***	***1,480***
Median	***6***	***65***	***103***	***21***	***39***	***547***	***48***	***89***	***195***	***149***	***5***	***1,343***

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among reaches within the Wenatchee River basin in 2018 (Table 8.20; Figure 8.9). Most of the carcasses in the Wenatchee River basin were found upstream from the Leavenworth Bridge. The highest percentage of carcasses (35.7%) was sampled in Reach 6.

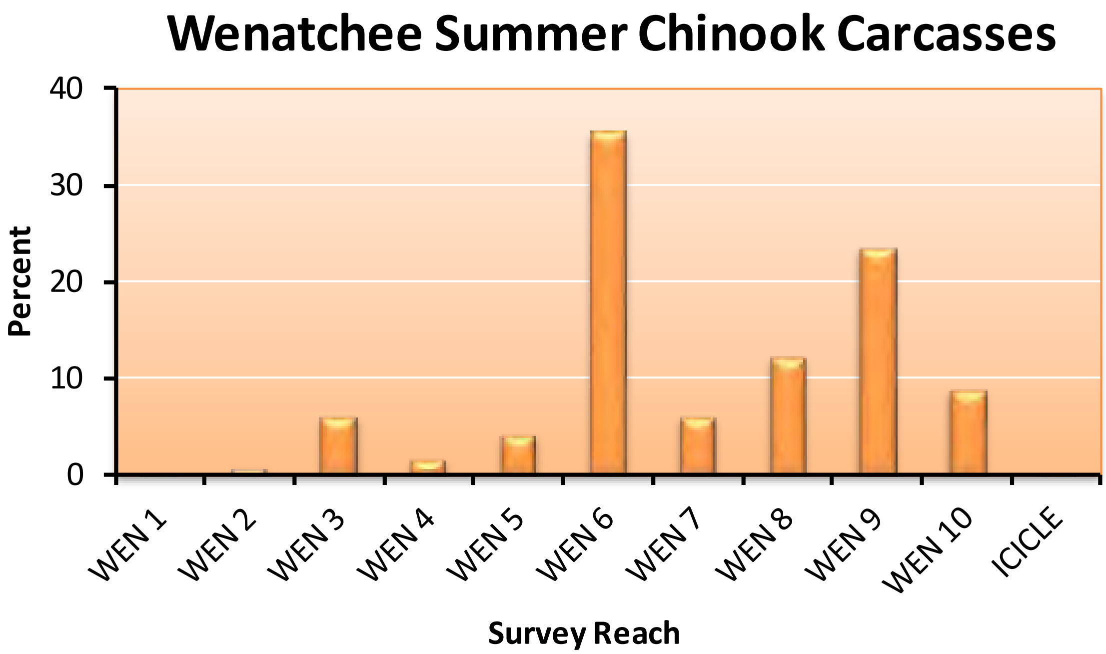


Figure 8.9. Percent of summer Chinook carcasses sampled within different reaches in the Wenatchee River basin during September through mid-November 2018. Reach codes are described in Table 2.10.

As in previous years, regardless of origin, most summer Chinook were found in Reach 6 (Leavenworth Bridge to Icicle Road Bridge) (Table 8.21). In general, a larger percentage of wild fish were found in the upper reaches than were hatchery fish (Figure 8.10). In contrast, a larger percentage of hatchery fish were found in reaches downstream from the Icicle Road Bridge.

Table 8.21. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Wenatchee River basin, 1993-2018; ND = no data.

Survey year	Origin	Survey reach											Total
		W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	
1993	Wild	59	146	660	12	82	133	213	40	0	0	0	**1,345**
	Hatchery	9	5	36	1	0	17	2	1	0	0	0	**71**
1994	Wild	0	2	18	1	19	36	20	49	130	1	0	**276**
	Hatchery	0	4	7	0	2	14	0	0	1	0	0	**28**
1995	Wild	0	4	11	0	0	105	50	35	20	0	0	**225**
	Hatchery	0	6	3	0	0	12	0	2	0	0	0	**23**
1996	Wild	0	5	82	40	9	196	27	37	43	0	0	**439**
	Hatchery	0	0	2	2	1	10	0	0	0	0	0	**15**
1997	Wild	1	38	112	5	22	266	8	80	69	13	0	**614**
	Hatchery	0	9	15	0	7	46	0	0	1	0	0	**78**
1998	Wild	6	62	124	3	1	191	29	374	327	62	0	**1,179**
	Hatchery	0	19	35	1	0	79	3	21	27	3	0	**188**
1999	Wild	0	88	70	8	18	600	58	137	169	75	0	**1,223**
	Hatchery	0	81	42	8	17	332	10	9	16	4	0	**519**

Survey year	Origin	Survey reach											Total
		W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	
2000	Wild	5	78	115	8	57	485	75	110	167	200	0	**1,300**
	Hatchery	3	40	63	1	28	208	7	11	5	8	0	**374**
2001	Wild	0	37	100	9	0	245	32	122	97	91	0	**733**
	Hatchery	0	12	38	22	0	93	4	2	4	3	0	**178**
2002	Wild	0	151	127	0	103	479	0	330	558	161	3	**1,912**
	Hatchery	0	98	62	0	102	369	0	11	6	5	3	**656**
2003	Wild	5	261	147	32	111	519	62	252	498	57	15	**1,959**
	Hatchery	1	108	48	40	38	249	4	14	39	1	25	**567**
2004	Wild	7	124	163	120	112	749	90	316	481	399	11	**2,572**
	Hatchery	1	33	30	56	61	337	13	30	12	10	5	**588**
2005	Wild	4	49	78	24	26	399	66	125	336	244	0	**1,351**
	Hatchery	4	36	28	15	20	310	4	15	17	14	7	**470**
2006	Wild	15	91	122	44	75	688	388	309	646	593	5	**2,976**
	Hatchery	7	49	38	20	37	265	47	34	57	65	13	**632**
2007	Wild	1	7	24	1	10	197	34	30	95	81	3	**483**
	Hatchery	2	8	25	9	16	278	4	8	1	10	5	**366**
2008	Wild	7	15	38	24	21	361	41	31	98	133	2	**771**
	Hatchery	3	19	25	14	15	315	6	11	8	11	6	**433**
2009	Wild	6	22	32	23	19	288	13	55	236	173	4	**871**
	Hatchery	5	7	11	9	8	101	3	3	4	2	2	**155**
2010	Wild	2	22	62	44	64	477	125	47	121	192	0	**1,156**
	Hatchery	1	9	36	13	58	204	10	2	3	2	15	**353**
2011	Wild	4	46	75	11	25	914	74	45	211	287	3	**1,695**
	Hatchery	1	42	51	7	13	418	3	0	0	2	6	**543**
2012	Wild	4	49	72	13	24	490	47	62	173	182	0	**1,116**
	Hatchery	4	33	23	9	16	110	6	0	0	1	0	**202**
2013	Wild	1	63	89	16	69	374	5	59	340	261	0	**1,277**
	Hatchery	2	52	60	6	40	395	0	1	13	4	0	**573**
2014	Wild	3	35	57	16	48	572	89	158	329	281	12	**1600**
	Hatchery	0	7	7	2	11	87	0	2	0	0	22	**139**
2015	Wild	6	6	36	13	16	263	26	107	301	148	6	**928**
	Hatchery	3	1	0	2	3	33	1	3	13	2	0	**61**
2016	Wild	5	40	78	29	75	426	27	79	243	175	4	**1,181**
	Hatchery	2	15	18	4	15	68	0	0	3	3	1	**129**
2017	Wild	13	58	85	25	36	328	22	120	202	147	0	**1,036**
	Hatchery	5	16	15	4	11	87	0	2	0	0	4	**144**
2018	Wild	1	4	38	9	19	162	42	94	183	71	1	**624**
	Hatchery	1	3	10	5	14	121	6	4	4	0	0	**168**
Average	***Wild***	***6***	***58***	***101***	***20***	***41***	***382***	***64***	***123***	***234***	***155***	***3***	***1,186***
	Hatchery	***2***	***27***	***28***	***10***	***21***	***175***	***5***	***7***	***9***	***6***	***4***	***294***
Median	***Wild***	***4***	***43***	***78***	***13***	***25***	***368***	***42***	***87***	***193***	***148***	***0***	***1,168***

Survey year	Origin	Survey reach											Total
		W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	
	Hatchery	*1*	*16*	*27*	*6*	*15*	*116*	*3*	*3*	*4*	*2*	*1*	*195*

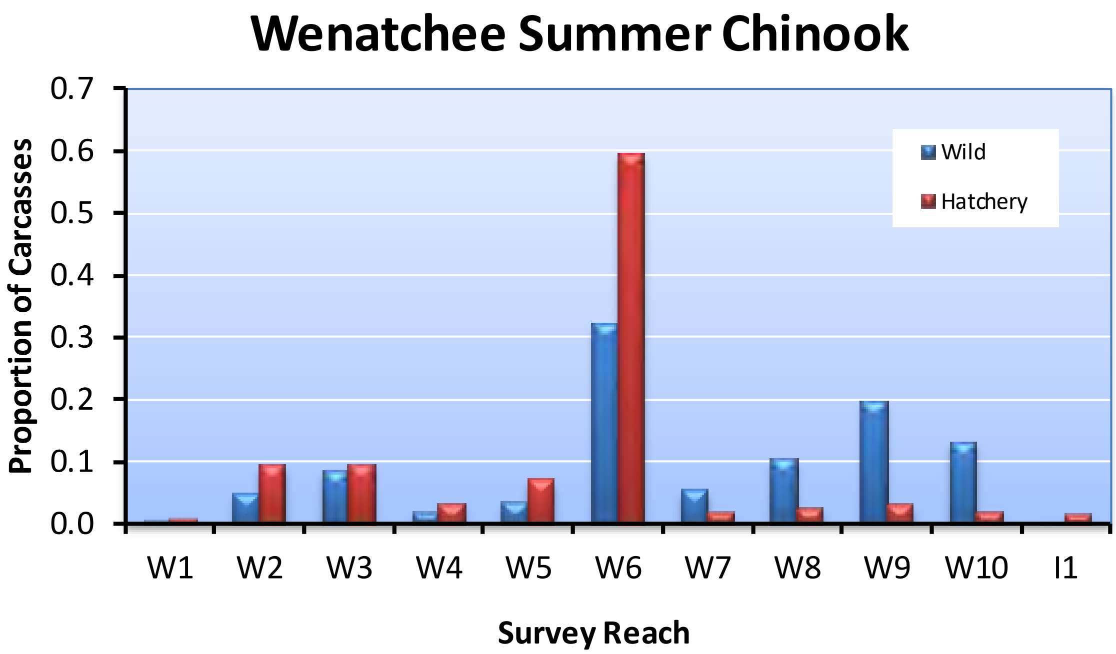


Figure 8.10. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, 1993-2018. Reach codes are described in Table 2.10.

Sampling Rate

If spawning escapement is based on total numbers of redds, then about 23% of the total spawning escapement of summer Chinook in the Wenatchee River basin was sampled in 2018 (Table 8.22). Sampling rates among survey reaches varied from 4 to 43%.

Table 8.22. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Wenatchee River basin, 2018.

Sampling reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Wenatchee 1 (W1)	4	2	9	0.22
Wenatchee 2 (W2)	19	7	44	0.16
Wenatchee 3 (W3)	90	48	207	0.23
Wenatchee 4 (W4)	27	14	62	0.23
Wenatchee 5 (W5)	33	33	76	0.43
Wenatchee 6 (W6)	504	283	1159	0.24
Wenatchee 7 (W7)	83	48	191	0.25

Sampling reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Wenatchee 8 (W8)	219	98	504	0.19
Wenatchee 9 (W9)	336	187	773	0.24
Wenatchee 10 (W10)	183	71	421	0.17
Icicle Creek (I1)	12	1	28	0.04
Total	***1,510***	***792***	***3,473***	***0.23***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys in the Wenatchee River basin in 2018 are provided in Table 8.23. The average size of males and females sampled in the Wenatchee River basin were 66 cm and 70 cm, respectively.

Table 8.23. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different streams/watersheds in the Wenatchee River basin, 2018. NA = not available.

Stream/watershed	Mean length (cm)	
	Male	Female
Wenatchee 1 (W1)	51 (NA)	74 (NA)
Wenatchee 2 (W2)	65 (16.5)	64 (6.3)
Wenatchee 3 (W3)	72 (9.9)	70 (6.0)
Wenatchee 4 (W4)	65 (13.5)	70 (3.1)
Wenatchee 5 (W5)	62(12.0)	71 (5.0)
Wenatchee 6 (W6)	65 (10.5)	68 (9.5)
Wenatchee 7 (W7)	72 (11.1)	69 (7.7)
Wenatchee 8 (W8)	70 (10.5)	70 (6.2)
Wenatchee 9 (W9)	68 (11.1)	71 (7.6)
Wenatchee 10 (W10)	69 (7.5)	70 (6.1)
Icicle Creek (I1)	NA	NA
Total	***66 (10.3)***	***70 (5.8)***

8.7 Life History Monitoring

Life history characteristics of Wenatchee summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Wenatchee summer Chinook was determined from broodstock data and stock assessment data collected at Dryden Dam. Sampling at Dryden Dam occurs from late June through late October. On average, during the early part of the migration, hatchery summer Chinook arrived about one week later than wild Chinook (Table 8.24). This pattern carried throughout the migration distribution of summer Chinook at Dryden Dam. By the end of the migration, hatchery fish passed Dryden Dam about two weeks after 90% of the wild fish passed the dam.

Table 8.24. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Dryden Dam, 2007-2018. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Dryden Dam.

Survey year	Origin	Wenatchee Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	28	31	37	31	274
	Hatchery	30	33	41	35	305
2008	Wild	29	31	40	32	219
	Hatchery	32	37	41	37	576
2009	Wild	27	29	41	31	469
	Hatchery	28	34	42	35	382
2010	Wild	30	33	35	32	403
	Hatchery	29	30	33	30	268
2011	Wild	30	31	34	32	293
	Hatchery	32	34	39	35	304
2012	Wild	30	32	39	33	247
	Hatchery	31	37	41	36	366
2013	Wild	28	30	34	31	494
	Hatchery	29	33	39	33	570
2014	Wild	29	31	37	32	512
	Hatchery	29	32	40	33	338
2015	Wild	25	30	40	31	511
	Hatchery	28	35	40	35	88
2016	Wild	28	30	40	32	407
	Hatchery	29	34	41	35	184
2017	Wild	27	30	36	31	386
	Hatchery	29	32	32	33	214
2018	Wild	29	32	41	34	237
	Hatchery	27	29	35.9	30	202
Average	***Wild***	***28***	***31***	***38***	***32***	***371***
	Hatchery	***29***	***33***	***39***	***34***	***316***
Median	***Wild***	***29***	***31***	***38***	***32***	***395***
	Hatchery	***29***	***34***	***40***	***35***	***305***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2018 in the Wenatchee River basin were salt age-3 fish (Table 8.25; Figure 8.11). Over the survey years, a higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 8.25. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Wenatchee River basin, 1993-2018.

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
1993	Wild	0.02	0.24	0.62	0.12	0.00	1,224
	Hatchery	0.03	0.91	0.03	0.03	0.00	64
1994	Wild	0.02	0.21	0.45	0.32	0.00	257
	Hatchery	0.00	0.14	0.86	0.00	0.00	21
1995	Wild	0.02	0.15	0.65	0.18	0.00	216
	Hatchery	0.00	0.00	0.05	0.95	0.00	21
1996	Wild	0.01	0.25	0.66	0.08	0.00	512
	Hatchery	0.00	0.33	0.33	0.29	0.05	21
1997	Wild	0.01	0.24	0.57	0.18	0.00	561
	Hatchery	0.05	0.20	0.67	0.08	0.00	75
1998	Wild	0.02	0.23	0.66	0.09	0.00	1,041
	Hatchery	0.03	0.49	0.38	0.10	0.00	187
1999	Wild	0.01	0.34	0.55	0.10	0.00	1,087
	Hatchery	0.01	0.15	0.79	0.05	0.00	510
2000	Wild	0.02	0.20	0.64	0.15	0.00	1,181
	Hatchery	0.07	0.11	0.66	0.15	0.00	342
2001	Wild	0.01	0.16	0.74	0.08	0.00	653
	Hatchery	0.05	0.76	0.14	0.04	0.00	181
2002	Wild	0.00	0.14	0.62	0.24	0.00	1,744
	Hatchery	0.01	0.16	0.80	0.02	0.00	646
2003	Wild	0.01	0.07	0.51	0.41	0.00	1,653
	Hatchery	0.05	0.07	0.75	0.12	0.00	530
2004	Wild	0.00	0.12	0.32	0.54	0.01	2,233
	Hatchery	0.08	0.57	0.25	0.10	0.00	566
2005	Wild	0.00	0.12	0.75	0.13	0.00	1,190
	Hatchery	0.02	0.09	0.86	0.03	0.00	450
2006	Wild	0.00	0.02	0.27	0.71	0.00	2,972
	Hatchery	0.02	0.16	0.24	0.57	0.00	299

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
2007	Wild	0.01	0.09	0.31	0.53	0.07	480
	Hatchery	0.00	0.15	0.75	0.07	0.03	275
2008	Wild	0.01	0.06	0.76	0.17	0.00	767
	Hatchery	0.02	0.12	0.76	0.11	0.00	329
2009	Wild	0.01	0.07	0.51	0.41	0.00	797
	Hatchery	0.10	0.36	0.49	0.05	0.00	132
2010	Wild	0.01	0.18	0.65	0.16	0.00	1,068
	Hatchery	0.00	0.49	0.47	0.03	0.00	294
2011	Wild	0.01	0.11	0.60	0.29	0.00	1,533
	Hatchery	0.06	0.04	0.90	0.01	0.00	472
2012	Wild	0.00	0.04	0.48	0.48	0.00	1,017
	Hatchery	0.00	0.03	0.88	0.08	0.03	200
2013	Wild	0.00	0.07	0.58	0.34	0.01	1,277
	Hatchery	0.00	0.01	0.13	0.86	0.00	573
2014	Wild	0.00	0.05	0.70	0.25	0.00	1,437
	Hatchery	0.02	0.06	0.20	0.70	0.02	128
2015	Wild	0.00	0.09	0.40	0.51	0.00	819
	Hatchery	0.00	0.10	0.65	0.24	0.00	49
2016	Wild	0.00	0.03	0.66	0.31	0.00	1,023
	Hatchery	0.03	0.11	0.83	0.03	0.00	97
2017	Wild	0.00	0.02	0.35	0.62	0.01	976
	Hatchery	0.01	0.40	0.45	0.14	0.00	117
2018	Wild	0.00	0.03	0.38	0.59	0.00	556
	Hatchery	0.03	0.23	0.73	0.00	0.00	132
Average	***Wild***	***0.01***	***0.12***	***0.53***	***0.34***	***0.00***	***1,088***
	Hatchery	***0.03***	***0.21***	***0.59***	***0.17***	***0.00***	***258***
Median	***Wild***	***0.00***	***0.09***	***0.62***	***0.28***	***0.00***	***1,032***
	Hatchery	***0.03***	***0.29***	***0.58***	***0.11***	***0.00***	***194***

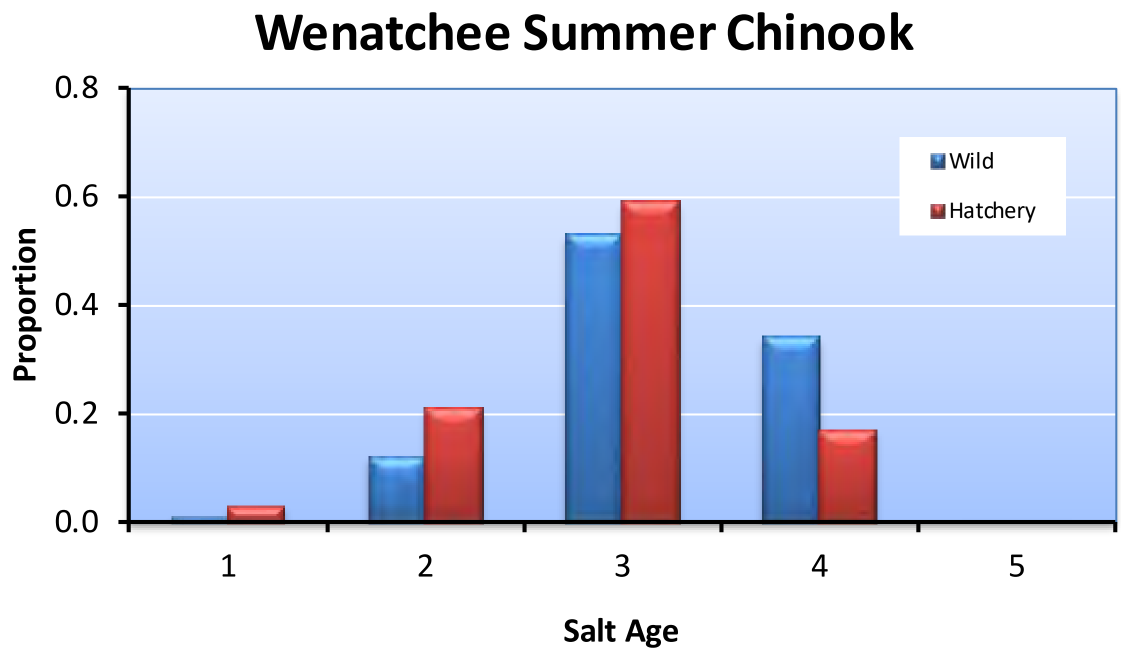


Figure 8.11. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Wenatchee River basin for the combined years 1993-2018.

Size at Maturity

On average, hatchery summer Chinook were about 5 cm smaller than wild summer Chinook sampled in the Wenatchee River basin (Table 8.26). This is likely because a higher percentage of hatchery fish returned as salt age-2 and 3 fish than did wild fish. In contrast, a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish. Analyses for the statistical and comprehensive reports will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 8.26. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Wenatchee River basin, 1993-2018; SD = 1 standard deviation.

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	1,344	73	8	33	94
	Hatchery	68	61	9	37	83
1994[a]	Wild	276	73	8	31	89
	Hatchery	25	70	8	54	85
1995[a]	Wild	225	75	7	48	87
	Hatchery	23	74	7	57	85
1996[a]	Wild	210	74	7	43	92
	Hatchery	9	66	12	52	84
1997	Wild	614	74	8	29	99

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	79	69	10	29	83
1998	Wild	1,179	73	8	28	97
	Hatchery	188	67	10	37	87
1999	Wild	1,217	72	8	29	95
	Hatchery	518	71	8	26	94
2000	Wild	1,301	71	10	24	94
	Hatchery	369	69	11	33	91
2001	Wild	728	70	9	30	93
	Hatchery	178	63	10	28	86
2002	Wild	1,911	72	8	39	94
	Hatchery	656	71	8	34	95
2003	Wild	1,943	74	9	24	105
	Hatchery	554	69	10	26	97
2004	Wild	2,570	72	9	32	98
	Hatchery	584	59	11	25	91
2005	Wild	1,352	69	7	41	92
	Hatchery	469	69	8	39	91
2006	Wild	3,249	74	6	29	99
	Hatchery	350	71	9	35	90
2007	Wild	566	73	9	29	92
	Hatchery	269	70	7	45	87
2008	Wild	836	69	8	29	89
	Hatchery	363	70	9	24	94
2009	Wild	872	71	8	30	94
	Hatchery	153	64	11	32	84
2010	Wild	1,147	68	8	32	92
	Hatchery	351	65	10	25	87
2011	Wild	1,698	68	8	33	101
	Hatchery	541	66	9	34	85
2012	Wild	1,116	70	7	29	91
	Hatchery	202	60	7	40	79
2013	Wild	1,277	66	9	24	95
	Hatchery	573	67	7	24	85
2014	Wild	1,600	68	7	29	98
	Hatchery	139	66	10	26	85
2015	Wild	928	68	8	39	86
	Hatchery	61	62	9	36	81
2016	Wild	1,180	69	6	43	93

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	129	67	8	37	82
2017	Wild	976	70	7	42	88
	Hatchery	117	65	8	38	82
2018	Wild	556	70	6	45	89
	Hatchery	132	65	8	41	81
Pooled	***Wild***	***30,871***	***71***	***2***	***24***	***105***
	Hatchery	***7,100***	***67***	***4***	***24***	***97***

[a] These years include sizes reported in annual reports. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Wenatchee summer Chinook occurred in the ocean (Table 8.27). Ocean harvest has made up 47% to 100% of all hatchery Wenatchee summer Chinook harvested. Total harvest on early brood years (e.g., 1990-1996) was generally lower than for brood years 1997-2012.

Table 8.27. Estimated number and percent (in parentheses) of hatchery-origin Wenatchee summer Chinook captured in different fisheries, brood years 1989-2012.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	1,510 (51)	1,432 (48)	0 (0)	20 (1)	2,962	58.0
1990	30 (100)	0 (0)	0 (0)	0 (0)	30	25.4
1991	30 (63)	0 (0)	0 (0)	18 (38)	48	67.6
1992	147 (79)	39 (21)	0 (0)	0 (0)	186	29.6
1993	35 (58)	25 (42)	0 (0)	0 (0)	60	39.5
1994	641 (91)	62 (9)	2 (0)	0 (0)	705	36.3
1995	562 (98)	9 (2)	5 (1)	0 (0)	576	36.5
1996	196 (96)	3 (1)	0 (0)	6 (3)	205	35.6
1997	2,982 (95)	49 (2)	12 (0)	106 (3)	3,149	42.0
1998	5,026 (92)	128 (2)	16 (0)	287 (5)	5,457	70.5
1999	1,550 (84)	168 (9)	21 (1)	104 (6)	1,843	74.3
2000	7,966 (73)	1,248 (11)	447 (4)	1,224 (11)	10,885	76.6
2001	1,061 (60)	238 (13)	106 (6)	364 (21)	1,769	73.2
2002	1,527 (56)	557 (21)	189 (7)	430 (16)	2,703	59.7
2003	833 (50)	484 (29)	89 (5)	257 (15)	1,663	53.7
2004	409 (47)	218 (25)	70 (8)	167 (19)	864	59.4
2005	1,329 (58)	481 (21)	187 (8)	287 (13)	2,284	63.0
2006	3,738 (51)	1,983 (27)	406 (6)	1,142 (16)	7,269	68.2
2007	212 (55)	109 (29)	8 (2)	53 (14)	382	75.0
2008	3,747 (52)	1,837 (26)	227 (3)	1,364 (19)	7,175	64.5

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2009	1,592 (51)	1,000 (32)	99 (3)	452 (14)	3,143	74.1
2010	1,342 (56)	558 (23)	81 (3)	401 (17)	2,382	80.2
2011	3,227 (58)	1,389 (25)	119 (2)	846 (15)	5,581	72.2
2012	695 (53)	330 (25)	24 (2)	274 (21)	1,323	67.2
Average	***1,726 (68)***	***522 (18)***	***91 (3)***	***327 (11)***	***2,666***	***58.1***
Median	***1,329 (58)***	***218 (21)***	***21 (2)***	***167 (13)***	***1,843***	***63.7***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia summer Chinook population, hatchery-origin Wenatchee summer Chinook have strayed into the Entiat, Chelan, Methow, and Okanogan River basins and onto the Hanford Reach (Table 8.28). Since 2011, stray rates have been less than 10% within the Upper Columbia River basin.

Hatchery-origin Wenatchee summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Wenatchee have been detected at Lower Granite Dam on the Snake River, at Three Mile Dam on the Umatilla River, in Big and Sand Hollow creeks, in the Baker and Elway rivers, and at Spring Creek, Skookum Creek, Crisp Creek, Lyons Ferry, Bonneville, Cowlitz, and Kalama Falls hatcheries. However, few Wenatchee summer Chinook have strayed into each of these locations.

Table 8.28. Number and percent of spawning escapements within other non-target spawning streams within the upper Columbia River basin that consisted of hatchery-origin Wenatchee summer Chinook, return years 1994-2017. For example, for return year 2000, 3% of the summer Chinook escapement in the Methow River basin consisted of hatchery-origin Wenatchee summer Chinook. Percent strays should be less than 10%.

Return year	Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	75	1.9	--	--	--	--	--	--
1995	0	0.0	0	0.0	--	--	--	--	--	--
1996	0	0.0	0	0.0	--	--	--	--	--	--
1997	0	0.0	0	0.0	--	--	--	--	--	--
1998	25	3.7	0	0.0	0	0.0	0	0.0	0	0.0
1999	20	2.0	3	0.1	0	0.0	0	0.0	13	0.0
2000	36	3.0	13	0.4	0	0.0	0	0.0	0	0.0
2001	163	5.9	57	0.5	30	3.0	0	0.0	0	0.0

Return year	Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2002	153	3.3	53	0.4	40	6.9	74	14.8	0	0.0
2003	80	2.0	24	0.7	44	10.5	132	19.1	26	0.0
2004	113	5.2	42	0.6	30	7.2	0	0.0	0	0.0
2005	245	9.6	67	0.8	51	9.7	49	13.4	0	0.0
2006	170	6.2	12	0.1	12	2.9	61	15.3	0	0.0
2007	127	9.3	5	0.1	9	4.8	49	34.5	20	0.1
2008	87	4.5	24	0.3	10	2.0	31	14.4	0	0.0
2009	101	5.7	13	0.2	2	0.3	12	6.6	0	0.0
2010	208	8.3	35	0.6	55	4.9	34	13.0	0	0.0
2011	258	8.8	5	0.1	78	6.1	15	5.1	0	0.0
2012	109	3.7	24	0.3	53	4.1	54	8.4	0	0.0
2013	252	7.0	57	0.7	2	0.1	8	1.7	0	0.0
2014	13	0.8	0	0.0	4	0.4	12	2.0	0	0.0
2015	75	1.9	13	0.1	4	0.3	12	3.1	0	0.0
2016	52	2.3	6	0.1	17	1.9	5	0.9	0	0.0
2017	24	1.7	0	0.0	0	0.0	7	1.2	0	0.0
Average	***96***	***4.0***	***22***	***0.3***	***22***	***3.3***	***28***	***7.7***	***3***	***0.0***
Median	***84***	***3.5***	***13***	***0.2***	***11***	***2.4***	***12***	***4.1***	***0***	***0.0***

Based on brood year analyses, on average, about 10% of the hatchery-origin Wenatchee summer Chinook spawners strayed into non-target streams (Table 8.29). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-20%. In addition, on average, about 14% of hatchery-origin Wenatchee summer Chinook broodstock have been included in non-target hatchery programs.

Table 8.29. Number and percent of hatchery-origin Wenatchee summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2012.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	1,352	62.9	75	3.5	60	2.8	662	30.8
1990	74	84.1	0	0.0	1	1.1	13	14.8
1991	15	65.2	0	0.0	0	0.0	8	34.8
1992	375	84.8	0	0.0	7	1.6	60	13.6
1993	67	72.8	4	4.3	9	9.8	12	13.0
1994	890	71.8	61	4.9	207	16.7	81	6.5

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	748	74.8	48	4.8	139	13.9	65	6.5
1996	261	70.4	53	14.3	42	11.3	15	4.0
1997	3,609	83.0	397	9.1	171	3.9	170	3.9
1998	1,790	78.5	416	18.2	11	0.5	64	2.8
1999	507	79.7	121	19.0	0	0.0	8	1.3
2000	2,745	82.5	545	16.4	0	0.0	37	1.1
2001	521	80.4	118	18.2	0	0.0	9	1.4
2002	1,521	83.4	284	15.6	10	0.5	8	0.4
2003	1,268	88.5	114	8.0	42	2.9	9	0.6
2004	497	84.2	72	12.2	3	0.5	18	3.1
2005	1,126	84.0	193	14.4	3	0.2	19	1.4
2006	2,693	79.4	623	18.4	8	0.2	69	2.0
2007	99	78.0	25	19.7	1	0.8	2	1.6
2008	3,260	82.5	458	11.6	61	1.5	173	4.4
2009	720	65.6	106	9.7	54	4.9	218	19.9
2010	158	26.8	16	2.7	47	8.0	368	62.5
2011	542	26.0	173	8.3	54	2.6	1,313	63.1
2012	382	59.1	20	3.1	11	1.7	233	36.1
Average	***1,051***	***72.9***	***163***	***9.8***	***39***	***3.6***	***151***	***13.7***
Median	***631***	***78.9***	***91***	***9.4***	***11***	***1.6***	***49***	***4.2***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Wenatchee River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Wenatchee River basin.

[3] Target hatchery includes broodstock collection at Tumwater and Dryden dams. Some adult hatchery-origin Wenatchee summer Chinook salmon have been used as broodstock to support the Chelan Falls summer Chinook Program (formerly Turtle Rock Hatchery program). Those adult fish are included in this table.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Wenatchee summer Chinook hatchery program. The Chief Joseph Hatchery intercepted large numbers of summer Chinook during the last three years.

Genetics

Genetic studies were conducted in 2011 to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix P). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next comprehensive report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For all brood years the PNI value has been greater than 0.67 (Table 8.30). This suggests that the natural environment has a greater influence on adaptation of Wenatchee summer Chinook than does the hatchery environment.

Table 8.30. Proportionate Natural Influence (PNI) values for the Wenatchee summer Chinook supplementation program for brood years 1989-2018. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	14,331	0	0.00	290	0	1.00	1.00
1990	10,861	0	0.00	57	0	1.00	1.00
1991	10,168	0	0.00	105	0	1.00	1.00
1992	11,652	0	0.00	274	0	1.00	1.00
1993	8,868	582	0.06	406	44	0.90	0.94
1994	8,476	1,678	0.17	333	54	0.86	0.84
1995	6,862	893	0.12	363	16	0.96	0.89
1996	6,002	166	0.03	263	3	0.99	0.97
1997	5,408	505	0.09	205	13	0.94	0.92
1998	4,611	741	0.14	299	78	0.79	0.85
1999	4,101	1,375	0.25	242	236	0.51	0.68
2000	4,462	1,050	0.19	275	180	0.60	0.77
2001	9,414	1,946	0.17	210	136	0.61	0.79
2002	11,892	3,831	0.24	409	10	0.98	0.81
2003	10,025	1,775	0.15	337	7	0.98	0.87
2004	9,220	1,259	0.12	424	2	1.00	0.90
2005	6,862	1,841	0.21	397	3	0.99	0.83
2006	16,060	1,732	0.10	433	4	0.99	0.91
2007	3,173	1,417	0.31	263	3	0.99	0.77
2008	4,452	2,044	0.31	378	69	0.85	0.74
2009	7,098	1,229	0.15	452	8	0.98	0.87
2010	5,886	1,582	0.21	388	5	0.99	0.83
2011	8,150	1,700	0.17	376	7	0.98	0.86
2012	7,327	1,212	0.14	267	1	1.00	0.88
2013	7,431	2,778	0.27	234	2	0.99	0.79
2014	9,676	767	0.07	261	2	0.99	0.94
2015	4,076	254	0.06	245	0	1.00	0.95
2016	5,416	486	0.08	259	0	1.00	0.93
2017	6,578	847	0.11	252	1	1.00	0.90
2018	2,767	678	0.20	206	4	0.98	0.83
Average	***7,710***	***1,146***	***0.14***	***297***	***30***	***0.93***	***0.88***

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
Median	***7,213***	***1,131***	***0.14***	***275***	***4***	***0.99***	***0.88***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery summer Chinook from the Wenatchee River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 8.31).[38] Over the eight brood years for which PIT-tagged hatchery fish were released, survival rates from the Wenatchee River to McNary Dam ranged from 0.619 to 0.910; SARs from release to detection at Bonneville Dam ranged from 0.002 to 0.017. Average travel time from the Wenatchee River to McNary Dam ranged from 11 to 29 days.

Most of the variation in survival rates and travel time resulted from releases of different experimental groups (Table 8.31). For example, brood year 2009 was split into three groups (control raceway group, long-term recirculating aquaculture system (RAS) group (R1), and short-term RAS group (R2)). In this case, the control group appeared to have a higher survival rate but a longer travel time from release to McNary Dam than did the two treatment groups. SARs varied little among the three groups.

Another evaluation was conducted with brood years 2012 and 2013. These brood years were split into four different treatment groups (small-size fish in raceway, large-size fish in raceway, small-size fish in RAS, and large-size fish in RAS). Although the number of replicates is small, releases from the RAS had higher survival rates to McNary Dam and faster travel times. Large-size fish from the RAS had the highest survival rates and fastest travel times. There was no clear relationship among experimental groups and SARs (Table 8.31).

Performance of fish reared in raceways compared to fish reared in recirculating aquaculture systems is ongoing. Based on three brood years, fish released from recirculating systems had higher survival rates to McNary Dam and generally faster travel times (Table 8.31). At this time, there are no SAR results.

Table 8.31. Total number of Wenatchee hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2016. SARs were adjusted for both tag loss before release and detection efficiencies. Standard errors are shown in parentheses. RAS = recirculating aquaculture system; NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	10,035	0.847 (0.054)	28.9 (9.6)	0.017 (0.001)
2009	9,965 (Control)	0.702 (0.039)	19.3 (10.3)	0.006 (0.001)
	9,971 (R1)	0.646 (0.030)	16.4 (8.8)	0.005 (0.001)

[38] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	9,994 (R2)	0.648 (0.031)	16.0 (8.4)	0.005 (0.001)
2010	0	--	--	--
2011	5,018	0.753 (0.070)	20.9 (8.9)	0.010 (0.001)
2012 (Raceway)	5,047 (small size)	0.724 (0.066)	18.9 (9.2)	0.005 (0.001)
	4,740 (large size)	0.619 (0.061)	16.9 (8.6)	0.004 (0.001)
2012 (RAS)	5,041 (small size)	0.784 (0.060)	11.8 (5.0)	0.003 (0.001)
	5,082 (large size)	0.910 (0.077)	11.1 (4.6)	0.004 (0.001)
2013 (Raceway)	5,196 (small size)	0.692 (0.054)	19.3 (6.1)	0.002 (0.001)
	5,158 (large size)	0.823 (0.071)	19.1 (5.6)	0.002 (0.001)
2013 (RAS)	5,229 (small size)	0.789 (0.057)	18.1 (5.6)	0.004 (0.001)
	5,201 (large size)	0.859 (0.068)	16.8 (4.8)	0.002 (0.001)
2014	10,241 (Circular)	0.800 (0.083)	15.1 (4.9)	NA
	10,243 (Raceway)	0.735 (0.065)	17.1 (6.1)	NA
2015	10,253 (Circular)	0.759 (0.068)	20.9 (6.9)	NA
	10,351 (Raceway)	0.694 (0.054)	26.2 (15.5)	NA
2016	10,371 (Circular)	0.763 (0.067)	25.5 (7.2)	NA
	10,306 (Raceway)	0.673 (0.052)	22.7 (6.2)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood year harvest rates from the hatchery program. For brood years 1989-2012, NRR for summer Chinook in the Wenatchee averaged 0.97 (range, 0.15-2.95) if harvested fish were not included in the estimate and 2.66 (range, 0.33-9.55) if harvested fish were included in the estimate (Table 8.32). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 5.7 (the calculated target value in Hillman et al. 2017). The target value of 5.7 includes harvest. HRRs exceeded NRRs in 19 of the 24 years of data, regardless if harvest was or was not included in the estimate (Table 8.32). Hatchery replacement rates for Wenatchee summer Chinook have exceeded the estimated target value of 5.7 in 13 of the 24 years of data.

Table 8.32. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for summer Chinook in the Wenatchee River basin, brood years 1989-2012.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	346	14,331	2,149	9,181	6.21	0.64	5,111	21,808	14.77	1.52
1990	87	10,861	88	9,595	1.01	0.88	118	12,984	1.36	1.20
1991	128	10,168	23	5,562	0.18	0.55	71	17,167	0.55	1.69
1992	341	11,652	442	5,858	1.30	0.50	628	8,393	1.84	0.72
1993	524	9,450	92	5,385	0.18	0.57	152	8,901	0.29	0.94
1994	418	10,154	1,239	4,219	2.96	0.42	1,944	6,634	4.65	0.65
1995	398	7,755	1,000	5,329	2.51	0.69	1,576	8,459	3.96	1.09
1996	334	6,168	371	4,441	1.11	0.72	576	6,950	1.72	1.13
1997	240	5,913	4,347	9,761	18.11	1.65	7,496	16,858	31.23	2.85
1998	472	5,352	2,281	15,795	4.83	2.95	7,738	53,724	16.39	10.04
1999	488	5,476	636	12,081	1.30	2.21	2,479	45,417	5.08	8.29
2000	492	5,512	3,327	3,885	6.76	0.70	14,212	16,532	28.89	3.00
2001	493	11,360	648	19,209	1.31	1.69	2,417	71,675	4.90	6.31
2002	482	15,723	1,823	4,954	3.78	0.32	4,526	12,385	9.39	0.79
2003	496	11,800	1,433	1,782	2.89	0.15	3,096	3,874	6.24	0.33
2004	496	10,479	590	7,197	1.19	0.69	1,454	17,727	2.93	1.69
2005	494	8,703	1,341	5,131	2.71	0.59	3,625	13,190	7.34	1.52
2006	488	17,792	3,393	6,814	6.95	0.38	10,662	17,078	21.85	0.96
2007	419	4,590	127	10,733	0.30	2.34	509	31,754	1.21	6.92
2008	472	6,496	3,952	6,282	8.37	0.97	11,127	13,716	23.57	2.11
2009	491	8,327	1,098	7,434	2.24	0.89	4,241	21,301	8.64	2.56
2010	434	7,468	589	9,971	1.36	1.34	2,971	32,061	6.85	4.29
2011	405	9,850	2,082	4,151	5.14	0.42	7,663	11,464	18.92	1.16
2012	274	8,539	646	8,345	2.36	0.98	1,969	18,795	7.19	2.20
Average	***405***	***9,330***	***1,438***	***7,629***	***3.55***	***0.97***	***4,104***	***20,369***	***9.57***	***2.66***
Median	***472***	***9,450***	***1,098***	***6,282***	***2.51***	***0.69***	***2,971***	***16,532***	***6.24***	***1.52***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns, which were adjusted for marking rates and tag lose before release. For the available brood years, SARs have ranged from 0.00037 to 0.01552 for hatchery summer Chinook in the Wenatchee River basin (Table 8.33).

Table 8.33. Smolt-to-adult ratios (SARs) for Wenatchee hatchery summer Chinook, brood years 1989-2012.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	144,905	1,027	0.00709
1990	119,214	115	0.00096
1991	190,371	71	0.00037
1992	605,055	613	0.00101
1993	210,626	152	0.00072
1994	452,340	1,919	0.00424
1995	668,409	1,542	0.00231
1996	585,590	568	0.00097
1997	480,418	7,456	0.01552
1998	641,109	7,664	0.01195
1999	988,328	2,457	0.00249
2000	903,368	13,861	0.01534
2001	596,618	2,403	0.00403
2002	805,919	4,395	0.00545
2003	639,381	3,048	0.00477
2004	875,758	1,439	0.00164
2005	631,492	3,578	0.00567
2006	931,880	10,484	0.01125
2007	453,719	509	0.00112
2008	859,401	10,803	0.01257
2009	822,986	4,203	0.00511
2010	789,056	2,969	0.00376
2011	819,724	7,627	0.00930
2012	524,535	1,898	0.00362
Average	***614,175***	***3,783***	***0.00547***
Median	***635,437***	***2,430***	***0.00414***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

8.8 ESA/HCP Compliance

Broodstock Collection

Per the 2016 broodstock collection protocol, 270 natural-origin (adipose fin present) summer Chinook adults were targeted for collection at Dryden and Tumwater dams. The actual 2016 collection totaled 270 natural-origin summer Chinook in combination from Dryden and Tumwater dams. Trapping began 29 June and ended on 17 August 2016.

Summer Chinook and steelhead broodstock collections occurred concurrently at Dryden Dam. Thus, steelhead and spring Chinook encounters at Dryden Dam during Wenatchee summer Chinook broodstock collection were attributable to steelhead broodstock collections authorized under ESA Permit 18583 take authorizations. No steelhead or spring Chinook takes were associated with the Wenatchee summer Chinook collection. Two bull trout were encountered during summer Chinook broodstock collection at Dryden Dam in 2016.

Consistent with impact minimization measures in ESA Permit 1347, all ESA-listed species handled during summer Chinook broodstock collection were subject to water-to-water transfers or anesthetized if removed from the water during handling.

Hatchery Rearing and Release

The 2016 Wenatchee summer Chinook program released an estimated 493,333 smolts, representing 98.7%% of the 500,001-programmed production, and was within the 110% overage allowance identified in ESA permit 1347.

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or the Dryden acclimation facility during the period 1 January through 31 December 2018. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G.

Smolt and Emigrant Trapping

ESA-listed spring Chinook and steelhead were encountered during operation of the Lower Wenatchee Trap. ESA takes are reported in the steelhead (Section 3.8) and spring Chinook (Section 5.8) sections and are not repeated here.

Spawning Surveys

Summer Chinook spawning ground surveys conducted in the Wenatchee River basin during 2018 were consistent with ESA Section 10 Permit No. 1347. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Bull Trout

Bull trout encounters associated with implementation of hatchery production and monitoring and evaluation activities for Chinook and steelhead programs in the Wenatchee sub-basin are required to be reported as outlined in Biological Opinion 01EWF00-2013-0444. The 2018 report for bull trout encounters was compiled under provisions of ESA Section 10 Permit 18118, 18120, 18121, and 18583. Data and reporting information are included in Appendix I.

SECTION 9: METHOW SUMMER CHINOOK

The original goal of summer Chinook salmon supplementation in the Methow Basin was in part to use artificial production to replace adult production lost because of mortality at Wells, Rocky Reach, and Rock Island dams, while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans. Beginning with broodstock collection in 2012, Grant PUD took over the summer Chinook salmon supplementation program in the Methow River basin. Grant PUD constructed a new overwinter acclimation facility adjacent to the Carlton Acclimation Pond and the first fish released from this facility was 2014. The first fish that were overwinter acclimated in the facility were released in 2015. The new facility includes eight, 30-foot diameter dual-drain circular tanks.

Presently, adult summer Chinook are collected for broodstock from the run-at-large at the west-ladder trapping facility at Wells Dam. Before 2012, the goal was to collect up to 222 natural-origin adult summer Chinook for the Methow program. In 2011, the Hatchery Committees reevaluated that amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (beginning in 2012) is to collect up to 102 natural-origin summer Chinook for the Methow program. Broodstock collection occurs from about 1 July through 15 September with trapping occurring no more than 16 hours per day, three days a week. If natural-origin broodstock collection falls short of expectation, hatchery-origin adults can be collected to make up the difference.

Adult summer Chinook are spawned and reared at Eastbank Fish Hatchery. Juvenile summer Chinook were transferred from the hatchery to Carlton Acclimation Pond in March until overwinter acclimation was initiated with the 2013 brood year. They are now transferred to the Carlton Acclimation Facility in October or November and released from the new facility in mid-April to early May.

Before 2012, the production goal for the Methow summer Chinook supplementation program was to release 400,000 yearling smolts into the Methow River at ten fish per pound. Beginning with the 2012 brood, the revised goal is to release 200,000 yearling smolts at 13-17 fish per pound. Targets for fork length and weight are 163 mm (CV = 9.0) and 45.4 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2009, juvenile summer Chinook have been PIT tagged annually.

9.1 Broodstock Sampling

This section focuses on results from sampling 2016-2018 Methow summer Chinook broodstock that were collected in the West Ladder of Wells Dam.

Origin of Broodstock

Broodstock collected in 2016-2018 consisted entirely of natural-origin (adipose fin present) summer Chinook (Table 9.1).

Table 9.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned for the Methow/Okanogan programs during 1989-2011. Numbers of broodstock collected from 2012 to present are only for the Methow summer Chinook Program. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989[b]	1,419	72	-	1,297	-	341	17	-	312	-	1,609
1990[b]	864	34	-	828	-	214	8	-	206	-	1,034
1991[b]	1,003	59	-	924	-	341	20	-	314	-	1,238
1992[b]	312	6	-	297	-	428	9	-	406	-	703
1993[b]	813	48	-	681	-	464	28	-	388	-	1,069
1994	385	33	11	341	12	266	15	7	244	1	585
1995	254	13	10	173	58	351	28	9	240	74	413
1996	316	15	11	290	0	234	2	9	223	0	513
1997	214	11	5	198	0	308	24	20	264	0	462
1998	239	28	58	153	0	348	18	119	211	0	364
1999	248	5	19	224	0	307	2	16	289	0	513
2000	184	15	5	164	0	373	17	17	339	0	503
2001	135	8	36	91	0	423	29	128	266	0	357
2002	270	2	21	247	0	285	11	33	241	0	488
2003	449	14	53	381	0	112	2	9	101	0	482
2004	541	23	12	506	0	17	0	1	16	0	522
2005	551	29	76	391	55	12	2	0	9	1	400
2006	579	50	10	500	19	12	2	0	10	0	510
2007	504	22	26	456	0	19	0	2	17	0	473
2008	418	5	9	404	0	41	0	0	41	0	445
2009	553	31	15	507	0	5	5	0	0	0	507
2010	503	13	6	484	0	8	0	0	8	0	492
2011	498	18	13	467	0	30	4	0	26	0	493
Average[c]	***380***	***19***	***22***	***332***	***8***	***175***	***9***	***21***	***141***	***4***	***473***
Median[c]	***434***	***18***	***13***	***391***	***0***	***266***	***8***	***8***	***223***	***0***	***503***
2012	125	5	0	98	22	3	0	0	1	2	99
2013	98	1	0	97	0	4	0	0	4	0	101
2014	100	4	0	96	0	0	0	0	0	0	96
2015	97	0	0	97	0	1	0	0	1	0	98
2016	106	2	1	103	0	0	0	0	0	0	103
2017	118	5	0	111	0	0	0	0	0	0	111
2018	136	5	0	131	0	0	0	0	0	0	131
Average[d]	***111***	***3***	***0***	***105***	***3.1***	***1***	***0***	***0***	***1***	***0***	***106***
Median[d]	***106***	***4***	***0***	***98***	***0***	***0***	***0***	***0***	***0***	***0***	***101***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.

[b] Number of fish spawned and collected during these years included fish retained from the right- and left-bank ladder traps at Wells Dam and fish collected from the volunteer channel. There was no distinction made between fish collected at trap locations and program (i.e., aggregated population used for Wells, Methow, and Okanogan summer Chinook programs).

[c] The average and median represent broodstock collected for the combined Methow and Okanogan programs. Because of bias from aggregating the spawning population from 1989-1993, averages are based on adult numbers collected from 1994-2011.
[d] The average and median represent broodstock collected only for the Methow program.

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2018 return consisted primarily of age-4 and 5 natural-origin Chinook (87.6%). Age-3 natural-origin Chinook made up 12.4% of the broodstock (Table 9.2).

Table 9.2. Percent of hatchery and wild summer Chinook of different ages (total age) collected from broodstock for the Methow/Okanogan programs, 1991-2018.

Return Year	Origin	Total age				
		2	3	4	5	6
1991	Wild	0.5	6.8	35.1	55.4	2.2
	Hatchery	0.5	5.1	36.2	49.0	9.2
1992	Wild	0.0	13.0	36.2	50.7	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
1993	Wild	0.0	3.9	75.3	20.8	0.0
	Hatchery	0.0	1.0	85.7	13.3	0.0
1994	Wild	3.1	9.7	26.3	60.3	0.6
	Hatchery	0.0	14.7	11.2	74.0	0.0
1995	Wild	0.0	4.6	15.3	75.6	4.6
	Hatchery	0.0	0.4	13.0	25.6	61.0
1996	Wild	0.0	8.4	56.7	30.4	4.6
	Hatchery	0.0	3.0	31.0	47.0	19.0
1997	Wild	0.5	9.4	53.0	35.1	2.0
	Hatchery	0.0	20.6	11.1	61.8	6.5
1998	Wild	1.1	12.1	56.3	30.5	0.0
	Hatchery	2.1	18.9	56.2	16.0	6.8
1999	Wild	4.7	5.1	53.7	36.0	0.5
	Hatchery	0.3	3.5	29.3	65.0	1.9
2000	Wild	0.6	14.0	28.7	56.1	0.6
	Hatchery	0.0	27.0	14.3	54.3	4.3
2001	Wild	0.0	23.5	58.8	11.8	5.9
	Hatchery	1.8	21.1	64.6	10.1	2.4
2002	Wild	0.4	17.4	65.6	16.6	0.0
	Hatchery	0.0	2.4	39.4	58.3	0.0
2003	Wild	0.7	3.9	65.8	29.5	0.0
	Hatchery	0.0	5.6	18.7	70.1	5.6
2004	Wild	0.6	15.4	11.6	72.2	0.2
	Hatchery	0.0	6.7	53.3	33.3	6.7
2005	Wild	0.0	17.1	69.9	11.0	1.9

Return Year	Origin	Total age				
		2	3	4	5	6
	Hatchery	0.0	10.0	40.0	50.0	0.0
2006	Wild	1.7	3.0	41.0	52.9	1.5
	Hatchery	0.0	16.7	25.0	50.0	8.3
2007	Wild	1.8	15.3	8.2	70.3	4.4
	Hatchery	0.0	0.0	21.1	57.9	21.1
2008	Wild	0.3	17.9	67.1	13.3	1.4
	Hatchery	0.0	7.2	62.7	47.7	2.4
2009	Wild	1.3	10.1	68.7	19.9	0.0
	Hatchery	0.0	0.0	16.7	83.3	0.0
2010	Wild	0.2	16.2	51.0	32.6	0.0
	Hatchery	0.0	12.5	50.0	25.0	12.5
2011	Wild	0.1	7.1	75.5	17.0	0.0
	Hatchery	0.0	30.0	20.0	40.0	0.0
2012	Wild	0.0	3.9	49.0	46.1	1.0
	Hatchery	0.0	0.0	0.0	100.0	0.0
2013	Wild	0.0	15.2	70.7	14.1	0.0
	Hatchery	0.0	0.0	50.0	50.0	0.0
2014	Wild	0.0	4.1	71.1	24.7	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
2015	Wild	0.0	12.2	42.2	45.6	0.0
	Hatchery	0.0	0.0	100.0	0.0	0.0
2016	Wild	0.0	1.1	71.7	26.1	1.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
2017	Wild	0.0	2.6	43.9	54.4	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
2018	Wild	0.0	12.4	37.2	50.4	0.0
	Hatchery	0.0	0.0	0.0	100.0	0.0
Average	***Wild***	***0.6***	***10.2***	***50.2***	***37.8***	***1.2***
	Hatchery	***0.2***	***7.4***	***30.3***	***42.2***	***6.0***
Median	***Wild***	***0.1***	***9.7***	***53.0***	***32.6***	***0.2***
	Hatchery	***0.2***	***7.4***	***30.3***	***42.2***	***6.0***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years 2016-2018 (Table 9.3). No hatchery-origin adults were collected for the 2016 and 2017 brood; however, there was one collected in 2018. Differences in hatchery-origin and natural-origin fish were hard to assess given the small sample size of hatchery-origin fish (i.e., few hatchery fish were included in the broodstock).

Table 9.3. Mean fork length (cm) at age (total age) of hatchery and wild Methow/Okanogan summer Chinook collected from broodstock for the Methow/Okanogan programs, 1991-2018; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	47	1	-	68	15	6	82	78	10	94	123	8	97	5	5
	Hatchery	47	1	-	49	10	6	78	71	5	91	96	8	96	18	6
1992	Wild	-	0	-	55	9	5	69	25	6	78	35	6	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	72	3	4	86	58	7	98	16	5	-	0	-
	Hatchery	-	0	-	42	1	-	75	84	8	88	13	6	-	0	-
1994	Wild	42	10	6	50	31	7	80	84	9	93	193	8	104	2	13
	Hatchery	-	0	-	49	38	5	76	29	7	88	191	7	-	0	-
1995	Wild	-	0	-	67	6	8	79	20	9	96	99	5	94	6	5
	Hatchery	-	0	-	52	1	-	73	32	9	89	63	9	95	150	7
1996	Wild	-	0	-	68	22	9	83	149	8	95	79	7	101	12	5
	Hatchery	-	0	-	52	7	10	77	72	7	90	109	8	100	44	6
1997	Wild	31	1	-	60	19	7	85	107	8	96	71	7	98	4	11
	Hatchery	-	0	-	45	63	5	72	34	9	92	189	7	97	20	7
1998	Wild	39	2	1	59	23	6	83	107	7	96	58	7	-	0	-
	Hatchery	43	7	6	50	64	6	74	190	7	92	54	8	98	23	5
1999	Wild	38	10	3	64	11	8	82	115	7	96	76	6	104	1	-
	Hatchery	37	1	-	53	11	9	75	92	6	91	204	6	98	6	5
2000	Wild	39	1	-	66	23	7	83	47	6	96	92	5	95	1	-
	Hatchery	-	0	-	54	100	7	78	53	8	92	201	6	99	16	6
2001	Wild	-	0	-	63	4	12	88	10	9	90	2	4	94	1	-
	Hatchery	41	9	3	55	107	9	79	327	8	93	51	7	101	12	9
2002	Wild	56	1	-	65	44	7	88	166	6	100	42	7	-	0	-
	Hatchery	-	0	-	45	6	5	76	100	7	95	148	5	-	0	-
2003	Wild	43	3	6	61	16	6	87	268	7	99	120	6	-	0	-
	Hatchery	-	0	-	55	6	9	73	20	8	91	75	7	102	6	9
2004	Wild	51	3	5	67	78	6	81	59	6	97	367	7	99	1	-
	Hatchery	-	0	-	52	1	-	70	8	5	97	5	8	109	1	-
2005	Wild	-	0	-	68	89	6	83	363	7	94	57	6	101	10	7
	Hatchery	-	0	-	55	1	-	70	4	4	89	5	4	-	0	-
2006	Wild	38	9	3	54	16	4	69	221	6	77	286	5	78	8	4
	Hatchery	-	0	-	42	2	1	62	3	2	69	6	6	76	1	-
2007	Wild	39	8	5	53	69	5	67	37	6	78	317	5	77	20	7
	Hatchery	-	0	-	-	0	-	54	4	2	75	11	5	78	4	3
2008	Wild	41	1	-	55	62	4	69	233	6	76	46	4	82	5	3
	Hatchery	-	0	-	59	6	9	67	52	5	73	23	6	79	2	8
2009	Wild	38	7	5	54	54	5	72	367	5	79	106	5	-	0	-

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	59	1	-	71	5	7	-	0	-
2010	Wild	43	1	-	54	78	5	71	246	5	78	157	5	-	0	-
	Hatchery	-	0	-	57	1	-	67	4	5	79	2	1	89	1	-
2011	Wild	43	2	3	66	32	8	87	338	7	97	76	5	-	0	-
	Hatchery	-	0	-	63	9	11	78	9	6	92	12	9	-	0	-
2012	Wild	-	0	-	70	10	3	84	62	5	96	54	6	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	90	1	-	-	0	-
2013	Wild	-	0	-	72	14	5	86	65	7	97	13	5	-	0	-
	Hatchery	-	0	-	-	0	-	76	2	6	92	2	0	-	0	-
2014	Wild	-	0	-	75	4	3	88	69	6	94	24	4	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
2015	Wild	-	0	-	71	11	4	83	38	5	94	41	6	-	0	-
	Hatchery	-	0	-	-	0	-	75	1	0	-	0	-	-	0	-
2016	Wild	-	0	-	72	1	-	84	66	6	96	24	7	102	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	72	0	1	82	50	8	90	62	8	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
2018	Wild	-	0	-	71	15	7	83	45	6	91	61	9	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	86	1	-	-	0	-
Average	***Wild***	***41***	***2***	***4***	***64***	***27***	***6***	***81***	***125***	***7***	***92***	***96***	***6***	***95***	***3***	***7***
	Hatchery	***42***	***1***	***5***	***52***	***16***	***7***	***72***	***44***	***6***	***87***	***52***	***6***	***94***	***11***	***7***

Sex Ratios

Male summer Chinook in the 2016 broodstock made just under 50.0% of the adults collected, resulting in an overall male to female ratio of 0.96:1.00 (Table 9.4.). In 2017, males made about 50.8% of the adults collected, resulting in an overall male to female ratio of 1.04:1.00 (Table 9.4). In 2018, males made up about 49.3% of the adults collected, resulting in an overall male to female ratio of 0.97:1.00 (Table 9.4). The ratios for 2015 and 2017 broodstock were above or at the assumed 1:1 ratio goal in the broodstock protocol.

Table 9.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock at Wells Dam for the Methow/Okanogan programs, 1991-2018. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989[a]	752	667	1.13:1.00	181	160	1.13:1.00	1.13:1.00
1990[a]	381	482	0.79:1.00	95	120	0.79:1.00	0.79:1.00
1991[a]	443	559	0.79:1.00	151	191	0.79:1.00	0.79:1.00
1992[a]	349	318	1.10:1.00	38	35	1.09:1.00	1.10:1.00
1993[a]	513	300	1.71:1.00	293	171	1.71:1.00	1.71:1.00
1994	205	180	1.14:1.00	165	101	1.63:1.00	1.32:1.00

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1995	103	149	0.69:1.00	158	197	0.80:1.00	0.75:1.00
1996	178	138	1.29:1.00	132	102	1.29:1.00	1.29:1.00
1997	102	112	0.91:1.00	174	134	1.30:1.00	1.12:1.00
1998	130	109	1.19:1.00	263	85	3.09:1.00	2.03:1.00
1999	138	110	1.25:1.00	161	146	1.10:1.00	1.17:1.00
2000	82	102	0.80:1.00	243	130	1.87:1.00	1.40:1.00
2001	89	46	1.93:1.00	311	112	2.78:1.00	2.53:1.00
2002	166	104	1.60:1.00	149	136	1.10:1.00	1.31:1.00
2003	255	194	1.31:1.00	61	51	1.20:1.00	1.29:1.00
2004	263	278	0.95:1.00	12	5	2.40:1.00	0.97:1.00
2005	365	186	1.96:1.00	6	6	1.00:1.00	1.93:1.00
2006	287	292	0.98:1.00	9	3	3.00:1.00	1.00:1.00
2007	228	276	0.83:1.00	11	8	1.38:1.00	0.84:1.00
2008	210	208	1.01:1.00	13	28	0.46:1.00	0.94:1.00
2009	261	292	0.89:1.00	2	3	0.67:1.00	0.89:1.00
2010	248	255	0.97:1.00	5	3	1.67:1.00	0.98:1.00
2011	236	262	0.90:1.00	23	7	3.29:1.00	0.96:1.00
2012	50	53	0.94:1.00	1	0	--	0.96:1.00
2013	49	49	1.00:1.00	3	1	3.00:1.00	1.04:1.00
2014	50	50	1.00:1.00	0	0	--	1.00:1.00
2015	49	49	1.00:1.00	1	0	--	1.02:1.00
2016	52	54	0.96:1.00	0	0	--	0.96:1.00
2017	60	58	1.04:1.00	0	0	-	1.04:1.00
2018	67	69	0.97:1.00	0	0	-	0.97:1.00
Total[b]	***6,361***	***6,001***	***1.06:1.00***	***2,661***	***1,935***	***1.38:1.00***	***1.14:1.00***

[a] Numbers and male to female ratios were derived from the aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.
[b] Total values were derived from 1994-present data to exclude aggregate population bias from 1989-1993 returns.

Fecundity

Fecundities for the 2016, 2017, and 2018 summer Chinook broodstock averaged 4,509, 3,858, and 4,156 eggs per female, respectively (Table 9.5). These values were below the overall average of 4,840 eggs per female. Mean observed fecundities for the 2016, 2017, and 2018 returns were also below the expected fecundity of 4,721, 4,596, and 3,858 eggs per female assumed in the broodstock protocols, respectively.

Table 9.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock at Wells Dam for the Methow/Okanogan programs, 1989-2018; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	4,750
1990*	NA	NA	4,838
1991*	NA	NA	4,819
1992*	NA	NA	4,804
1993*	NA	NA	4,849
1994*	NA	NA	5,907
1995*	NA	NA	4,930
1996*	NA	NA	4,870
1997	5,166	5,296	5,237
1998	5,043	4,595	4,833
1999	4,897	4,923	4,912
2000	5,122	5,206	5,170
2001	5,040	4,608	4,735
2002	5,306	5,258	5,279
2003	5,090	4,941	5,059
2004	5,130	5,118	5,130
2005	4,545	4,889	4,553
2006	4,854	4,824	4,854
2007	5,265	5,093	5,260
2008	4,814	4,588	4,787
2009	5,115	--	5,115
2010	5,124	4,717	5,116
2011	4,594	3,915	4,578
2012	4,470	--	4,470
2013	4,700	5,490	4,717
2014	4,685	--	4,685
2015	4,410	--	4,410
2016	4,509	--	4,509
2017	3,858	--	3,858
2018	4,156	--	4,156
Average	***4,813***	***4,897***	***4,840***
Median	***4,876***	***4,923***	***4,836***

* Individual fecundities were not assigned to females until 1997 brood.

To estimate fecundities by length, weight, and age[39], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2003 through 2018 broodstock (complete data for all variables are available for years 2014-2018). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin summer Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

Mean fecundity by age varied between hatchery and natural-origin summer Chinook and over time (Table 9.6). On average, mean fecundities varied between hatchery and natural-origin summer Chinook by 454 eggs for age-4 fish, 320 eggs for age-5 fish, and 77 eggs for age-6 fish.

Table 9.6. Mean fecundity by age (total age) for hatchery and wild summer Chinook collected from broodstock for the Methow River program, brood years 2003-2018; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2003	Wild	-	0	-	4,836	88	935	5,485	74	806	-	0	-
	Hatchery	-	0	-	-	0	-	4,939	41	857	5,186	4	515
2004	Wild	4,984	1	-	4,086	12	644	5,216	223	821	6,005	1	-
	Hatchery	-	0	-	3,673	1	-	5,430	3	152	5,628	1	-
2005	Wild	-	0	-	4,461	108	683	4,722	38	821	4,704	5	491
	Hatchery	-	0	-	-	0	-	4,681	3	546	-	0	-
2006	Wild	-	0	-	4,642	73	824	4,951	167	894	4,808	2	216
	Hatchery	-	0	-	-	0	-	4,824	2	1,957	-	0	-
2007	Wild	-	0	-	4,973	13	974	5,260	191	851	5,394	13	662
	Hatchery	-	0	-	-	0	-	4,955	6	678	5,505	2	13
2008	Wild	4,345	1	-	4,843	115	912	5,155	29	793	5,849	3	414
	Hatchery	4,259	3	852	4,405	42	903	4,882	20	871	5,283	1	-
2009	Wild	3,582	2	96	5,070	186	826	5,491	73	811	-	0	-
	Hatchery	-	0	-	-	0	-	4,151	2	552	-	0	-
2010	Wild	-	0	-	4,887	118	834	5,236	112	719	-	0	-
	Hatchery	-	0	-	3,849	1	-	5,006	2	820	-	0	-
2011	Wild	3,605	1	-	4,508	148	773	5,018	41	801	-	0	-
	Hatchery	3,652	1	-	4,074	1	-	3,950	3	948	-	0	-
2012	Wild	-	0	-	4,216	15	645	4,675	32	704	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2013	Wild	4,173	1	-	4,614	33	787	5,120	11	491	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-

[39] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2014	Wild	-	0	-	4,532	26	864	4,845	18	630	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2015	Wild	-	0	-	3,998	18	525	4,776	26	693	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2016	Wild	-	0	-	4,323	31	672	4,921	15	634	5,182	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	3,608	17	744	3,957	36	895	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2018	Wild	-	0	-	3,669	16	768	4,366	40	665	-	0	-
	Hatchery	-	0	-	-	0	-	3,477	1	-	-	0	-
Average	***Wild***	***4,138***	***0***	***96***	***4,454***	***64***	***776***	***4,950***	***70***	***752***	***5,324***	***2***	***446***
	Hatchery	***3,956***	***0***	***852***	***4,000***	***3***	***903***	***4,630***	***5***	***820***	***5,401***	***1***	***264***

We pooled fecundity data from brood years 2014 through 2018 (only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for natural-origin females are shown in Figures 9.1, 9.2, and 9.3. Note that no hatchery-origin Chinook were included in broodstock in 2014-2018. All fecundity variables increase linearly with fork length.

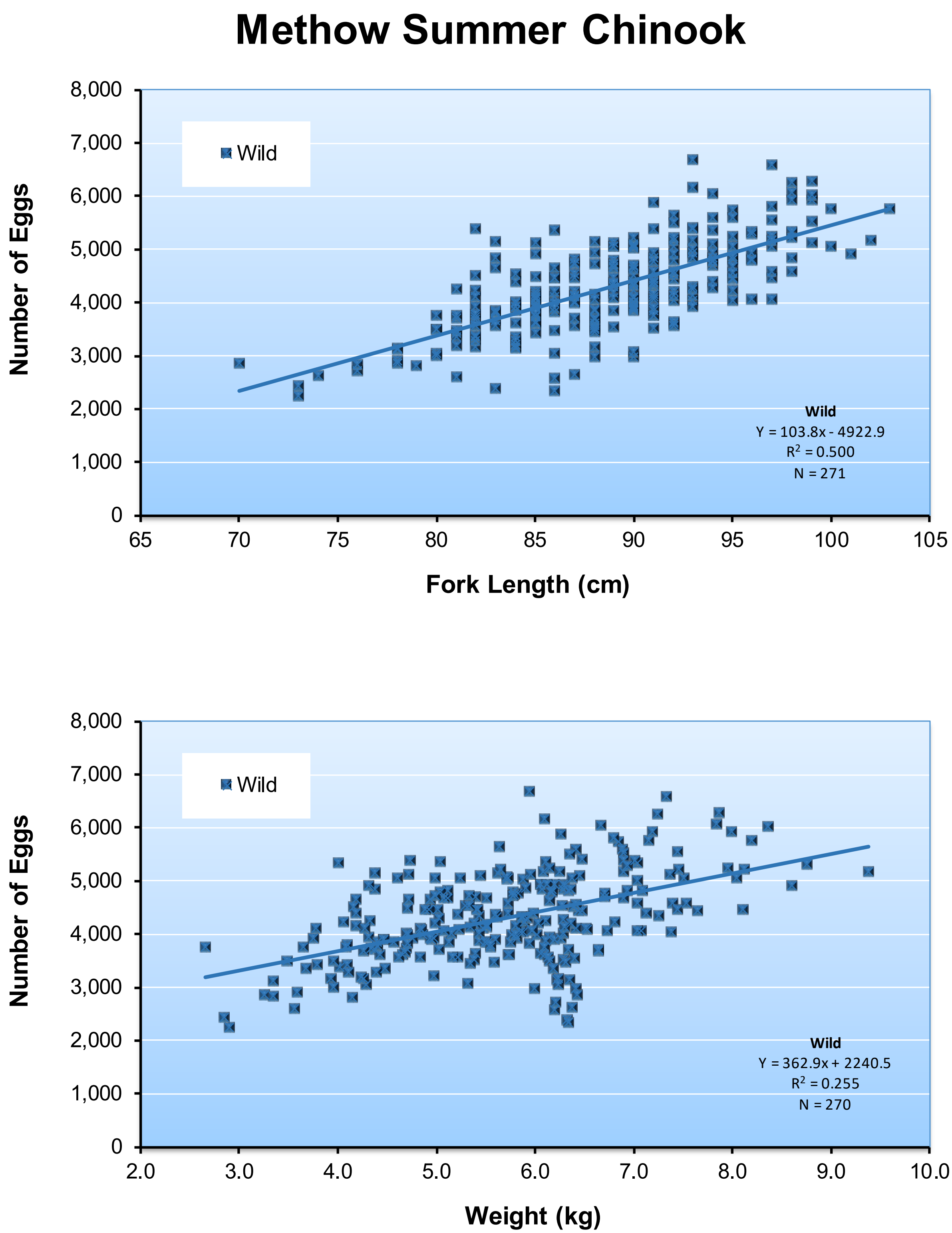


Figure 9.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural-origin summer Chinook for return years 2014-2018.

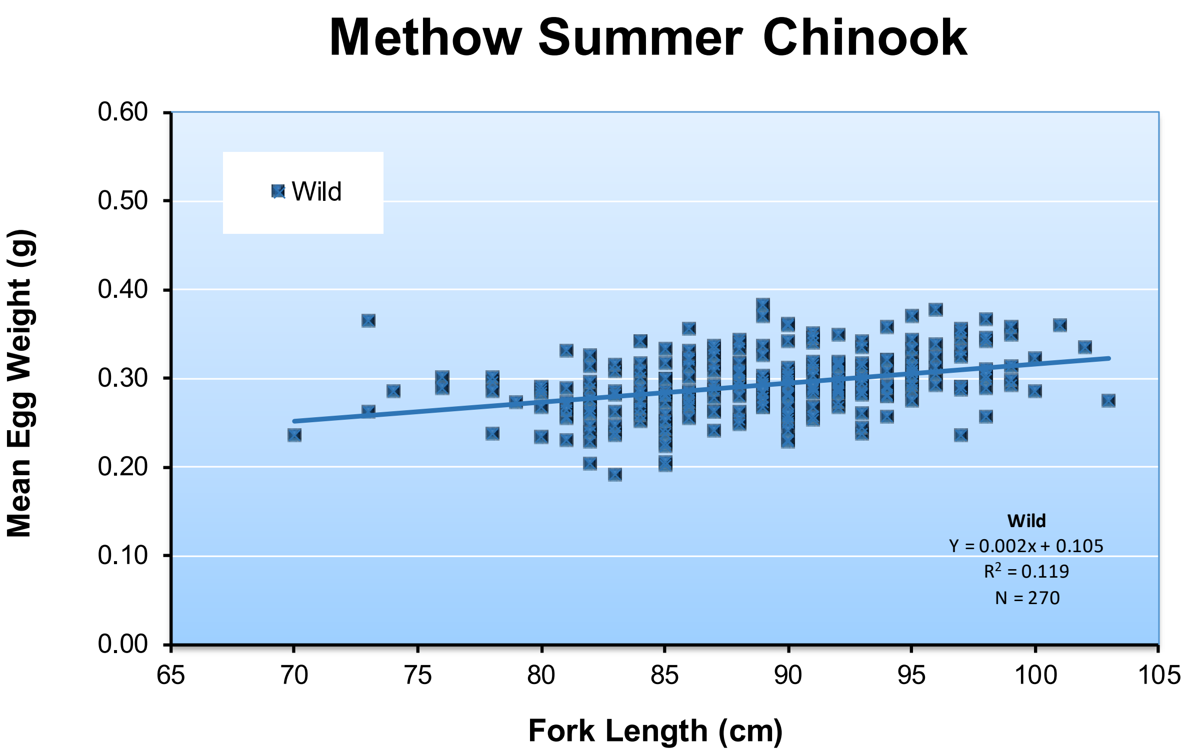


Figure 9.2. Relationships between mean egg weight and fork length for natural-origin summer Chinook for return years 2014-2018.

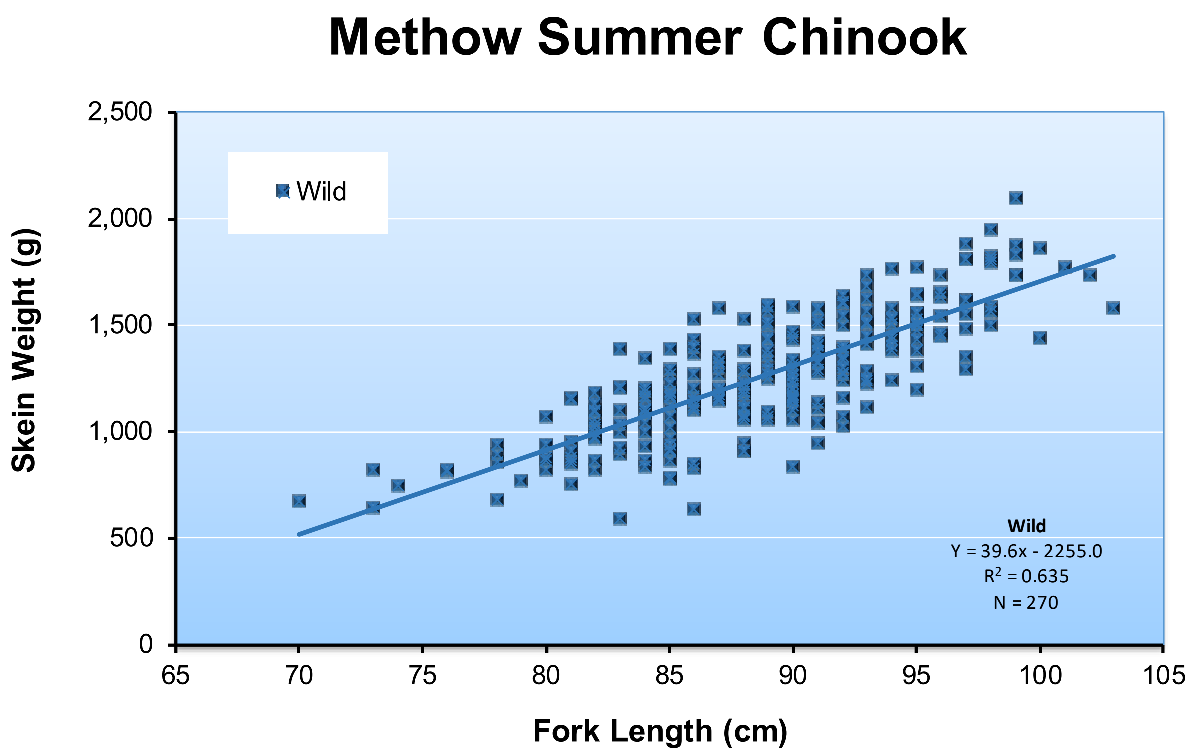


Figure 9.3. Relationships between skein weight and fork length for natural-origin summer Chinook for return years 2014-2018.

9.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 493,827 eggs were needed to meet the program release goal of 400,000 smolts for brood years 1989-2011. An evaluation of the program in 2011 determined that 246,913 eggs are needed to meet the revised release goal of 200,000 smolts. This revised goal began with brood year 2012. From 1989 through 2011, the egg take goal was reached in eight of those years (Table 9.7). From 2012 to present, the egg take goal was achieved once in 2018 (Table 9.7).

Table 9.7. Numbers of eggs taken from summer Chinook broodstock collected at Wells Dam for the Methow/Okanogan programs, 1989-2018.

Return year	Number of eggs taken
1989	482,800
1990	464,097
1991	586,594
1992	486,260

Return year	Number of eggs taken
1993	531,490
1994	595,390
1995	491,000
1996	448,000
1997	401,162
1998	389,346
1999	483,726
2000	403,268
2001	279,272
2002	466,530
2003	473,681
2004	537,210
2005	305,826
2006	509,334
2007	549,802
2008	441,778
2009	560,602
2010	505,188
2011	488,747
Average (1989-2011)	***473,091***
Median (1989-2011)	***483,726***
2012	245,245
2013	231,136
2014	223,839
2015	216,098
2016	239,025
2017	208,341
2018	278,463
Average (2012-present)	***234,592***
Median (2012-present)	***231,136***

Number of acclimation days

Improvements to Carlton Acclimation Pond made overwinter rearing feasible beginning with the 2013 brood Methow summer Chinook. Fish are held on well water at Eastbank Fish Hatchery before being transferred to Carlton Acclimation Pond for final acclimation on Methow River water in October (Table 9.8). Only the 1994 and 1995 broods were reared for longer durations at the Methow Fish Hatchery on Methow River water.

Table 9.8. Number of days Methow summer Chinook were acclimated at Carlton Acclimation Pond, brood years 1989-2016.

Brood year	Release year	Transfer date	Release date	Number of days
1989	1991	15-Mar	6-May	52
1990	1992	26-Feb	28-Apr	61
1991	1993	10-Mar	23-Apr	44
1992	1994	4-Mar	21-Apr	48
1993	1995	18-Mar	2-May	45
1994	1996	25-Sep	28-Apr	215
		19-Mar	28-Apr	40
1995	1997	22-Oct	8-Apr	168
		19-Mar	22-Apr	34
1996	1998	9-Mar	14-Apr	36
1997	1999	10-Mar	20-Apr	41
1998	2000	19-Mar	2-May	44
1999	2001	18-Mar	18-Apr	31
2000	2002	28-Mar	1-May	34
2001	2003	27-Mar	24-Apr	28
2002	2004	16-Mar	24-Apr	39
2003	2005	18-Mar	21-Apr	34
2004	2006	12-Mar	22-Apr	41
2005	2007	12-Mar	15-Apr – 8-May	34-57
2006	2008	4-7-Mar	16-Apr – 2 May	40-59
2007	2009	18-24-Mar	21-Apr	28-34
2008	2010	4-5, 8-9-Mar	4-21-Apr	33-50
2009	2011	25, 29, 31-Mar & 4-Apr	11-25-Apr	8-31
2010	2012	19-21, 24-Mar	23-24-Apr	31-37
2011	2013	13-21-Mar	15-23-Apr	25-41
2012	2014	19-21-Mar	7-Apr – 14 May	18-57
2013	2015	20-21-Oct	13-May	204-205
2014	2016	26 & 28-Oct	18-Apr	173-175
2015	2017	20-21-Oct	18-Apr	179-180
2016	2018	19-20, 23-24-Oct	24-25-Apr	182-188

Release Information

Numbers released

The 2016 brood Methow summer Chinook program achieved 104.8% of the 200,000 goal with about 209,490 Chinook being force released from the circular ponds on the nights of 24-25 April 2018 (Table 9.9). Forced releases at night were initiated in 2016 to improve post-release survival.

Table 9.9. Numbers of Methow summer Chinook smolts released from the hatchery, brood years 1989-2016. Beginning with the 2014 release group (brood year 2012), the release target for Methow summer Chinook is 200,000 smolts. CWT marking rates were adjusted for tag loss before the fish were released.

Brood year	Release year	CWT mark rate	Number of smolts released
1989	1991	0.8529	420,000
1990	1992	0.9485	391,650
1991	1993	0.6972	540,900
1992	1994	0.9752	402,641
1993	1995	0.4623	433,375
1994	1996	0.9851	406,560
1995	1997	0.9768	353,182
1996	1998	0.9221	298,844
1997	1999	0.9884	384,909
1998	2000	0.9429	205,269
1999	2001	0.9955	424,363
2000	2002	0.9928	336,762
2001	2003	0.9902	248,595
2002	2004	0.9913	399,975
2003	2005	0.9872	354,699
2004	2006	0.9848	400,579
2005	2007	0.9897	263,723
2006	2008	0.9783	419,734
2007	2009	0.9837	433,256
2008	2010	0.9394	397,554
2009	2011	0.9862	404,956
2010	2012	0.9962	439,000
2011	2013	0.9734	436,092
Average (1989-2011)		***0.9365***	***382,462***
Median (1989-2011)		***0.9837***	***400,579***
2012	2014	0.9987	197,391
2013	2015	0.9903	188,834
2014	2016	0.9921	167,616
2015	2017	0.9923	177,762
2016	2018	0.9926	209,490
Average (2012-present)		***0.9932***	***188,219***

Brood year	Release year	CWT mark rate	Number of smolts released
Median (2012-present)		***0.9923***	***188,834***

Numbers tagged

The 2016 brood Methow summer Chinook were 99.3% CWT[40] and adipose fin-clipped (Table 9.9).

On 11-13 April 2019, a total of 5,052 Methow summer Chinook from the 2017 brood were PIT tagged at the Carlton Acclimation Facility. These fish were tagged in circular ponds #1 through #6. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 123 mm in length and 23 g at time of tagging.

Table 9.10 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Methow River.

Table 9.10. Summary of PIT-tagging activities for Methow hatchery summer Chinook, brood years 2008-2016.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	10,100	4	0	10,096
2009	2011	5,050	17	9	5,024
2010	2012	0	--	--	0
2011	2013	0	--	--	0
2012	2014	10,099	41	7	10,051
2013	2015	10,159	35	1	10,123
2014	2016	5,000	8	0	4,992
2015	2017	5,064	0	0	5,064
2016	2018	4,424	0	0	4,424

Fish size and condition at release

A forced release of yearling Chinook smolts took place on the nights of 24-25 April 2018. Size at release was within the respective size range for fish per pound goals (Table 9.11). For this brood year, CV was less than the target CV for length by 7%.

[40] Sixty days after tagging, taggers conduct a quality control procedure, which includes collecting a sample of tagged fish and scanning for tag retention. Thus, the number of tagged fish released is adjusted for tag loss.

Table 9.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Methow summer Chinook smolts released from the hatchery, brood years 1991-2016. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1991	1993	152	13.6	40.3	11
1992	1994	145	16.0	37.2	12
1993	1995	154	8.6	37.1	12
1994	1996	163	8.2	48.2	9
1995	1997	141	9.6	37.0	12
1996	1998	199	13.1	105.1	4
1997	1999	153	7.6	39.5	12
1998	2000	164	8.7	51.7	9
1999	2001	153	9.3	41.5	11
2000	2002	170	10.2	54.2	8
2001	2003	167	7.4	52.7	9
2002	2004	148	13.1	35.7	13
2003	2005	148	10.1	35.5	13
2004	2006	142	9.8	31.1	15
2005	2007	158	15.0	42.2	11
2006	2008	156	18.0	42.8	11
2007	2009	138	21.0	32.1	14
2008	2010	155	14.2	42.0	11
2009	2011	170	15.8	56.9	8
2010	2012	145	16.7	34.5	13
2011	2013	160	13.0	43.6	6
Average		***156***	***12.3***	***44.8***	***11***
Targets		***163***	***9.0***	***45.4***	***10***
2012	2014	158	12.1	41.6	11
2013	2015	130	12.6	27.2	17
2014	2016	125	10.8	23.0	20
2015	2017	134	8.4	29.4	15
2016	2018	131	8.0	26.7	17
Average		***136***	***10.4***	***29.6***	***16***
Targets		***163***	***9.0***	***45.4***	***13-17***

Survival Estimates

Overall survival of the 2016 brood Methow summer Chinook from green (unfertilized) egg-to-release was above the standard set for the program (Table 9.12). There was higher than expected survivals throughout all stages, contributing to increased program performance. Pre-spawn survival of adults was also above the standard set for the program.

Table 9.12. Hatchery life-stage survival rates (%) for Methow summer Chinook, brood years 1989-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989[a]	89.8	99.5	89.9	96.7	99.7	99.4	73.3	98.5	87.0
1990[a]	93.9	99.0	84.9	97.1	81.2	80.6	97.7	99.5	84.4
1991[a]	93.1	95.5	88.2	98.0	99.4	99.1	97.5	99.6	92.2
1992[a]	96.9	99.0	87.8	98.0	99.9	99.9	90.9	98.3	82.8
1993[a]	82.2	99.4	85.4	97.6	99.8	99.5	92.0	99.4	81.5
1994	96.1	90.0	86.6	100.0	98.1	97.4	73.1	99.1	68.3
1995	91.9	96.2	98.2	84.1	96.5	96.2	92.7	89.6	71.9
1996	95.4	98.1	83.2	100.0	97.7	96.9	86.5	89.0	66.7
1997	91.9	94.6	86.1	98.4	98.7	98.3	98.8	99.7	95.9
1998	84.0	96.2	54.1	98.0	99.4	98.9	96.6	99.9	52.7
1999	98.8	98.7	92.9	96.9	98.0	97.6	96.9	99.9	87.7
2000	90.5	96.9	89.2	98.1	98.5	98.3	94.6	94.4	83.5
2001	96.2	92.3	89.1	97.6	97.2	97.1	97.5	99.8	89.0
2002	97.1	98.1	88.3	99.9	97.7	97.5	96.7	99.9	85.7
2003	96.7	97.5	82.8	98.2	99.7	99.2	93.7	99.9	74.9
2004	93.6	98.2	84.0	97.8	99.6	99.2	98.3	98.5	74.6
2005	97.0	89.6	88.0	95.5	99.6	98.9	96.6	99.9	86.2
2006	92.9	89.5	86.3	98.3	99.6	98.7	97.2	99.5	82.4
2007	92.6	99.6	84.1	98.5	99.7	99.5	98.9	99.8	81.9
2008	99.6	97.9	91.9	99.5	99.3	98.9	98.5	99.9	90.0
2009[b]	93.6	93.5	91.0	97.7	99.7	99.2	98.8	100.0	87.9
2010[c]	96.5	100.0	91.1	100.0	96.4	96.1	95.4	99.5	86.9
2011	94.9	96.4	93.8	97.8	99.7	99.1	98.6	99.9	90.4
2012	94.3	94.2	93.1	97.8	99.4	99.0	97.0	98.3	88.3
2013	98.0	100.0	89.5	97.8	99.9	99.2	93.4	94.2	81.7
2014	96.0	96.0	94.0	95.8	99.6	99.4	87.1	88.0	78.4
2015	93.1	95.0	89.1	98.0	99.7	99.4	94.2	95.6	82.3
2016	100.0	100.0	92.4	98.3	99.7	99.5	96.6	97.4	87.6
Average	***94.2***	***96.5***	***87.7***	***97.6***	***98.3***	***97.9***	***93.9***	***97.8***	***82.2***
Median	***94.6***	***97.2***	***88.7***	***98.0***	***99.5***	***99.0***	***96.6***	***99.5***	***84.0***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival rates were calculated from aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.

[b]Survival rates were calculated from aggregate collections at Wells east fish ladder for the Methow and Okanogan/Similkameen programs. About 41% of the total fish collected were used to estimate survival rates.
[c] Survival rates were calculated from aggregate collections at Wells West Ladder for the Methow and Similkameen programs. About 71% of the total fish collected were used to estimate survival rates.

9.3 Disease Monitoring

Results of 2018 adult broodstock bacterial kidney disease (BKD) monitoring indicated that 100% of females had ELISA values less than 0.120 (Table 9.13).

Table 9.13. Proportion of bacterial kidney disease (BKD) titer groups for the Methow/Okanogan summer Chinook broodstock, brood years 1997-2018. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.6267	0.1333	0.0622	0.1778	0.6844	0.3156
1998	0.9632	0.0184	0.0123	0.0061	0.9816	0.0184
1999	0.9444	0.0198	0.0238	0.0119	0.9643	0.0357
2000	0.7476	0.0952	0.0238	0.1333	0.8000	0.2000
2001	0.9801	0.0199	0.0000	0.0000	1.0000	0.0000
2002	0.9567	0.0130	0.0130	0.0173	0.9740	0.0260
2003	0.9620	0.0127	0.0169	0.0084	0.9747	0.0253
2004	0.9585	0.0151	0.0075	0.0189	0.9736	0.0264
2005	0.9884	0.0000	0.0000	0.0116	0.9884	0.0116
2006	0.9962	0.0038	0.0000	0.0000	0.9962	0.0038
2007	0.9202	0.0266	0.0152	0.0380	0.9354	0.0646
2008	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2009	0.9891	0.0073	0.0037	0.0000	0.9927	0.0073
2010	0.9960	0.0040	0.0000	0.0000	1.0000	0.0000
2011	0.9766	0.0140	0.0000	0.0093	0.9860	0.0140
2012	0.9341	0.0440	0.0110	0.0110	0.9780	0.0220
2013	0.8776	0.1224	0.0000	0.0000	0.9388	0.0612
2014	0.9170	0.0210	0.0210	0.0420	0.9381	0.0630
2015	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2016	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2017	0.7778	0.0556	0.0556	0.1111	0.7778	0.0222
2018	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
Average	***0.9324***	***0.0285***	***0.0121***	***0.0271***	***0.9492***	***0.0417***
Median	***0.9626***	***0.0146***	***0.0056***	***0.0089***	***0.9798***	***0.0202***

[a] Individual ELISA samples were not collected before the 1997 brood.

[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

9.4 Natural Juvenile Productivity

During 2018, juvenile summer Chinook were sampled at the Methow Trap located near RM 18.6. Trapping has occurred in this location since 2004.

Emigrant Estimates

Methow Trap

On the Methow River, WDFW used traps with cone diameters of 2.4 m and 1.5 m to increase trap efficiency over a greater range of river discharge. Large variation in discharge and channel configuration required the use of two trapping positions. The 1.5-m trap was deployed in the lower position at discharges less than 45.3 m^3/s. At discharges greater than 45.3 m^3/s, the 2.4-m trap was installed and operated in tandem with the 1.5 m trap.

A pooled-efficiency model estimated the total number of emigrants when the trap was operated in the low trapping position. A flow-efficiency model estimated the total number of emigrants when the trap was operated in the upper trapping position. The pooled-efficiency estimate was based on eight mark-recapture release groups in 2018. The flow-efficiency estimate was based on 13 mark-recapture release groups that were conducted over the period 2007-2018.

The Methow Trap operated at night between 1 March and 4 December 2018. During that time, the trap was inoperable for 25 days because of high river discharge. During the ten-month sampling period, a total of 3,984 wild subyearling summer Chinook were captured at the Methow Trap. Based on the pooled-efficiency model and the flow efficiency model, the total number of wild subyearling summer Chinook that emigrated past the Methow Trap in 2018 was 352,899 (±481,655) (Table 9.13). This value contains an estimated 85,634 fish that likely emigrated past the trapping location during the 25 days in which the trap was not operating. Because 120 summer Chinook redds were observed downstream from the trap in 2017, the total number of summer Chinook emigrating from the Methow River in 2018 was expanded using the ratio of the number of redds downstream from the trap to the number upstream from the trap. This resulted in a total summer Chinook emigrant estimate of 427,193 (±529,935) fish (Table 9.14). Most of these fish emigrated during March through June (Figure 9.4).

Table 9.14. Numbers of redds and juvenile summer Chinook emigrants in the Methow River basin for brood years 2003-2017; NA = not available.

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
2003	1,624	8,215,816	1,454,913	NA
2004*	973	4,991,490	2,016,696	NA
2005*	874	3,979,322	269,870	NA
2006	1,353	6,567,462	2,481,762	3,465,247
2007	620	3,261,200	446,860	664,396
2008	599	2,867,413	385,087	508,077
2009	692	3,539,580	838,989	1,202,030
2010	887	4,537,892	514,724	703,483

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
2011	941	4,307,898	1,861,614	2,292,904
2012	960	4,291,200	7,533,462	11,212,595
2013	1,551	7,316,067	473,625	709,066
2014	591	2,768,835	706,071	742,505
2015	1,231	5,428,710	761,769	1,219,425
2016	1,115	5,027,535	669,432	829,352
2017	690	2,662,020	352,899	427,193
Average	***980***	***4,650,829***	***1,384,518***	***1,998,023***
Median	***941***	***4,307,898***	***706,071***	***785,929***

* Trap did not operate for entire migration period.

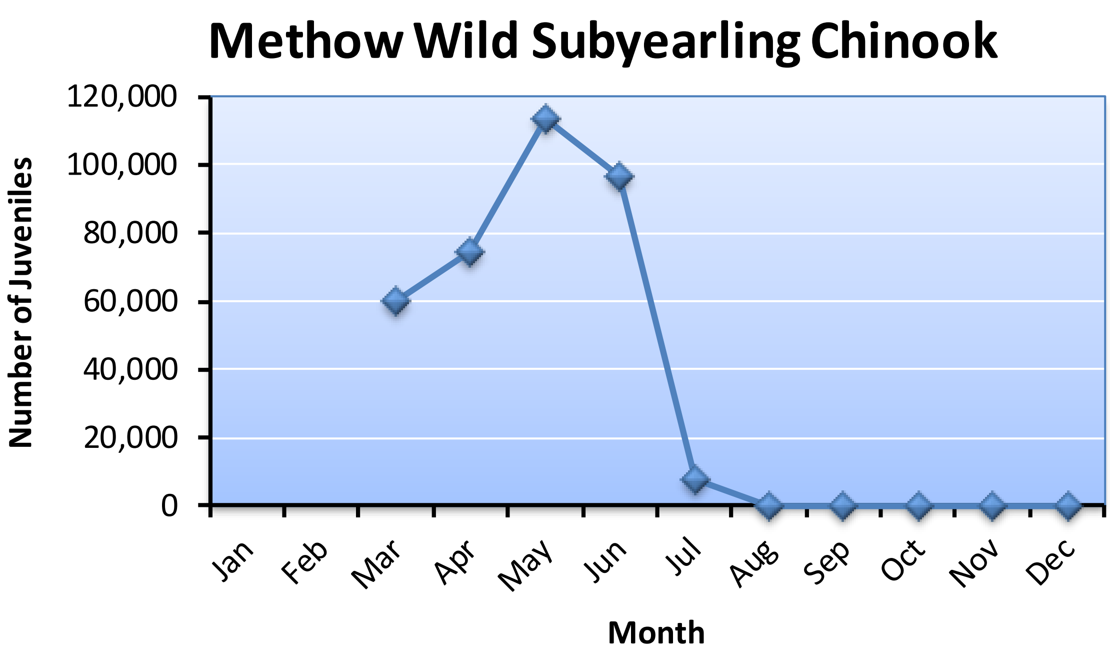


Figure 9.4. Estimated numbers of wild subyearling Chinook at the Methow Trap during March to early December 2018.

Subyearling summer Chinook sampled in 2018 averaged 63.7 mm in length, 3.3 g in weight, and had a mean condition of 1.13 (Table 9.15). These size estimates were similar to the overall mean of subyearling summer Chinook sampled in previous years (overall means: 63.6 mm, 3.8 g, and condition of 1.22). Environmental conditions at the trapping location do not allow for accurate weight measurements on fry (i.e., <50 mm fork length), so this size class is underrepresented in the averages.

Table 9.15. Mean fork length (mm), weight (g), and condition factor of subyearling summer Chinook collected in the Methow Trap, 2004-2018. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2004	506	56.5 (17.5)	2.8 (2.8)	1.29 (0.36)
2005	326	42.6 (6.5)	1.1 (0.6)	1.34 (0.39)
2006	787	38.5 (3.0)	0.6 (0.3)	1.02 (0.28)
2007	437	73.9 (17.3)	5.8 (3.8)	1.24 (0.26)
2008	123	78.8 (16.3)	6.7 (3.9)	1.27 (0.35)
2009	162	67.4 (12.4)	4.3 (2.3)	1.31 (0.34)
2010	142	69.7 (14.4)	4.6 (2.9)	1.26 (0.50)
2011	590	70.6 (13.5)	4.9 (2.8)	1.28 (0.31)
2012	373	61.4 (10.9)	2.9 (2.1)	1.16 (0.22)
2013	602	62.0 (11.0)	3.2 (2.1)	1.22 (0.23)
2014	707	67.1 (13.2)	3.9 (2.6)	1.16 (0.18)
2015	633	69.2 (13.6)	4.6 (2.8)	1.25 (0.22)
2016	645	65.6 (12.8)	3.8 (2.6)	1.20 (0.24)
2017	424	67.1 (14.1)	4.0 (3.0)	1.14 (0.23)
2018	575	63.7 (12.7)	3.3 (2.5)	1.13 (0.18)
Average	***469***	***63.6 (12.6)***	***3.8 (2.5)***	***1.22 (0.29)***
Median	***506***	***67.1 (13.2)***	***3.9 (2.6)***	***1.24 (0.26)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

Both productivity and survival estimates for juvenile emigrants of summer Chinook in the Methow River basin are provided in Table 9.16. Estimates for brood year 2017 were within the range of estimates for brood years 2006-2016. During the period 2006-2017, freshwater productivities ranged from 457-2,561 emigrants/redd. Survivals during the same period ranged from 9.7-53.2% for egg-emigrants.

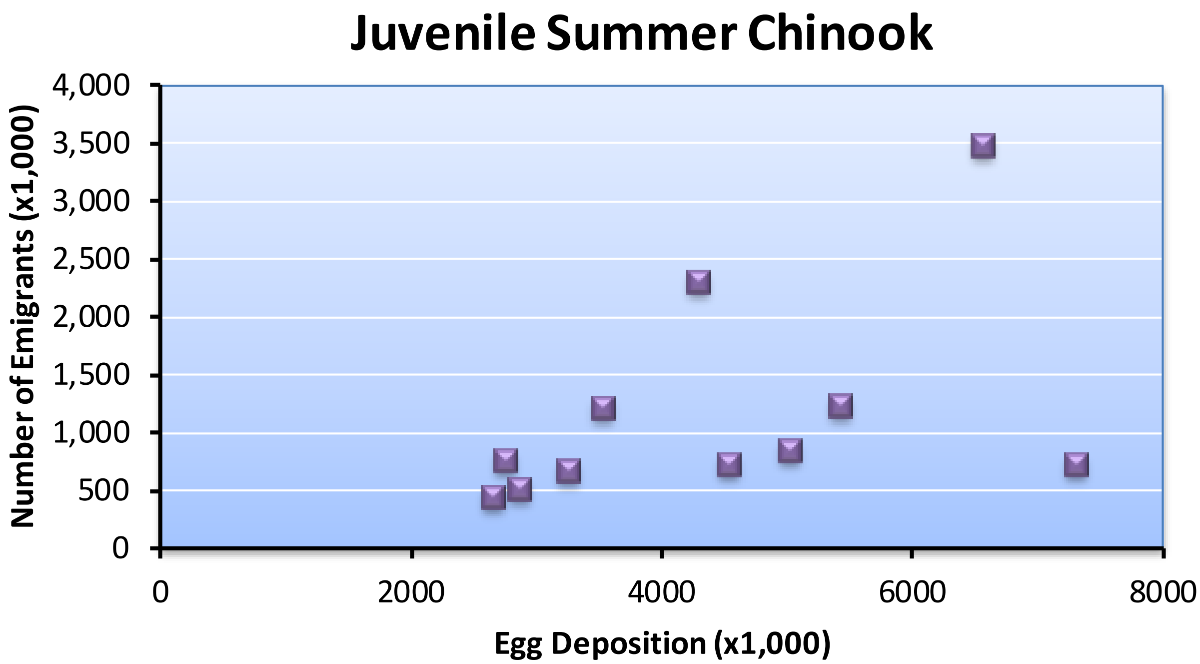
Table 9.16. Productivity (emigrants/redd) and survival (egg-emigrant) estimates for summer Chinook in the Methow River basin for brood years 2006-2017; ND = no data. These estimates were derived from data in Table 9.14.

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
2006	2,561	52.8
2007	1,072	20.4
2008	848	17.7
2009	1,737	34.0
2010	793	15.5
2011	2,437	53.2
2012	11,680[a]	261.3[a]
2013	457	9.7

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
2014	1,256	26.8
2015	991	22.5
2016	744	16.5
2017	619	16.1
Average	***1,229***	***25.9***
Median	***991***	***20.4***

[a] Because these values are extreme outliers (e.g., >100% survival), they are not included in statistical summaries or analyses.

Numbers of juvenile emigrants increased with increasing egg deposition; however, egg-emigrant survival did not decrease significantly with increasing egg deposition (Figure 9.5). This suggests a density-independent relationship between seeding levels and emigrants within the Methow River basin (see Population Carrying Capacity section below).



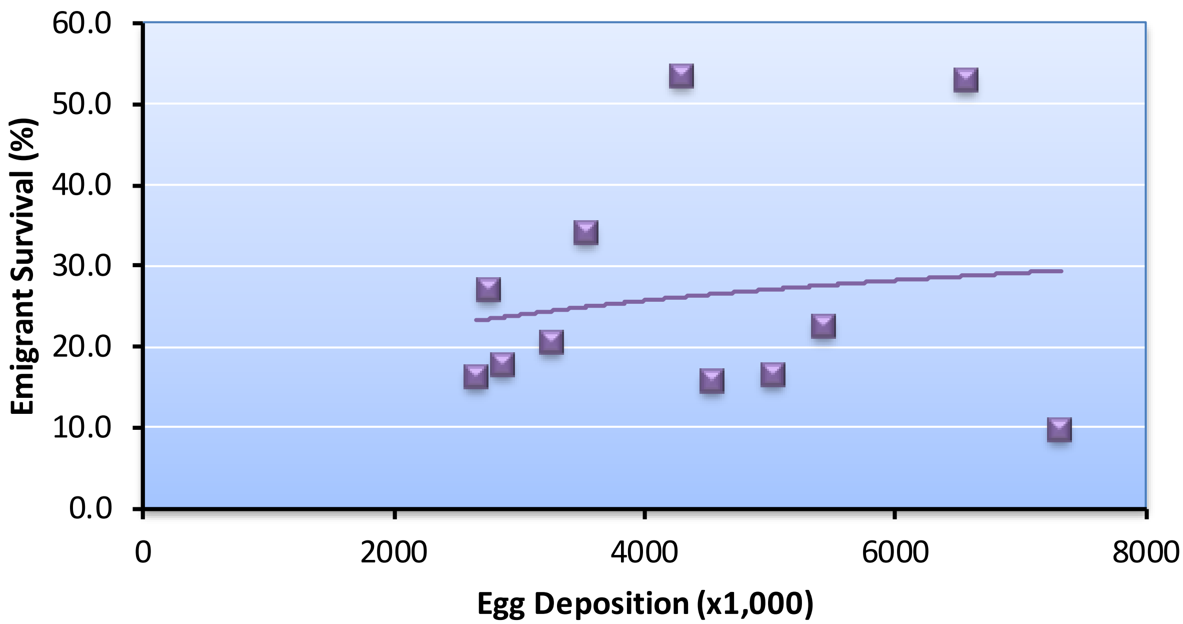


Figure 9.5. Relationships between seeding levels (egg deposition) and juvenile productivity (top figure) and emigrant survival (bottom figure) for Methow summer Chinook, brood years 2006-2017.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[41] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we used population models to estimate juvenile summer Chinook carrying capacities (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods).

Only the density-independent model adequately fit the juvenile emigrant data for Methow summer Chinook (Figure 9.6). This means that under the range of seeding levels examined, there is no estimate of carrying capacity for juvenile emigrants. This implies that spawning habitat is not currently limiting juvenile productivity within the Methow River basin. It does not mean that there is no limit to juvenile rearing within the Methow River basin. Indeed, there is likely a limit to the number of parr that can rear within the basin; however, there are no parr data to estimate rearing capacity.

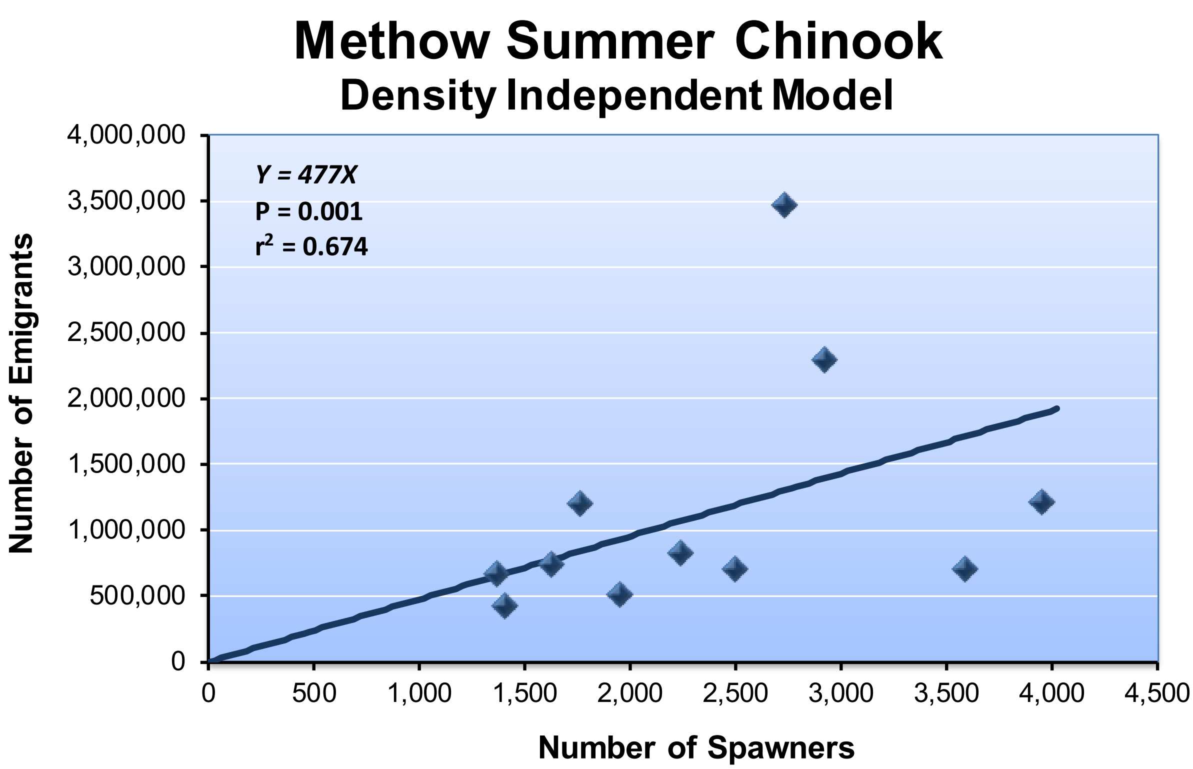


Figure 9.6. Density-independent relationship between spawners and number of juvenile emigrants produced in the Methow River basin.

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[41] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

9.5 Spawning Surveys

Surveys for Methow summer Chinook redds were conducted from late September to mid-November 2018 in the Methow River. Total redd counts (not peak counts) were conducted in the river (see Appendix Q for more details).

Redd Counts

A total of 594 summer Chinook redds were counted in the Methow River in 2018 (Table 9.17). This is less than the overall average of 706 redds.

Table 9.17. Total number of redds counted in the Methow River, 1989-2018.

Survey year	Total redd count
1989	149*
1990	418*
1991	153
1992	107
1993	154
1994	310
1995	357
1996	181
1997	205
1998	225
1999	448
2000	500
2001	675
2002	2,013
2003	1,624
2004	973
2005	874
2006	1,353
2007	620
2008	599
2009	692
2010	887
2011	941
2012	960
2013	1,551
2014	591
2015	1,231
2016	1,115
2017	690
2018	594
Average	***706***

Survey year	Total redd count
Median	***610***

* Total counts based on expanded aerial counts.

Redd Distribution

Summer Chinook redds were not evenly distributed among the seven reaches in the Methow River. Most redds (84%) were located within the lower three reaches (downstream from Twisp) (Table 9.18; Figure 9.7). Few Chinook spawned upstream from Winthrop (Reaches 6 and 7).

Table 9.18. Total number of summer Chinook redds counted in different reaches on the Methow River during September through early November 2018. Reach codes are described in Table 2.11.

Survey reach	Total redd count	Percent
Methow 1 (M1)	120	20.2
Methow 2 (M2)	204	34.3
Methow 3 (M3)	172	29.0
Methow 4 (M4)	22	3.7
Methow 5 (M5)	59	9.9
Methow 6 (M6)	3	0.5
Methow 7 (M7)	14	2.4
Totals	***594***	***100***

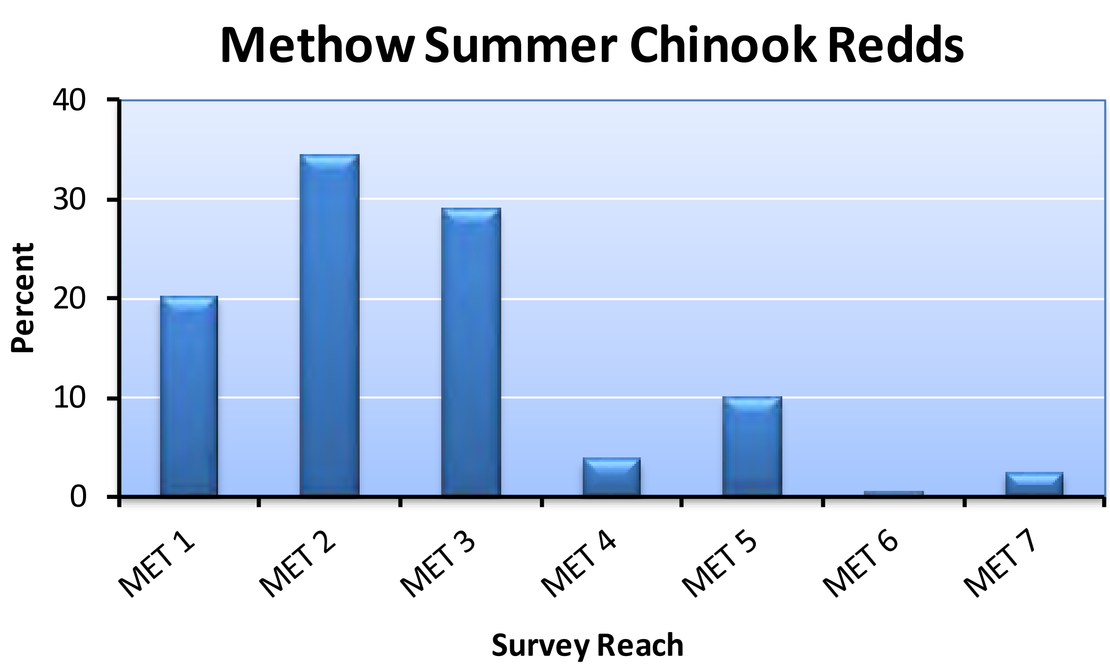


Figure 9.7. Percent of the total number of summer Chinook redds counted in different reaches on the Methow River during September through mid-November 2018. Reach codes are described in Table 2.11.

Spawn Timing

Spawning in 2018 began the last week of September, peaked in early October, and ended the third week of November (Figure 9.8). Stream temperatures in the Methow River, when spawning began, varied from 7.5-11.5°C. Peak spawning occurred during the first week of October in the upper reaches of the Methow River and one-two weeks later in the lower reaches.

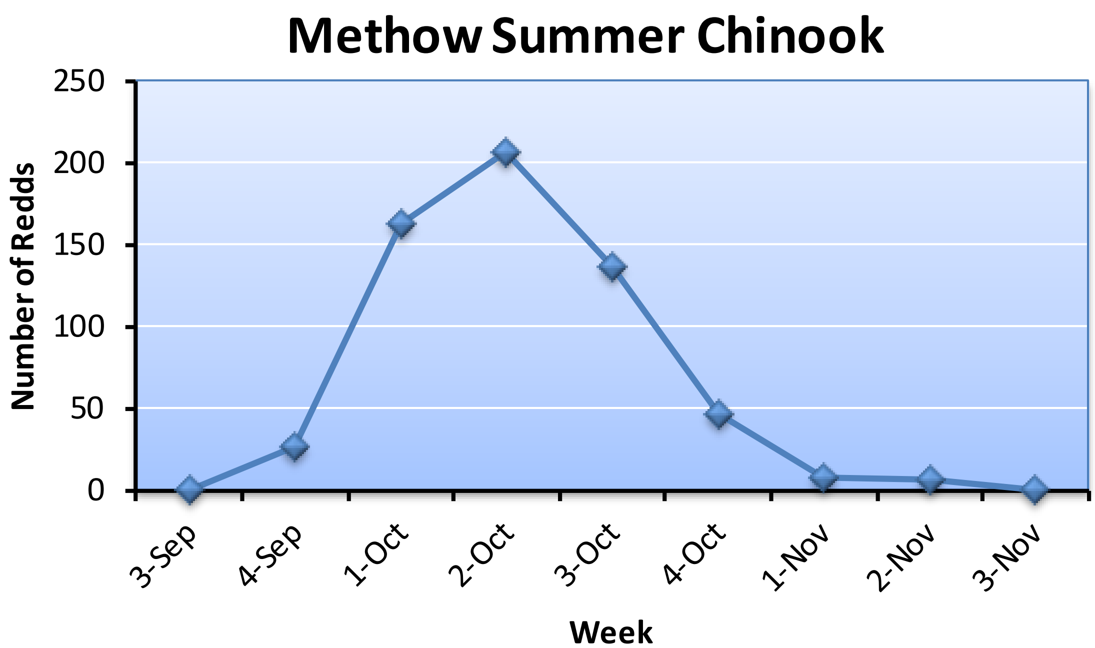


Figure 9.8. Number of new summer Chinook redds counted during different weeks in the Methow River, September through mid-November 2018.

Spawning Escapement

Spawning escapement for Methow summer Chinook was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[42] The estimated fish per redd ratio for Methow summer Chinook in 2018 was 2.30. Multiplying this ratio by the number of redds counted in the Methow River resulted in a total spawning escapement of 1,367 summer Chinook (Table 9.19).

Table 9.19. Spawning escapements for summer Chinook in the Methow River for return years 1989-2018.

Return year	Fish/Redd	Redds	Total spawning escapement
1989*	3.30	149	492
1990*	3.40	418	1,421
1991*	3.70	153	566
1992*	4.30	107	460

[42] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Redds	Total spawning escapement
1993*	3.30	154	508
1994*	3.50	310	1,085
1995*	3.40	357	1,214
1996*	3.40	181	615
1997*	3.40	205	697
1998	3.00	225	675
1999	2.20	448	986
2000	2.40	500	1,200
2001	4.10	675	2,768
2002	2.30	2,013	4,630
2003	2.42	1,624	3,930
2004	2.25	973	2,189
2005	2.93	874	2,561
2006	2.02	1,353	2,733
2007	2.20	620	1,364
2008	3.25	599	1,947
2009	2.54	692	1,758
2010	2.81	887	2,492
2011	3.10	941	2,917
2012	3.07	960	2,947
2013	2.31	1,551	3,583
2014	2.75	591	1,625
2015	3.21	1,231	3,952
2016	2.01	1,115	2,241
2017	2.04	690	1,408
2018	2.30	594	1,367
Average	***2.90***	***706***	***1,878***
Median	***2.97***	***610***	***1,523***

* Spawning escapement was calculated using the "Modified Meekin Method" (i.e., 3.1 x jack multiplier).

9.6 Carcass Surveys

Surveys for Methow summer Chinook carcasses were conducted during late September to mid-November 2018 in the Methow River (see Appendix Q for more details).

Number sampled

A total of 333 summer Chinook carcasses were sampled during September through mid-November in the Methow River (Table 9.20). This was less than the overall average of 512 carcasses sampled since 1991.

Table 9.20. Numbers of summer Chinook carcasses sampled within each survey reach on the Methow River, 1991-2018. Reach codes are described in Table 2.11.

Survey year	Number of summer Chinook carcasses							
	M-1	M-2	M-3	M-4	M-5	M-6	M-7	Total
1991	0	12	8	4	2	0	0	**26**
1992	8	8	19	0	17	1	0	**53**
1993	19	25	14	2	5	0	0	**65**
1994[a]	43	33	20	5	13	0	0	**114**
1995	14	33	58	7	7	0	0	**119**
1996	6	30	46	5	2	0	0	**89**
1997	6	12	38	2	19	1	0	**78**
1998	90	84	99	17	30	0	0	**320**
1999	47	144	232	32	37	12	2	**506**
2000	62	118	105	9	99	5	0	**398**
2001	392	275	88	14	76	11	1	**857**
2002	551	318	518	164	219	34	10	**1,814**
2003	115	268	317	115	128	5	0	**948**
2004	40	173	187	82	92	2	1	**577**
2005	154	173	182	42	112	3	0	**666**
2006	121	148	110	56	144	3	1	**583**
2007	142	132	108	27	53	0	0	**462**
2008	64	128	197	33	57	3	0	**482**
2009	144	158	159	36	94	0	0	**591**
2010	105	180	184	38	63	5	1	**576**
2011	56	134	201	78	83	5	1	**558**
2012	127	154	169	75	82	14	7	**628**
2013	296	287	385	90	100	7	5	**1,170**
2014	6	14	176	53	148	73	17	**487**
2015	229	194	221	56	95	19	25	**839**
2016	83	168	216	44	70	1	5	**587**
2017	61	149	120	22	51	5	12	**420**
2018	71	118	98	12	33	1	0	**333**
Average	***109***	***131***	***153***	***40***	***69***	***8***	***3***	***512***
Median	***68***	***139***	***140***	***33***	***67***	***3***	***0***	***497***

[a] An additional 113 carcasses were sampled, but reach was not identified.

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among reaches within the Methow River in 2018 (Table 9.20; Figure 9.9). Most of the carcasses were found in the lower three reaches (downstream from Twisp). Few carcasses were observed upstream from Winthrop (Reaches 6 and 7).

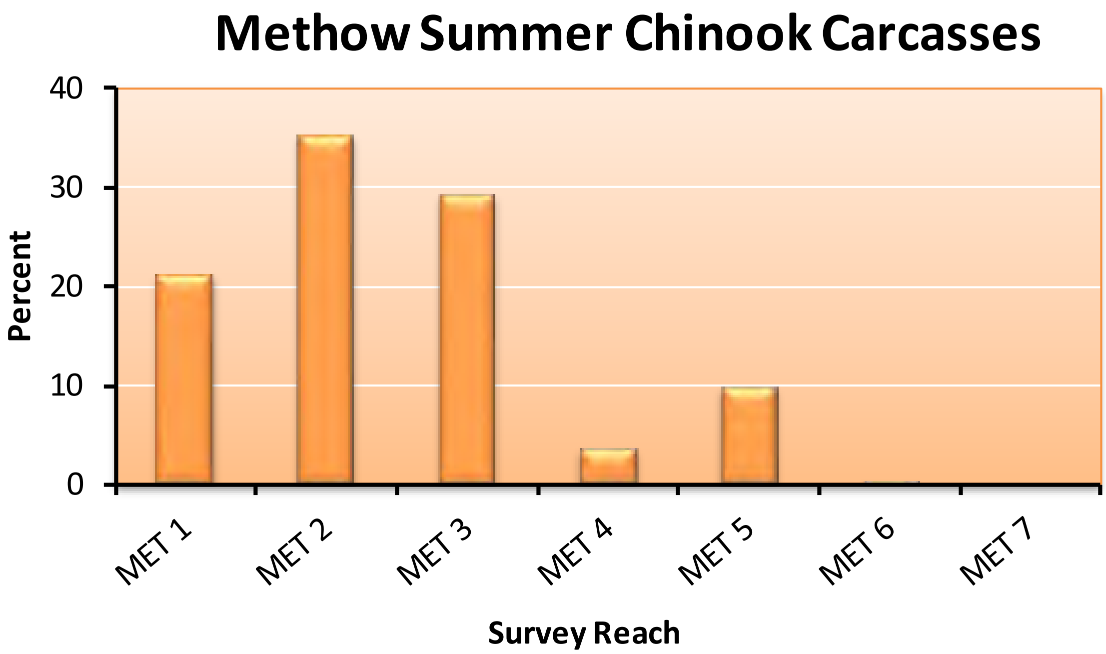


Figure 9.9. Percent of summer Chinook carcasses sampled within different reaches on the Methow River during September through mid-November 2018. Reach codes are described in Table 2.11.

Based on the available data (1991-2018), hatchery and wild summer Chinook carcasses were not distributed equally among the reaches in the Methow River (Table 9.21). A larger percentage of hatchery carcasses occurred in the lower reaches, while a larger percentage of wild summer Chinook carcasses occurred in upstream reaches (Figure 9.10).

Table 9.21. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches on the Methow River, 1991-2018.

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
1991	Wild	0	12	8	4	2	0	0	**26**
	Hatchery	0	0	0	0	0	0	0	**0**
1992	Wild	8	8	19	0	17	1	0	**53**
	Hatchery	0	0	0	0	0	0	0	**0**
1993	Wild	11	18	9	0	3	0	0	**41**
	Hatchery	8	7	5	2	2	0	0	**24**
1994	Wild	23	18	9	5	10	0	0	**65**
	Hatchery	20	15	11	0	3	0	0	**49**
1995	Wild	7	9	33	7	6	0	0	**62**
	Hatchery	7	24	25	0	1	0	0	**57**
1996	Wild	1	23	35	4	2	0	0	**65**
	Hatchery	5	7	11	1	0	0	0	**24**
1997	Wild	5	8	31	1	17	0	0	**62**

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
	Hatchery	1	4	7	1	2	1	0	**16**
1998	Wild	42	48	71	11	25	0	0	**197**
	Hatchery	48	36	28	6	5	0	0	**123**
1999	Wild	32	87	130	15	24	4	2	**294**
	Hatchery	15	57	102	17	13	8	0	**212**
2000	Wild	25	85	85	8	83	3	0	**289**
	Hatchery	37	33	20	1	16	2	0	**109**
2001	Wild	62	118	56	10	70	11	1	**328**
	Hatchery	330	157	32	4	6	0	0	**529**
2002	Wild	138	177	380	140	197	34	9	**1,075**
	Hatchery	413	141	138	24	22	0	1	**739**
2003	Wild	33	146	188	76	92	3	0	**538**
	Hatchery	82	122	129	39	36	2	0	**410**
2004	Wild	16	120	155	65	78	1	0	**435**
	Hatchery	24	53	32	17	14	1	1	**142**
2005	Wild	62	99	133	33	107	3	0	**437**
	Hatchery	92	74	49	9	5	0	0	**229**
2006	Wild	52	82	67	44	109	2	1	**357**
	Hatchery	69	66	43	12	35	1	0	**226**
2007	Wild	35	58	59	16	40	0	0	**208**
	Hatchery	107	74	49	11	13	0	0	**254**
2008	Wild	13	62	146	27	52	2	0	**302**
	Hatchery	51	66	51	6	5	1	0	**180**
2009	Wild	45	87	103	27	84	0	0	**346**
	Hatchery	99	71	56	9	10	0	0	**245**
2010	Wild	33	79	101	24	53	5	1	**296**
	Hatchery	72	101	83	14	10	0	0	**280**
2011	Wild	21	56	87	54	56	5	1	**280**
	Hatchery	35	78	114	24	27	0	0	**278**
2012	Wild	59	53	96	58	74	13	7	**360**
	Hatchery	73	101	73	17	8	1	0	**273**
2013	Wild	110	128	178	67	64	7	5	**559**
	Hatchery	186	160	208	23	36	0	0	**613**
2014	Wild	5	10	148	48	140	70	17	**438**
	Hatchery	2	4	27	5	8	3	0	**49**
2015	Wild	169	136	182	50	90	19	25	**671**
	Hatchery	60	58	39	6	5	0	0	**168**
2016	Wild	51	107	126	33	61	1	5	**384**
	Hatchery	32	61	90	11	9	0	0	**203**
2017	Wild	38	97	91	21	43	5	11	**306**
	Hatchery	23	52	29	1	8	0	1	**114**

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
2018	Wild	20	51	65	7	22	1	0	**159**
	Hatchery	51	67	40	5	11	1	0	**175**
Average	***Wild***	***40***	***71***	***100***	***31***	***58***	***7***	***3***	***308***
	Hatchery	***69***	***60***	***53***	***9***	***11***	***1***	***0***	***204***
Median	***Wild***	***33***	***71***	***89***	***23***	***55***	***2***	***0***	***299***
	Hatchery	***43***	***60***	***40***	***6***	***8***	***0***	***0***	***178***

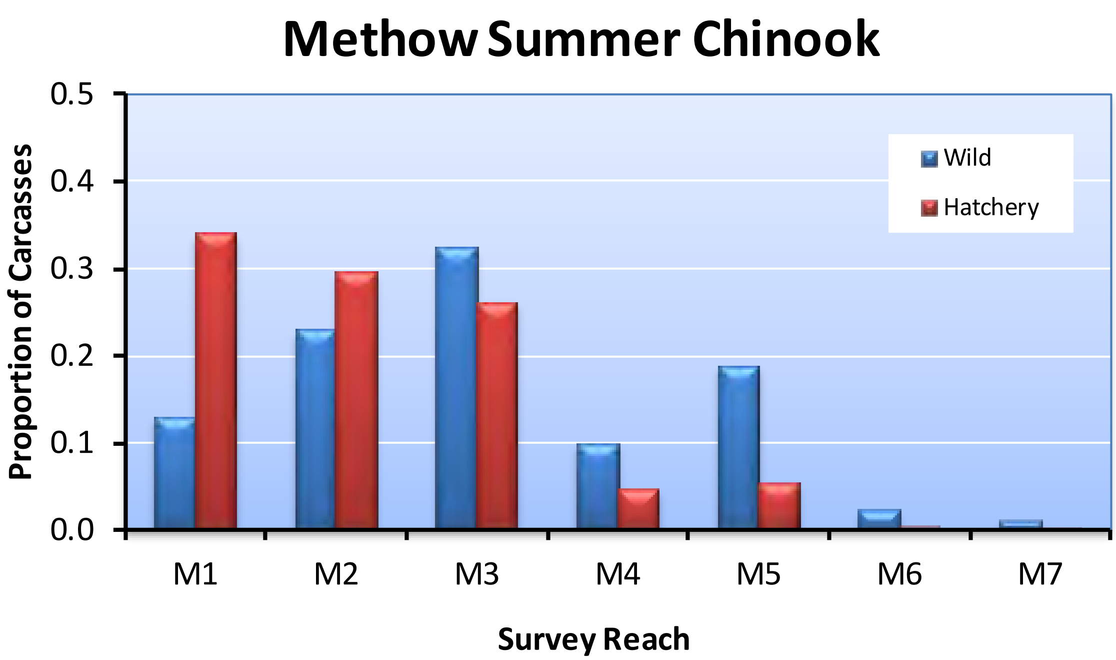


Figure 9.10. Distribution of wild and hatchery produced carcasses in different reaches on the Methow River, 1993-2018. Reach codes are described in Table 2.11.

Sampling Rate

Overall, 24% of the total spawning escapement of summer Chinook in the Methow River basin was sampled in 2018 (Table 9.22). Sampling rates among survey reaches varied from 0 to 26%.

Table 9.22. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Methow River basin, 2018. Reach codes are described in Table 2.11.

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Methow 1 (M1)	120	71	276	0.26
Methow 2 (M2)	204	118	469	0.25
Methow 3 (M3)	172	98	396	0.25
Methow 4 (M4)	22	12	51	0.24

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Methow 5 (M5)	59	33	136	0.24
Methow 6 (M6)	3	1	7	0.14
Methow 7 (M7)	14	0	32	0.00
Total	***594***	***333***	***1,367***	***0.24***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Methow River in 2018 are provided in Table 9.23. The average size of males and females sampled in the Methow River were 62 cm and 68 cm, respectively.

Table 9.23. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different reaches on the Methow River, 2018. Reach codes are described in Table 2.11.

Stream/watershed	Mean length (cm)	
	Male	Female
Methow 1 (M1)	60.8 (8.8)	66.7 (5.9)
Methow 2 (M2)	62.0 (8.3)	67.1 (5.2)
Methow 3 (M3)	60.5 (7.3)	68.3 (4.9)
Methow 4 (M4)	69.1 (9.8)	66.6 (4.0)
Methow 5 (M5)	64.1 (14.9)	68.0 (4.6)
Methow 6 (M6)	--	73.0 (--)
Methow 7 (M7)	--	--
Total	***61.8 (8.9)***	***67.6 (5.2)***

9.7 Life History Monitoring

Life history characteristics of Methow summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Methow/Okanogan summer Chinook was determined from broodstock data collected at Wells Dam. Counting of summer/fall Chinook at Wells Dam occurs from 29 June to 15 November. Broodstock collection at the Dam occurs from early July (week 27) to mid-September (week 37) (see Table 2.1). Based on broodstock sampling in 2018, wild summer Chinook arrived at Wells Dam earlier than hatchery summer Chinook (Table 9.24). This was true throughout most of the migration period. In contrast, there was little difference in migration timing between wild and hatchery summer Chinook when data were pooled for the 2007-2018 survey period.

Table 9.24. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Wells Dam, 2007-2018. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Wells Dam.

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	27	30	34	30	485
	Hatchery	27	30	33	30	433
2008	Wild	28	30	34	30	542
	Hatchery	28	30	36	31	884
2009	Wild	27	29	34	30	585
	Hatchery	27	29	33	29	708
2010	Wild	27	29	33	29	377
	Hatchery	27	29	32	29	801
2011	Wild	30	32	36	32	516
	Hatchery	30	32	35	33	1223
2012	Wild	28	30	34	31	192
	Hatchery	28	31	34	31	591
2013	Wild	27	30	33	30	229
	Hatchery	27	30	33	30	282
2014	Wild	27	31	40	32	316
	Hatchery	27	30	35	30	208
2015	Wild	26	28	30	28	217
	Hatchery	27	28	31	29	164
2016	Wild	26	29	39	30	314
	Hatchery	25	28	34	29	251
2017	Wild	27	30	35	30	228
	Hatchery	28	31	35	31	236
2018	Wild	25	29	34	29	232
	Hatchery	26	28	33	29	760
Average	***Wild***	***27***	***30***	***35***	***30***	***353***
	Hatchery	***27***	***30***	***34***	***30***	***545***
Median	***Wild***	***27***	***30***	***34***	***30***	***315***
	Hatchery	***27***	***30***	***34***	***30***	***512***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2018 in the Methow River were salt age-3 fish (Table 9.25; Figure 9.11). A higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 9.25. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Methow River, 1993-2018.

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
1993	Wild	0.05	0.08	0.76	0.11	0.00	0.00	38
	Hatchery	0.00	1.00	0.00	0.00	0.00	0.00	20
1994	Wild	0.03	0.26	0.51	0.20	0.00	0.00	101
	Hatchery	0.00	0.07	0.93	0.00	0.00	0.00	111
1995	Wild	0.00	0.09	0.70	0.20	0.00	0.00	54
	Hatchery	0.02	0.04	0.44	0.51	0.00	0.00	55
1996	Wild	0.04	0.30	0.54	0.13	0.00	0.00	56
	Hatchery	0.00	0.05	0.50	0.41	0.05	0.00	22
1997	Wild	0.00	0.22	0.51	0.27	0.00	0.00	55
	Hatchery	0.13	0.06	0.56	0.25	0.00	0.00	16
1998	Wild	0.09	0.38	0.45	0.09	0.00	0.00	188
	Hatchery	0.02	0.52	0.41	0.04	0.00	0.00	123
1999	Wild	0.01	0.51	0.43	0.05	0.00	0.00	252
	Hatchery	0.00	0.07	0.90	0.03	0.00	0.00	210
2000	Wild	0.01	0.09	0.75	0.16	0.00	0.00	257
	Hatchery	0.10	0.16	0.62	0.11	0.00	0.00	97
2001	Wild	0.02	0.20	0.72	0.07	0.00	0.00	292
	Hatchery	0.10	0.60	0.26	0.04	0.00	0.00	526
2002	Wild	0.01	0.17	0.61	0.21	0.00	0.00	1,003
	Hatchery	0.01	0.41	0.57	0.01	0.00	0.00	734
2003	Wild	0.01	0.11	0.50	0.37	0.00	0.00	478
	Hatchery	0.02	0.03	0.90	0.04	0.00	0.00	399
2004	Wild	0.00	0.09	0.35	0.56	0.00	0.00	394
	Hatchery	0.07	0.28	0.30	0.35	0.00	0.00	141
2005	Wild	0.11	0.74	0.14	0.01	0.00	0.00	410
	Hatchery	0.06	0.26	0.65	0.02	0.00	0.00	220
2006	Wild	0.00	0.02	0.33	0.64	0.00	0.00	356
	Hatchery	0.01	0.19	0.50	0.30	0.00	0.00	164
2007	Wild	0.03	0.09	0.24	0.59	0.05	0.00	208
	Hatchery	0.07	0.09	0.75	0.09	0.01	0.00	213
2008	Wild	0.01	0.14	0.71	0.13	0.01	0.00	298

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
	Hatchery	0.10	0.45	0.30	0.15	0.00	0.00	138
2009	Wild	0.00	0.11	0.41	0.48	0.00	0.00	317
	Hatchery	0.17	0.26	0.53	0.04	0.00	0.00	242
2010	Wild	0.01	0.16	0.59	0.24	0.00	0.00	269
	Hatchery	0.01	0.69	0.29	0.02	0.00	0.00	247
2011	Wild	0.02	0.09	0.60	0.30	0.00	0.00	255
	Hatchery	0.16	0.10	0.74	0.01	0.00	0.00	261
2012	Wild	0.03	0.24	0.53	0.21	0.00	0.00	315
	Hatchery	0.09	0.71	0.16	0.04	0.00	0.00	243
2013	Wild	0.02	0.25	0.62	0.11	0.00	0.00	533
	Hatchery	0.02	0.18	0.79	0.01	0.00	0.00	570
2014	Wild	0.01	0.12	0.69	0.18	0.00	0.00	412
	Hatchery	0.06	0.43	0.47	0.04	0.00	0.00	47
2015	Wild	0.00	0.20	0.45	0.35	0.00	0.00	588
	Hatchery	0.02	0.61	0.35	0.02	0.00	0.00	136
2016	Wild	0.00	0.02	0.77	0.20	0.00	0.00	350
	Hatchery	0.02	0.14	0.84	0.00	0.00	0.00	175
2017	Wild	0.00	0.02	0.24	0.73	0.01	0.00	283
	Hatchery	0.02	0.45	0.36	0.17	0.00	0.00	104
2018	Wild	0.00	0.06	0.52	0.41	0.01	0.00	144
	Hatchery	0.01	0.56	0.42	0.01	0.00	0.00	146
Average	***Wild***	***0.02***	***0.19***	***0.52***	***0.28***	***0.00***	***0.00***	***304***
	Hatchery	***0.05***	***0.33***	***0.56***	***0.06***	***0.00***	***0.00***	***206***
Median	***Wild***	***0.01***	***0.15***	***0.57***	***0.26***	***0.00***	***0.00***	***288***
	Hatchery	***0.03***	***0.32***	***0.59***	***0.06***	***0.00***	***0.00***	***155***

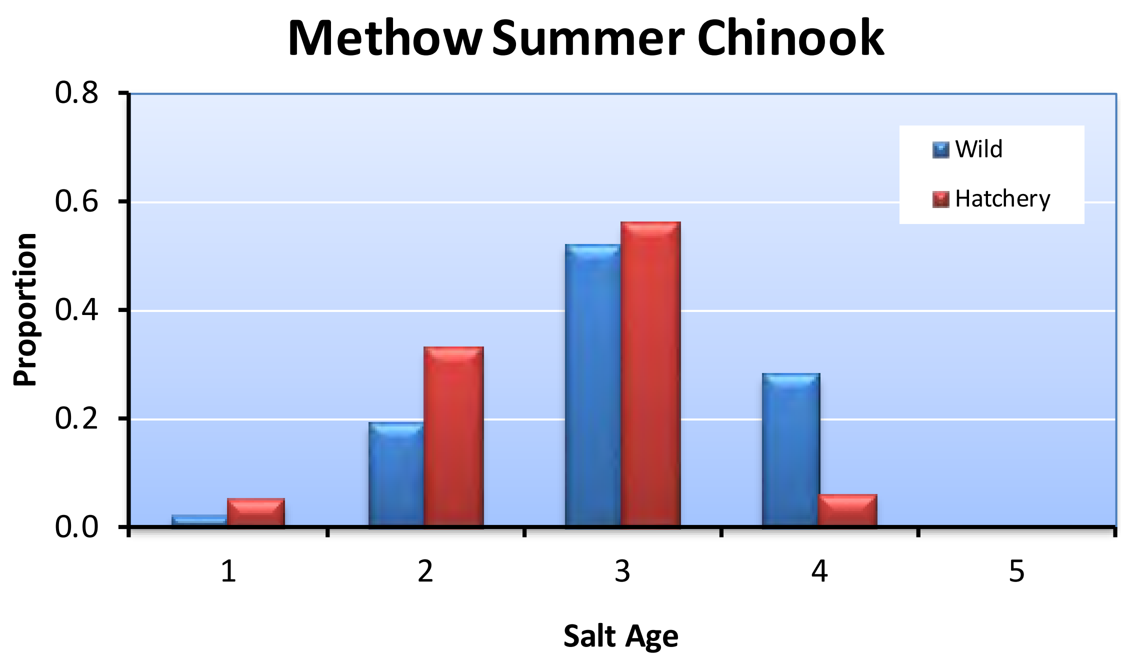


Figure 9.11. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Methow River for the combined years 1993-2018.

Size at Maturity

On average, hatchery summer Chinook were about 5 cm smaller than wild summer Chinook sampled in the Methow River basin (Table 9.26). This is likely because a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish. Future analyses will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 9.26. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Methow River basin, 1993-2018; SD = 1 standard deviation.

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	41	74	9	51	89
	Hatchery	24	62	8	36	80
1994[a]	Wild	112	69	8	35	87
	Hatchery	114	67	5	43	77
1995	Wild	62	74	6	52	88
	Hatchery	56	73	7	46	85
1996	Wild	64	70	11	34	91
	Hatchery	23	72	7	58	85
1997	Wild	62	76	9	35	90
	Hatchery	16	68	15	33	87
1998	Wild	196	67	10	38	97

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	123	63	10	37	87
1999	Wild	292	66	8	43	99
	Hatchery	212	66	7	26	89
2000	Wild	288	74	8	37	89
	Hatchery	109	68	12	24	87
2001	Wild	328	67	10	29	86
	Hatchery	529	63	10	31	87
2002	Wild	1,075	70	8	37	94
	Hatchery	739	67	9	33	87
2003	Wild	538	71	8	35	88
	Hatchery	410	69	8	35	89
2004	Wild	435	73	7	38	89
	Hatchery	142	65	12	34	85
2005	Wild	437	69	8	45	86
	Hatchery	229	64	9	36	79
2006	Wild	438	73	7	35	92
	Hatchery	149	69	8	38	91
2007	Wild	249	72	11	33	89
	Hatchery	219	69	9	22	84
2008	Wild	384	69	8	30	90
	Hatchery	210	63	15	23	86
2009	Wild	363	71	9	32	88
	Hatchery	228	63	12	30	83
2010	Wild	296	69	8	33	90
	Hatchery	280	62	9	39	81
2011	Wild	280	70	9	31	89
	Hatchery	278	64	11	26	82
2012	Wild	355	68	8	36	85
	Hatchery	273	59	9	21	81
2013	Wild	559	65	9	31	89
	Hatchery	613	66	8	27	83
2014	Wild	438	67	7	31	88
	Hatchery	49	60	10	35	76
2015	Wild	588	66	8	38	87
	Hatchery	136	59	8	38	79
2016	Wild	384	68	6	46	84
	Hatchery	203	66	7	37	83
2017	Wild	306	70	7	47	88

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	114	63	8	30	78
2018	Wild	159	67	8	35	91
	Hatchery	175	63	7	39	78
Pooled	***Wild***	***336***	***70***	***8***	***29***	***99***
	Hatchery	***217***	***65***	***9***	***21***	***91***

[a] These years include sizes reported in annual reports. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Methow summer Chinook occurred in the Ocean (Table 9.27). Ocean harvest has made up 13% to 99% of all hatchery-origin Methow summer Chinook harvested. Brood year 2011 provided the largest harvest, while brood years 1996 and 1999 provided the lowest.

Table 9.27. Estimated number and percent (in parentheses) of hatchery-origin Methow summer Chinook captured in different fisheries, brood years 1989-2012.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	1,043 (52)	884 (44)	0 (0)	66 (3)	1,993	58.9
1990	55 (57)	41 (43)	0 (0)	0 (0)	96	25.4
1991	12 (20)	49 (80)	0 (0)	0 (0)	61	32.8
1992	17 (55)	14 (45)	0 (0)	0 (0)	31	22.3
1993	29 (58)	17 (34)	4 (8)	0 (0)	50	37.9
1994	153 (81)	34 (18)	1 (1)	1 (1)	189	26.4
1995	77 (99)	0 (0)	1 (1)	0 (0)	78	33.6
1996	12 (92)	1 (8)	0 (0)	0 (0)	13	17.6
1997	215 (88)	7 (3)	0 (0)	21 (9)	243	37.6
1998	1,765 (83)	101 (5)	14 (1)	234 (11)	2,114	54.8
1999	2 (13)	13 (87)	0 (0)	0 (0)	15	45.5
2000	366 (71)	88 (17)	27 (5)	33 (6)	514	66.7
2001	326 (52)	97 (15)	43 (7)	160 (26)	626	67
2002	271 (48)	96 (17)	61 (11)	137 (24)	565	62.9
2003	58 (58)	17 (17)	7 (7)	18 (18)	100	43.1
2004	133 (49)	55 (20)	16 (6)	68 (25)	272	54.5
2005	298 (54)	137 (25)	50 (9)	65 (12)	550	57.2
2006	1,128 (48)	811 (34)	100 (4)	314 (13)	2,353	62
2007	205 (56)	94 (25)	16 (4)	54 (15)	369	72.8
2008	1,231 (48)	531 (21)	65 (3)	716 (28)	2,543	56.6
2009	318 (39)	258 (32)	28 (3)	209 (26)	813	75.6

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2010	530 (43)	481 (39)	26 (2)	207 (17)	1,244	69.9
2011	1578 (46)	988 (29)	136 (4)	725 (21)	3,427	72.5
2012	133 (57)	55 (24)	0 (0)	46 (20)	234	60
Average	***415 (57)***	***203 (28)***	***24 (3)***	***128 (11)***	***771***	***50.6***
Median	***210 (55)***	***72 (25)***	***11(2)***	***50 (12)***	***321***	***55.7***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Methow River basin. Targets for strays based on return year (recovery year) within the Upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia summer Chinook population, few hatchery-origin Methow summer Chinook have strayed into basins outside the Methow (Table 9.28). Although hatchery-origin Methow summer Chinook have strayed into the Wenatchee River basin, Okanogan River basin, Entiat River basin, Chelan tailrace, and Hanford Reach, on average, they have made up less than 1% of the spawning escapements within those areas.

Hatchery-origin Methow summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Methow have been detected in Noble Creek in the Coos River watershed, at Big Canyon Trap (for the Wallowa Hatchery), and at Spring Creek, Lyons Ferry, and Marblemount hatcheries. However, few Methow summer Chinook have strayed into each of these locations.

Table 9.28. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Methow summer Chinook, return years 1994-2017. For example, for return year 2002, 0.4% of the summer Chinook escapement in the Okanogan River basin consisted of hatchery-origin Methow summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	72	1.8	-	-	-	-	-	-
1995	0	0.0	9	0.3	-	-	-	-	-	-
1996	0	0.0	0	0.0	-	-	-	-	-	-
1997	0	0.0	0	0.0	-	-	-	-	-	-
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	9	0.2	0	0.0	0	0.0	7	0.0
2000	0	0.0	3	0.1	0	0.0	0	0.0	0	0.0
2001	0	0.0	0	0.0	0	0.0	0	0.0	7	0.0
2002	0	0.0	54	0.4	0	0.0	0	0.0	0	0.0
2003	0	0.0	1	0.0	6	1.4	0	0.0	0	0.0

Return year	Wenatchee		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2004	0	0.0	7	0.1	3	0.7	0	0.0	0	0.0
2005	0	0.0	24	0.3	0	0.0	0	0.0	0	0.0
2006	0	0.0	12	0.1	0	0.0	0	0.0	0	0.0
2007	0	0.0	17	0.4	2	1.1	3	2.1	0	0.0
2008	0	0.0	12	0.2	0	0.0	0	0.0	0	0.0
2009	0	0.0	14	0.2	0	0.0	0	0.0	0	0.0
2010	6	0.1	44	0.7	22	2.0	0	0.0	0	0.0
2011	0	0.0	45	0.5	8	0.6	0	0.0	0	0.0
2012	0	0.0	31	0.4	0	0.0	0	0.0	0	0.0
2013	0	0.0	10	0.1	0	0.0	0	0.0	0	0.0
2014	0	0.0	15	0.1	0	0.0	0	0.0	0	0.0
2015	0	0.0	40	0.3	4	0.3	0	0.0	0	0.0
2016	0	0.0	20	0.2	0	0.0	0	0.0	0	0.0
2017	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***0***	***0.0***	***18***	***0.3***	***2***	***0.3***	***0***	***0.1***	***1***	***0.0***
Median	***0***	***0.0***	***12***	***0.2***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, 3.5% of the hatchery-origin Methow summer Chinook spawners strayed into non-target streams (Table 9.29). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-12%. In addition, on average, about 6% of hatchery-origin Methow summer Chinook broodstock have been included in non-target hatchery programs.

Table 9.29. Number and percent of hatchery-origin Methow summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2012.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	773	55.7	81	5.8	459	33	76	5.5
1990	199	70.6	0	0.0	81	28.7	2	0.7
1991	82	65.6	0	0.0	43	34.4	0	0.0
1992	68	63.0	0	0.0	40	37.0	0	0.0
1993	54	65.9	6	7.3	22	26.8	0	0.0
1994	419	79.7	13	2.5	94	17.9	0	0.0
1995	126	81.8	0	0.0	28	18.2	0	0.0
1996	57	93.4	0	0.0	4	6.6	0	0.0

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1997	379	93.8	18	4.5	7	1.7	0	0.0
1998	1,653	94.7	60	3.4	32	1.8	0	0.0
1999	18	100.0	0	0.0	0	0.0	0	0.0
2000	239	93.0	14	5.4	4	1.6	0	0.0
2001	272	88.3	29	9.4	6	1.9	1	0.3
2002	315	94.6	14	4.2	4	1.2	0	0.0
2003	131	99.2	0	0.0	1	0.8	0	0.0
2004	194	85.5	27	11.9	6	2.6	0	0.0
2005	373	90.5	23	5.6	13	3.2	3	0.7
2006	1317	91.3	109	7.6	15	1.0	2	0.1
2007	134	97.1	0	0.0	2	1.4	2	1.4
2008	1,886	96.8	25	1.3	15	0.8	23	1.2
2009	182	69.2	0	0.0	14	5.3	67	25.5
2010	223	41.7	42	7.9	9	1.7	261	48.8
2011	775	59.7	47	3.6	79	6.1	398	30.6
2012	90	57.7	0	0.0	4	2.6	62	39.7
Average	***415***	***80.4***	***21***	***3.4***	***41***	***9.8***	***37***	***6.4***
Median	***211***	***86.9***	***14***	***3.0***	***14***	***2.6***	***0***	***0.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Methow River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Methow River basin.

[3] Target hatchery includes broodstock collection at Wells Dam.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Methow summer Chinook hatchery program. During the last four years, Chief Joseph Hatchery has intercepted most of these fish. Small numbers were intercepted by Eastbank and Marblemount hatcheries.

Genetics

Genetic studies were conducted to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix P). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery

(Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next comprehensive report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1993-2003, the PNI values were generally less than 0.67 (Table 9.30). However, since brood year 2003, PNI has generally been greater than 0.67; brood year 2018 had a PNI value of 0.67.

Table 9.30. Proportionate Natural Influence (PNI) values for the Methow summer Chinook supplementation program for brood years 1989-2018. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	492	0	0.00	1,297	312	0.81	1.00
1990	1,421	0	0.00	828	206	0.80	1.00
1991	566	0	0.00	924	314	0.75	1.00
1992	460	0	0.00	297	406	0.42	1.00
1993	314	194	0.38	681	388	0.64	0.64
1994	596	489	0.45	341	244	0.58	0.58
1995	596	618	0.51	173	240	0.42	0.47
1996	435	180	0.29	287	155	0.65	0.70
1997	529	168	0.24	197	265	0.43	0.66
1998	436	239	0.35	153	211	0.42	0.56
1999	573	413	0.42	224	289	0.44	0.53
2000	861	339	0.28	164	337	0.33	0.56
2001	1,122	1,646	0.59	12	345	0.03	0.09
2002	2,572	2,058	0.44	247	241	0.51	0.55
2003	2,307	1,623	0.41	381	101	0.79	0.67
2004	1,622	567	0.26	506	16	0.97	0.79
2005	1,672	889	0.35	391	9	0.98	0.74
2006	1,675	1,058	0.39	500	10	0.98	0.72
2007	660	704	0.52	456	17	0.96	0.66
2008	1,194	753	0.39	359	86	0.81	0.68
2009	1,042	716	0.41	503	4	0.99	0.72
2010	1,326	1,166	0.47	484	8	0.98	0.68
2011	1,503	1,414	0.48	467	26	0.95	0.67
2012	1,593	1,354	0.46	98	1	0.99	0.69
2013	1,693	1,890	0.53	97	4	0.96	0.65
2014	1,451	174	0.11	96	0	1.00	0.90
2015	3,138	814	0.21	97	1	0.99	0.83
2016	1,464	777	0.35	103	0	1.00	0.75
2017	1,042	366	0.26	111	0	1.00	0.80
2018	681	686	0.50	131	0	1.00	0.67
Average	***1,168***	***710***	***0.33***	***354***	***141***	***0.75***	***0.70***
Median	***1,082***	***652***	***0.38***	***292***	***94***	***0.81***	***0.68***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery summer Chinook from the Methow River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 9.31).[43] Over the seven brood years for which PIT-tagged hatchery fish were released, survival rates from the Methow River to McNary Dam ranged from 0.485 to 0.775; SARs from release to detection at Bonneville Dam ranged from 0.001 to 0.016. Average travel time from the Methow River to McNary Dam ranged from 17 to 55 days.

Table 9.31. Total number of Methow hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2016. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	10,094	0.747 (0.055)	39.1 (13.0)	0.016 (0.001)
2009	5,020	0.485 (0.037)	30.2 (11.1)	0.002 (0.001)
2010	0	--	--	--
2011	0	--	--	--
2012	9,801	0.545 (0.046)	17.0 (8.1)	0.001 (0.000)
2013	9,825	0.558 (0.101)	54.5 (8.3)	0.005 (0.001)
2014	4,992	0.624 (0.053)	24.5 (8.1)	NA
2015	5,064	0.775 (0.088)	23.8 (9.8)	NA
2016	4,424	0.609 (0.068)	24.3 (7.7)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2012, NRR for summer Chinook in the Methow averaged 1.08 (range, 0.09-4.90) if harvested fish were not included in the estimate and 2.16 (range, 0.16-9.78) if harvested fish were included in the estimate (Table 9.32). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

[43] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 3.0 (the calculated target value in Hillman et al. 2017). The target value of 3.0 includes harvest. HRRs exceeded NRRs in 16 out of the 24 years of data, regardless if harvest was or was not included in the estimate (Table 9.32). Hatchery replacement rates for Methow summer Chinook have exceeded the estimated target value of 3.0 in 13 of the 24 years of data.

Table 9.32. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for wild summer Chinook in the Methow River basin, brood years 1989-2012.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	202	492	1,389	631	6.88	1.28	3,382	1,532	16.74	3.11
1990	202	1,421	282	978	1.40	0.69	378	1,318	1.87	0.93
1991	266	566	125	287	0.47	0.51	186	429	0.70	0.76
1992	214	460	108	614	0.50	1.33	139	792	0.65	1.72
1993	234	508	82	430	0.35	0.85	132	701	0.56	1.38
1994	260	1,085	526	542	2.02	0.50	715	738	2.75	0.68
1995	242	1,214	154	1,201	0.64	0.99	232	1,809	0.96	1.49
1996	220	615	61	445	0.28	0.72	74	541	0.34	0.88
1997	209	697	404	1,493	1.93	2.14	651	2,315	3.11	3.32
1998	235	675	1,745	3,307	7.43	4.90	3,859	6,601	16.42	9.78
1999	222	986	18	2,862	0.08	2.90	33	5,251	0.15	5.33
2000	222	1,200	257	800	1.16	0.67	771	2,286	3.47	1.91
2001	223	2,768	308	2,574	1.38	0.93	934	6,435	4.19	2.32
2002	222	4,630	333	924	1.50	0.20	898	2,504	4.05	0.54
2003	224	3,930	132	352	0.59	0.09	232	619	1.04	0.16
2004	223	2,189	227	1,540	1.02	0.70	499	3,392	2.24	1.55
2005	225	2,561	412	1,120	1.83	0.44	963	2,489	4.28	0.97
2006	236	2,733	1,443	1,706	6.11	0.62	3,796	3,842	16.08	1.41
2007	209	1,364	138	1,509	0.66	1.11	507	3,992	2.43	2.93
2008	184	1,947	1,949	1,501	10.59	0.77	4,493	2,575	24.42	1.32
2009	223	1,758	263	1,542	1.18	0.88	1,076	4,047	4.83	2.30
2010	210	2,492	535	2,719	2.55	1.09	1,779	8,857	8.47	3.55
2011	222	2,917	1,299	2,184	5.85	0.75	4,726	5,673	21.29	1.94
2012	128	2,947	156	2,286	1.22	0.78	390	4,646	3.05	1.58
Average	***219***	***1,756***	***514***	***1,398***	***2.40***	***1.08***	***1,285***	***3,058***	***6.00***	***2.16***
Median	***222***	***1,393***	***273***	***1,347***	***1.30***	***0.77***	***681***	***2,497***	***3.07***	***1.56***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00008 to 0.01888 for hatchery summer Chinook in the Methow River basin (Table 9.33).

Table 9.33. Smolt-to-adult ratios (SARs) for Methow summer Chinook, brood years 1989-2012.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	358,237	2,871	0.00801
1990	371,483	361	0.00097
1991	377,097	130	0.00034
1992	392,636	138	0.00035
1993	200,345	62	0.00031
1994	400,488	710	0.00177
1995	344,974	229	0.00066
1996	289,880	73	0.00025
1997	380,430	643	0.00169
1998	202,559	3,825	0.01888
1999	422,473	33	0.00008
2000	334,337	770	0.00230
2001	246,159	930	0.00378
2002	310,846	895	0.00288
2003	353,495	232	0.00066
2004	394,490	496	0.00126
2005	262,496	961	0.00366
2006	417,795	3,788	0.00907
2007	426,188	506	0.00119
2008	373,234	4,260	0.01141
2009	450,237	1,071	0.00238
2010	428,458	1,758	0.00410
2011	424,124	4,643	0.01095
2012	197,391	390	0.00198
Average	***348,327***	***1,241***	***0.00371***
Median	***372,359***	***677***	***0.00188***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

9.8 ESA/HCP Compliance

Broodstock Collection

Summer Chinook adults collected at Wells Dam are used primarily for the Methow supplementation programs. On an as needed basis, adults collected at Wells Dam may be used to augment adult collections for the Okanogan summer Chinook supplementation program. Per the 2016 broodstock collection protocol, 106 natural-origin (adipose fin present) adults were targeted for collection between 1 July and 15 September at the West Ladder of Wells Dam for the Methow summer Chinook program. Actual collections occurred between 28 June and 29 August and totaled 106 summer Chinook. ESA Permit 1347 provides authorization to collect Methow and Okanogan summer Chinook at Wells Dam three days per week and up to 16 hours per day from July through November. During 2016, broodstock collection activities were accomplished within the allowable trapping days authorized under ESA Permit 1347.

Collection of Methow summer Chinook broodstock at Wells Dam occurred concurrently with collection of summer steelhead for the Wells steelhead program authorized under ESA Section 10 Permit 1395. Encounters with steelhead and spring Chinook during Methow summer Chinook broodstock collections did not result in takes that were outside those authorized in Permit 1347 and in Permit 1395 for the Wells Steelhead program. Steelhead encountered during summer Chinook collections that were not required for steelhead broodstock were passed at the trap site and were not physically handled. Any spring Chinook encountered during summer Chinook broodstock activities were also passed without handling. No Chinook were collected at Wells Dam for the 2016 Okanogan summer Chinook program.

Hatchery Rearing and Release

The 2016 brood Methow summer Chinook reared throughout their juvenile life-stages at Eastbank Fish Hatchery and the Carlton Acclimation Pond without incident (see Section 9.2). The 2016 brood smolt release totaled 209,490 summer Chinook, representing 104.7% of the 200,000-production objective and was within with the 10% overage allowable in ESA Section 10 Permit 1347.

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or at the Carton Acclimation Facility during the period 1 January through 31 December 2018. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G.

Spawning Surveys

Summer Chinook spawning ground surveys conducted in the Methow River basin during 2018 were consistent with ESA Section 10 Permit No. 1347. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

SECTION 10: OKANOGAN/SIMILKAMEEN SUMMER CHINOOK

The goal of summer Chinook salmon supplementation in the Okanogan Basin is to use artificial production to replace adult production lost because of mortality at Wells, Rocky Reach, and Rock Island dams, while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans.

Before 2012, adult summer Chinook were collected for broodstock from the run-at-large at Wells Dam. Since then, the Colville Tribes collect broodstock using purse seines in the Okanogan and Columbia rivers. The goal was to collect up to 334 adult summer Chinook for the Okanogan program. Broodstock collection occurred from about 7 July through 15 September with trapping occurring no more than 16 hours per day, three days a week. If natural-origin broodstock collection fell short of expectation, hatchery-origin adults could be collected to make up the difference.

Before 2012, adult summer Chinook were spawned and reared at Eastbank Fish Hatchery. Juvenile summer Chinook were transferred from the hatchery to Similkameen Acclimation Pond in October. In addition, since 2005, about 20% (100,000) of the juveniles were transferred to Bonaparte Pond. Chinook were released from the ponds in April to early May.

Prior to 2012, the production goal for the Okanogan summer Chinook supplementation program was to release 576,000 yearling smolts into the Similkameen and Okanogan rivers at ten fish per pound. Beginning with the 2012 brood, the revised production goal is to release 166,569 yearling smolts into the rivers. Targets for fork length and weight are 176 mm (CV = 9.0) and 45.4 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2009, juvenile summer Chinook have been PIT tagged annually.

The Colville Tribes began monitoring the Okanogan/Similkameen summer Chinook program in 2013. Their monitoring results are published in annual reports to Bonneville Power Administration (BPA). The purpose of retaining this section is to provide readers with monitoring data collected with Chelan PUD funding through brood year 2012. Thus, this section tracks the status and life histories of summer Chinook up to and including brood year 2012. Results from monitoring brood year 2013 and beyond will be included in annual reports to BPA.

10.1 Broodstock Sampling

Summer Chinook broodstock for the Okanogan/Similkameen and Methow programs were typically collected at the East and West Ladders of Wells Dam. In 2012, purse seines were used to collect broodstock at the mouth of the Okanogan River. In 2012, a total of 81 summer Chinook (79 wild Chinook and two hatchery Chinook)[44] were spawned for the Okanogan program. Refer

[44] It is important to point out that some summer Chinook were used for both the Methow and Okanogan programs in 2012 because of the availability of ripe adults at the time of spawning. In addition, some eyed-eggs were split between the two programs

to Section 9.1 for information on the origin, age and length, sex ratios, and fecundity of summer Chinook broodstock collected at Wells Dam before 2013.

10.2 Hatchery Rearing

In this section, we describe the hatchery rearing of the Okanogan summer Chinook program through brood year 2012. The Colville Tribes began operating the program in 2013. Information on rearing history since brood year 2012 can be found in annual reports prepared by the Colville Tribes and submitted to BPA.

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 711,111 eggs were required to meet the program release goal of 576,000 smolts through the 2011 brood year. An evaluation of the program in 2012 determined that 205,134 eggs were needed to meet the revised release goal of 166,569 smolts. This revised goal began with brood year 2012. From 1989 through 2012, the egg take goal was reached in 13 of those years (Table 10.1).

Table 10.1. Numbers of eggs taken from summer Chinook broodstock for the Okanogan program during 1989-2012. From 1989-2011, broodstock were collected at Wells Dam. In 2012, broodstock were collected in purse seines in the Okanogan River.

Return year	Number of eggs taken
1989	724,200
1990	696,144
1991	879,892
1992	729,389
1993	797,234
1994	893,086
1995	736,500
1996	672,000
1997	601,744
1998	584,018
1999	725,589
2000	645,403
2001	418,907
2002	718,599
2003	710,521
2004	805,814
2005	452,928
2006	757,350
2007	824,703
2008	662,668
2009	840,902
2010	726,979

Return year	Number of eggs taken
2011	683,419
Average (1989-2011)	***708,173***
Median (1989-2011)	***724,200***
2012	201,295
Average (2012)	***201,295***
Median (2012)	***201,295***

Number of acclimation days

Summer Chinook were released volitionally from Similkameen Pond as yearling smolts. Transfer dates, release dates, and the number of acclimation days for Okanogan summer Chinook are shown in Table 10.2.

Table 10.2. Number of days Okanogan summer Chinook broods were acclimated at Similkameen and Bonaparte ponds, brood years 1989-2012.

Brood year	Release year	Rearing facility	Transfer date	Release date	Number of days
1989	1991	Similkameen	29-Oct	7-May	190
1990	1992	Similkameen	5-Nov	25-Apr	171
1991	1993	Similkameen	1-Nov	9-Apr	159
1992	1994	Similkameen	2-Nov	1-Apr	150
			26-Feb	1-Apr	34
1993	1995	Similkameen	24-Oct	1-Apr	159
			24-Feb	1-Apr	36
1994	1996	Similkameen	30-Oct	6-Apr	158
			14-Mar	6-Apr	23
1995	1997	Similkameen	1-Oct	1-Apr	182
1996	1998	Similkameen	10-Oct	15-Mar	156
1997	1999	Similkameen	7-Oct	19-Apr	194
1998	2000	Similkameen	5-Oct	19-Apr	196
1999	2001	Similkameen	5-Oct	18-Apr	195
2000	2002	Similkameen	10-Oct	8-Apr	180
2001	2003	Similkameen	1-Oct	29-Apr	210
2002	2004	Similkameen	9-Nov	23-Apr	165
2003	2005	Similkameen	19-Oct	28-Apr	191
2004	2006	Similkameen	26-Oct	23-Apr	179
2005	2007	Bonaparte	6-Nov	11-Apr	156
		Similkameen	25-Oct	18-Apr – 9-May	179-200

Brood year	Release year	Rearing facility	Transfer date	Release date	Number of days
2006	2008	Similkameen	15-17-Oct	16-Apr – 7-May	182-205
2007	2009	Bonaparte	3-4-Nov	10-22-Apr	157-170
		Similkameen	20-24-Oct	14-Apr – 9-May	172-201
2008	2010	Bonaparte	2-4-Nov	19-Apr – 5-May	167-185
		Similkameen	26-28-Oct	19-Apr – 14-May	176-201
2009	2011	Bonaparte	8-9-Nov	12-Apr	155-156
		Similkameen	25-27-Oct	13-Apr – 5-May	169-193
2010	2012	Bonaparte	No program	No program	No program
		Similkameen	25-27 Oct	16-Apr – 7-May	173-196
2011	2013	Bonaparte	No program	No program	No program
		Similkameen	23-26 Oct	16-Apr – 8-May	175-197
2012	2014	Bonaparte	No program	No program	No program
		Similkameen	28-30 Oct	15 Apr – 5 May	167-189

Release Information

Numbers released

The 2012 Okanogan summer Chinook program achieved 68.4% of the 166,569 target goal with about 114,000 fish being released volitionally into the Similkameen River (Table 10.3).

Table 10.3. Numbers of Okanogan summer Chinook smolts released from the Similkameen and Bonaparte ponds, brood years 1989-2012; NA = not available. For brood years 1998-2012, the release target was 576,000 smolts. Since brood year 2013, the release target for Okanogan summer Chinook is 114,000 smolts.

Brood year	Release year	Rearing facility	CWT mark rate	Number of smolts released
1989	1991	Similkameen	0.5732	352,600
1990	1992	Similkameen	0.6800	540,000
1991	1993	Similkameen	0.5335	675,500
1992	1994	Similkameen	0.9819	548,182
1993	1995	Similkameen	0.6470	586,000
1994	1996	Similkameen	0.4176	536,299
1995	1997	Similkameen	0.9785	587,000
1996	1998	Similkameen	0.9769	507,913
1997	1999	Similkameen	0.9711	589,591
1998	2000	Similkameen	0.9825	293,191
1999	2001	Similkameen	0.9689	630,463
2000	2002	Similkameen	0.9928	532,453
2001	2003	Similkameen	0.9877	26,642

Brood year	Release year	Rearing facility	CWT mark rate	Number of smolts released
2002	2004	Similkameen	0.9204	388,589
2003	2005	Similkameen	0.9929	579,019
2004	2006	Similkameen	0.9425	703,359
2005	2007	Bonaparte	0	0 (assumed)
		Similkameen	0.9862	275,919
2006	2008	Similkameen	0.9878	604,035
2007	2009	Bonaparte	0.9920	102,099
		Similkameen	0.9914	513,039
2008	2010	Bonaparte	0.9947	175,729
		Similkameen	0.9947	343,628
2009	2011	Bonaparte	0.9981	151,382
		Similkameen	0.9953	524,521
2010	2012	Similkameen	0.9886	617,950
2011	2013	Similkameen	0.9956	627,978
Average (1989-2011)		***Bonaparte***	***0.7462***	***143,070***
		Similkameen	***0.8907***	***503,647***
Median (1989-2011)		***Bonaparte***	***0.9819***	***540,000***
		Similkameen	***0.9934***	***151,382***
2012	2014	Bonaparte	No program	No program
		Similkameen	0.9939	114,000
Average (2012-present)		***Bonaparte***	***No program***	***No program***
		Similkameen	***0.9939***	***114,000***
Median (2012-present)		***Bonaparte***	***No program***	***No program***
		Similkameen	***0.9939***	***114,000***

Numbers tagged

The 2012 brood Okanogan summer Chinook from the Similkameen facility were 99.4% CWT and adipose fin-clipped (Table 10.3). Table 10.4 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Okanogan River basin. No fish from the 2012 brood year were PIT tagged.

Table 10.4. Summary of PIT-tagging activities for Okanogan hatchery summer Chinook, brood years 2008-2011.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	5,700 (high density)	1,169	0	4,531
		5,700 (low density)	1,407	0	4,293
2009	2011	5,100	11	0	5,089
2010	2012	0	0	0	0

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2011	2013	5,100	64	0	5,036

Fish size and condition at release

Size at release of the Similkameen population was 73.3% and 56.8% of the fork length and weight targets, respectively. The CV for fork length exceeded the target by 18.9% (Table 10.5). There was no Bonaparte program for the 2014 release year.

Table 10.5. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Okanogan summer Chinook smolts released from the hatchery, brood years 1989-2012. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	-	-	41.3	11
1990	1992	143	9.5	37.8	12
1991	1993	125	15.5	22.4	20
1992	1994	120	15.4	20.7	22
1993	1995	132	-	23.2	20
1994	1996	136	16.0	29.6	15
1995	1997	137	8.2	32.8	14
1996	1998	127	12.8	26.2	17
1997	1999	144	9.9	36.0	13
1998	2000	148	5.9	41.0	11
1999	2001	141	15.7	35.4	13
2000	2002	121	13.4	20.4	22
2001	2003	132	8.2	25.7	18
2002	2004	119	13.4	20.8	22
2003	2005	133	10.6	28.9	16
2004	2006	132	9.9	29.8	15
2005	2007	132	9.6	25.9	18
2006	2008	120	12.3	20.9	22
2007	2009	124	12.6	21.9	21
2008	2010	140	12.3	35.1	13
2009	2011	132	11.6	24.7	18
2010	2012	125	10.1	23.2	20
2011	2013	132	9.5	27.9	16
2012	2014	129	7.3	25.8	18
Average		***131***	***11.4***	***28.2***	***17***
Median		***132***	***11.1***	***26.1***	***18***
Targets		***176***	***9.0***	***45.4***	***10***

Survival Estimates

Overall survival of Okanogan summer Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 10.6). Low survival can be attributed to high mortality after ponding through release because of external fungus. Currently, it is unknown if gamete viability is sex biased or is uniform between sexes and more influenced by between-year environmental variations.

Table 10.6. Hatchery life-stage survival rates (%) for Okanogan summer Chinook, brood years 1989-2012. Survival standards or targets are provided in the last row of the table.

Brood year	Rearing facility	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
		Female	Male							
1989[a]	Similkameen	89.8	99.5	89.9	96.7	99.7	99.4	73.3	57.4	48.7
1990[a]	Similkameen	93.9	99.0	84.9	97.1	81.2	80.6	97.7	98.6	77.6
1991[a]	Similkameen	93.1	95.5	88.2	97.1	99.4	99.1	98.4	97.1	76.8
1992[a]	Similkameen	96.9	99.0	87.0	98.0	99.9	99.9	91.7	92.6	75.2
1993[a]	Similkameen	82.2	99.4	85.4	97.6	99.8	99.5	92.0	90.2	73.5
1994	Similkameen	96.1	90.0	86.6	100.0	98.1	97.4	73.1	89.8	60.1
1995	Similkameen	91.9	96.2	98.2	84.1	96.5	96.2	92.7	98.2	79.7
1996	Similkameen	95.4	98.1	83.2	100.0	97.7	96.9	86.5	92.5	75.6
1997	Similkameen	91.9	94.6	86.1	98.4	98.7	98.3	98.8	99.4	98.0
1998	Similkameen	84.0	96.2	54.1	98.0	99.4	98.9	96.6	99.6	50.2
1999	Similkameen	98.8	98.7	92.9	96.9	98.0	97.6	96.9	99.0	86.9
2000	Similkameen	90.5	96.9	89.2	98.5	98.2	98.0	93.6	97.2	82.5
2001	Similkameen	96.2	92.3	89.1	97.6	99.7	99.5	7.4	11.9	6.4
2002	Similkameen	97.1	98.1	89.8	98.0	99.7	99.5	51.6	52.2	54.1
2003	Similkameen	96.7	97.5	86.8	97.6	99.3	98.5	98.0	98.8	81.5
2004	Similkameen	93.6	98.2	84.0	97.6	99.6	99.3	97.8	98.8	80.2
	Bonaparte	93.6	98.2	84.0	97.6	99.6	99.3	97.9	98.9	80.3
2005	Similkameen	97.0	89.6	88.0	99.5	99.5	99.0	93.5	94.6	81.8
	Bonaparte	97.0	89.6	88.0	99.5	99.5	99.0	0.0	0.0	0.0
2006	Similkameen	92.9	89.5	86.3	98.3	99.6	99.3	94.1	95.5	79.8
2007	Similkameen	92.6	99.6	80.8	99.1	99.5	99.1	97.0	98.1	77.7
	Bonaparte	92.6	99.6	80.8	99.1	99.5	99.1	95.6	96.7	76.6
2008	Similkameen	97.9	99.6	91.2	96.8	99.7	99.3	89.8	90.5	79.3
	Bonaparte	97.9	99.6	91.2	96.8	99.7	99.3	86.9	87.8	76.7
2009[b]	Similkameen	93.6	93.5	91.0	98.2	99.7	99.5	97.8	98.6	87.4
	Bonaparte	93.6	93.5	91.0	98.2	99.7	99.5	74.8	75.3	66.8
2010	Similkameen	96.5	100.0	91.2	99.9	97.4	97.1	93.3	96.3	85.0
2011	Similkameen	100.0	90.2	95.9	98.3	99.8	99.1	97.8	98.8	92.2
2012	Similkameen	100.0	100.0	85.1	98.6	99.7	99.3	70.6	71.2	59.3
Mean	***Similkameen***	***94.1***	***96.3***	***86.9***	***97.6***	***98.3***	***97.9***	***86.7***	***88.2***	***72.9***
	Bonaparte	***94.9***	***96.1***	***87.0***	***98.2***	***99.6***	***99.2***	***71.0***	***71.7***	***60.1***
Median	***Similkameen***	***94.7***	***97.8***	***87.5***	***98.0***	***99.5***	***99.1***	***93.6***	***96.7***	***78.5***
	Bonaparte	***93.6***	***98.2***	***88.0***	***98.2***	***99.6***	***99.3***	***86.9***	***87.8***	***76.6***
Standard		***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival rates were calculated from the aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.

[b] Survival rates were calculated from aggregate collections at Wells east fish ladder for the Methow and Okanogan/Similkameen programs. About 59% of the total fish collected were used to estimate survival rates.

10.3 Disease Monitoring

Results of adult broodstock bacterial kidney disease (BKD) monitoring for brood years 1997 through 2012 are shown in Table 10.7.

Table 10.7. Proportion of bacterial kidney disease (BKD) titer groups for the Methow/Okanogan summer Chinook broodstock, brood years 1997-2012. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.6267	0.1333	0.0622	0.1778	0.6844	0.3156
1998	0.9632	0.0184	0.0123	0.0061	0.9816	0.0184
1999	0.9444	0.0198	0.0238	0.0119	0.9643	0.0357
2000	0.7476	0.0952	0.0238	0.1333	0.8000	0.2000
2001	0.9801	0.0199	0.0000	0.0000	1.0000	0.0000
2002	0.9567	0.0130	0.0130	0.0173	0.9740	0.0260
2003	0.9620	0.0127	0.0169	0.0084	0.9747	0.0253
2004	0.9585	0.0151	0.0075	0.0189	0.9736	0.0264
2005	0.9884	0.0000	0.0000	0.0116	0.9884	0.0116
2006	0.9962	0.0038	0.0000	0.0000	0.9962	0.0038
2007	0.9202	0.0266	0.0152	0.0380	0.9354	0.0646
2008	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2009	0.9891	0.0073	0.0037	0.0000	0.9927	0.0073
2010	0.9960	0.0040	0.0000	0.0000	1.0000	0.0000
2011	0.9766	0.0140	0.0000	0.0093	0.9860	0.0140
2012	0.9341	0.0440	0.0110	0.0110	0.9780	0.0220
Average	***0.9542***	***0.0267***	***0.0118***	***0.0277***	***0.9518***	***0.0482***
Median	***0.9632***	***0.0146***	***0.0093***	***0.0102***	***0.9798***	***0.0202***

[a] Individual ELISA samples were not collected before the 1997 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

10.4 Spawning Surveys

Surveys for Okanogan/Similkameen summer Chinook redds were conducted from late September to mid-November in the Okanogan and Similkameen rivers. Total redd counts (not peak counts) were conducted in the rivers.

Redd Counts

During the survey period 1989 through 2018, the number of summer Chinook redds in the Okanogan River basin averaged 2,211 and ranged from 110 to 6,025 (Table 10.8).

Table 10.8. Total number of redds counted in the Okanogan River basin, 1989-2018. The Colville Tribes provided data for survey years 2013 to present.

Survey year	Number of summer Chinook redds		
	Okanogan River	Similkameen River	Total count
1989	151	370	521
1990	99	147	246
1991	64	91	155
1992	53	57	110
1993	162	288	450
1994	375	777	1,152
1995	267	616	883
1996	116	419	535
1997	158	486	644
1998	88	276	364
1999	369	1,275	1,644
2000	549	993	1,542
2001	1,108	1,540	2,648
2002	2,667	3,358	6,025
2003	1,035	378	1,413
2004	1,327	1,660	2,987
2005	1,611	1,423	3,034
2006	2,592	1,666	4,258
2007	1,301	707	2,008
2008	1,146	1,000	2,146
2009	1,672	1,298	2,970
2010	1,011	1,107	2,118
2011	1,714	1,409	3,123
2012	1,613	1,066	2,679
2013	2,267	1,280	3,547
2014	2,231	2,022	4,253
2015	2,379	1,897	4,276
2016	3,486	1,790	5,276
2017	2,434	787	3,221
2018	1,554	558	2,112
Average	***1,187***	***1,025***	***2,211***
Median	***1,127***	***997***	***2,115***

* Reach-expanded aerial counts.

Spawning Escapement

Spawning escapement for Okanogan/Similkameen summer Chinook was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[45] During the survey period 1989 through 2018, the summer Chinook spawning escapement within the Okanogan River basin averaged 5,861 and ranged from 473 to 13,857 (Table 10.9).

Table 10.9. Spawning escapements for summer Chinook in the Okanogan and Similkameen rivers for return years 1989-2018. The Colville Tribes provided data for return years 2013 to present.

Return year	Fish/Redd	Spawning escapement		
		Okanogan	Similkameen	Total
1989*	3.30	498	1,221	1,719
1990*	3.40	337	500	837
1991*	3.70	237	337	574
1992*	4.30	228	245	473
1993*	3.30	535	950	1,485
1994*	3.50	1,313	2,720	4,033
1995*	3.40	908	2,094	3,002
1996*	3.40	394	1,425	1,819
1997*	3.40	537	1,652	2,189
1998	3.00	264	828	1,092
1999	2.20	812	2,805	3,617
2000	2.40	1,318	2,383	3,701
2001	4.10	4,543	6,314	10,857
2002	2.30	6,134	7,723	13,857
2003	2.42	2,505	915	3,420
2004	2.25	2,986	3,735	6,721
2005	2.93	4,720	4,169	8,889
2006	2.02	5,236	3,365	8,601
2007	2.20	2,862	1,555	4,417
2008	3.25	3,725	3,250	6,975
2009	2.54	4,247	3,297	7,544
2010	2.81	2,841	3,111	5,952
2011	3.10	5,313	4,368	9,681
2012	3.07	4,952	3,273	8,225
2013	2.31	5,237	2,957	8,194
2014	2.86	6,381	5,783	12,164
2015	3.21	7,637	6,089	13,726
2016	2.01	7,007	3,598	10,605
2017	2.04	4,963	1,605	6,568
2018	2.30	3,576	1,284	4,860

[45] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Spawning escapement		
		Okanogan	Similkameen	Total
Average	***2.90***	***3,076***	***2,786***	***5,861***
Median	***2.97***	***2,924***	***2,763***	***5,406***

* Spawning escapement was calculated using the "Modified Meekin Method" (i.e., 3.1 x jack multiplier).

10.5 Carcass Surveys

Surveys for summer Chinook carcasses were conducted during late September to mid-November in the Okanogan and Similkameen rivers.

Number sampled

During the survey period 1993 through 2018, the number of summer Chinook carcasses sampled in the Okanogan River basin averaged 1,356 and ranged from 115 to 3,293 (Table 10.10). In all years, most were sampled in the upper Okanogan River and lower Similkameen River (Table 10.10).

Table 10.10. Numbers of summer Chinook carcasses sampled within each survey reach in the Okanogan River basin, 1993-2018. Reach codes are described in Table 2.11. The Colville Tribes provided data for survey years 2013 to present.

Survey year	Number of summer Chinook carcasses								
	Okanogan						Similkameen		Total
	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
1993[a]	0	2	3	0	23	13	73	1	115
1994[b]	0	4	4	0	27	5	318	60	418
1995	0	0	2	0	30	0	239	15	286
1996	0	0	0	2	5	2	226	0	235
1997	0	0	2	0	9	3	225	1	240
1998	0	1	8	1	7	7	340	4	368
1999	0	0	3	2	23	53	766	48	895
2000	0	2	20	15	47	16	727	41	868
2001	0	26	75	10	127	112	1,141	105	1,596
2002	10	32	83	35	204	572	1,265	259	2,460
2003[c]	0	0	28	0	17	243	596	381	1,265
2004	0	4	31	24	146	283	1,392	298	2,178
2005	0	8	93	37	371	434	731	276	1,950
2006	4	3	31	16	120	291	508	106	1,079
2007	2	0	55	1	453	519	658	29	1,717
2008	4	10	40	36	248	665	859	157	2,019
2009	2	7	31	32	348	500	703	150	1,773
2010	3	10	30	42	241	352	627	148	1,453
2011	0	0	55	14	361	478	753	114	1,775
2012	1	0	56	15	256	537	495	54	1,414

Survey year	Number of summer Chinook carcasses								
	Okanogan						Similkameen		Total
	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
2013[d]	0	0	30	9	52	432	380	7	910
2014	0	2	79	54	275	783	770	489	2,452
2015	0	10	61	11	283	994	1,702	232	3,293
2016	0	12	14	11	230	1,075	1,214	199	2,755
2017	0	8	9	16	60	628	453	27	1,201
2018	0	0	78	8	134	190	131	6	547
Average	***1***	***5***	***35***	***15***	***158***	***353***	***665***	***123***	***1,356***
Median	***0***	***2***	***31***	***11***	***131***	***322***	***643***	***83***	***1,340***

[a] 25 additional carcasses were sampled on the Similkameen and 46 on the Okanogan without any reach designation.
[b] One additional carcass was sampled on the Similkameen without any reach designation.
[c] 793 carcasses were sampled on the Similkameen before initiation of spawning (pre-spawn mortality) and an additional 40 carcasses were sampled on the Okanogan. The cause of the high mortality (*Ichthyophthirius multifilis* and *Flavobacterium columnarae*) was exacerbated by high river temperatures.
[d] In 2013, the Colville Tribes combined survey reaches O-3 and O-4, and S-1 and S-2. Carcass totals in these reaches were re-apportioned based on redd counts within each reach.

Carcass Distribution and Origin

Based on the available data (1991-2018), most fish, regardless of origin, were found in Reach 1 on the Similkameen River (Driscoll Channel to Oroville Bridge) (Table 10.11). However, a slightly larger percentage of hatchery fish were found in reaches on the Similkameen River than were wild fish (Figure 10.1). In contrast, a larger percentage of wild fish were found in reaches on the Okanogan River.

Table 10.11. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Okanogan River basin, 1993-2018.

Survey year	Origin	Survey reach								Total
		O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
1993	Wild	0	0	3	0	13	4	48	1	69
	Hatchery	0	2	0	0	10	9	25	0	46
1994	Wild	0	0	1	0	7	1	113	22	144
	Hatchery	0	4	3	0	20	4	205	38	274
1995	Wild	0	0	1	0	10	0	66	4	81
	Hatchery	0	0	1	0	20	0	173	11	205
1996	Wild	0	0	0	1	3	1	53	0	58
	Hatchery	0	0	0	1	2	1	173	0	177
1997	Wild	0	0	1	0	0	3	83	0	87
	Hatchery	0	0	1	0	9	0	142	1	153
1998	Wild	0	1	3	1	6	5	162	4	182
	Hatchery	0	0	5	0	1	2	178	0	186
1999	Wild	0	0	0	0	9	23	293	9	334
	Hatchery	0	0	3	2	14	30	473	39	561
2000	Wild	0	0	8	8	24	11	189	4	244

Survey year	Origin	Survey reach								Total
		O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
	Hatchery	0	2	12	7	23	5	538	37	624
2001	Wild	0	10	23	5	67	42	390	54	591
	Hatchery	0	16	52	5	60	70	751	51	1,005
2002	Wild	6	14	20	10	81	212	340	72	755
	Hatchery	4	18	63	25	123	360	925	187	1,705
2003	Wild	0	0	13	0	12	152	231	124	532
	Hatchery	0	0	15	0	5	91	365	257	733
2004	Wild	0	2	19	19	108	225	1,125	260	1,758
	Hatchery	0	2	12	5	38	58	267	38	420
2005	Wild	0	5	51	21	256	364	531	176	1,404
	Hatchery	0	3	42	16	115	70	200	100	546
2006	Wild	2	2	22	10	105	247	370	73	831
	Hatchery	2	1	9	6	15	44	138	33	248
2007	Wild	1	0	30	1	284	322	405	20	1,063
	Hatchery	1	0	25	0	169	197	253	9	654
2008	Wild	2	1	14	11	107	324	347	41	847
	Hatchery	2	9	26	25	141	341	512	116	1,172
2009	Wild	2	3	13	14	189	347	330	75	973
	Hatchery	0	4	18	18	159	153	373	75	800
2010	Wild	1	5	19	18	154	180	329	69	775
	Hatchery	2	5	11	24	87	172	296	79	676
2011	Wild	0	0	21	4	201	362	216	19	823
	Hatchery	0	0	34	10	160	116	537	95	952
2012	Wild	0	0	18	9	133	427	206	23	816
	Hatchery	1	0	38	6	123	110	288	31	597
2013	Wild	0	0	22	7	37	352	191	4	613
	Hatchery	0	0	8	2	15	80	188	4	297
2014	Wild	0	1	60	47	233	716	641	425	2,123
	Hatchery	1	0	19	7	42	67	129	64	329
2015	Wild	0	5	39	9	209	931	1,186	176	2,555
	Hatchery	0	5	22	2	74	63	516	56	738
2016	Wild	0	6	13	7	186	1,019	819	121	2,171
	Hatchery	0	6	1	4	44	56	395	78	584
2017	Wild	0	4	4	11	50	562	347	19	997
	Hatchery	0	4	5	5	10	66	106	8	204
2018	Wild	0	0	38	7	85	157	83	4	374
	Hatchery	0	0	40	1	49	33	48	2	173
Average	***Wild***	***1***	***2***	***18***	***8***	***99***	***269***	***350***	***69***	***815***
	Hatchery	***1***	***3***	***18***	***7***	***59***	***85***	***315***	***54***	***541***
Median	***Wild***	***0***	***1***	***16***	***7***	***83***	***219***	***311***	***23***	***765***
	Hatchery	***0***	***2***	***12***	***5***	***40***	***65***	***260***	***38***	***554***

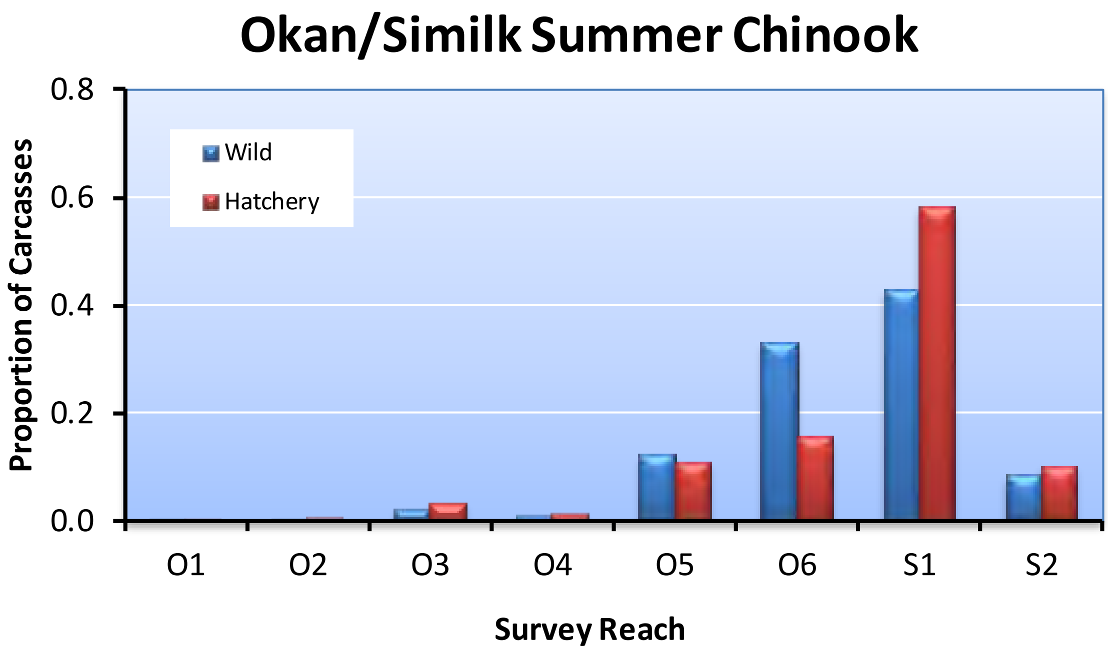


Figure 10.1. Distribution of wild and hatchery produced carcasses in different reaches in the Okanogan River basin, 1993-2018. Reach codes are described in Table 2.11.

10.6 Life History Monitoring

Life history characteristics of Okanogan/Similkameen summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Methow/Okanogan summer Chinook was determined from broodstock data collected at Wells Dam. Counting of summer/fall Chinook at Wells Dam occurs from 29 June to 15 November. Broodstock collection at the Dam occurs from early July (week 27) to mid-September (week 37) (see Table 2.1). Based on broodstock sampling in 2018, wild summer Chinook arrived at Wells Dam earlier than hatchery summer Chinook (Table 10.12). This was true throughout most of the migration period. In contrast, there was little difference in migration timing between wild and hatchery summer Chinook when data were pooled for the 2007-2018 survey period.

Table 10.12. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Wells Dam, 2007-2018. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Wells Dam.

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	27	30	34	30	485
	Hatchery	27	30	33	30	433
2008	Wild	28	30	34	30	542
	Hatchery	28	30	36	31	884
2009	Wild	27	29	34	30	585
	Hatchery	27	29	33	29	708
2010	Wild	27	29	33	29	377
	Hatchery	27	29	32	29	801
2011	Wild	30	32	36	32	516
	Hatchery	30	32	35	33	1223
2012	Wild	28	30	34	31	192
	Hatchery	28	31	34	31	591
2013	Wild	27	30	33	30	229
	Hatchery	27	30	33	30	282
2014	Wild	27	31	40	32	316
	Hatchery	27	30	35	30	208
2015	Wild	26	28	30	28	217
	Hatchery	27	28	31	29	164
2016	Wild	26	29	39	30	314
	Hatchery	25	28	34	29	251
2017	Wild	27	30	35	30	228
	Hatchery	28	31	35	31	236
2018	Wild	25	29	34	29	232
	Hatchery	26	28	33	29	760
Average	***Wild***	***27***	***30***	***35***	***30***	***353***
	Hatchery	***27***	***30***	***34***	***30***	***545***
Median	***Wild***	***27***	***30***	***34***	***30***	***315***
	Hatchery	***27***	***30***	***34***	***30***	***512***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2018 in the Okanogan River basin were salt age-3 fish (Table 10.13; Figure 10.2). A higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 10.13. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Okanogan River basin, 1993-2018.

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
1993	Wild	0.00	0.21	0.70	0.10	0.00	63
	Hatchery	0.00	0.98	0.02	0.00	0.00	44
1994	Wild	0.02	0.13	0.54	0.31	0.00	134
	Hatchery	0.02	0.09	0.89	0.00	0.00	290
1995	Wild	0.00	0.19	0.59	0.22	0.00	68
	Hatchery	0.01	0.15	0.36	0.49	0.00	200
1996	Wild	0.03	0.28	0.61	0.08	0.00	36
	Hatchery	0.02	0.22	0.56	0.20	0.01	174
1997	Wild	0.04	0.27	0.53	0.15	0.00	73
	Hatchery	0.00	0.02	0.87	0.11	0.00	148
1998	Wild	0.02	0.35	0.52	0.11	0.00	151
	Hatchery	0.05	0.50	0.23	0.22	0.00	185
1999	Wild	0.00	0.20	0.64	0.16	0.00	268
	Hatchery	0.00	0.12	0.85	0.02	0.00	552
2000	Wild	0.03	0.15	0.62	0.20	0.00	216
	Hatchery	0.12	0.02	0.76	0.10	0.00	545
2001	Wild	0.02	0.18	0.76	0.04	0.00	531
	Hatchery	0.05	0.88	0.02	0.05	0.00	1,005
2002	Wild	0.02	0.15	0.62	0.21	0.00	692
	Hatchery	0.01	0.19	0.80	0.01	0.00	1,681
2003	Wild	0.03	0.18	0.63	0.17	0.00	477
	Hatchery	0.03	0.06	0.79	0.12	0.00	653
2004	Wild	0.01	0.17	0.26	0.55	0.00	1,528
	Hatchery	0.01	0.32	0.45	0.23	0.00	382
2005	Wild	0.00	0.12	0.79	0.08	0.01	1,281
	Hatchery	0.02	0.06	0.77	0.15	0.00	530
2006	Wild	0.00	0.02	0.53	0.45	0.00	830
	Hatchery	0.05	0.18	0.24	0.53	0.00	139
2007	Wild	0.02	0.07	0.12	0.78	0.02	1,061
	Hatchery	0.22	0.30	0.42	0.05	0.01	559
2008	Wild	0.01	0.32	0.63	0.04	0.01	846

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
	Hatchery	0.02	0.60	0.36	0.02	0.00	1,108
2009	Wild	0.01	0.03	0.81	0.15	0.00	926
	Hatchery	0.05	0.05	0.86	0.03	0.00	783
2010	Wild	0.00	0.16	0.45	0.39	0.00	708
	Hatchery	0.02	0.65	0.27	0.06	0.00	619
2011	Wild	0.01	0.07	0.82	0.10	0.00	787
	Hatchery[a]	0.16	0.08	0.76	0.00	0.00	873
2012	Wild	0.02	0.23	0.41	0.34	0.00	750
	Hatchery	0.05	0.55	0.35	0.05	0.00	532
2013	Wild	0.01	0.17	0.75	0.07	0.00	520
	Hatchery	0.03	0.21	0.74	0.02	0.00	252
2014	Wild	0.02	0.08	0.76	0.14	0.00	1,892
	Hatchery	0.18	0.26	0.55	0.02	0.00	300
2015	Wild	0.00	0.40	0.34	0.25	0.00	2,167
	Hatchery	0.03	0.68	0.26	0.02	0.00	549
2016	Wild	0.00	0.03	0.76	0.21	0.00	1,979
	Hatchery	0.02	0.06	0.87	0.04	0.00	1,255
2017	Wild	0.00	0.02	0.37	0.60	0.00	993
	Hatchery	0.01	0.28	0.40	0.31	0.00	137
2018	Wild	0.01	0.11	0.53	0.35	0.00	260
	Hatchery	0.00	0.51	0.45	0.04	0.00	142
Average	***Wild***	***0.01***	***0.15***	***0.56***	***0.28***	***0.00***	***739***
	Hatchery	***0.05***	***0.30***	***0.59***	***0.07***	***0.00***	***524***
Median	***Wild***	***0.01***	***0.12***	***0.70***	***0.18***	***0.00***	***700***
	Hatchery	***0.04***	***0.24***	***0.63***	***0.10***	***0.00***	***531***

[a] There was one salt age-6 hatchery fish that was not included in this table.

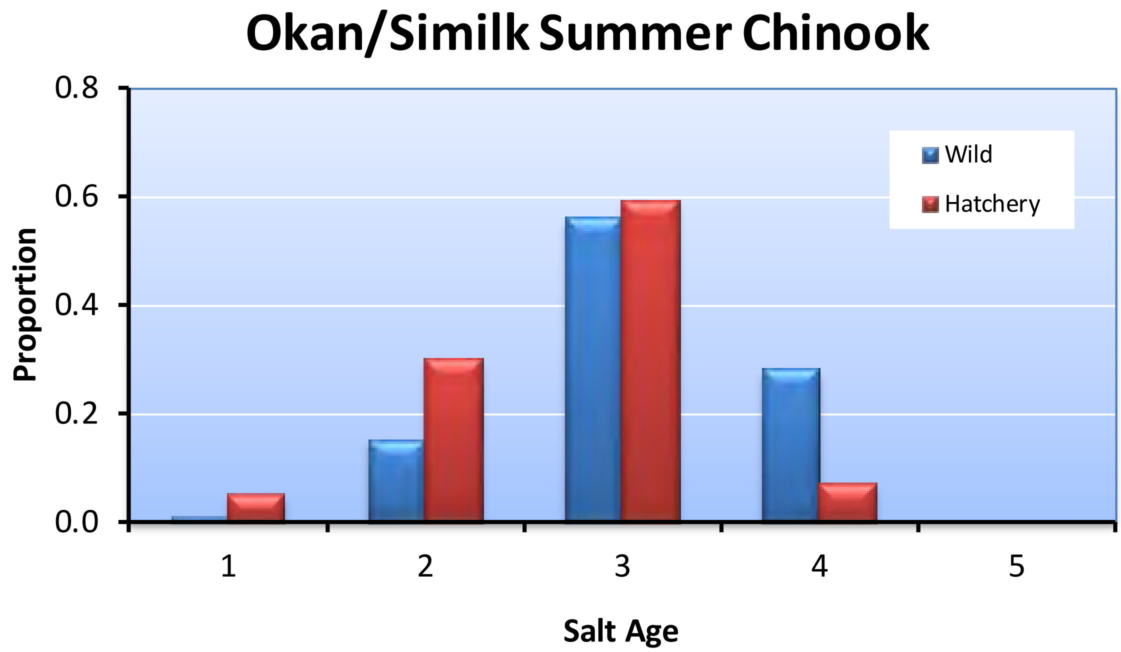


Figure 10.2. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Okanogan River basin for the combined years 1993-2018.

Size at Maturity

For the period 1993 through 2018, on average, hatchery summer Chinook were about 2 cm smaller than wild summer Chinook sampled in the Okanogan River basin (Table 10.14). This is likely because a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish.

Table 10.14. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Okanogan River basin, 1993-2018; SD = 1 standard deviation.

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	69	73	7	52	90
	Hatchery	59	62	6	47	75
1994	Wild	136	71	7	40	86
	Hatchery	268	69	8	30	84
1995	Wild	81	75	6	54	87
	Hatchery	201	73	8	39	87
1996	Wild	22	68	14	22	85
	Hatchery	26	75	8	60	88
1997	Wild	87	70	7	44	84
	Hatchery	148	74	6	48	88
1998	Wild	182	70	8	45	94
	Hatchery	186	65	12	30	87

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1999	Wild	333	73	7	56	91
	Hatchery	559	71	7	23	84
2000	Wild	241	70	10	32	86
	Hatchery	624	69	12	24	92
2001	Wild	578	67	9	26	86
	Hatchery	997	61	8	32	90
2002	Wild	755	69	9	28	91
	Hatchery	1705	70	8	33	87
2003	Wild	532	68	9	30	93
	Hatchery	733	69	10	26	90
2004	Wild	1756	71	10	33	94
	Hatchery	417	66	9	41	92
2005	Wild	1403	66	7	41	99
	Hatchery	546	68	8	31	85
2006	Wild	831	72	6	31	91
	Hatchery	248	71	9	33	87
2007	Wild	1063	75	9	27	99
	Hatchery	654	64	13	30	87
2008	Wild	847	65	9	29	86
	Hatchery	1172	65	8	32	89
2009	Wild	973	70	7	28	89
	Hatchery	799	70	9	35	86
2010	Wild	775	71	9	43	90
	Hatchery	676	64	10	22	87
2011	Wild	823	68	7	29	89
	Hatchery	952	66	11	26	86
2012	Wild	816	67	10	27	93
	Hatchery	597	63	9	23	86
2013	Wild	642	67	8	23	87
	Hatchery	267	71	8	36	88
2014	Wild	2,134	68	8	30	83
	Hatchery	318	64	13	30	89
2015	Wild	2,572	60	9	24	87
	Hatchery	720	58	8	23	78
2016	Wild	2,171	66	6	28	92
	Hatchery	584	67	6	37	86
2017	Wild	997	71	8	30	96
	Hatchery	204	68	9	25	92

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
2018	Wild	374	71	8	30	96
	Hatchery	173	68	9	25	92
Pooled	***Wild***	***21,193***	***69***	***8***	***22***	***99***
	Hatchery	***13,833***	***67***	***9***	***22***	***92***

[a] This year includes sizes reported in the annual report. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Okanogan/Similkameen summer Chinook occurred in the Ocean (Table 10.15). Ocean harvest has made up 36-100% of all hatchery-origin Okanogan/Similkameen summer Chinook harvested. Brood year 2011 provided the largest harvest, while brood year 1996 provided the lowest.

Table 10.15. Estimated number and percent (in parentheses) of hatchery-origin Okanogan/Similkameen summer Chinook captured in different fisheries, brood years 1989-2012.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	2,360 (80)	553 (19)	0 (0)	53 (2)	2,966	39.8
1990	355 (89)	34 (8)	0 (0)	12 (3)	401	28.2
1991	220 (86)	37 (14)	0 (0)	0 (0)	257	14.0
1992	422 (91)	28 (6)	2 (0)	10 (2)	462	20.0
1993	24 (80)	6 (20)	0 (0)	0 (0)	30	25.6
1994	372 (92)	23 (6)	2 (0)	7 (2)	404	26.1
1995	643 (93)	9 (1)	12 (2)	25 (4)	689	23.8
1996	6 (100)	0 (0)	0 (0)	0 (0)	6	18.2
1997	6,483 (92)	136 (2)	36 (1)	424 (6)	7,079	37.1
1998	4,414 (89)	251 (5)	45 (1)	223 (5)	4,933	62.8
1999	1,359 (68)	224 (11)	31 (2)	384 (19)	1,998	70.0
2000	3,139 (69)	533 (12)	222 (5)	675 (15)	4,559	67.1
2001	184 (58)	81 (25)	31 (10)	23 (7)	319	74.9
2002	706 (56)	200 (16)	90 (7)	258 (21)	1,254	63.2
2003	711 (38)	568 (30)	130 (7)	466 (25)	1,875	53.3
2004	3,153 (39)	2,162 (26)	694 (8)	2,168 (27)	8,177	60.9
2005	470 (46)	306 (30)	79 (8)	167 (16)	1,022	61.1
2006	3,136 (37)	3,352 (40)	469 (6)	1,419 (17)	8,376	61.0
2007	1,549 (44)	992 (28)	67 (2)	905 (26)	3,513	70.8
2008	4,226 (38)	2,576 (23)	218 (2)	3,969 (36)	10,989	73.5
2009	2,005 (36)	2,155 (39)	207 (4)	1,138 (21)	5,505	77.2
2010	3,193 (38)	3,933 (46)	247 (3)	1,110 (13)	8,483	79.0
2011	5,801 (40)	5,812 (40)	456 (3)	2,598 (18)	14,667	78.0

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2012	747 (51)	395 (27)	13 (1)	320 (22)	1,475	89.4
Average	***1,903 (51)***	***1,015 (27)***	***127 (3)***	***681 (18)***	***3,727***	***53***
Median	***1,053 (63)***	***279 (20)***	***41 (2)***	***289 (14)***	***1,937***	***61***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Okanogan River basin. Targets for strays based on return year (recovery year) within the upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia River summer Chinook population, few hatchery-origin Okanogan summer Chinook have strayed into basins outside the Okanogan (Table 10.16). Although hatchery-origin Okanogan summer Chinook have strayed into other spawning areas, they usually made up less than 10% of the spawning escapement within those areas. The Chelan tailrace has received the largest number of Okanogan strays.

Hatchery-origin Okanogan summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Okanogan have been detected in the White Salmon River, Klickitat River, Tucannon River, at Lower Granite Dam on the Snake River, at Three Mile Dam on the Umatilla River, at Pelton Dam on the Deschutes River, and at Tumwater Falls, Lyons Ferry, and Bonneville hatcheries. However, few Okanogan summer Chinook have strayed into each of these locations.

Table 10.16. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Okanogan summer Chinook, return years 1994-2017. For example, for return year 2002, 1% of the summer Chinook spawning escapement in the Entiat Basin consisted of hatchery-origin Okanogan summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	0	0.0	-	-	-	-	-	-
1995	0	0.0	0	0.0	-	-	-	-	-	-
1996	0	0.0	0	0.0	-	-	-	-	-	-
1997	0	0.0	0	0.0	-	-	-	-	-	-
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	0	0.0	6	0.5	30	4.5	0	0.0	3	0.0
2001	12	0.1	0	0.0	10	1.0	0	0.0	0	0.0
2002	0	0.0	3	0.1	4	0.7	5	1.0	0	0.0
2003	0	0.0	8	0.2	22	5.3	14	2.0	0	0.0
2004	0	0.0	0	0.0	5	1.2	0	0.0	0	0.0

Return year	Wenatchee		Methow		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2005	5	0.1	27	1.1	36	6.9	7	1.9	8	0.0
2006	0	0.0	5	0.2	4	1.0	7	1.8	0	0.0
2007	0	0.0	3	0.2	4	2.1	0	0.0	0	0.0
2008	0	0.0	9	0.5	46	9.3	4	1.9	0	0.0
2009	15	0.2	3	0.2	11	1.8	18	9.9	0	0.0
2010	6	0.1	0	0.0	33	3.0	0	0.0	0	0.0
2011	0	0.0	0	0.0	46	3.6	0	0.0	0	0.0
2012	7	0.1	5	0.2	19	1.5	0	0.0	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	3	0.2	8	0.7	0	0.0	0	0.0
2015	4	0.1	5	0.1	4	0.3	0	0.0	0	0.0
2016	0	0.0	4	0.2	4	0.4	0	0.0	0	0.0
2017	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***2***	***0.0***	***3***	***0.2***	***14***	***2.2***	***3***	***0.9***	***1***	***0.0***
Median	***0***	***0.0***	***2***	***0.1***	***7***	***1.1***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 1% of the hatchery-origin Okanogan summer Chinook spawners strayed into non-target streams (Table 10.17). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-4%. In addition, on average, 0.2% of hatchery-origin Okanogan summer Chinook broodstock have been included in non-target hatchery programs.

Table 10.17. Number and percent of hatchery-origin Okanogan summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2012.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	3,132	69.7	2	0.0	1,328	29.6	31	0.7
1990	729	71.4	0	0.0	291	28.5	1	0.1
1991	1,125	71.3	0	0.0	453	28.7	0	0.0
1992	1,264	68.5	8	0.4	572	31.0	1	0.1
1993	54	62.1	0	0.0	32	36.8	1	1.1
1994	924	80.8	16	1.4	203	17.7	1	0.1
1995	1,883	85.4	50	2.3	271	12.3	0	0.0
1996	27	100.0	0	0.0	0	0.0	0	0.0
1997	11,659	97.1	34	0.3	309	2.6	3	0.0

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1998	2,784	95.4	31	1.1	102	3.5	2	0.1
1999	828	96.7	10	1.2	18	2.1	0	0.0
2000	2,091	93.6	99	4.4	29	1.3	15	0.7
2001	105	98.1	0	0.0	2	1.9	0	0.0
2002	702	96.2	11	1.5	17	2.3	0	0.0
2003	1,580	96.2	16	1.0	47	2.9	0	0.0
2004	4,947	94.4	85	1.6	206	3.9	2	0.0
2005	606	93.2	22	3.4	22	3.4	0	0.0
2006	5,220	97.6	68	1.3	60	1.1	0	0.0
2007	1,396	96.4	10	0.7	42	2.9	0	0.0
2008	3,600	90.8	23	0.6	337	8.5	4	0.1
2009	993	61.1	11	0.7	621	38.2	1	0.1
2010	924	40.9	9	0.4	1,314	58.2	10	0.4
2011	2,805	67.8	13	0.3	1,295	31.3	25	0.6
2012	97	55.7	0	0.0	76	43.7	1	0.6
Average	***2,061***	***82.5***	***22***	***0.9***	***319***	***16.4***	***4***	***0.2***
Median	***1,195***	***92.0***	***11***	***0.7***	***153***	***6.2***	***1***	***0.1***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Okanogan River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Okanogan River basin.

[3] Target hatchery includes broodstock collection at Wells Dam.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Okanogan summer Chinook hatchery program.

Genetics

Genetic studies were conducted to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix P). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next comprehensive report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1993-2003, the PNI values were less than 0.67 (Table 10.18). However, since brood year 2003, PNI has generally been greater than 0.67, save 2008 and 2011. PNI results reported here end with brood year 2012. Beginning with brood year 2013, the Colville Confederated Tribes report PNI values for Okanogan summer Chinook in their annual reports to BPA.

Table 10.18. Proportionate Natural Influence (PNI) values for the Okanogan/Similkameen summer Chinook supplementation program for brood years 1989-2012. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	1,719	0	0	1,297	312	0.81	1.00
1990	837	0	0	828	206	0.80	1.00
1991	574	0	0	924	314	0.75	1.00
1992	473	0	0	297	406	0.42	1.00
1993	915	570	0.38	681	388	0.64	0.64
1994	1,323	2,710	0.67	341	244	0.58	0.48
1995	979	2,023	0.67	173	240	0.42	0.40
1996	568	1,251	0.69	287	155	0.65	0.50
1997	862	1,327	0.61	197	265	0.43	0.43
1998	600	492	0.45	153	211	0.42	0.50
1999	1,274	2,343	0.65	224	289	0.44	0.42
2000	1,174	2,527	0.68	164	337	0.33	0.35
2001	4,306	6,551	0.6	12	345	0.03	0.09
2002	4,346	9,511	0.69	247	241	0.51	0.44
2003	1,933	1,487	0.43	381	101	0.79	0.66
2004	5,309	1,412	0.21	506	16	0.97	0.83
2005	6,441	2,448	0.28	391	9	0.98	0.78
2006	5,507	3,094	0.36	500	10	0.98	0.74
2007	2,983	1,434	0.32	456	17	0.96	0.76
2008	2,998	3,977	0.57	359	86	0.81	0.60
2009	4,204	3,340	0.44	503	4	0.99	0.70
2010	3,189	2,763	0.46	484	8	0.98	0.69
2011	4,642	5,039	0.52	467	26	0.95	0.65
2012	4,494	3,731	0.45	79	2	0.98	0.69
Average	***2,569***	***2,418***	***0.42***	***415***	***176***	***0.69***	***0.64***
Median	***1,826***	***2,183***	***0.45***	***370***	***209***	***0.77***	***0.66***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel times (arithmetic mean days) of hatchery summer Chinook from the Similkameen River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 10.19).[46] Over the three brood years for which PIT-tagged hatchery fish were released, survival rates from the Similkameen River to McNary Dam ranged from 0.432 to 0.720; SARs from release to detection at Bonneville Dam ranged from 0.016 to 0.031. Average travel time from the Similkameen River to McNary Dam ranged from 41 to 44 days. Although there is only one year in which low densities were compared to high densities (brood year 2008), there was little difference in survival rates and travel times between the two groups (Table 10.19).

Table 10.19. Total number of Okanogan hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2011. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	4,531 (high density)	0.445 (0.061)	44.0 (10.2)	0.028 (0.002)
	4,293 (low density)	0.432 (0.050)	41.4 (9.7)	0.030 (0.003)
2009	5,089	0.720 (0.102)	41.5 (10.1)	0.016 (0.002)
2010	0	--	--	--
2011	5,036	0.683 (0.064)	41.9 (12.3)	0.031 (0.002)

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood year harvest rates from the hatchery program. For brood years 1989-2012, NRR for summer Chinook in the Okanogan averaged 1.07 (range, 0.17-3.82) if harvested fish were not included in the estimate and 2.36 (range, 0.32-9.83) if harvested fish were included in the estimate (Table 10.20). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 8.6 (the calculated target value in Hillman et al. 2017). The target value of 8.6 includes harvest. HRRs exceeded NRRs in 21 of the 24 years of data, regardless if harvest was or was not included in the estimate (Table 10.20). Hatchery

[46] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

replacement rates for Okanogan summer Chinook have exceeded the estimated target value of 8.6 in 13 of the 24 years of data.

Table 10.20. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for wild summer Chinook in the Okanogan River basin, brood years 1989-2011.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	304	1,719	4,493	2,146	14.78	1.25	7,459	3,577	24.54	2.08
1990	288	837	1,021	1,477	3.55	1.76	1,422	2,063	4.94	2.46
1991	364	574	1,578	629	4.34	1.10	1,835	728	5.04	1.27
1992	304	473	1,845	752	6.07	1.59	2,307	942	7.59	1.99
1993	328	1,485	87	1,003	0.27	0.68	117	1,348	0.36	0.91
1994	302	4,033	1,144	2,168	3.79	0.54	1,548	2,942	5.13	0.73
1995	385	3,002	2,204	959	5.72	0.32	2,893	1,262	7.51	0.42
1996	330	1,819	27	466	0.08	0.26	33	574	0.10	0.32
1997	313	2,189	12,005	4,363	38.35	1.99	19,084	6,807	60.97	3.11
1998	352	1,092	2,919	4,166	8.29	3.82	7,852	10,737	22.31	9.83
1999	333	3,617	856	6,641	2.57	1.84	2,854	16,080	8.57	4.45
2000	334	3,701	2,234	1,716	6.69	0.46	6,793	4,727	20.34	1.28
2001	335	10,857	107	8,959	0.32	0.83	426	35,836	1.27	3.30
2002	333	13,857	730	6,077	2.19	0.44	1,984	16,559	5.96	1.19
2003	337	3,420	1,643	566	4.88	0.17	3,518	1,215	10.44	0.36
2004	335	6,721	5,240	3,119	15.64	0.46	13,417	7,977	40.05	1.19
2005	338	8,889	650	6,177	1.92	0.69	1,672	14,707	4.95	1.65
2006	355	8,601	5,348	2,421	15.06	0.28	13,724	5,206	38.66	0.61
2007	314	4,417	1,448	6,241	4.61	1.41	4,961	13,993	15.80	3.17
2008	276	6,975	3,964	2,702	14.36	0.39	14,953	5,537	54.18	0.79
2009	335	7,544	1,626	7,074	4.85	0.94	7,131	19,541	21.29	2.59
2010	301	5,952	2,257	12,236	7.50	2.06	10,740	41,338	35.68	6.95
2011	306	9,681	4,138	6,418	13.52	0.66	18,805	19,870	61.45	2.05
2012	94	8,225	889	15,343	9.46	1.87	2,574	31,570	27.38	3.84
Average	***317***	***4,987***	***2,436***	***4,326***	***7.87***	***1.07***	***6,171***	***11,047***	***20.19***	***2.36***
Median	***332***	***3,867***	***1,635***	***2,911***	***5.30***	***0.76***	***3,206***	***6,172***	***13.12***	***1.82***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00007 to 0.03243 for hatchery summer Chinook in the Okanogan River basin (Table 10.21).

Table 10.21. Smolt-to-adult ratios (SARs) for Okanogan/Similkameen summer Chinook, brood years 1989-2012.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	202,125	4,293	0.02124
1990	367,207	972	0.00265
1991	360,380	975	0.00271
1992	537,190	2,282	0.00425
1993	379,139	117	0.00031
1994	217,818	1,526	0.00701
1995	574,197	2,842	0.00495
1996	487,776	32	0.00007
1997	572,531	18,570	0.03243
1998	287,948	7,742	0.02689
1999	610,868	2,782	0.00455
2000	528,639	6,765	0.01280
2001	26,315	424	0.01611
2002	245,997	1,979	0.00804
2003	574,908	3,503	0.00609
2004	676,222	12,960	0.01917
2005	273,512	1,662	0.00608
2006	597,276	13,605	0.02278
2007	610,379	4,943	0.00810
2008	516,533	14,894	0.02883
2009	522,295	7,119	0.01363
2010	610,927	10,666	0.01746
2011	625,234	18,757	0.03000
2012	113,305	2,567	0.02266
Average	***438,280***	***5,916***	***0.01328***
Median	***519,414***	***3,173***	***0.01045***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

10.7 ESA/HCP Compliance

Broodstock Collection

Direct and/or indirect take of ESA-listed species during broodstock collection for the Okanogan summer Chinook outside of Wells Dam is covered by permits held by the Colville Tribes.

Hatchery Rearing and Release

Activities associated with the spawning, rearing, and release of Okanogan summer Chinook that could result in either direct or incidental take of listed species is covered under ESA permits held by the Colville Tribes.

Hatchery Effluent Monitoring

Per ESA Permits 1347, 1395, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at the Similkameen Acclimation Facility during the period 1 January through 31 December 2018. NPDES monitoring and reporting for PUD Hatchery Programs during 2018 are provided in Appendix G. NPDES reporting for Okanogan summer Chinook only covers the Similkameen Acclimation Facility and only during the time fish are present.

SECTION 11: CHELAN FALLS SUMMER CHINOOK

The Chelan Falls summer Chinook program (formerly the Turtle Rock program) included the production of 200,000 fish for No Net Impact (NNI) compensation for passage mortalities associated with Rocky Reach Dam and a 400,000 subyearling/yearling program for compensation for lost spawning habitat as a result of the construction of Rocky Reach Dam. In 2011, as part of the periodic recalculation of NNI for Rocky Reach Dam (inundation), the previous 200,000 NNI program was reduced to 176,000 fish. This reduced the combined Chelan Falls summer Chinook production from 600,000 to 576,000 beginning with the 2012 brood.

Before 2012, broodstock were collected at Wells Dam and consisted of volunteers to the Wells Dam Fishway. Summer Chinook were spawned at Wells Fish Hatchery and fertilized eggs were then transferred to Eastbank Fish Hatchery for hatching and rearing. In 2012, adults were collected at Wells Fish Hatchery and then transferred to Eastbank Fish Hatchery for spawning, hatching, and rearing. Beginning in 2013, broodstock collection was initiated at the Eastbank Fish Hatchery Outfall. With returns to the Outfall diminishing, a pilot broodstock collection program was initiated in 2016 at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station (Chelan Falls Canal Trap). Concurrently, while collection of broodstock from the Chelan Falls Canal Trap was evaluated, the Entiat National Fish Hatchery, Chief Joseph Fish Hatchery, and Wells Fishway were used as backup broodstock collection sites. Evaluation of the Chelan Falls Canal Trap continued in 2018.

The original program consisted of both subyearling (normal and accelerated groups) and yearling releases. Subyearlings were transferred to Turtle Rock Fish Hatchery for acclimation in May. These fish were released in June after about 30 days of acclimation on Columbia River water. The goal of this program was to release 1,620,000 subyearling summer Chinook (810,000 normal and 810,000 accelerated subyearlings) into the Columbia River at 40 fish per pound. Targets for fork length and weight were 112 mm (CV = 9.0) and 11.4 g, respectively. Over 50% of both subyearling groups were marked with CWTs. In 2010, the subyearling program was converted to a 400,000-yearling program.

The goal of the yearling program was to release 200,000 summer Chinook smolts into the Columbia River from Turtle Rock Fish Hatchery at 10 fish per pound. Targets for fork length and weight were 176 mm (CV = 9.0) and 45.4 g, respectively. Beginning with the 2006 brood year, yearling summer Chinook were acclimated at both Turtle Rock Fish Hatchery and the Chelan River net pens. With the conversion of the subyearling program to a yearling program and the reduction of the NNI component to 176,000, the current goal is to release 576,000 yearling summer Chinook smolts (176,000 from the NNI program plus 400,000 from the converted subyearling program). Beginning in 2012, the 576,000 yearlings are acclimated overwinter at facilities at Chelan Hatchery on Chelan River water. In 2012, the Turtle Rock program officially became the Chelan Falls summer Chinook program.

Over 90% of yearling summer Chinook have been marked with CWTs and all are ad-clipped. In addition, juvenile summer Chinook were PIT tagged within each of the circular and standard raceways.

11.1 Broodstock Sampling

Before 2013, broodstock for the program were collected as part of the Wells summer Chinook volunteer program. Refer to Snow et al. (2012) for information related to adults collected for those programs. Beginning in 2013, broodstock collection for the Chelan Falls program was piloted at the Eastbank Hatchery Outfall and at the Chelan Falls Canal Trap. This section focuses on results from sampling broodstock from 2013 to present.

Origin of Broodstock

Broodstock collected in 2015-2018 consisted entirely of hatchery-origin summer Chinook (Table 11.1).

Table 11.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned for the Chelan Falls summer Chinook program during 2013-2018. Unknown-origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2013[c]	-	-	-	-	-	318	4	0	314	0	314
2014[c]	-	-	-	-	-	331	19	15	297	0	297
2015[cd]	-	-	-	-	-	351	17	14[b]	320	0	320
2016[ce]	-	-	-	-	-	350	5	1	344	0	344
2017[fe]	-	-	-	-	-	351	10	0	341	0	341
2018[fg]	-	-	-	-	-	389	5	4	380	0	380
Average	**-**	**-**	**-**	**-**	**-**	***348***	***10***	***4***	***332***	***0***	***332***
Median	**-**	**-**	**-**	**-**	**-**	***351***	***9***	***1***	***330***	***0***	***330***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] There was an additional 85 fish surplused that were excess from collections at Chief Joseph Fish Hatchery and were not included in mortality estimates.
[c] Broodstock collected from Eastbank Fish Hatchery outfall
[d] Broodstock collected from Chief Joe Fish Hatchery adult fish ladder
[e] Broodstock collected from Entiat National Fish Hatchery
[f] Broodstock collected from Chelan Falls Canal Trap
[g] Broodstock collected from Wells Dam Volunteer Trap

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2016 return consisted primarily of age-4 and 5 hatchery-origin Chinook (98.7%). Age-3 hatchery-origin Chinook made up 0.6% of the broodstock (Table 11.2).

Broodstock collected from the 2017 return consisted primarily of age-4 and 5 hatchery-origin Chinook (96.9%). Age-3 hatchery-origin Chinook made up 3.1% of the broodstock (Table 11.2).

Broodstock collected from the 2018 return consisted primarily of age-4 and 5 hatchery-origin Chinook (99.7%). Age-6 hatchery-origin Chinook made up 0.3% of the broodstock. There were two natural-origin Chinook broodstock but only one had a useable scale age (Table 11.2).

Table 11.2. Percent of hatchery and wild summer Chinook of different ages (total age) collected from broodstock for the Chelan Falls summer Chinook program, 2013-2018.

Return Year	Origin	Total age				
		2	3	4	5	6
2013	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	37.0	62.0	1.0
2014	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	37.0	62.0	1.0
2015	Wild	--	--	--	--	--
	Hatchery	0.0	2.3	53.8	43.5	0.3
2016	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	35.4	64.0	0.7
2017	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	47.5	49.4	3.1
2018	Wild	0.0	0.0	0.0	100.0	0.0
	Hatchery	0.0	0.0	54.7	45.0	0.3
Average	***Wild***	***0.0***	***0.0***	***0.0***	***100.0***	***0.0***
	Hatchery	***0.0***	***0.4***	***44.2***	***54.3***	***1.1***
Median	***Wild***	***0.0***	***0.0***	***0.0***	***100.0***	***0.0***
	Hatchery	***0.0***	***0.0***	***42.3***	***55.7***	***0.9***

Mean lengths of hatchery-origin summer Chinook of a given age differed little among return years 2013-2018 (Table 11.3).

Table 11.3. Mean fork length (cm) at age (total age) of hatchery and wild summer Chinook collected from broodstock for the Chelan Falls program, 2013-2018; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	77	99	6	91	196	5	-	0	-
2014	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	78	114	6	90	191	5	95	3	6
2015	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	70	7	3	78	162	5	87	131	6	107	1	-
2016	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	77	104	5	88	188	6	89	2	8
2017	Wild	-	0	-	-	0	-	-	-	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	75	154	5	88	160	6	89	10	7
2018	Wild	-	0	-	-	0	-	-	0	-	95	1	-	-	0	-
	Hatchery	-	0	-	-	0	-	77	180	5	87	148	6	95	1	-
Average	***Wild***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***	***95***	***0***	***-***	***-***	***0***	***-***

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	*-*	*0*	*-*	*70*	*1*	*3*	*77*	*136*	*5*	*88*	*169*	*6*	*95*	*3*	*7*

Sex Ratios

Male summer Chinook in the 2016 broodstock made up about 50.6% of the adults collected, resulting in an overall male to female ratio of 1.02:1.00 (Table 11.4.). In 2017, males made up about 49.9% of the adults collected, resulting in an overall male to female ratio of 0.99:1.00 (Table 11.4). In 2018, males made up about 50.1% of the adults collected, resulting in an overall male to female ratio of 1.01:1.00 (Table 11.4). The ratio for 2016 and 2018 broodstock was above the assumed 1:1 ratio goal in the broodstock protocol. The ratio for 2015 and 2017 broodstock was below the assumed 1:1 ratio goal in the broodstock protocol.

Table 11.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock at for the Chelan Falls program, 2013-2018. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2013	-	-	-	160	158	1.01:1.00	1.01:1.00
2014	-	-	-	168	163	1.03:1.00	1.03:1.00
2015	-	-	-	149	175	0.85:1.00	0.85:1.00
2016	-	-	-	177	173	1.02:1.00	1.02:1.00
2017	-	-	-	175	176	0.99:1.00	0.99:1.00
2018	0	2	0.00:1.00	196	193	1.02:1.00	1.01:1.00
Total	*0*	*2*	*0.00:1.00*	*1,025*	*1,038*	*0.99:1.00*	*0.98:1.00*

Fecundity

Fecundities for the 2016, 2017, and 2018 summer Chinook broodstock averaged 4,008, 3,779, and 3,906 eggs per female, respectively (Table 11.5). These values are close to the overall average of 4,012 eggs per female. Mean observed fecundities for the 2016-2018 returns were below the expected fecundities of 4,372, 4,072, and 4,024 eggs per female assumed in the broodstock protocol, respectively.

Table 11.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock for the Chelan Falls program, 2013-2018; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
2013	-	4,462	4,462
2014	-	4,275	4,275
2015	-	3,597	3,597
2016	-	4,008	4,008
2017	-	3,823	3,823
2018	4,568	3,899	3,906

Return year	Mean fecundity		
	Wild	Hatchery	Total
Average	***4,568***	***4,011***	***4,012***
Median	***4,568***	***3,954***	***3,957***

To estimate fecundities by length, weight, and age[47], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2013 through 2018 broodstock (complete data for all variables are available for years 2014-2018). For the available brood years, we developed age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass relationships for hatchery-origin summer Chinook. Wild Chinook are not included in broodstock for the Chelan Falls program. Hatchery staff randomly sampled about fifty females.

On average, mean fecundities for hatchery-origin age-4 and age-5 Chinook were 3,508 and 4,123 eggs, respectively (Table 11.6).

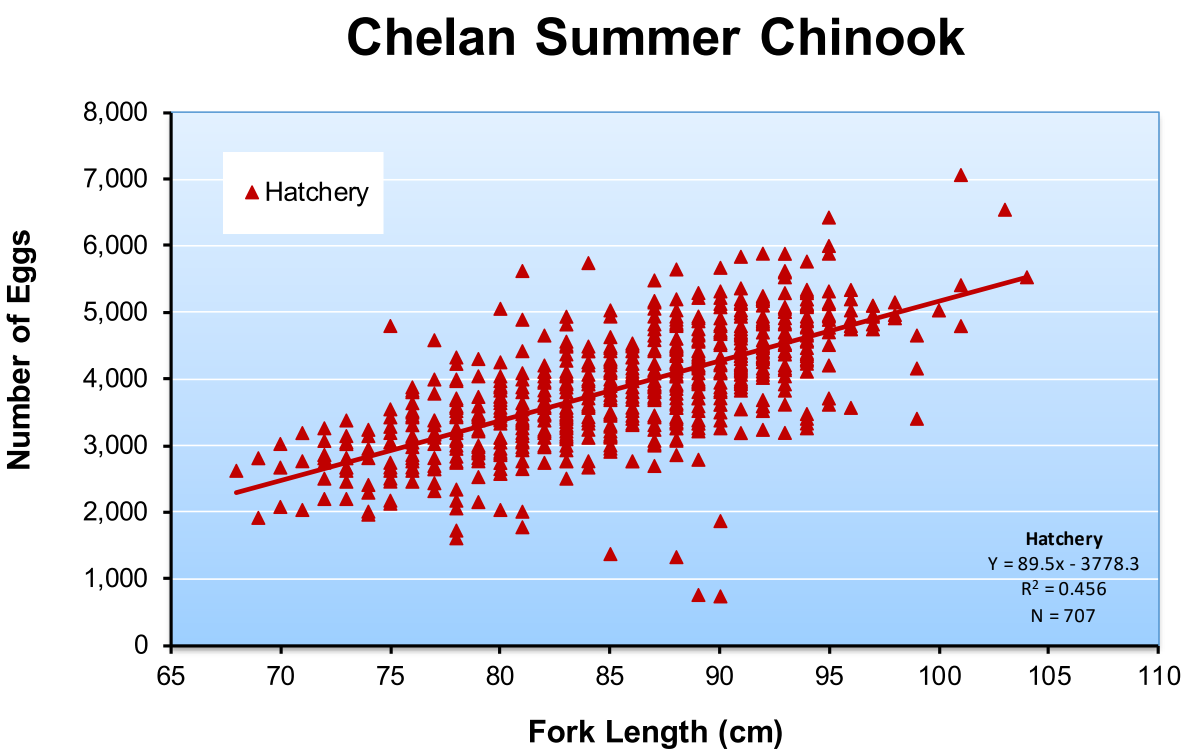
Table 11.6. Mean fecundity by age (total age) for hatchery summer Chinook collected from broodstock for the Chelan River program, brood years 2013-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013[a]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,354	16	524	4,593	130	906	-	0	-
2014[a]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,934	9	642	4,301	119	772	5,601	2	2,055
2015[ac]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	2,919	3	193	3,351	57	740	3,809	85	894	-	0	-
2016[ac]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,509	21	679	4,071	123	759	4,037	2	1,079
2017[cd]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,391	45	660	3,908	108	839	-	0	-
2018[de]	Wild	-	0	-	-	0	-	4,495	1	-	-	0	-
	Hatchery	-	0	-	3,506	57	561	4,054	95	779	5,142	1	-
Average	***Wild***	***-***	***0***	***-***	***-***	***0***	***-***	***4,495***	***1***	***-***	***-***	***0***	***-***
	Hatchery	***2,919***	***1***	***193***	***3,508***	***34***	***634***	***4,123***	***110***	***825***	***4,927***	***1***	***1,567***

[a] Broodstock collected from Eastbank Fish Hatchery outfall
[b] Broodstock collected from Chief Joe Fish Hatchery adult fish ladder
[c] Broodstock collected from Entiat National Fish hatchery
[d] Broodstock collected from Chelan Falls Canal Trap
[e] Broodstock collected from Wells Dam Volunteer Trap

[47] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

We pooled fecundity data from brood years 2014 through 2018 (only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery-origin females are shown in Figures 11.1, 11.2, and 11.3. All fecundity variables increase linearly with fork length.



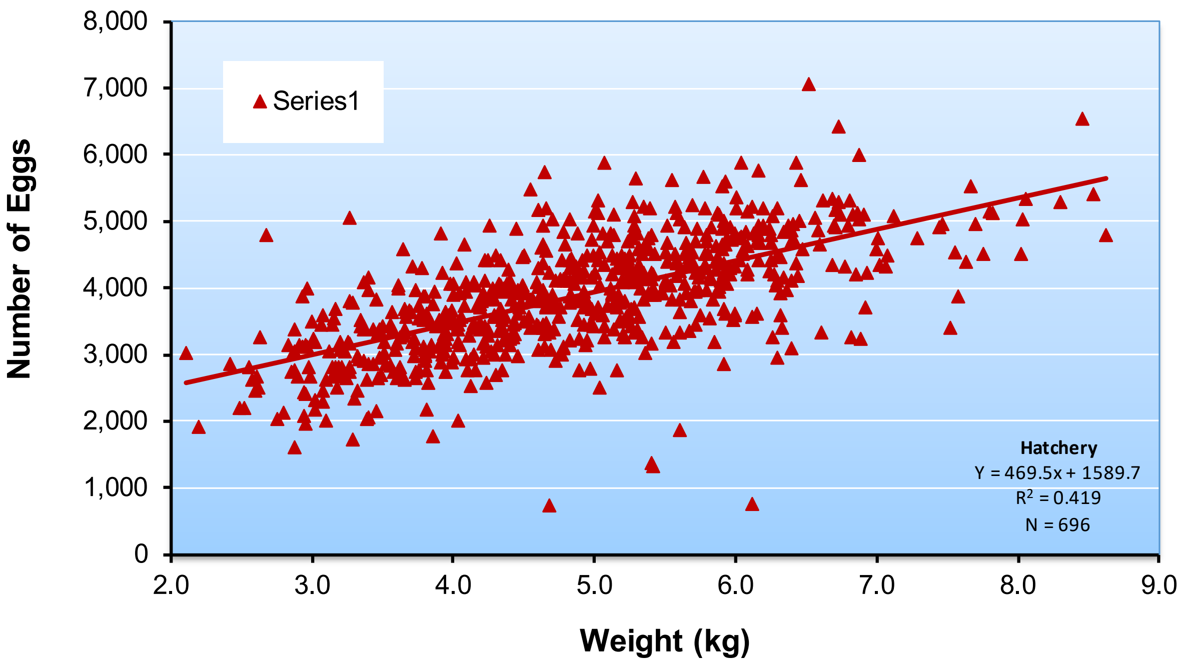


Figure 10.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for hatchery-origin summer Chinook for return years 2014-2018.

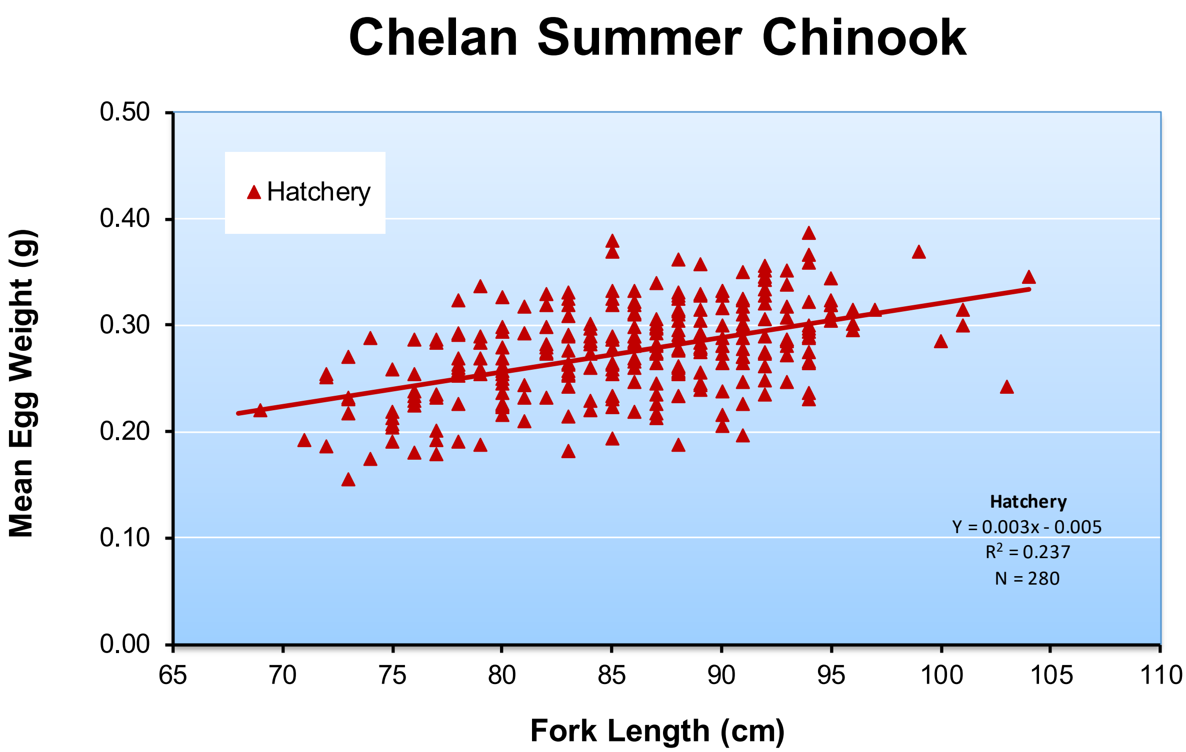


Figure 10.2. Relationships between mean egg weight and fork length for hatchery-origin summer Chinook for return years 2014-2018.

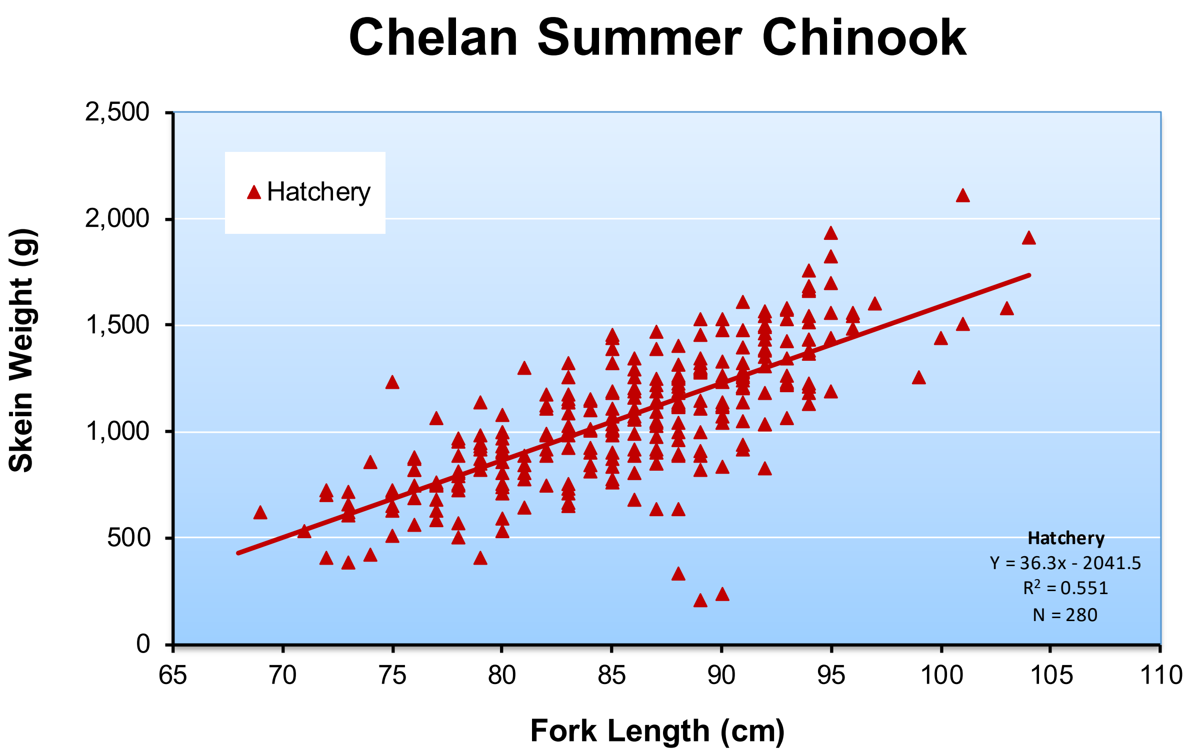


Figure 10.3. Relationships between skein weight and fork length for hatchery-origin summer Chinook for return years 2014-2018.

11.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release standard of 81%, a total of 688,995 eggs were needed to meet the program goal of 576,000 smolts for brood years 2012 and 2013. An evaluation of the program in 2014 concluded that 696,493 eggs were needed to attain the 576,000 smolts. From 2013-2018, the egg take goal has been achieved twice (Table 11.7).

Table 11.7. Numbers of eggs taken from summer Chinook broodstock for the Chelan Falls program, 2013-2018.

Brood year	Number of eggs taken
2013	696,131
2014	618,092
2015	573,144
2016	680,448
2017	634,843
2018	745,798
Average	***658,076***

Brood year	Number of eggs taken
Median	***657,646***

Number of acclimation days

Rearing of the 2016 brood Chelan Falls summer Chinook was similar to previous years with fish being held on well water at Eastbank Hatchery until transfer to the Chelan Falls Acclimation Facility for overwinter acclimation. This was the sixth year that the entire program was transferred to the Chelan Falls Acclimation Facility for overwinter acclimation on Chelan River water. Transfer occurred from 31 October to 1 November 2017. A forced release took place on 16 April 2018 after 166-167 days of acclimation (Table 11.8).

Table 11.8. Number of days Chelan summer Chinook were acclimated at Chelan Falls Acclimation Facility, brood years 2013-2016.

Brood year	Release year	Transfer date	Release date	Number of days
2013	2015	3-6 Nov	15 Apr	160-163
2014	2016	2-4-Nov	15-18-Apr	163-168
2015	2017	1-3 Nov	17 Apr	165-167
2016	2018	31 Oct -1 Nov	16 Apr	166-167

Release Information

Numbers released

The subyearling Turtle Rock summer Chinook program was discontinued in 2010; however, releases of subyearling Chinook in past years are shown in Tables 11.9 and 11.10. Production from the subyearling programs was converted to the yearling program.

Table 11.9. Numbers of Turtle Rock summer Chinook subyearlings released from the hatchery, brood years 1995-2009. The release target for Turtle Rock summer Chinook subyearlings was 810,000 fish.

Brood year	Release year	CWT mark rate	Number of subyearlings released
1995	1996	0.1873	1,074,600
1996	1997	0.9653	385,215
1997	1998	0.9780	508,060
1998	1999	0.6453	301,777
1999	2000	0.9748	369,026
2000	2001	0.3678	604,892
2001	2002	0.9871	214,059
2002	2003	0.3070	656,399
2003	2004	0.4138	491,480
2004	2005	0.4591	411,707
2005	2006	0.4337	490,074

Brood year	Release year	CWT mark rate	Number of subyearlings released
2006	2007	0.3388	538,392
2007	2008	0.4385	439,806
2008	2009	0.6355	309,003
2009	2010	NA	713,130
Average		***0.6111***	***500,508***
Median		***0.4488***	***490.074***

Table 11.10. Numbers of Turtle Rock summer Chinook accelerated subyearlings released from the hatchery, brood years 1995-2008. The release target for Turtle Rock summer Chinook accelerated subyearlings was 810,000 fish.

Brood year	Release year	CWT mark rate	Number of subyearlings released
1995	1996	0.9834	169,000
1996	1997	0.4163	477,300
1997	1998	0.3767	521,480
1998	1999	0.6033	307,571
1999	2000	0.9556	347,946
2000	2001	0.4331	449,329
2001	2002	0.4086	480,584
2002	2003	0.5492	364,461
2003	2004	0.6414	289,696
2004	2005	0.5471	364,453
2005	2006	0.9783	457,340
2006	2007	0.5510	342,273
2007	2008	0.4745	392,024
2008	2009	0.5295	372,320
Average		***0.6034***	***381,127***
Median		***0.5482***	***368,391***

The 2016 yearling summer Chinook program achieved 104.3% of the 576,000 goal with about 600,894 fish being released from the Chelan River Acclimation Ponds (Table 11.11).

Table 11.11. Numbers of Turtle Rock/Chelan Falls summer Chinook yearling smolts released from the hatchery, brood years 1995-2016. The release target for Turtle Rock summer Chinook was 200,000 smolts for the period before brood year 2010. The current release target is 600,000 smolts. CWT marking rates were adjusted for tag loss before the fish were released.

Brood year	Release year	Acclimation facility	CWT mark rate	Number of smolts released
1995	1997	Turtle Rock	0.9688	150,000
1996	1998	Turtle Rock	0.9582	202,727

Brood year	Release year	Acclimation facility	CWT mark rate	Number of smolts released
1997	1999	Turtle Rock	0.9800	202,989
1998	2000	Turtle Rock	0.9337	217,797
1999	2001	Turtle Rock	0.9824	285,707
2000	2002	Turtle Rock	0.9941	279,969
2001	2003	Turtle Rock	0.9824	203,279
2002	2004	Turtle Rock	0.9799	195,851
2003	2005	Turtle Rock	0.9258	215,366
2004	2006	Turtle Rock	0.9578	206,734
2005	2007	Chelan	0.9810	204,644
2006	2008	Chelan	0.9752	99,271
		Turtle Rock	0.9752	43,943
2007	2009	Chelan Falls	0.9426	112,604
		Turtle Rock	0.9426	61,003
2008	2010	Chelan Falls	0.9818	200,999
		Turtle Rock	0.9818	252,762
2009	2011	Chelan Falls[a]	-	190,449
		Turtle Rock	0.9721	250,667
Average (1995-2009)		***Chelan Falls***	***0.9665***	***137,625***
		Turtle Rock	***0.9745***	***233,429***
Median (1995-2009)		***Chelan Falls***	***0.9737***	***205,007***
		Turtle Rock	***0.9781***	***190,449***
2010	2012	Chelan Falls	0.9702	563,824
2011	2013	Chelan Falls	0.9859	582,460
2012	2014	Chelan Falls	0.9879	566,188
2013	2015	Chelan Falls	0.9917	599,584
2014	2016	Chelan Falls	0.9901	465,450
2015	2017	Chelan Falls	0.9864	442,063
2016	2018	Chelan Falls	0.9941	600,894
Average (2010-present)		***Chelan Falls***	***0.9866***	***545,780***
Median (2010-present)		***Chelan Falls***	***0.9879***	***566,188***

[a] No CWT mark rate was provided because of the early release of this group.

Numbers tagged

Brood year 2016 yearling Chinook were 99.9% CWT[48] and 99.5% adipose fin-clipped.

On 24-28 September 2018, a total of 10,499 Chelan River summer Chinook from the 2017 brood were PIT tagged at Eastbank Hatchery. These were tagged and released into raceway #10. Fish

[48] Sixty days after tagging, taggers conduct a quality control procedure, which includes collecting a sample of tagged fish and scanning for tag retention. Thus, the number of tagged fish released is adjusted for tag loss.

were not fed during tagging or for two days before and after tagging. Fish averaged 99 mm in length and 12.0 g at time of tagging.

Table 11.12 summarizes the number of yearling summer Chinook that have been PIT-tagged and released from the Turtle Rock/Chelan Falls Program.

Table 11.12. Summary of PIT-tagging activities for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2007-2016; fpp = fish per pound.

Brood year	Release year	Raceway/Program	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2007	2009	Circular Reuse	10,104	128	1	9,975
		Standard	10,102	162	3	9,937
2008	2010	Circular Reuse	11,102	20	0	11,082
		Standard	11,100	28	2	11,070
2009	2011	Turtle Rock	5,051	106	0	4,945
		Chelan Net Pens	5,050	2	0	5,048
2010	2012	Chelan Falls	4,200	10	0	4,186
2011	2013	Chelan Falls	4,101	26	0	4,075
2012	2014	Chelan Falls (small)	2,500	17	0	4,983
		Chelan Falls (large)	5,000	40	0	4,960
2013	2015	Chelan Falls (small)	5,000	41	0	4,959
		Chelan Falls (large)	5,000	37	0	4,963
2014	2016	Chelan Falls (18 fpp)	2,500	5	0	2,495
		Chelan Falls (22 fpp)	2,500	19	0	2,481
		Chelan Falls (10 fpp)	2,500	22	0	2,478
		Chelan Falls (13 fpp)	2,500	140	0	2,360
2015	2017	Chelan Falls	10,103	597	0	9,506
2016	2018	Chelan Falls	10,500	82	0	10,418

Fish size and condition at release

Although the subyearling summer Chinook program was discontinued, sizes of subyearlings released from Turtle Rock Hatchery before 2010 are shown in Tables 11.13 and 11.14.

Table 11.13. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock summer Chinook subyearlings released from the hatchery, brood years 1995-2009. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1995	1996	102	6.3	12.6	36
1996	1997	87	8.0	7.4	62
1997	1998	98	6.2	10.2	45
1998	1999	96	6.3	10.7	43
1999	2000	90	9.0	9.8	46
2000	2001	100	7.1	11.3	40
2001	2002	104	7.2	13.4	34
2002	2003	97	7.3	11.8	39
2003	2004	101	8.0	12.0	43
2004	2005	100	7.8	11.4	40
2005	2006	100	6.5	12.5	36
2006	2007	95	7.2	9.5	48
2007	2008	79	7.4	5.6	81
2008	2009	86	7.9	7.9	57
2009[a]	2010	89	7.1	7.0	65
Average		***95***	***7.3***	***10.2***	***48***
Targets		***112***	***9.0***	***11.4***	***40***

[a] Pre-release growth sample was conducted using pond mortalities.

Table 11.14. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock summer Chinook accelerated subyearlings released from the hatchery, brood years 1995-2008. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1995	1996	129	7.1	27.3	17
1996	1997	107	6.5	15.6	29
1997	1998	117	6.0	18.9	24
1998	1999	119	8.0	18.9	24
1999	2000	114	6.7	19.0	24
2000	2001	111	7.0	16.8	27
2001	2002	117	8.4	19.5	23
2002	2003	116	11.3	21.2	21
2003	2004	113	14.9	17.0	30
2004	2005	117	11.3	20.1	23
2005	2006	119	9.1	22.2	21

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2006	2007	118	8.3	19.1	24
2007	2008	95	7.7	10.0	45
2008[a]	2009	97	8.6	10.6	43
Average		***114***	***8.6***	***18.3***	***27***
Targets		***112***	***9.0***	***11.4***	***40***

[a] The 2008 brood year was the last year of the accelerated subyearling program.

Size at release of the brood year 2016 yearling summer Chinook was just over the fish per pound target for the Chelan Falls group. This group exceeded the target CV for length (Table 11.15).

Table 11.15. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock/Chelan summer Chinook yearling releases, brood years 1995-2016. Size targets are provided in the last row of the table.

Brood year	Release year	Acclimation facility	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
1995	1997	Turtle Rock	-	-	-	-
1996	1998	Turtle Rock	166	14.2	60.9	7
1997	1999	Turtle Rock	198	4.6	91.3	5
1998	2000	Turtle Rock	161	11.9	53.9	8
1999	2001	Turtle Rock	164	18.6	59.0	8
2000	2002	Turtle Rock	170	15.3	59.0	8
2001	2003	Turtle Rock	154	22.3	48.6	9
2002	2004	Turtle Rock	157	16.7	44.0	12
2003	2005	Turtle Rock	173	13.8	54.7	8
2004	2006	Turtle Rock	176	20.6	45.3	7
2005	2007	Turtle Rock	158	11.0	43.5	10
2006	2008	Chelan Nets	172	14.5	58.4	8
		Turtle Rock	157	25.8	54.1	8
2007	2009	Chelan Nets	153	18.8	45.7	10
		Turtle Rock	167	14.6	49.3	9
2008	2010	Chelan Nets	146	22.9	40.6	11
		Turtle Rock	172	15.9	58.5	8
2009	2011	Chelan Nets	158	15.1	46.6	10
		Turtle Rock	174	17.5	59.3	8
2010	2012	Chelan Falls	132	27.4	33.2	14
2011	2013	Chelan Falls	148	18.6	42.6	11
2012	2014	Chelan Falls	129	17.1	24.5	19
2013	2015	Chelan Falls	137	9.8	26.8	17
2014	2016	Chelan Falls	141	13.5	31.5	14
2015	2017	Chelan Falls	142	14.0	33.8	13

Brood year	Release year	Acclimation facility	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2016	2018	Chelan Falls	145	13.5	38.6	12
Average			***158***	***16.3***	***48.1***	***10***
Targets[a]			***161***	***9.0***	***45.4***	***13***

[a] For size-target studies, fish per pound (fpp) targets for brood year 2012 were 10, 13, 18, 22 fpp.

Survival Estimates

Normal subyearling releases

Overall survival of the normal subyearling Turtle Rock summer Chinook program from green egg to release was below the standard set for the program (Table 11.16). Lower than expected survival at ponding and post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.16. Hatchery life-stage survival rates (%) for Turtle Rock subyearling (zero program) summer Chinook, brood years 2004-2009. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2004	NA	NA	93.5	74.4	93.9	91.4	90.8	99.7	63.1
2005	NA	NA	94.4	87.9	85	84.8	84.2	99.4	69.8
2006	NA	NA	97.8	87.9	85.0	84.8	84.2	99.4	72.4
2007	NA	NA	92.7	84.9	88.5	86.7	84.8	99.6	66.7
2008	NA	NA	78.8	95.0	80.7	79.3	79.9	99.8	59.8
2009	NA	NA	95.0	89.4	89.5	89.2	79.7	89.5	67.7
Average	***NA***	***NA***	***92.0***	***86.6***	***87.1***	***86.0***	***83.9***	***97.9***	***66.6***
Median	***NA***	***NA***	***94.0***	***87.9***	***86.8***	***85.8***	***84.2***	***99.5***	***67.2***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

Accelerated subyearling releases

Overall survival of the accelerated subyearling Turtle Rock summer Chinook program from green egg to release was below the standard set for the program (Table 11.17). Lower than expected survival in post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.17. Hatchery life-stage survival rates (%) for Turtle Rock subyearling (accelerated program) summer Chinook, brood years 2004-2009. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2004	NA	NA	92.5	98.3	93.4	92.4	90.0	97.8	81.8
2005	NA	NA	93.8	94.6	83.7	83.4	81.7	98.8	72.5
2006	NA	NA	86.1	94.6	83.7	83.4	81.7	98.8	66.5
2007	NA	NA	93.4	95.4	78.4	77.5	76.3	98.9	67.9
2008[a]	NA	NA	93.4	95.0	79.8	78.8	78.2	99.3	67.1
Average	***NA***	***NA***	***91.8***	***95.6***	***83.8***	***83.1***	***81.6***	***98.7***	***71.2***
Median	***NA***	***NA***	***93.4***	***95.0***	***83.7***	***83.4***	***81.7***	***98.8***	***67.9***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] The 2008 brood year was the last year of the accelerated subyearling program.

Yearling releases

Overall survival of the 2016 brood yearling Chelan Falls summer Chinook program from green egg to release was above the standard set for the program (Table 11.18). Survival was above the standard set for the program at all stages with the exception of eyed-egg to ponding.

Table 11.18. Hatchery life-stage survival rates (%) for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2004-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Un-fertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Un-fertilized egg-release
	Female	Male							
2004	NA	NA	92.9	97.7	96.8	96.4	95.5	99.6	86.7
2005	NA	NA	89.1	97.5	98.1	97.8	96.6	99.1	83.9
2006	NA	NA	86.2	78.8	97.6	97.1	95.2	98.7	64.8
2007 (Turtle Rock)	NA	NA	80.3	97.6	98.8	98.2	95.4	99.1	74.8
2007 (Chelan Falls)	NA	NA	80.3	97.6	98.8	98.2	94.9	97.1	74.4
2008 (Turtle Rock)	NA	NA	93.5	98.0	99.4	97.2	95.9	98.8	87.8
2008 (Chelan Falls)	NA	NA	93.5	98.0	97.6	98.7	96.4	99.3	88.2
2009 (Turtle Rock)	NA	NA	90.8	96.8	99.7	99.0	97.2	98.1	85.5
2009 (Chelan Falls)	NA	NA	90.9	96.9	99.8	99.0	96.7	97.7	85.2
2010 (Chelan Falls)	NA	NA	94.8	97.7	99.4	95.2	92.4	97.6	85.5
2011 (Chelan Falls)	NA	NA	90.0	99.4	91.7	98.2	83.4	85.2	74.6
2012 (Chelan Falls)	NA	NA	93.5	98.5	99.8	99.3	95.9	96.7	88.3
2013 (Chelan Falls)	100.0	98.1	90.6	96.5	99.5	98.9	98.5	99.7	86.1
2014 (Chelan Falls)	89.6	98.8	83.6	96.3	99.6	98.8	97.0	98.3	78.1
2015 (Chelan Falls)	95.5	97.7	85.6	97.1	99.3	98.9	93.6	95.0	77.7
2016 (Chelan Falls)	98.3	98.9	92.7	96.9	99.8	99.6	98.4	99.0	88.3
Average (Chelan)	***95.9***	***98.4***	***89.3***	***96.3***	***98.5***	***98.2***	***95.2***	***97.4***	***81.9***

Brood year	Collection to spawning		Un-fertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Un-fertilized egg-release
	Female	Male							
Median (Chelan)	***96.9***	***98.5***	***90.7***	***97.6***	***99.4***	***98.5***	***95.9***	***98.5***	***85.4***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

11.3 Spawning Surveys

Surveys for summer Chinook redds in the Chelan River were conducted from late September to late-November 2018. Total redd counts were conducted in the river (see Appendix Q for more details).

Redd Counts

A total of 420 summer Chinook redds were counted in the Chelan River in 2018 (Table 11.19). This was higher than the overall average of 317 redds.

Table 11.19. Total number of redds counted in the Chelan River, 2000-2018.

Survey year	Total redd count
2000	196
2001	240
2002	253
2003	173
2004	185
2005	179
2006	208
2007	86
2008	153
2009	246
2010	398
2011	413
2012	426
2013	729
2014	400
2015	448
2016	448
2017	421
2018	420
Average	***317***
Median	***253***

Redd Distribution

Summer Chinook redds were not evenly distributed among the four sampling areas within the Chelan River. Most redds (37%) were located in the Chelan Tailrace (Table 11.20. Fewer summer Chinook spawned in the Habitat Pool (20%) and Columbia Tailrace (13%).

Table 11.20. Total number of summer Chinook redds counted in different survey areas within the Chelan River during September through early November 2018.

Survey area	Total redd count	Percent
Chelan Tailrace	157	37
Columbia Tailrace	55	13
Habitat Channel	125	30
Habitat Pool	83	20
Totals	***420***	***100***

Spawn Timing

Spawning in 2018 began the second week of October, peaked mid-October, and ended mid-November. Peak spawning occurred in the Habitat Pool in early October and during mid-October in the Chelan Tailrace, Habitat Channel, and Columbia Tailrace (Figure 11.4).

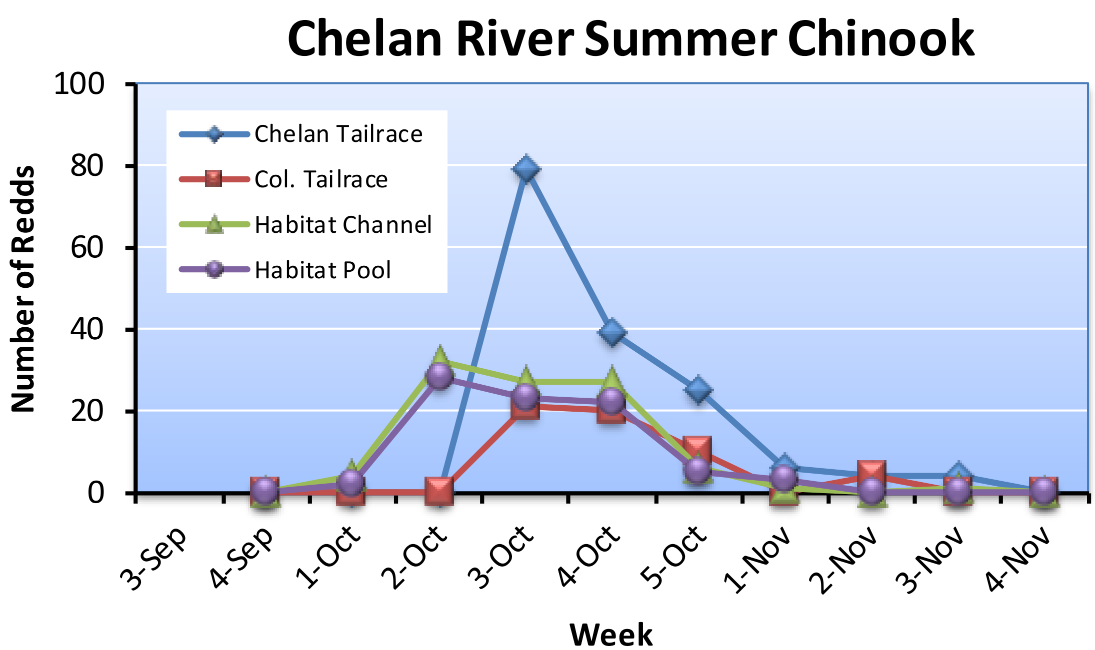


Figure 11.4. Number of new summer Chinook redds counted during different weeks within different sections of the Chelan River, September through November 2018.

Spawning Escapement

Spawning escapement for summer Chinook in the Chelan River was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[49] The estimated fish per redd ratio for Methow summer Chinook in 2018 was 2.30. Multiplying this ratio by the number of redds counted in the Chelan River resulted in a total spawning escapement of 966 summer Chinook (Table 11.21).

Table 11.21. Spawning escapements for summer Chinook in the Chelan River for return years 2000-2018.

Return year	Fish/Redd	Redds	Total spawning escapement
2000	2.40	196	470
2001	4.10	240	984
2002	2.30	253	582
2003	2.42	173	419
2004	2.25	185	416
2005	2.93	179	524
2006	2.02	208	420
2007	2.20	86	189
2008	3.25	153	497
2009	2.54	246	625
2010	2.81	398	1,118
2011	3.10	413	1,280
2012	3.07	426	1,308
2013	2.31	729	1,684
2014	2.75	400	1,100
2015	3.21	448	1,438
2016	2.01	448	900
2017	2.04	421	859
2018	2.30	420	966
Average	***2.63***	***317***	***830***
Median	***2.42***	***253***	***859***

11.4 Carcass Surveys

Surveys for summer Chinook carcasses within the Chelan River were conducted during late September to mid-November 2018 (see Appendix Q for more details).

[49] Expansion factor = (1 + (number of males/number of females)).

Number sampled

A total of 213 summer Chinook carcasses were sampled during September through late-November in the Chelan River (Table 11.22). This was higher than the overall average of 183 carcasses sampled since 2000.

Table 11.22. Numbers of summer Chinook carcasses sampled within each survey area within the Chelan River, 2000-2018; ND = no data.

Survey year	Number of summer Chinook carcasses				
	Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	Total
2000	ND	ND	ND	ND	**48**
2001	ND	ND	ND	ND	**101**
2002	ND	ND	ND	ND	**145**
2003	ND	ND	ND	ND	**168**
2004	ND	ND	ND	ND	**159**
2005	ND	ND	ND	ND	**103**
2006	ND	ND	ND	ND	**107**
2007	ND	ND	ND	ND	**106**
2008	ND	ND	ND	ND	**132**
2009	ND	ND	ND	ND	**51**
2010	ND	ND	ND	ND	**106**
2011	ND	ND	ND	ND	**201**
2012	ND	ND	ND	ND	**317**
2013	50	120	157	28	**355**
2014	171	82	50	6	**309**
2015	49	255	41	18	**363**
2016	27	128	64	34	**253**
2017	27	124	58	22	**231**
2018	47	94	39	33	**213**
Average	***62***	***134***	***68***	***24***	***183***
Median	***48***	***122***	***54***	***25***	***159***

Carcass Distribution and Origin

In 2018, hatchery and wild summer Chinook carcasses were not distributed equally among the survey areas within the Chelan River (Table 11.23; Figure 11.5). A larger percentage of hatchery carcasses occurred in the Habitat Channel and Habitat Pool, while a larger percentage of wild summer Chinook carcasses occurred in the Chelan Tailrace and Columbia Tailrace. There was a larger sample size of hatchery than wild summer Chinook carcasses in the Chelan River in 2018.

Table 11.23. Numbers of wild and hatchery summer Chinook carcasses sampled within different survey areas on the Chelan River, 2000-2018; ND = no data.

Survey year	Origin	Survey reach				Total
		Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	
2000	Wild	ND	ND	ND	ND	**17**
	Hatchery	ND	ND	ND	ND	**31**
2001	Wild	ND	ND	ND	ND	**26**
	Hatchery	ND	ND	ND	ND	**75**
2002	Wild	ND	ND	ND	ND	**37**
	Hatchery	ND	ND	ND	ND	**108**
2003	Wild	ND	ND	ND	ND	**33**
	Hatchery	ND	ND	ND	ND	**135**
2004	Wild	ND	ND	ND	ND	**91**
	Hatchery	ND	ND	ND	ND	**68**
2005	Wild	ND	ND	ND	ND	**42**
	Hatchery	ND	ND	ND	ND	**61**
2006	Wild	ND	ND	ND	ND	**69**
	Hatchery	ND	ND	ND	ND	**38**
2007	Wild	ND	ND	ND	ND	**35**
	Hatchery	ND	ND	ND	ND	**71**
2008	Wild	ND	ND	ND	ND	**69**
	Hatchery	ND	ND	ND	ND	**63**
2009	Wild	ND	ND	ND	ND	**2**
	Hatchery	ND	ND	ND	ND	**49**
2010	Wild	ND	ND	ND	ND	**46**
	Hatchery	ND	ND	ND	ND	**60**
2011	Wild	ND	ND	ND	ND	**89**
	Hatchery	ND	ND	ND	ND	**112**
2012	Wild	ND	ND	ND	ND	**64**
	Hatchery	ND	ND	ND	ND	**253**
2013	Wild	18	55	51	6	**130**
	Hatchery	23	65	106	22	**225**
2014	Wild	32	142	18	1	**193**
	Hatchery	17	113	23	17	**170**
2015	Wild	35	137	11	0	**183**
	Hatchery	21	117	23	21	**180**
2016	Wild	15	63	26	7	**111**
	Hatchery	12	65	38	27	**142**
2017	Wild	14	58	22	7	**101**
	Hatchery	13	66	36	15	**130**
2018	Wild	24	52	15	9	**100**
	Hatchery	23	42	24	24	**113**
Average	***Wild***	***23***	***85***	***24***	***5***	***136***

Survey year	Origin	Survey reach				Total
		Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	
	Hatchery	*18*	*78*	*42*	*21*	*160*
Median	*Wild*	*21*	*61*	*20*	*7*	*121*
	Hatchery	*19*	*66*	*30*	*22*	*156*

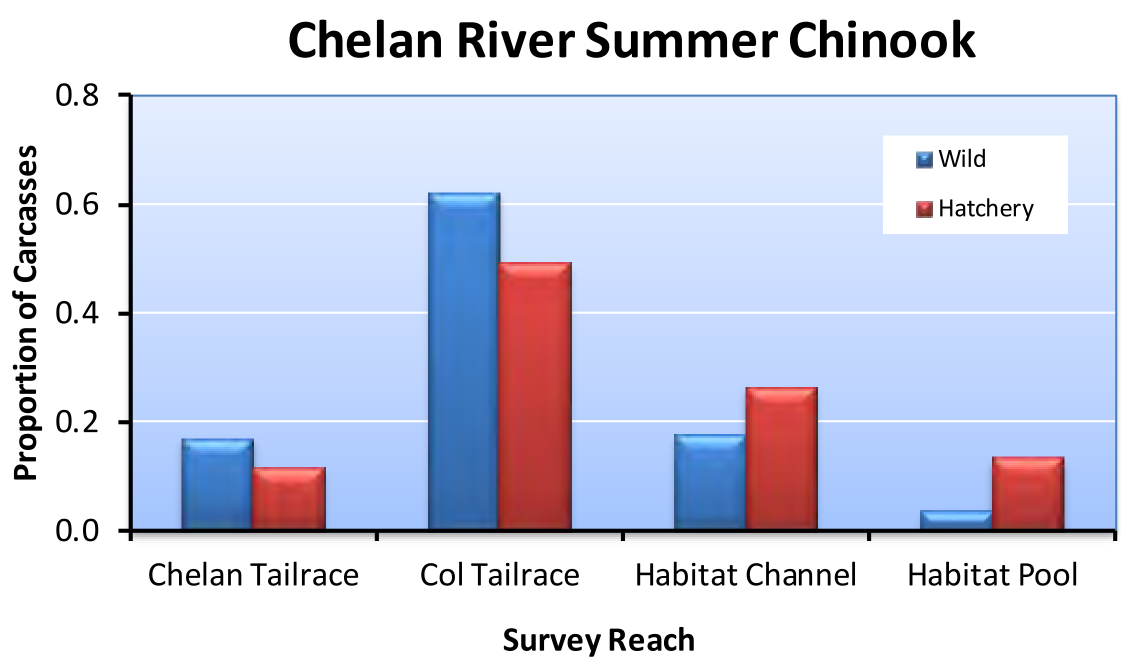


Figure 11.5. Average distribution of wild and hatchery produced carcasses in different survey areas within the Chelan River, 2013-2018.

Sampling Rate

Overall, 22% of the total spawning escapement of summer Chinook in the Chelan River was sampled in 2018 (Table 11.24). Sampling rates among survey reaches varied from 13 to 74%.

Table 11.24. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Chelan River, 2018.

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chelan Tailrace	157	47	361	0.13
Columbia Tailrace	55	94	127	0.74
Habitat Channel	125	39	288	0.14
Habitat Pool	83	33	191	0.17
Total	***420***	***213***	***966***	***0.22***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Chelan River in 2018 are provided in Table 11.25. The average size of males and females sampled in the Chelan River were 62 cm and 66 cm, respectively.

Table 11.25. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different areas on the Chelan River, 2018.

Stream/watershed	Mean length (cm)	
	Male	Female
Chelan Tailrace	55.0 (17.7)	65.1 (4.7)
Columbia Tailrace	62.3 (7.8)	64.9 (5.5)
Habitat Channel	65.8 (8.0)	65.2 (5.9)
Habitat Pool	62.3 (4.8)	69.0 (4.2)
Total	***62.0 (8.7)***	***65.6 (5.4)***

11.5 Life History Monitoring

Life history characteristics of Chelan Falls and Turtle Rock summer Chinook were assessed by examining carcasses on spawning grounds and by reviewing tagging data and fisheries statistics.

Contribution to Fisheries

Normal subyearling releases

Most of the harvest on Turtle Rock summer Chinook (normal subyearling releases) occurred in the Ocean (10-100% of the fish harvested; Table 11.26). Brood years 1995 and 2006 provided the largest total harvests, while brood year 1997 and 1998 provided the lowest. The subyearling hatchery program was discontinued after brood year 2009.

Table 11.26. Estimated number and percent (in parentheses) of Turtle Rock summer Chinook (normal subyearling releases) captured in different fisheries, brood years 1995-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	688 (84)	106 (13)	11 (1)	16 (2)	821	75.5
1996	71 (80)	0 (0)	5 (6)	13 (14)	89	47.3
1997	11 (100)	0 (0)	0 (0)	0 (0)	11	61.1
1998	21 (100)	0 (0)	0 (0)	0 (0)	21	46.7
1999	184 (64)	26 (9)	4 (1)	75 (26)	289	75.9
2000	36 (55)	8 (12)	8 (12)	14 (21)	66	86.8
2001	162 (63)	30 (12)	20 (8)	44 (17)	256	78.0
2002	23 (20)	33 (29)	3 (3)	56 (49)	115	92.0
2003	9 (10)	55 (61)	2 (2)	24 (27)	90	76.9
2004	42 (37)	29 (25)	2 (2)	42 (37)	115	61.2
2005	100 (38)	95 (36)	24 (9)	44 (17)	263	75.1

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2006	305 (41)	288 (38)	53 (7)	104 (14)	750	73.6
2007	110 (34)	91 (28)	20 (6)	104 (32)	325	66.3
2008	42 (31)	32 (24)	4 (3)	56 (42)	134	87.0
2009	82 (36)	89 (39)	6 (3)	52 (23)	229	72.9
Average	***126 (53)***	***59 (22)***	***11 (4)***	***43 (21)***	***238***	***71.8***
Median	***71 (41)***	***32 (24)***	***5 (3)***	***44 (21)***	***134***	***75.1***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Accelerated subyearling releases

Most of the harvest on Turtle Rock summer Chinook (accelerated subyearling releases) occurred in ocean fisheries (Table 11.27). Ocean harvest has made up 0% to 100% of all Turtle Rock summer Chinook harvested. Brood year 1999 provided the largest total harvest, while brood years 1995, 1997, 2002, and 2003 provided the lowest. This program was discontinued after brood year 2008.

Table 11.27. Estimated number and percent (in parentheses) of Turtle Rock summer Chinook (accelerated subyearling releases) captured in different fisheries, brood years 1995-2008.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	3 (100)	0 (0)	0 (0)	0 (0)	3	23.1
1996	77 (89)	5 (6)	5 (6)	0 (0)	87	46.0
1997	3 (100)	0 (0)	0 (0)	0 (0)	3	33.3
1998	102 (95)	2 (2)	3 (3)	0 (0)	107	89.9
1999	1,026 (76)	142 (10)	12 (1)	178 (13)	1,358	84.2
2000	117 (100)	0 (0)	0 (0)	0 (0)	117	79.6
2001	205 (59)	49 (14)	13 (4)	80 (23)	347	84.4
2002	9 (100)	0 (0)	0 (0)	0 (0)	9	75.0
2003	0 (0)	0 (0)	0 (0)	0 (0)	0	0.0
2004	50 (30)	79 (47)	6 (4)	34 (20)	169	66.5
2005	65 (59)	12 (11)	26 (24)	7 (6)	110	52.6
2006	130 (43)	113 (37)	16 (5)	43 (14)	302	57.2
2007	169 (41)	168 (41)	15 (4)	59 (14)	411	93.0
2008	20 (54)	2 (5)	4 (11)	11 (30)	37	3.4
Average	***141 (68)***	***41 (12)***	***7 (4)***	***29 (9)***	***219***	***56.3***
Median	***71 (67)***	***4 (6)***	***5 (3)***	***4 (3)***	***109***	***61.9***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Yearling releases

Most of the harvest on Turtle Rock/Chelan Falls summer Chinook (yearling releases) occurred in ocean fisheries (Table 11.28). Ocean harvest has made up 39% to 95% of all Turtle Rock/Chelan Falls summer Chinook harvested. Brood year 2010 provided the largest harvest, while brood year 1995 provided the lowest.

Table 11.28. Estimated number and percent (in parentheses) of Turtle Rock/Chelan Falls summer Chinook (yearling releases) captured in different fisheries, brood years 1995-2012.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	456 (75)	51 (8)	31 (5)	70 (12)	608	57.0
1996	771 (95)	14 (2)	2 (0)	21 (3)	808	50.2
1997	2,835 (91)	61 (2)	27 (1)	176 (6)	3,099	63.4
1998	4,284 (90)	224 (5)	16 (0)	230 (5)	4,754	82.2
1999	1,658 (73)	233 (10)	7 (0)	383 (17)	2,281	84.3
2000	1,214 (72)	147 (9)	54 (3)	273 (16)	1,688	82.8
2001	1,952 (59)	453 (14)	178 (5)	729 (22)	3,312	83.2
2002	1,018 (50)	384 (19)	102 (5)	537 (26)	2,041	78.5
2003	758 (46)	449 (27)	70 (4)	378 (23)	1,655	73.4
2004	827 (39)	560 (26)	127 (6)	605 (29)	2,119	80.7
2005	500 (44)	303 (27)	123 (11)	206 (18)	1,132	69.1
2006	1,163 (39)	880 (30)	231 (8)	688 (23)	2,962	73.6
2007	753 (48)	398 (25)	67 (4)	349 (23)	1,567	77.8
2008	3,697 (50)	1,243 (17)	248 (3)	2,168 (30)	7,356	78.9
2009	1,698 (46)	1,106 (30)	122 (3)	743 (22)	3,669	75.4
2010	4,173 (44)	3,414 (36)	409 (4)	1,547 (16)	9,543	77.6
2011	3,374 (45)	2,403 (32)	309 (4)	1,445 (19)	7,531	69.8
2012	1,930 (40)	1,805 (37)	56 (1)	1,068 (22)	4,859	70.2
Average	***1,837 (58)***	***785 (20)***	***121 (4)***	***645 (18)***	***3,388***	***73.9***
Median	***1,436 (49)***	***424 (22)***	***86 (4)***	***460 (20)***	***2,622***	***76.6***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Normal subyearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. There were 17 tag codes used to differentiate Turtle Rock/Chelan normal subyearling releases by brood year, release type, and location. There was one subyearling group released into the Chelan River in 2010 (brood year 2009). There were also six non-associated releases.[50] All tag codes, except brood year

[50] Non-associated releases are release groups not containing any coded-wire tagged fish.

2009, recovered in the Chelan River or other tributaries in the Upper Columbia were considered strays.

Rates of Turtle Rock summer Chinook (normal subyearling releases) straying into spawning areas in the upper basin have been low. Although Turtle Rock summer Chinook have strayed into other spawning areas, they made up less than 10% of the spawning escapement within those areas (Table 11.29). The Chelan tailrace has received the largest number of Turtle Rock strays. This hatchery program was discontinued after brood year 2009.

Table 11.29. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock summer Chinook (normal subyearling releases), return years 1998-2015. For example, for return year 2003, 0.6% of the summer Chinook spawning escapement in the Okanogan River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	8	0.1	3	0.3	13	0.4	63	13.4	0	0.0	0	0.0
2001	0	0.0	5	0.2	13	0.1	0	0.0	0	0.0	0	0.0
2002	0	0.0	0	0.0	13	0.1	0	0.0	0	0.0	0	0.0
2003	7	0.1	7	0.2	19	0.6	6	1.4	0	0.0	0	0.0
2004	5	0.0	4	0.2	13	0.2	6	1.4	0	0.0	0	0.0
2005	5	0.1	0	0.0	5	0.1	0	0.0	2	0.5	0	0.0
2006	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2009	0	0.0	16	0.9	0	0.0	2	0.3	9	3.6	0	0.0
2010	0	0.0	26	1.0	0	0.0	0	0.0	14	3.2	0	0.0
2011	0	0.0	14	0.5	0	0.0	34	2.7	0	0.0	0	0.0
2012	0	0.0	0	0.0	0	0.0	0	0.0	8	0.9	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2015	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***1***	***0.0***	***4***	***0.2***	***4***	***0.1***	***6***	***1.1***	***2***	***0.5***	***0***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 29% of the hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) spawners strayed into non-target streams (Table 11.30). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-100%. In addition, on average, about 2% of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) broodstock have been included in non-target hatchery programs.

Table 11.30. Number and percent of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2009.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	64	24.1	197	74.1	5	1.9
1996	-	-	44	44.4	54	54.5	1	1.0
1997	-	-	5	71.4	2	28.6	0	0.0
1998	-	-	24	100.0	0	0.0	0	0.0
1999	-	-	52	56.5	40	43.5	0	0.0
2000	-	-	5	50.0	5	50.0	0	0.0
2001	-	-	16	22.2	56	77.8	0	0.0
2002	-	-	0	0.0	10	100.0	0	0.0
2003	-	-	0	0.0	27	100.0	0	0.0
2004	-	-	2	2.7	71	97.3	0	0.0
2005	-	-	7	8.0	80	92.0	0	0.0
2006	-	-	72	26.8	194	72.1	3	1.1
2007	-	-	34	20.6	113	68.5	18	10.9
2008	-	-	0	0.0	16	80.0	4	20.0
2009	27	42.2	8	12.5	29	45.3	0	0.0
Average	***27***	***42.2***	***22***	***29.3***	***60***	***65.6***	***2***	***2.3***
Median	***27***	***42.2***	***8***	***22.2***	***40***	***72.1***	***0***	***0.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Chelan River. Before 2009, there was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam and Wells Hatchery.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Accelerated subyearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. There were 16 tag codes used to differentiate Turtle Rock accelerated subyearling releases by brood year and release type. There were also four non-associated releases. All tag codes recovered in the Chelan River or other tributaries in the Upper Columbia were considered strays.

Rates of Turtle Rock summer Chinook (accelerated subyearling releases) straying into spawning areas in the upper basin have been low. Although Turtle Rock summer Chinook have strayed into other spawning areas, they made up less than 10% of the spawning escapement within those areas

(Table 11.31). The Chelan tailrace, Entiat Basin, and Methow River basin have received the largest numbers of Turtle Rock strays. This hatchery program was discontinued after brood year 2008.

Table 11.31. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock summer Chinook (accelerated subyearling releases), return years 1998-2014. For example, for return year 2001, 0.2% of the summer Chinook spawning escapement in the Methow River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	3	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	7	0.1	0	0.0	0	0.0	24	3.6	0	0.0	0	0.0
2001	0	0.0	12	0.4	31	0.3	0	0.0	0	0.0	0	0.0
2002	0	0.0	5	0.1	0	0.0	0	0.0	0	0.0	0	0.0
2003	0	0.0	45	1.1	0	0.0	22	5.3	13	1.9	16	0.0
2004	0	0.0	7	0.3	0	0.0	14	3.3	0	0.0	18	0.0
2005	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2006	0	0.0	0	0.0	0	0.0	0	0.0	7	1.3	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	7	0.4	0	0.0	27	5.4	0	0.0	0	0.0
2009	19	0.2	0	0.0	0	0.0	2	0.3	0	0.0	0	0.0
2010	0	0.0	19	0.8	0	0.0	0	0.0	10	2.3	0	0.0
2011	17	0.2	10	0.3	10	0.1	0	0.0	15	3.2	0	0.0
2012	0	0.0	0	0.0	0	0.0	0	0.0	8	0.9	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***3***	***0.0***	***6***	***0.2***	***2***	***0.0***	***5***	***1.1***	***3***	***0.6***	***2***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 29.5% of the hatchery-origin Turtle Rock summer Chinook (accelerated subyearling releases) spawners strayed into non-target streams (Table 11.32). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-83%. In addition, on average, about 1.3% of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) broodstock have been included in non-target hatchery programs.

Table 11.32. Number and percent of hatchery-origin Turtle Rock summer Chinook (accelerated subyearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2008.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	3	30.0	7	70.0	0	0.0
1996	-	-	69	67.6	33	32.4	0	0.0
1997	-	-	0	0.0	6	100.0	0	0.0
1998	-	-	10	83.3	2	16.7	0	0.0
1999	-	-	117	45.9	138	54.1	0	0.0
2000	-	-	18	60.0	12	40.0	0	0.0
2001	-	-	7	10.9	57	89.1	0	0.0
2002	-	-	0	0.0	0	0.0	0	0.0
2003	-	-	0	0.0	3	100.0	0	0.0
2004	-	-	29	24.4	90	75.6	0	0.0
2005	-	-	19	22.4	64	75.3	2	2.4
2006	-	-	7	7.1	88	88.9	4	4.0
2007	-	-	81	35.8	133	61.9	12	5.3
2008	-	-	8	25.8	21	84.0	2	6.5
Average	**-**	**-**	***26***	***29.5***	***47***	***63.4***	***1***	***1.3***
Median	**-**	**-**	***9***	***25.1***	***27***	***72.7***	***0***	***0.0***

[1] There was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam and Wells Hatchery.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Yearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. Yearlings have been released in the Columbia River and in the Chelan River. There were 16 tag codes used to differentiate Turtle Rock yearling releases by brood year, release type, and location. All these fish were released into the Columbia River and therefore any tag recoveries in the Chelan River or other tributaries were considered strays. In contrast, there were 21 tag codes[51] used to differentiate Chelan River yearling releases by brood year, release type, and location (there were four non-

[51] The Regional Mark Information System (RMIS) indicates that one tag code was released into Lake Chelan. Interestingly, some of these fish have been reported in ocean and Columbia River fisheries.

associated releases). All these fish were released into the Chelan River and therefore any tag recoveries in tributaries other than the Chelan River were considered strays.

Rates of Turtle Rock/Chelan Falls summer Chinook (yearling releases) straying into spawning areas within the Upper Columbia Summer Chinook population have varied widely depending on spawning area. Most of these fish strayed to spawning areas within the Methow River basin, Entiat River basin, and Chelan tailrace (Turtle Rock released fish). On average, Turtle Rock summer Chinook have made up 4-11% of the spawning escapement within those basins (Table 11.33). Relatively few, on average, have strayed to spawning areas in Wenatchee River basin, Okanogan River basin, and the Hanford Reach (i.e., they made up less than 1% of the spawning escapement in these areas).

Turtle Rock/Chelan Falls summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged Turtle Rock/Chelan Falls hatchery summer Chinook have been detected in the Umatilla River, at Lower Granite Dam on the Snake River, in Sand Hollow Creek, and at Tumwater Falls, Lyons Ferry, and Forks Creek hatcheries. However, few Turtle Rock/Chelan Falls summer Chinook have strayed into each of these locations.

Table 11.33. Number (No.) and percent of spawning escapements within non-target basins that consisted of Turtle Rock/Chelan Falls summer Chinook (yearling releases), return years 1998-2017. For example, for return year 2003, 4.3% of the summer Chinook spawning escapement in the Methow River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	0	0.0	2	0.3	0	0.0	0	0.0	0	0.0	0	0.0
1999	3	0.1	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0
2000	18	0.3	57	4.8	167	4.5	73	15.5	0	0.0	10	0.0
2001	109	1.0	523	18.9	334	3.1	316	32.1	0	0.0	7	0.0
2002	92	0.6	437	9.4	194	1.4	191	32.8	136	27.1	0	0.0
2003	64	0.5	170	4.3	14	0.4	165	39.4	180	26.0	9	0.0
2004	10	0.1	55	2.5	116	1.7	75	18.0	0	0.0	0	0.0
2005	5	0.1	73	2.9	78	0.9	88	16.8	46	12.5	0	0.0
2006	0	0.0	100	3.7	25	0.3	64	15.2	30	7.5	0	0.0
2007	0	0.0	65	4.8	31	0.7	40	21.2	58	40.8	19	0.1
2008	18	0.3	72	3.7	60	0.9	110	22.1	46	21.4	0	0.0
2009	8	0.1	95	5.4	32	0.4	5	0.8	18	9.9	0	0.0
2010	12	0.2	105	4.2	111	1.9	0	0.0	30	11.5	0	0.0
2011	8	0.1	88	3.0	35	0.4	15	1.2	12	4.1	0	0.0
2012	21	0.2	33	1.1	43	0.5	110	8.4	29	4.5	0	0.0
2013	0	0.0	128	3.6	20	0.2	14	0.8	0	0.0	0	0.0
2014	7	0.1	20	1.2	23	0.2	16	1.5	18	3.0	0	0.0
2015	0	0.0	177	4.5	15	0.1	0	0.0	6	1.6	0	0.0
2016	3	0.1	44	2.0	13	0.1	0	0.0	1	0.2	0	0.0
2017	6	0.1	4	0.3	0	0.0	0	0.0	1	0.2	0	0.0
Average	***19***	***0.2***	***113***	***4.0***	***66***	***0.9***	***64***	***11.3***	***31***	***8.5***	***2***	***0.0***

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Median	***7.5***	***0.1***	***73***	***3.6***	***32***	***0.4***	***28***	***4.9***	***15***	***3.6***	***0***	***0.0***

Based on brood year analyses since 2005, on average, about 13% of the hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) spawners strayed into non-target streams (Table 11.34). Depending on brood year, percent strays into non-target spawning areas have ranged from 1-29%. In addition, on average, about 27% of hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) broodstock have been included in non-target hatchery programs.

Table 11.34. Number and percent of hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2012.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	278	60.7	180	39.3	0	0.0
1996	-	-	583	72.8	218	27.2	0	0.0
1997	-	-	1531	85.6	254	14.2	3	0.2
1998	-	-	864	83.8	166	16.1	1	0.1
1999	-	-	243	57.3	181	42.7	0	0.0
2000	-	-	249	70.9	102	29.1	0	0.0
2001	-	-	279	41.8	389	58.2	0	0.0
2002	-	-	254	45.5	303	54.3	1	0.2
2003	-	-	225	37.6	373	62.3	1	0.2
2004	-	-	219	43.2	287	56.6	1	0.2
Average[b]	-	-	***473***	***59.9***	***245***	***40.0***	***1***	***0.1***
Median[b]	-	-	***266***	***59.0***	***236***	***41.0***	***1***	***0.0***
2005	149	29.4	144	28.5	202	39.9	11	2.2
2006	429	40.3	223	21.0	376	35.3	36	3.4
2007	121	27.1	69	15.4	218	48.8	39	8.7
2008	775	39.3	326	16.5	736	37.3	135	6.8
2009	96	8.0	91	7.6	877	73.3	133	11.1
2010	606	23.5	211	8.2	430	16.7	1,329	51.6
2011	453	15.1	101	3.4	356	11.9	2,092	69.7
2012	283	13.7	17	0.8	429	20.8	1,332	64.6
Average[c]	***364***	***24.6***	***148***	***12.7***	***453***	***35.5***	***638***	***27.3***
Median[c]	***356***	***25.3***	***122.5***	***11.8***	***403***	***36.3***	***134***	***9.9***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Chelan River. Before 2005, there was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam, Wells Hatchery, Eastbank Hatchery outfall, and the Chelan River.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel times (arithmetic mean days) of hatchery summer Chinook from the Turtle Rock/Chelan River release sites to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 11.35).[52] Over the ten brood years for which PIT-tagged hatchery fish were released, survival rates from the release sites to McNary Dam ranged from 0.423 to 0.810; SARs from release to detection at Bonneville Dam ranged from 0.008 to 0.028. Average travel times from release sites to McNary Dam ranged from 15 to 33 days.

Much of the variation in survival rates and travel time among brood years resulted from releases of different experimental groups (Table 11.35). For example, brood years 2007 and 2008 were each split into two experimental groups (Circular Reuse group and Standard Raceway group). For both brood years, survival from the release site to McNary Dam and SARs were greater for the Circular Reuse fish than for the Standard Raceway fish. For both brood years, travel time from release to McNary Dam appeared to be longer for the Standard Raceway fish than for the Circular Reuse fish.

Another evaluation was conducted with brood years 2012, 2013, and 2014 (Table 11.35). These brood years were split into different treatment groups based on fish size. Based on available information, there were no clear differences in survival rates and travel times to McNary Dam among the different experimental groups. On the other hand, larger fish tended to have higher SARs than smaller fish (Table 11.35).

Table 11.35. Total number of Turtle Rock/Chelan Falls yearling summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2007-2016. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River); fpp = fish per pound.

Brood year	Raceway/Program	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam	SAR to Bonneville Dam
2007	Circular Reuse	9,975	0.722 (0.036)	22.4 (8.6)	0.017 (0.001)
	Standard	9,937	0.550 (0.034)	28.4 (11.6)	0.010 (0.001)
2008	Circular Reuse	11,082	0.631 (0.040)	26.5 (9.8)	0.028 (0.002)
	Standard	11,070	0.581 (0.038)	27.9 (18.7)	0.025 (0.001)
2009	Turtle Rock	4,945	0.603 (0.061)	15.4 (8.6)	0.018 (0.002)
	Chelan Net Pens	5,048	0.616 (0.059)	19.5 (10.2)	0.012 (0.002)
2010	Chelan Falls	4,186	0.655 (0.050)	22.5 (12.1)	0.025 (0.002)

[52] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Raceway/Program	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam	SAR to Bonneville Dam
2011*	Chelan Falls	4,075	0.552 (0.054)	27.2 (11.5)	0.016 (0.002)
2012	Chelan Falls (Small Fish)	4,983	0.590 (0.049)	25.0 (11.2)	0.011 (0.001)
	Chelan Falls (Big Fish)	4,960	0.579 (0.043)	24.4 (10.1)	0.012 (0.002)
2013	Chelan Falls (Small Fish)	4,958	0.423 (0.068)	33.0 (13.6)	0.008 (0.001)
	Chelan Falls (Big Fish)	4,963	0.760 (0.175)	28.6 (12.4)	0.014 (0.002)
2014	Chelan Falls (10 fpp)	2,478	0.798 (0.077)	16.4 (5.9)	NA
	Chelan Falls (13 fpp)	2,360	0.672 (0.074)	16.1 (5.6)	NA
	Chelan Falls (18 fpp)	2,495	0.637 (0.064)	18.7 (7.8)	NA
	Chelan Falls (22 fpp)	2,481	0.449 (0.049)	20.6 (9.6)	NA
2015	Chelan Falls	9,506	0.747 (0.063)	16.9 (7.4)	NA
2016	Chelan Falls	10,418	0.810 (0.064)	23.1 (9.7)	NA

* Brood year 2011 experienced high mortality due to fungus, bacterial cold-water disease, bacterial gill disease, and erythrocytic inclusion body syndrome during April 2013.

Smolt-to-Adult Survivals

Subyearling-to-adult and smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery subyearling or yearling Chinook released. For these analyses, SARs were based on CWT returns.

Normal subyearling releases

For the available brood years, SARs for normal subyearling-released Chinook have ranged from 0.000036 to 0.001886 (Table 11.36). This hatchery program was discontinued after brood year 2009.

Table 11.36. Subyearling-to-adult ratios (SARs) for Turtle Rock normal subyearling-released summer Chinook, brood years 1995-2009.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	201,230	204	0.001014
1996	371,848	187	0.000503
1997	496,904	18	0.000036
1998	194,723	28	0.000144
1999	197,793	203	0.001026
2000	222,460	28	0.000126
2001	211,306	328	0.001552
2002	200,163	38	0.000190
2003	203,410	49	0.000241
2004	198,019	91	0.000460

Brood year	Number released[a]	Estimated adult captures[b]	SAR
2005	197,135	143	0.000725
2006	188,250	355	0.001886
2007	194,437	216	0.001111
2008	152,993	77	0.000503
2009	341,928	133	0.000389
Average	***238,173***	***140***	***0.000660***
Median	***200,163***	***133***	***0.000503***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

Accelerated subyearling releases

For the available brood years, SARs for accelerated subyearling-released Chinook have ranged from 0.000011 to 0.004614 (Table 11.37). This hatchery program was discontinued after brood year 2008.

Table 11.37. Subyearling-to-adult ratios (SARs) for Turtle Rock accelerated subyearling-released summer Chinook, brood years 1995-2008.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	166,203	13	0.000078
1996	198,720	79	0.000398
1997	196,459	3	0.000015
1998	185,551	72	0.000388
1999	192,665	889	0.004614
2000	194,603	63	0.000324
2001	196,355	169	0.000861
2002	200,165	5	0.000025
2003	185,834	2	0.000011
2004	203,255	159	0.000782
2005	192,045	82	0.000427
2006	186,324	217	0.001165
2007	188,328	309	0.001641
2008	197,136	35	0.000178
Average	***191,689***	***150***	***0.000779***
Median	***193,634***	***76***	***0.000393***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

Yearling releases

For the available brood years since 2004, SARs for yearling-released Chinook have ranged from 0.008056 to 0.028164 (Table 11.38).

Table 11.38. Smolt-to-adult ratios (SARs) for Turtle Rock/Chelan Falls yearling-released summer Chinook, brood years 1995-2012.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	145,318	1,047	0.007205
1996	194,251	1,558	0.008021
1997	198,924	4,813	0.024195
1998	215,646	5,764	0.026729
1999	280,683	2,673	0.009523
2000	278,308	2,038	0.007323
2001	199,694	3,937	0.019715
2002	192,234	2,570	0.013369
2003	199,386	2,100	0.010532
2004	202,682	2,594	0.012798
Average[c]	***210,713***	***2,909***	***0.013941***
Median[c]	***199,540***	***2,582***	***0.011665***
2005	202,329	1,630	0.008056
2006	142,699	4,019	0.028164
2007	161,071	1,904	0.011821
2008	447,155	9,258	0.020704
2009	423,565	4,769	0.011259
2010	547,205	11,796	0.021557
2011	580,057	10,504	0.018109
2012	559,350	6,871	0.012284
Average[d]	***382,929***	***6,344***	***0.016494***
Median[d]	***435,360***	***5,820***	***0.015196***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

[c] Summary statistics for yearling Turtle Rock summer Chinook released into the Columbia River (brood years 1995-2004).

[d] Summary statistics for yearling Turtle Rock/Chelan River summer Chinook released into the Chelan River (brood years 2005 to present).

11.6 ESA/HCP Compliance

Broodstock Collection

The 2016 brood Chelan Falls (formerly Turtle Rock) summer Chinook program was supported through adult collections at the Eastbank outfall and surplus adults from Entiat National Fish

Hatchery. During 2016, broodstock collections were consistent with the 2016 Upper Columbia River Salmon and Steelhead Broodstock Objectives and site-based broodstock collection protocols as required in ESA permit 1347. The 2016 collection target totaled 350 summer Chinook. Actual 2016 broodstock collection was 350 adults.

Hatchery Rearing and Release

The brood year 2016 release totaled 600,894 yearling fish. These releases represented 104.3% of the 576,000 Rocky Reach HCP and ESA Section 10 Permit 1347 production for the Chelan Falls yearling summer Chinook production.

Hatchery Effluent Monitoring

Per ESA Permit Numbers 1347, 18118, 18120, 18121, and 18583, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or the Chelan Falls Acclimation Facility during the period 1 January through 31 December 2018. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2018 are provided in Appendix G.

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SECTION 13: APPENDICES

Appendix A: **Juvenile Release Type and Location, Washington, 2018.**

Appendix B: **Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River Basin, Washington, 2018.**

Appendix C: **Fish Trapping at the Chiwawa and Wenatchee Smolt Traps during 2018.**

Appendix D: **Summary of CSS PIT-Tagging Activities in the Wenatchee River Basin, 2018.**

Appendix E: **Wenatchee Steelhead Spawning Escapement Estimates, 2018.**

Appendix F: **Examining the Genetic Structure of Wenatchee River Basin Steelhead and Evaluating the Effects of the Supplementation Program.**

Appendix G: **NPDES Hatchery Effluent Monitoring, 2018.**

Appendix H: **Steelhead Stock Assessment at Priest Rapids Dam, 2018.**

Appendix I: **Bull Trout Encounters within the Wenatchee River Basin, 2018.**

Appendix J: **Wenatchee Sockeye Salmon Spawning Escapement, 2018.**

Appendix K: **Genetic Diversity of Wenatchee Sockeye Salmon.**

Appendix L: **Wenatchee Spring Chinook Redd Estimates, 2018.**

Appendix M: **Genetic Diversity of Natural Chiwawa River Spring Chinook Salmon.**

Appendix N: **Fish Trapping at the Nason Creek Smolt Trap during 2018.**

Appendix O: **Fish Trapping at the White River Smolt Trap during 2018.**

Appendix P: **Genetic Diversity of Upper Columbia Summer Chinook Salmon.**

Appendix Q: **Summer Chinook Spawning Ground Surveys in the Methow and Chelan Rivers, 2018.**

Appendix A

Juvenile Production Targets, Marking Methods, Release Locations, Release Sizes, and Release Types for Fish Releases in 2018

Appendix A. Brood year juvenile production targets, marking methods, release locations, release size, and release type. Table is from Tonseth (2016).

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2016	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2018	13-18	Forced
2016	Wells SUC 0+ (DPUD)	480,000	Ad + CWT	3K-5K PIT	Columbia R. at Wells Dam	2017	50	Forced
2016	Wells SUC 1+ (DPUD)	320,000	Ad + CWT		Columbia R. at Wells Dam	2018	10	Volitional
2016	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2018	13-	Forced
2016	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	5,000 PIT minimum	Wenatchee R. at DAF	2018	10-15	Forced
2016	CJH SUS 1+	500,000	Ad + 100K CWT	5,000 PIT	CJH	2018	10	Volitional
2016	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2017	50	Volitional
2016	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2018	10	Volitional
2016	Okanogan SUS 1+	266,666	Ad + CWT		Riverside Pond	2018	10	Volitional
2016	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2018	10	Volitional
2016	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2017	50	Forced
Spring Chinook								
2016	Methow SPC (PUD)	108,249	CWT only	7,000 PIT	Methow R. at MFH	2018	15	Volitional
2016	Methow SPC (PUD)	25,000[1]	CWT only	7,000 PIT	Methow R. at GWP (YN)	2018	15	Volitional
2016	Methow SPC (PUD)	60,516	CWT only	TBD	Chewuch R. at CAF	2018	15	Volitional
2016	Twisp SPC (PUD)	30,000	CWT only	5,000 PIT	Twisp R. at TAF	2018	15	Volitional
2016	Methow SPC (USFWS)	400,000	Ad + CWT	10,000 PIT	Methow River at WNFH	2018	17	Volitional
2016	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond	2018	15	Volitional

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
2016	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT?	Columbia R. at CJH	2018	15	Forced
2016	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only	5,000 PIT minimum	Chiwawa River at CPD	2018	22	Short term volitional
2016	Nason Cr. SPC (GPUD) (conservation)	125,000	CWT + blank body tag	5,000 PIT	Nason Cr. at NAF	2018	18	Forced
2016	Nason Cr. SPC (GPUD) (safety net)	98,670	Ad + CWT		Nason Cr. at NAF[9]	2018	18	Forced
Fall Chinook								
2016	Priest Rapids FAC 0+ (ACOE)	1.7M	Ad + Oto	Approximately 43,000 spread across the fish released from PRH	Columbia River at PRH	2017	50	Forced
2016	Priest Rapids FAC 0+ (GPUD)	600,000	Ad+CWT+Oto		Columbia River at PRH	2017	50	Forced
2016	Priest Rapids FAC 0+ (GPUD)	600,000	CWT + Oto		Columbia River at PRH	2017	50	Forced
2016	Priest Rapids FAC 0+ (GPUD)	1M[2]	Ad + Oto		Columbia River at PRH	2017	50	Forced
2016	Priest Rapids FAC 0+ (GPUD)	3.4M	Oto only		Columbia River at PRH	2017	50	Forced
2016	Ringold Springs FAC 0+ (ACOE)	3.5M	Ad + Oto		Columbia River at RSH	2017	50	Forced
Steelhead								
2017	Wenatchee Mixed (HxH/WxW) (CPUD)	66,771	Ad + CWT (HxH) CWT only (WxW)	Estimated 5,400 PIT[7]	Nason Cr. direct release	2018	6	Forced/Volitional
2017	Wenatchee Mixed (HxH/WxW) (CPUD)	53,170	Ad + CWT (HxH) CWT only (WxW)	Estimated 4,300 PIT[7]	Chiwawa R. direct release	2018	6	Forced/Volitional
2017	Wenatchee Mixed (HxH/WxW) (CPUD)	102,359	Ad + CWT (HxH) CWT only (WxW)	Estimated 8,278 PIT[7]	Wenatchee R. direct release	2018	6	Forced/Volitional

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
2017	Wenatchee HxH (CPUD)	25,000	Ad + CWT	Estimated 2,022 PIT[7]	Wenatchee R. at BBP	2018	6	Volitional
2017	Twisp WxW (DPUD)	48,000	CWT only	5,000 PIT	Twisp River at TAF	2018	6	Volitional
2017	Wells HxH (DPUD)	100,000	Ad only	5,000 PIT	Methow River at MFH	2018	6	Volitional
2017	Wells HxH (DPUD)	160,000	Ad only	5,000 PIT	Columbia R. at Wells Dam	2018	6	Volitional
2017	Methow WxW (USFWS)	200,000	Ad + CWT	10,000 PIT	Methow R. at WNFH	2018	4-6	Volitional
2017	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K[6]	Ad /CWT (TBD)[8]	Up to 20,000 PIT[9]	Okanogan/Similkameen Omak, Salmon, Antoine, other tribs. (TBD)	2018	5-8	Volitional capture Wells; dropped planted in tributaries?
2017	Okanogan WxW (CCT/GPUD)	Up to 100K[6]	Body/snout CWT/Alternate fin clip (TBD)[7]	Up to 20,000 PIT[8]	Okanogan/Similkameen Omak, Salmon, Antoine, other tribs. (TBD)	2018	5-8	Volitional

[1] Release of fish at the Goat Wall Pond remote acclimation site operated by the YN is conditional upon HC and HSC approval.
[2] Externally marking of this group is presently funded by WDFW. Marking of this 1M fish is contingent on *US v. Oregon* Policy Committee approval for 20162015.
[3] Presently all CWT's are applied to the snout.
[4] The Okanogan SPC program derives its juveniles from a 200K transfer of Methow SPC from WNFH as part of a reintroduction effort. Fish are released into the Okanogan Basin.
[5] The Chief Joe Hatchery SPC program presently receives surplus adults from the Leavenworth NFH. Juveniles are released on station from CJH.
[6] Total Okanogan release not to exceed 100K + 10%.
[7]PIT number s to each release site are estimated and not actual.
[8]Dependent upon conditions in pending Section 10 Permit.
[9] Total PIT tag release in the Okanogan 20,000
[10] For brood years 2015 and 2016, Chiwawa hatchery fish will be collected at TWD to satisfy the Nason Creek safety net program and released from the NAF. These two brood years will be adipose fin clipped and snout CWT'd and will be targeted for 100% removal at TWD as adults consistent with the Wenatchee Basin Spring Chinook Management Plan. Beginning with the 2017 brood, adult returns from the Nason conservation program will be utilized to meet the Nason safety net program and will receive a supplemental body tag (blank wire either at the base of the adipose or the caudal peduncle) in addition to the adipose clip and snout CWT so that they can be differentiated and prioritized at TWD.

Appendix B

Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2018

BioAnalysts, Inc.
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December 30, 2019

TO: HCP Hatchery Committee

FROM: Tracy Hillman

Subject: Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2018

The Chelan County Public Utility District (PUD) hatchery program is operated through a habitat conservation plan (HCP) that was incorporated into the PUD's license in 2004. The HCP directed the signatories to develop a monitoring and evaluation plan within one year of the effective date. This resulted in the development of the Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs (Murdoch and Peven 2005). In 2017, the Hatchery Committees updated the hatchery monitoring and evaluation plan (Hillman et al. 2017). This study will help the Hatchery Committees determine if it is meeting Objective 2 in the updated monitoring and evaluation plan.

Objective 2: *Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.*

We estimated densities and total numbers of age-0 spring Chinook salmon *Oncorhynchus tshawytscha,* trout *Oncorhynchus* sp., and char *Salvelinus* sp. in the Chiwawa River basin, Washington, in August 2018. This was the 26th year of an ongoing study to assess the freshwater productivity (juveniles/redd) of Chinook salmon in the Chiwawa River basin. We used landscape classification to stratify streams in the basin that supported juvenile Chinook salmon (Hillman and Miller 2004). Classification "explained" most of the variability in fish numbers caused by geology, land type, valley bottom type, stream state condition, and habitat type. We identified ten reaches on the lower 31 miles (50 km) of the Chiwawa River and one reach in each of Phelps, Rock, Chikamin, Big Meadow, Alder, Brush, Clear, Y, and Unnamed[1] creeks (Figure 1). Each reach consisted of several combinations of state-type and habitat-type strata. We used classification to find reference areas for reaches in the Chiwawa River. We matched Reach 3 and Reach 8 of the Chiwawa River with a moderately-confined section of Nason Creek (RM 0.62-1.70) and an unconfined area of the Little Wenatchee River (RM 4.39-8.55), respectively (Hillman and Miller

[1]Unnamed tributary that drains the eastside of Chiwawa Ridge. Its confluence with the Chiwawa River is about 1 mile (1.6 km) downstream from the mouth of Phelps Creek.

2004). Because of the supplementation program in Nason Creek, the use of Nason Creek as a reference for the Chiwawa River is no longer valid. Therefore, we no longer sample in Nason Creek. Following methods described in Hillman and Miller (2004), we used underwater observations to estimate numbers of fish in 201 randomly selected sites.

During sampling in August 2018, discharge in the Chiwawa River averaged 181 cubic feet per second (cfs) and ranged from 118-309 cfs (Figure 2). Stream temperatures during the study period ranged from 9.0 to 16.0ºC. Fish species observed in the Chiwawa River basin and reference areas during the 1992-2018 survey period[2] included: spring Chinook salmon, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, steelhead/rainbow trout *O. mykiss* (hatchery rainbow were present only in 1992 and 1993), cutthroat trout *O. clarki lewisi*, bull trout *S. confluentus*, brook trout *S. fontinalis*, mountain whitefish *Prosopium williamsoni*, dace *Rhinichthys* sp., northern pikeminnow *Ptychocheilus oregonensis*, suckers *Catostomus* sp., and sculpin *Cottus* sp. The age-0 spring Chinook that we observed in the Chiwawa River basin during the 2018 survey were produced from 222 redds counted in the fall of 2017 (Hillman et al. 2018). Assuming a mean fecundity of 4,615 eggs per female Chinook (from females collected for broodstock), and that no female produced more than one redd (Murdoch et al. 2009), we estimated that the Chiwawa River basin was seeded with 1,024,530 eggs in 2017 (Appendix A).

In 2018, riffles made up the largest fraction of habitat types in reaches of the Chiwawa River basin (53% of the total stream surface area) (Table 1). Pools (23%), glides (7%), and multiple channels (17%) constituted the remaining 47% of the stream surface area. We found woody debris associated with most multiple-channel habitat.

Chinook Salmon Abundance

Chinook salmon were the most abundant salmonid in the Chiwawa River basin. We estimated, based on surface area, that age-0 Chinook salmon numbered 83,729 (±10% of the estimated total) in the Chiwawa River basin in August 2018 (Table 2). Extrapolating based on volume of habitat types, age-0 Chinook numbered 83,273 (±9%) in the Chiwawa River basin. About 6% of the juvenile Chinook were in tributaries to the Chiwawa River. During the 1992-2018 surveys, numbers of age-0 Chinook ranged from 5,815 to 149,563 in the Chiwawa River basin (Figure 3; Appendix A and B). Most of the difference in juvenile numbers among years resulted from different seeding (stock) levels (Figure 4). Numbers of Chinook redds in the Chiwawa River basin during 1992-2018 ranged from 13 to 1,078, resulting in seeding levels of 66,248 to 4,984,672 eggs (Appendix A).

As in most years, age-0 Chinook in 2018 were distributed contagiously among reaches in the Chiwawa River (Table 2). In the Chiwawa River, densities of age-0 Chinook were highest in the upper reaches (Reaches 7-10). The highest densities in the Chiwawa River basin were in tributaries to the Chiwawa River (Table 2). Age-0 Chinook were most abundant in multiple channels and pools, and least abundant in glides and riffles. We found the majority of the Chinook associated with woody debris in multiple channels (multiple channel use index = 2.82)[3]. These sites (multiple

[2] The study period 1992-2018 includes only 26 years of sampling because there was no sampling in 2000.

[3] The habitat use index was calculated as follows: Multiple channel use = ($parr_{mc}$/$parr_t$) / ($area_{mc}$/$area_t$), where parr $_{mc}$

channels) made up 17% of the total surface area of the Chiwawa River basin, but they provided habitat for 44% of all the age-0 Chinook in the basin in 2018 (Appendix C). In contrast, riffles made up 53% of the total surface area, but provided habitat for only 8% of all age-0 Chinook in the Chiwawa River basin (riffle use index = 0.23). Pools made up 23% of the total surface area and provided habitat for 47% of all age-0 Chinook in the basin (pool use index = 1.62). Few Chinook used glides that lacked woody debris (glide use index = 0.24).

As noted earlier, we assumed that the Chiwawa River was seeded with 1,024,530 Chinook eggs (222 redds times 4,615 eggs/female) in fall, 2017, and that at least 83,729 of those survived to August 2018. This means that the egg-to-parr survival was at least 8.2% (95% confidence bound 7.3-9.0%). During 1992-2018, egg-to-parr survival averaged 8.0% (range 2.7-19.1%) in the Chiwawa River basin (Appendix A). This survival rate comports with those from other streams. For example, Mullan et al. (1992) estimated an egg-to-parr survival rate of 9.8% for spring Chinook salmon in Icicle Creek, a tributary of the Wenatchee River. Using a Beverton and Holt model, Hubble (1993) estimated that egg-to-parr survival of Chinook in the Chewuck River, a tributary to the Methow River, ranged between 13% and 32%, depending on percent seeding level in the basin. Kiefer and Forster (1991) estimated a mean egg-to-parr survival rate of 5.5% (range 5.1-6.7%) for naturally-spawning spring Chinook salmon in the entire upper Salmon River. They also noted that egg-to-parr survival of natural spawners and adult outplants in the headwater streams of the upper Salmon River averaged 24.4% (range 16.1-32.0%). Petrosky (1990) reported an egg-to-parr survival range of 1.2-29.0% for Chinook in the upper Salmon River, Idaho. Konopacky et al. (1986) estimated egg-to-parr survival of Chinook in Bear Valley Creek, Idaho, as 8.1-9.4%. Work by Richards and Cernera (1987) in Bear Valley Creek indicated an egg-to-parr survival of 2.1%.

Mean densities of age-0 Chinook salmon in one reach on the Chiwawa River were not consistently greater than those in a corresponding reference area (Little Wenatchee River) (Figure 5). Mean densities of age-0 Chinook in pools and riffles were greater in the Chiwawa River than in the reference area, while mean densities of age-0 Chinook in glides and multiple channels were greater in the reference area than in the Chiwawa River. Within both the Chiwawa River and its reference area, pools and multiple channels consistently had the highest densities of age-0 Chinook.

We estimated a total of 739 (±36% of the estimated total) age-1+ Chinook salmon in the Chiwawa River basin in August 2018 (Table 3). In August 1992-2018, numbers of age-1+ Chinook ranged from 5 to 967 in the Chiwawa River basin (Figure 3; Appendix B). These fish occurred throughout the Chiwawa River. We found relatively few age-1+ Chinook in tributaries. Age-1+ Chinook were most abundant in multiple channels and pools.

= the number of parr counted in multiple channel habitat, $parr_t$ = the total number of parr counted within all habitat types, $area_{mc}$ = the area of multiple channel habitat within the sampling frame, and $area_t$ = the total area of the sampling frame. A multiple channel use index value of 1 would indicate that parr were uniformly distributed among habitat types and exhibited no preference for multiple habitat types. Values greater than 1 indicate use of multiple channels to a greater extent than the average, while scores between 0 and 1 indicate below-average use of multiple channel habitat.

Juvenile Chinook Salmon Productivity (Fish/Redd)

Freshwater productivity of juvenile Chinook salmon was estimated as the number of parr (age-0 Chinook) per redd in the Chiwawa River basin. Theoretically, the relationship between number of parr and redds can be explained mathematically provided the relationship between the two parameters goes through the origin, increases monotonically at low spawning levels, and shows some level of density dependence at high spawning levels. We identified four alternative hypotheses that may explain the relationship between spawning level (redds) and numbers of age-0 Chinook:

1. The first hypothesis assumed that the number of juveniles increases constantly toward an asymptote as the number of redds increases. After the asymptote is reached, the number of juveniles neither increases nor decreases. The asymptote represents the maximum number of juveniles the system can support (i.e., carrying capacity for the system). This hypothesis was modeled with a Beverton-Holt curve that took the form:

$$\boldsymbol{J} = \frac{(\boldsymbol{\alpha R})}{(\boldsymbol{\beta} + \boldsymbol{R})}$$

   where $\boldsymbol{J}$ is the number of juvenile (age-0) Chinook, $\boldsymbol{R}$ is the number or redds, $\boldsymbol{\alpha}$ is the maximum number of juveniles produced, and $\boldsymbol{\beta}$ is the number of redds needed to produce (on average) juveniles equal to one-half the maximum number of juveniles.

2. The second hypothesis, like the first, assumed that the number of juveniles increases toward an asymptote (carrying capacity) as the number of redds increases. After the carrying capacity is reached, the number of juveniles neither increases nor decreases. The carrying capacity represents the maximum number of juveniles the system can support. This hypothesis was modeled with a smooth hockey stick function that took the form:

$$\boldsymbol{J} = \boldsymbol{J}_{\infty}\left(\boldsymbol{1} - \boldsymbol{e}^{-\left(\frac{\boldsymbol{\alpha}}{\boldsymbol{J}_{\infty}}\right)\boldsymbol{R}}\right)$$

   where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the slope at the origin of the spawner-recruitment curve, and $\boldsymbol{J}_{\infty}$ is the carrying capacity of juveniles.

3. The third hypothesis assumed that the number of juveniles increases to a maximum and then declines as the number or redds increases. In this case, mortality rate of juveniles (or eggs) is proportional to the initial number of redds. Higher mortality rate is associated with density-dependent growth coupled with size-dependent predation. This hypothesis was modeled with a Ricker curve that took the form:

$$\boldsymbol{J} = \boldsymbol{\alpha R e}^{-\boldsymbol{\beta R}}$$

   where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the number of juveniles per redd at low spawning levels, and $\boldsymbol{\beta}$ describes how quickly the juveniles per redd drop as the number of redds increases.

4. The fourth hypothesis, like the first, assumed that the number of juveniles increases constantly, but unlike the first, the number of juveniles does not reach an asymptote. Rather, the number of juveniles increases indefinitely, but at a slowing rate of increase. This hypothesis was modeled with both a Cushing curve and a Gamma function. The

Cushing curve took the form:

$$J = \alpha R^{\gamma}$$

where J and R are as above, α is the number of juveniles per redd at low spawning levels, and γ describes the level of density dependence at high spawning levels. The Gamma function is a three-parameter model that has the form:

$$J = \alpha R^{\gamma} e^{-\beta R}.$$

This is an un-normalized gamma function that is similar to the Cushing curve when $\beta = 0$.

We used Akaike's Information Criterion for small sample size (AIC_c) to determine which model(s) best explained the productivity of juvenile Chinook in the Chiwawa River basin. AIC_c was estimated as:

$$AIC_c = -2log\left(£(\theta|data)\right) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)$$

where $log(£(\theta|data))$ is the maximum likelihood estimate, K is the number of estimable parameters (structural parameters plus the residual variance parameter), and n is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate $log(£(\theta|data))$, which was calculated as $log(\sigma^2)$, where σ^2 = residual sum of squares divided by the sample size ($\sigma^2 = RSS/n$). AIC_c assesses model fit in relation to model complexity (number of parameters). The model with the smallest AIC_c value represents the "best approximating" model within the model set. Remaining models were ranked relative to the best model using AIC_c difference scores (ΔAIC_c), Akaike weights (w_i), and evidence ratios. Models with ΔAIC_c values less than 2 indicate that there is substantial support for these models as being the best-fitting models within the set (Burnham and Anderson 2002). Models with values greater than 2 have less support. Akaike weights are probabilities estimating the strength of the evidence supporting a particular model as being the best model within the model set. Models with small w_i values are less plausible as competing models (Burnham and Anderson 2002). If no single model could be specified as the best model, a "best subset" of competing models was identified using (1) AIC_c differences to indicate the level of empirical support each model had as being the best model, (2) evidence ratios based on Akaike weights to indicate the relative probability that any model is the best model, and (3) coefficients of determination (R^2) assessing the explanatory power of each model.

The use of AIC_c indicated that the Beverton-Holt model best approximated the information in the juveniles/redd data (Table 4; Figure 6). The estimated structural parameters for this model were:

$$Juveniles = \frac{(153{,}414 \times Redds)}{(192 + Redds)}$$

where the bootstrap estimated standard errors for the two parameters were 17,099 and 55, respectively. The adjusted $R^2 = 0.84$.

The second-best model was the smooth hockey stick model, which was 1.78 AIC_c units from the best model (Table 4; Figure 6). The estimated parameters for this model were:

$$LN(Juveniles) = 11.7 + LN\left(1 - e^{-\left(\frac{714.7}{116{,}438}\right)Redds}\right)$$

where the bootstrap estimated standard errors of the two parameters were 0.08 and 128, respectively, and the R^2 = 0.83. The AIC_c difference scores, Akaike weights, and evidence ratios indicated that there was substantial support for both the Beverton-Holt and smooth hockey stick models (Table 4). There was less support for the remaining models (Ricker, Gamma[4], and Cushing), which were > 2 AIC_c units from the best models. This was further supported by the fact that, relative to the best models, the remaining models had evidence ratios greater than 20.

Because there was substantial support for both the Beverton-Holt and smooth hockey stick models, we used model averaging to compute a weighted estimate of the predicted values (productivity and population capacity[5]) (Burnham and Anderson 2002). Model averaging estimated a population capacity of 142,654 parr and an intrinsic productivity of 774 parr per spawner.

Although the Beverton-Holt, smooth hockey stick, and Ricker models have different biological assumptions, they all indicated a density-dependent relationship between spawning levels (redds) and juvenile Chinook production in the Chiwawa River basin. This was not only evident in the best approximating models, but there was also a significant negative relationship between juveniles per redd and numbers of redds in the Chiwawa River basin (Figure 7). Although data at high seeding levels are lacking, the Beverton-Holt model estimates the population capacity of juvenile Chinook in the Chiwawa River basin at about 153,414 parr. This equates to about 1,280 Chinook parr per hectare. In contrast, the smooth hockey stick model, which fit the data as well as the Beverton-Holt model, estimates the population carrying capacity for juvenile Chinook at about 116,438 parr. This equates to about 971 Chinook parr per hectare. As noted above, model averaging estimates the population capacity at 142,654, which equates to 1,190 Chinook parr per hectare. As a comparison, Thorson et al. (2013) estimated the carrying capacity for 15 populations of juvenile Chinook in the Snake River metapopulation as 5,000 juveniles per hectare. However, those authors noted that the estimate could be biased because of imperfect detectability and estimates of spawning numbers.

Steelhead/Rainbow Abundance

Based on stream surface area, we estimated a total of 11,854 (±12% of the estimated total) age-0 steelhead/rainbow (<4 in) in reaches of the Chiwawa River basin in August 2018 (Table 5). During the 1992-2018 survey period, numbers of age-0 steelhead/rainbow ranged from 1,410 to 45,727 in the Chiwawa River basin (Figure 8; Appendix B). In 1992-2018, numbers of age-0 steelhead/rainbow varied among reaches but were typically highest in the lower reaches of the Chiwawa River. In all years they most often used riffle and multiple channel habitats in the Chiwawa River, although we also found them associated with woody debris in pool and glide habitat. In tributaries, they were generally most abundant in small pools. Those that we observed

[4] The γ parameter in the Gamma model was greater than 0, which means that this model is nearly identical to the Ricker model.

[5] In these analyses, we are calculating "population" carrying capacity (*K*), which is defined as the maximum equilibrium population size estimated with population models. This should not be confused with "habitat" carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

in riffles selected stations in quiet water behind small and large boulders or occupied stations in quiet water along the stream margin. In pool and multiple-channel habitats, we found age-0 steelhead/rainbow using the same kinds of habitat as age-0 Chinook salmon.

We estimated that 3,151 (±17% of the estimated total) age-1+ steelhead/rainbow (4-8 in) lived in reaches of the Chiwawa River basin in August 2018 (Table 6). During the survey period 1992-2018, numbers of age-1+ steelhead/rainbow ranged from 754 to 22,130 (Figure 8; Appendix B). In most years, we found these fish in nearly all reaches, but they were typically most numerous in lower reaches of the Chiwawa River. We observed age-1+ steelhead/rainbow mostly in pool, riffle, and multiple-channel habitats. Those that we observed in pools were usually in deeper water than age-0 steelhead/rainbow and Chinook. Like age-0 steelhead/rainbow, age-1+ steelhead/rainbow selected stations in quiet water behind boulders in riffles, but we generally did not find the two age groups together. Age-1+ steelhead/rainbow appeared to use deeper and faster water than did age-0 steelhead/rainbow.

We estimated that steelhead/rainbow larger than 8 inches numbered 19 (±68% of the estimated total) in the Chiwawa River basin in August 2018 (Table 7). During the period 1992-2018, steelhead/rainbow numbers ranged from 8 to 1,869 (Appendix B). Steelhead/rainbow larger than 8 inches were generally most abundant in the lower Chiwawa River; however, in 1992 and 1993, they were most abundant near campgrounds in Reaches 8, 9, and 10 (these were mostly hatchery rainbow trout planted near the campgrounds). We found very few in tributaries. Most of the steelhead/rainbow larger than 8 inches used deep pools (>5 feet), and occupied stations near the bottom at the upstream end of pools.

Bull Trout Abundance

We estimated, based on surface area that at least 256 (±16% of the estimated total) juvenile (2-8 in) bull trout lived in reaches of the Chiwawa River basin in August 2018 (Table 8). We found most of these fish in the upper-most reaches of the Chiwawa River and in Rock, Chikamin, and Phelps creeks. During 1992-2018, numbers of juvenile bull trout ranged from 79 to 505 (Figure 9; Appendix B). These estimates and those for adult bull trout are incomplete because we did not sample the entire range of bull trout in all tributaries. That is, we did not extend our surveys into the headwaters of the Chiwawa River because there were no juvenile Chinook there. Areas beyond the distribution of juvenile Chinook salmon are known to support bull trout, steelhead/rainbow, and cutthroat trout (USFS 1993). In addition, our estimates of bull trout abundance were based on daytime snorkel surveys, which may underestimate the actual abundance of bull trout.[6] Several studies (e.g., Goetz 1994; Thurow and Schill 1996; Hillman and Chapman 1996; Bonar et al. 1997) have found bull trout population estimates based on nighttime snorkeling to be in some cases more accurate than daytime snorkeling, especially for juvenile bull trout. Our estimates of adult bull trout numbers may be more accurate than those for juveniles.

In all years, we found most juvenile bull trout in the upstream reaches of the Chiwawa River. In 2018, they occurred primarily in Reaches 9-10 on the Chiwawa River. We found the majority of

[6] Because there are no estimates for probability of detecting bull trout with daytime underwater observation methods in the Chiwawa River basin, we could not adjust bull trout numbers based on detectability. Therefore, the numbers reported in this report likely underestimate the "true" number of bull trout in the survey area.

these fish in multiple channels, pools, and riffles, and few in glides. They consistently occupied stations close to the stream bottom over rubble and small boulder substrate or near woody debris. This is similar to the observation of Pratt (1984) in the upper Flathead River Basin in Montana. She found that juvenile bull trout lay close to instream cover and that they tended to conceal themselves. Consequently, she found it difficult to estimate accurately their numbers. Although this implies that we underestimated numbers of juvenile bull trout in the Chiwawa River, the relative distribution of juvenile bull trout is valid if we assume that we saw the same fraction of juveniles in all reaches (i.e., detection probability was the same across survey sites).

We estimated a total of 1,380 (±10% of the estimated total) adult (>8 in) bull trout in reaches of the Chiwawa River basin in August 2018 (Table 9). This was the second highest number of adult bull trout that we recorded during the more than 20-year survey period. During 1992-2018, numbers of adult bull trout ranged from 76 to 2,286 (Figure 9; Appendix B). As with juvenile bull trout, we found most of the adult bull trout upstream from Reach 6; although they were found in all reaches on the Chiwawa River. We found few adult bull trout in tributaries of the Chiwawa River. Adult bull trout primarily used pools and multiple channel habitat, although most of the smaller adults (<10 in) used riffles.

Abundance of Other Salmonids

In August 2018, we estimated that at least 208 brook trout, an exotic species closely related to the bull trout, occurred in the Chiwawa River, Chikamin Creek, Big Meadow Creek, Minnow Creek, and in the Little Wenatchee River survey areas. In both the Chiwawa and Little Wenatchee rivers, brook trout usually used multiple channels and pools. Few appeared to be bull trout/brook trout hybrids. In Chikamin, Minnow, and Big Meadow creeks, brook trout were most abundant in pools. Brook trout lengths ranged from 2-12 inches.

At least 432 westslope cutthroat trout occurred in the Chiwawa River, Phelps Creek, Rock Creek, and Little Wenatchee River survey areas in August 2018. These fish most often occurred in pools and multiple channel habitats. They ranged in size from 2-23 inches. Few juvenile coho salmon were observed in the lower Chiwawa River.

We observed both juvenile and adult mountain whitefish in the Chiwawa River, Phelps Creek, Rock Creek, and the Little Wenatchee River survey areas. In sum, at least 6,419 adult and 1,917 juvenile whitefish lived in these streams in August 2018. Most were in the mainstem Chiwawa River; few whitefish occurred in tributaries to the Chiwawa River.

Conclusion

This was the 26th year of a study to monitor trends in juvenile spring Chinook production in the Chiwawa River basin. As shown in Figure 3, numbers of juvenile Chinook salmon in the Chiwawa River basin have fluctuated widely over the 26-year period. Numbers of juveniles in 2001, 2002, and 2009-2017 were some of the highest recorded, while numbers in the mid-1990s were some of the lowest. Interestingly, the highest spawning escapements (highest redd numbers) resulted in the lowest egg-parr survival rates (Appendix A). This is supported by the fact that the best approximating models clearly demonstrated a density-dependent relationship between seeding levels and juvenile production. Indeed, there was a significant negative relationship between parr per redd and numbers of redds in the Chiwawa River basin. This is an important observation because some of the hypotheses in the revised monitoring and evaluation plan (Hillman et al. 2013) are only valid when the supplemented population is below its carrying capacity.

The best fitting stock-recruitment models indicate that the population capacity of the Chiwawa River basin is between 116,000 to 153,000 spring Chinook parr. This equates to an overall density of about 971-1,280 parr per hectare. These densities can be achieved with about 488 redds. Assuming a female Chinook produces only one redd (Murdoch et al. 2009), a spawning escapement of about 488 females is needed to fill the capacity of the Chiwawa River basin.

The proportion of hatchery-origin spawners (pHOS) within the Chiwawa River basin during the survey period has ranged from 0 to 100%. Thus, some of the variation in juvenile productivity may be related to pHOS. Although there appeared to be a negative relationship between juvenile productivity (parr/redd) and pHOS, the correlation was not significant (Figure 10). In addition, there was no relationship between juvenile productivity and pHOS after the effects of spawning escapement were removed from the analysis (Figure 10). This suggests that spawning escapement has a larger effect on juvenile productivity than does the presence of hatchery spawners.

The presence of density dependence in the early life stages of spring Chinook is not surprising. Rarely does density dependence appear in numbers of adult spring Chinook or on their spawning grounds. The Chiwawa River basin appears to have plenty of spawning habitat, as indicated by the large numbers of spawners and redds widely distributed throughout the basin during high spawning escapements. However, those large spawning escapements did not translate into large numbers of juveniles or smolts. Thus, density-dependent regulation appears to occur sometime during the early life stages of the fish, likely at the fry or early parr stage. It is possible that physical habitat (space) during higher flows when fry are emerging may limit juvenile Chinook production in the basin. Low nutrient levels and its effects on food webs may also be a limiting factor in the basin. If spawning escapements remain relatively high, marine-derived nutrients should increase in the basin, resulting in more food for juvenile Chinook salmon.

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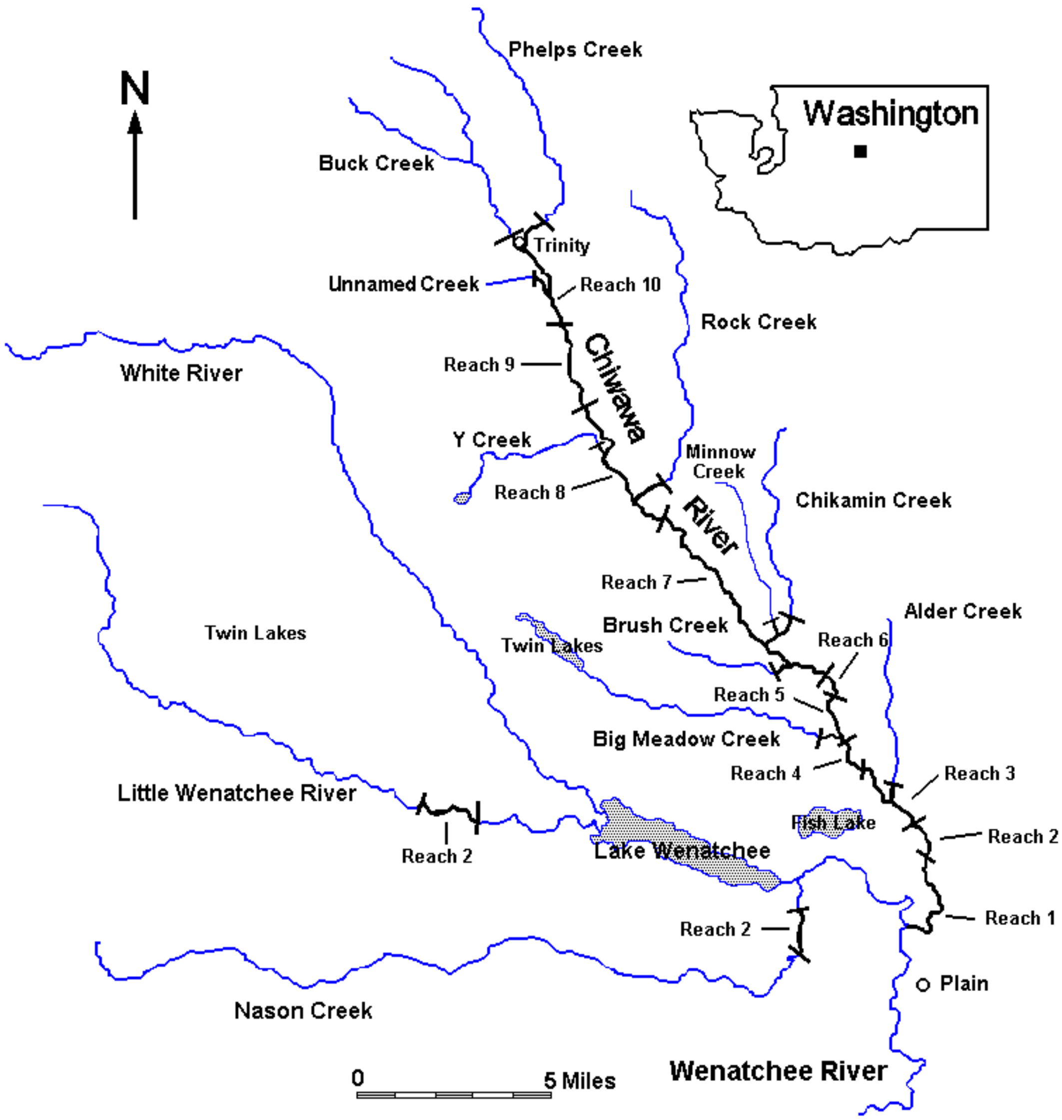

Figure 1. Location of study reaches on the Chiwawa River, and Chikamin, Rock, Big Meadow, Unnamed, Alder, Brush and Phelps creeks, Chelan County, Washington. Reach 2 on Nason Creek and Reach 2 on the Little Wenatchee River were matched with Reaches 3 and 8 on the Chiwawa River, respectively. Nason Creek is no longer used as a reference.

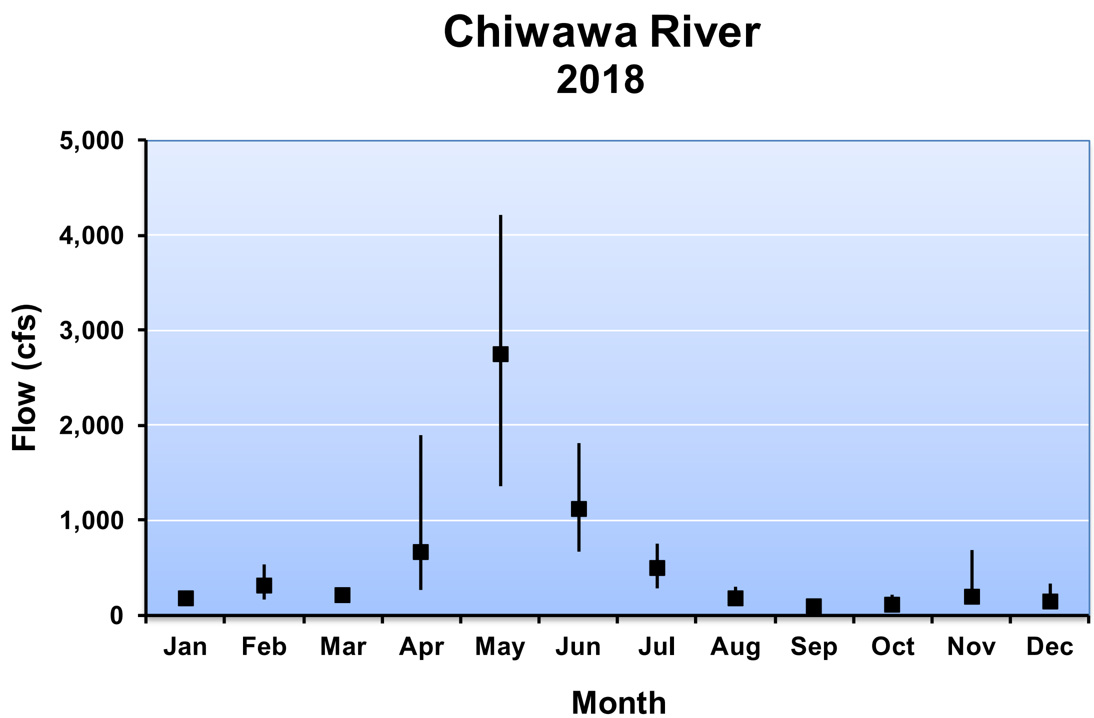

Figure 2. Mean, minimum, and maximum monthly flows in the Chiwawa River for 2018.

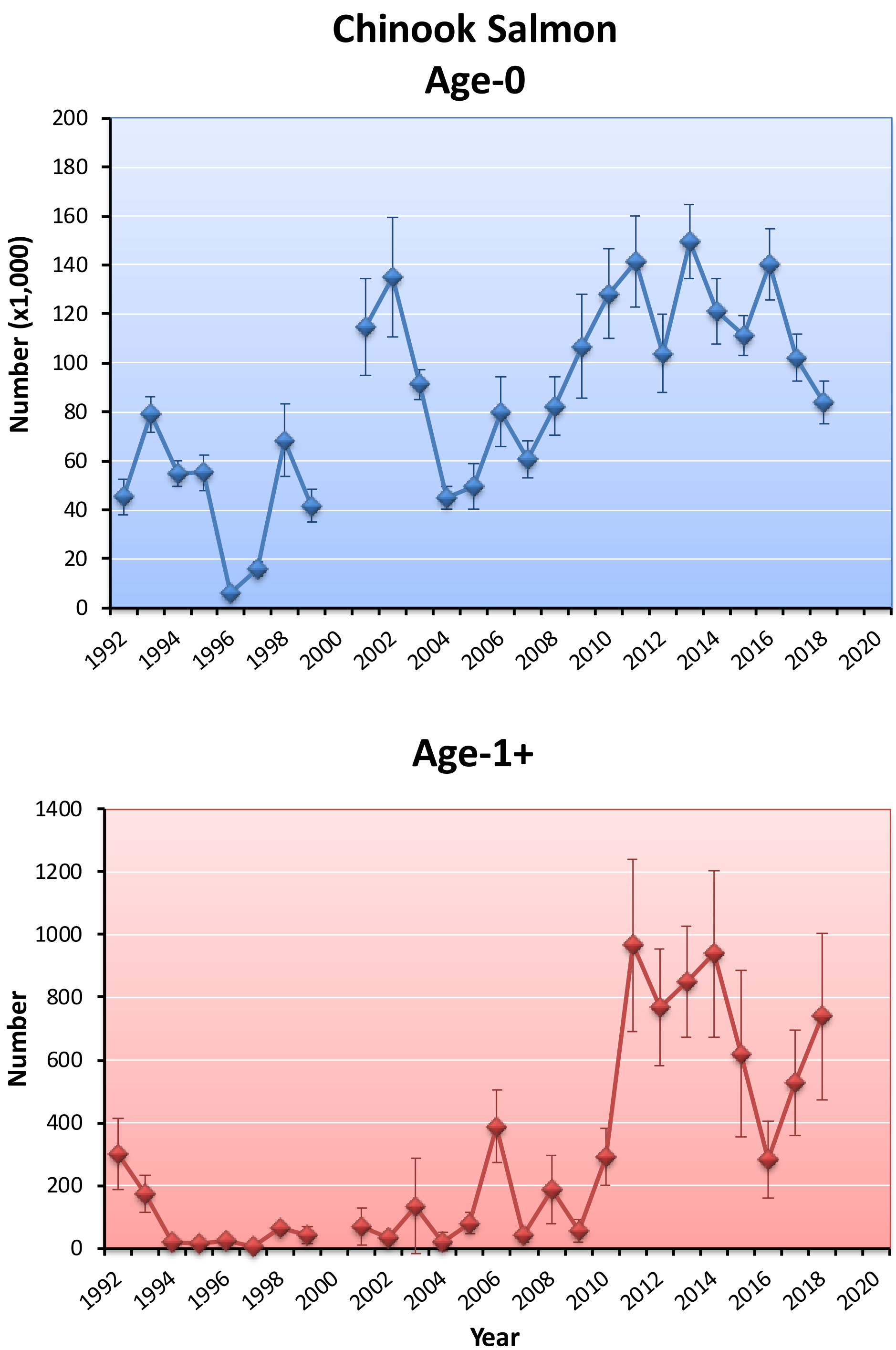

Figure 3. Numbers of age-0 and age-1+ Chinook salmon within the Chiwawa River basin in August 1992-2018. Vertical bars indicate 95% confidence bounds.

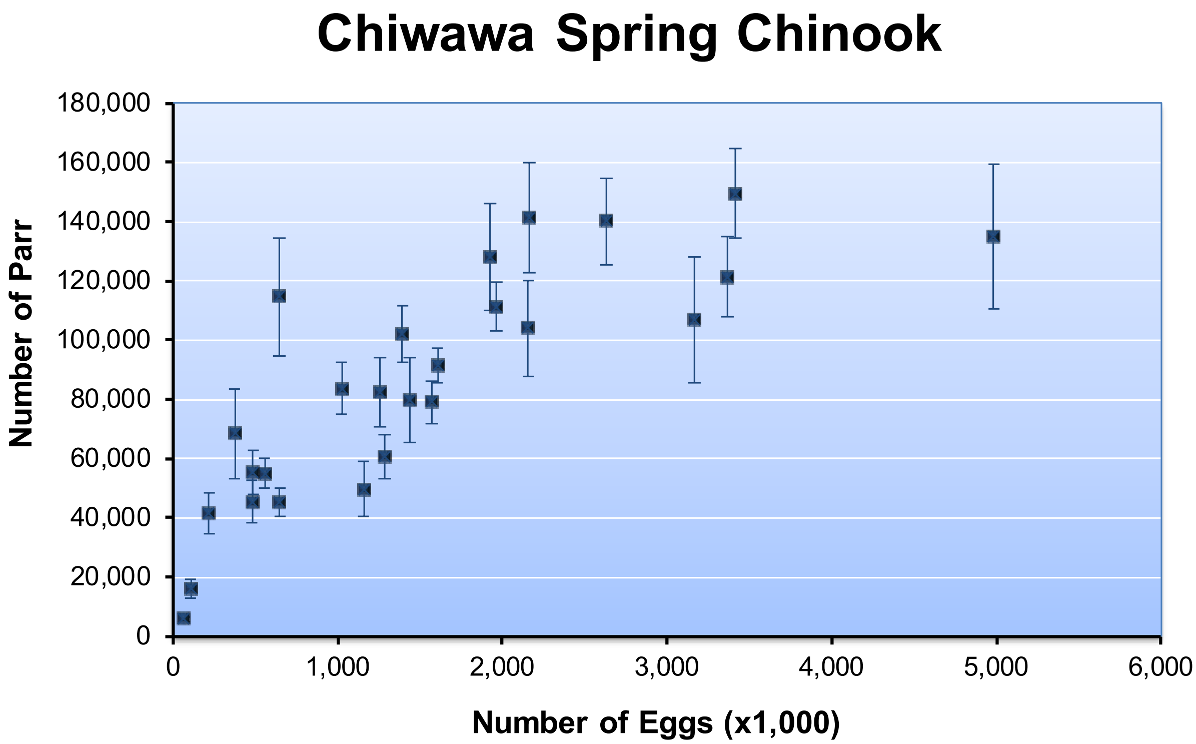

Figure 4. Relationship between total number of Chinook salmon parr counted during the summer (based on fish/ha) and number of eggs deposited in the Chiwawa River basin, 1992-2018. Vertical bars indicate 95% confidence bounds.

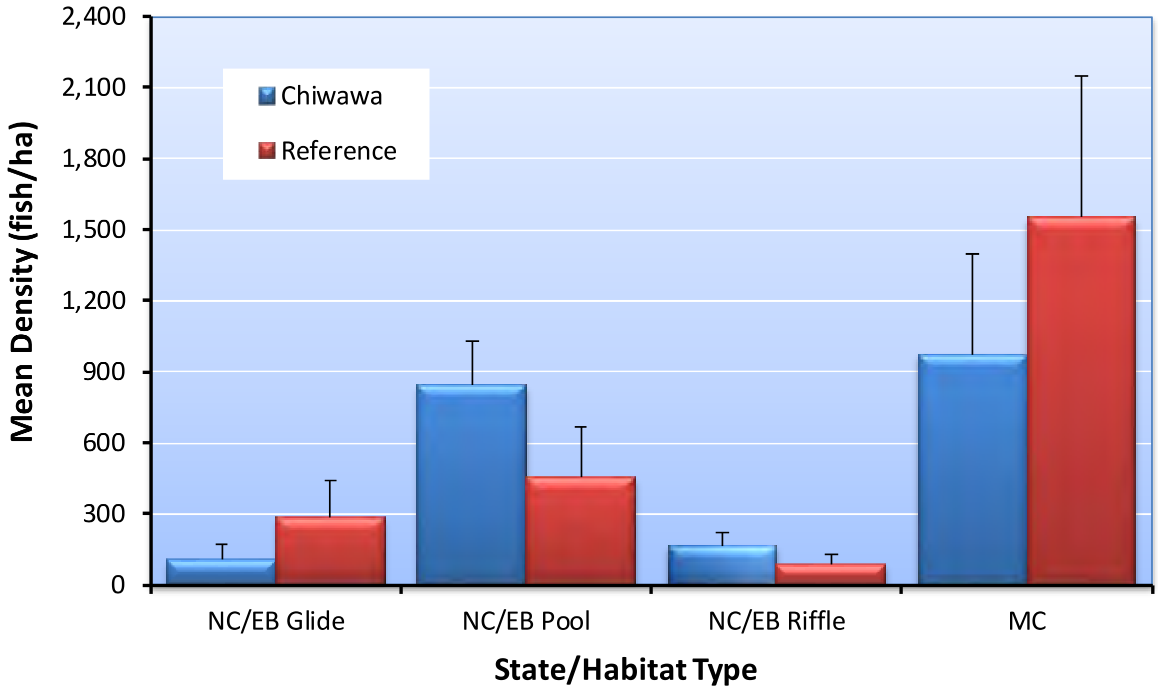

Figure 5. Comparison of the means (95% CI) of age-0 Chinook salmon densities (fish/ha) within state/habitat types in Reach 8 of the Chiwawa River and their matched reference areas on the Little Wenatchee River. There was no sampling in 2000 and no sampling in reference areas in 1992.

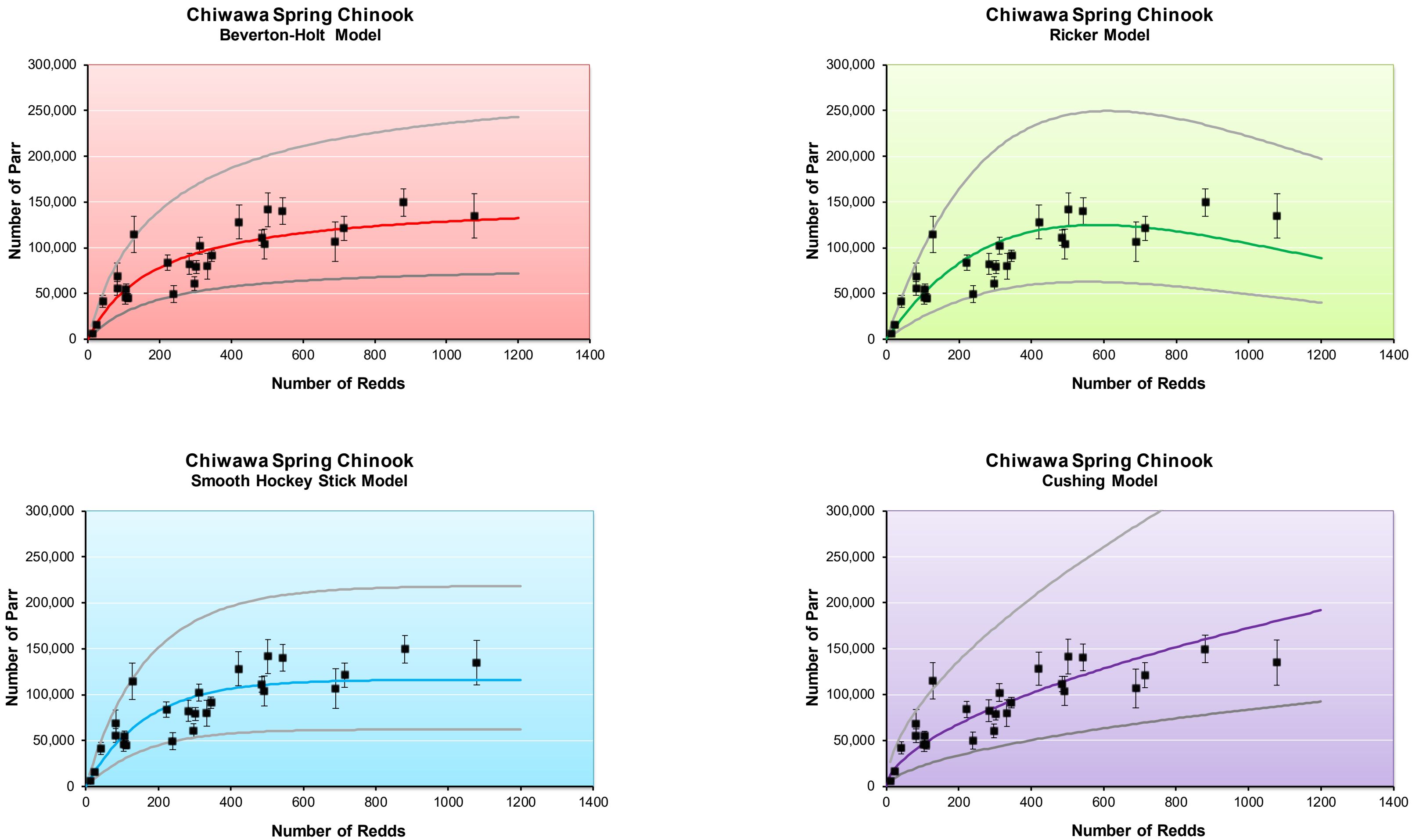

Figure 6. Relationship between numbers of juvenile (age-0) Chinook and redds in the Chiwawa River basin, 1992-2018 (no sampling occurred in 2000). Figures show the fit of the Beverton-Holt model, smooth hockey stick, Ricker model, and the Cushing model to the data. Gray lines indicate the upper and lower 95% C.B.

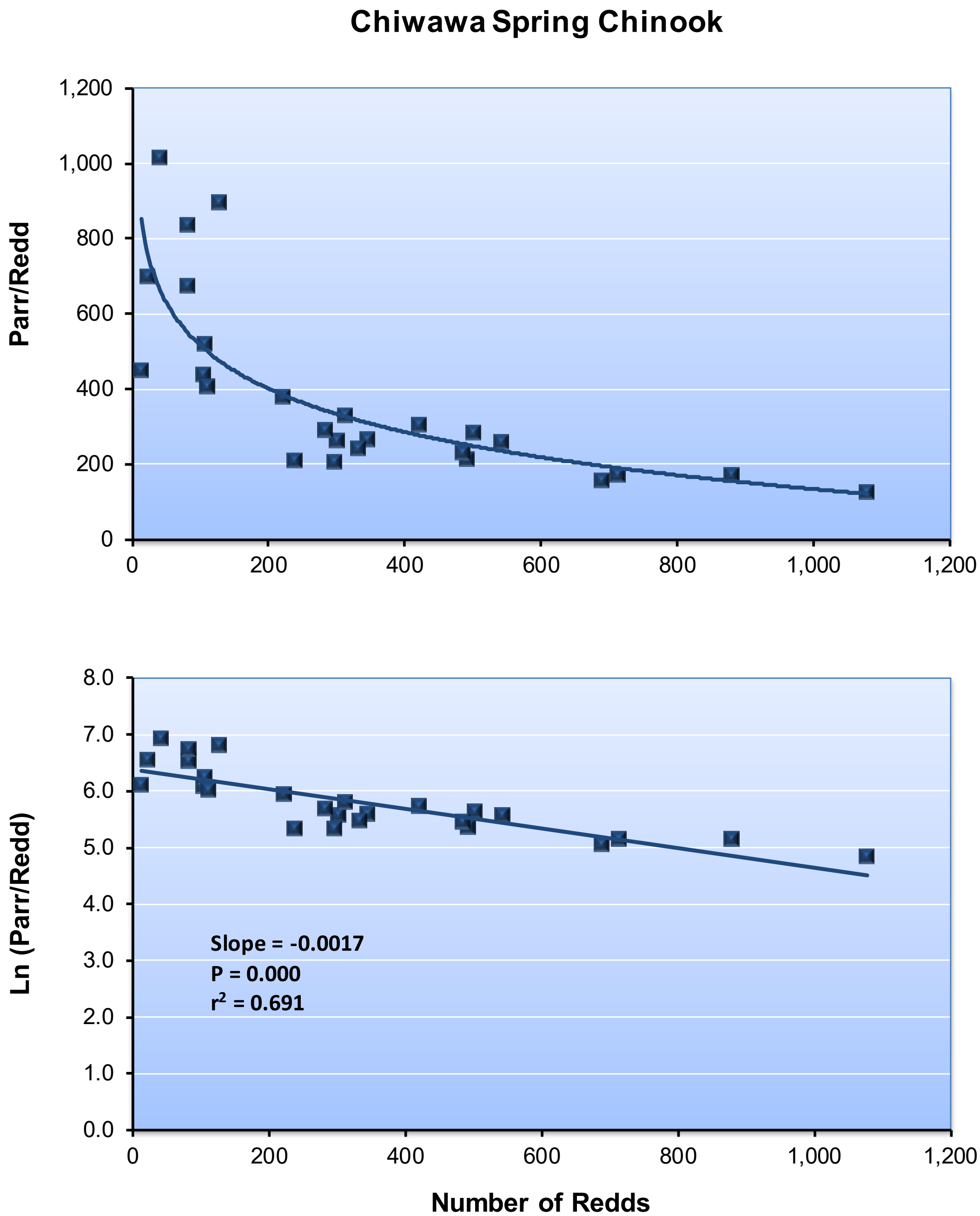

Figure 7. Relationship between parr/redd and numbers of redds (top figure) and natural log parr/redd and numbers of redds (bottom figure) in the Chiwawa River basin, 1992-2018. No sampling was conducted in 2000. Estimates for 1993-2018 included the Chiwawa River and its tributaries; the 1992 estimate included only the Chiwawa River. The linear relationship LN(P/R) = 6.3728 – 0.0017(Redds) was significant with P = 0.000; r^2 = 0.691.

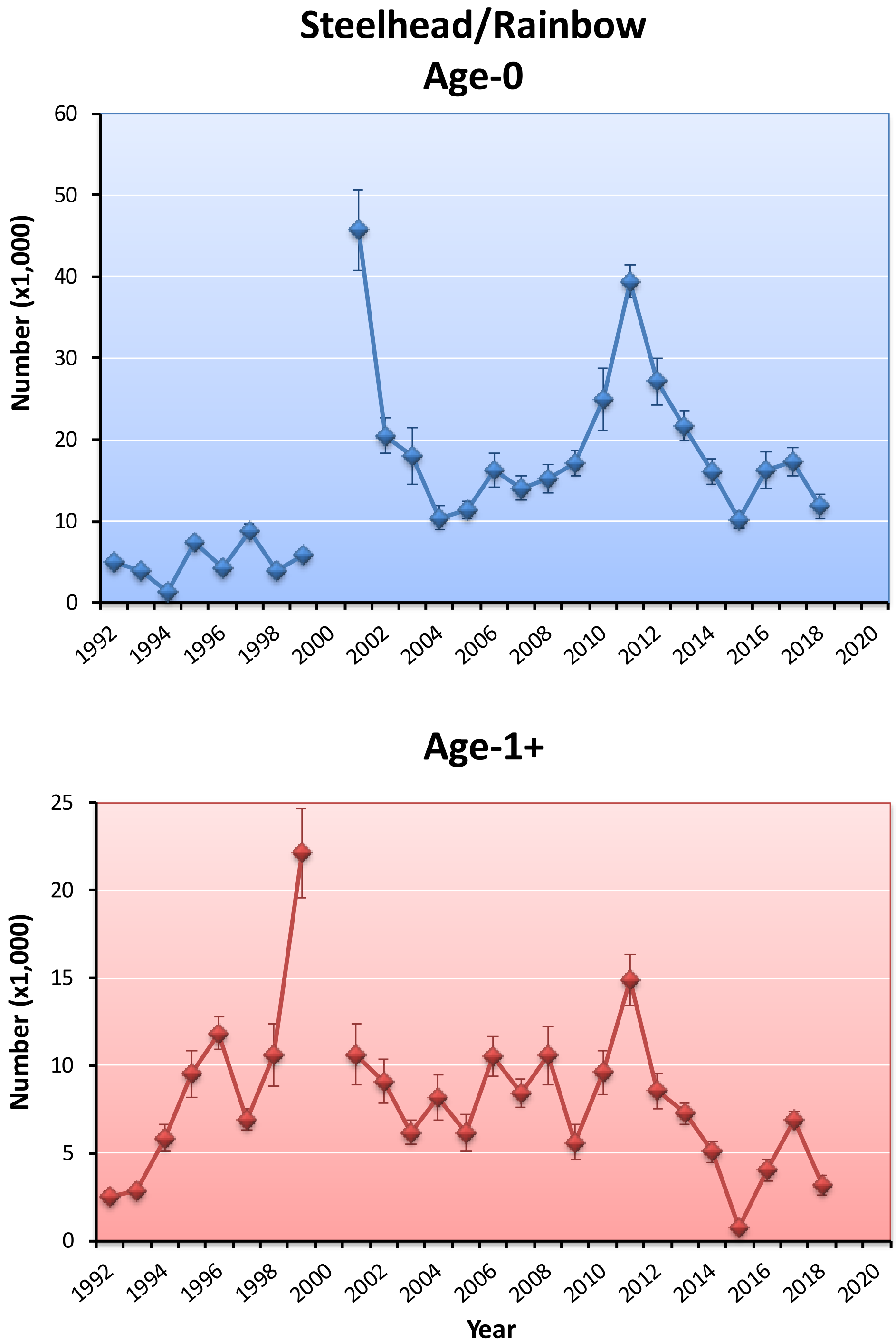

Figure 8. Numbers of age-0 (<4 in) and age-1+ (4-8 in) steelhead/rainbow within the Chiwawa River basin in August 1992-2018. Vertical bars indicate 95% confidence bounds.

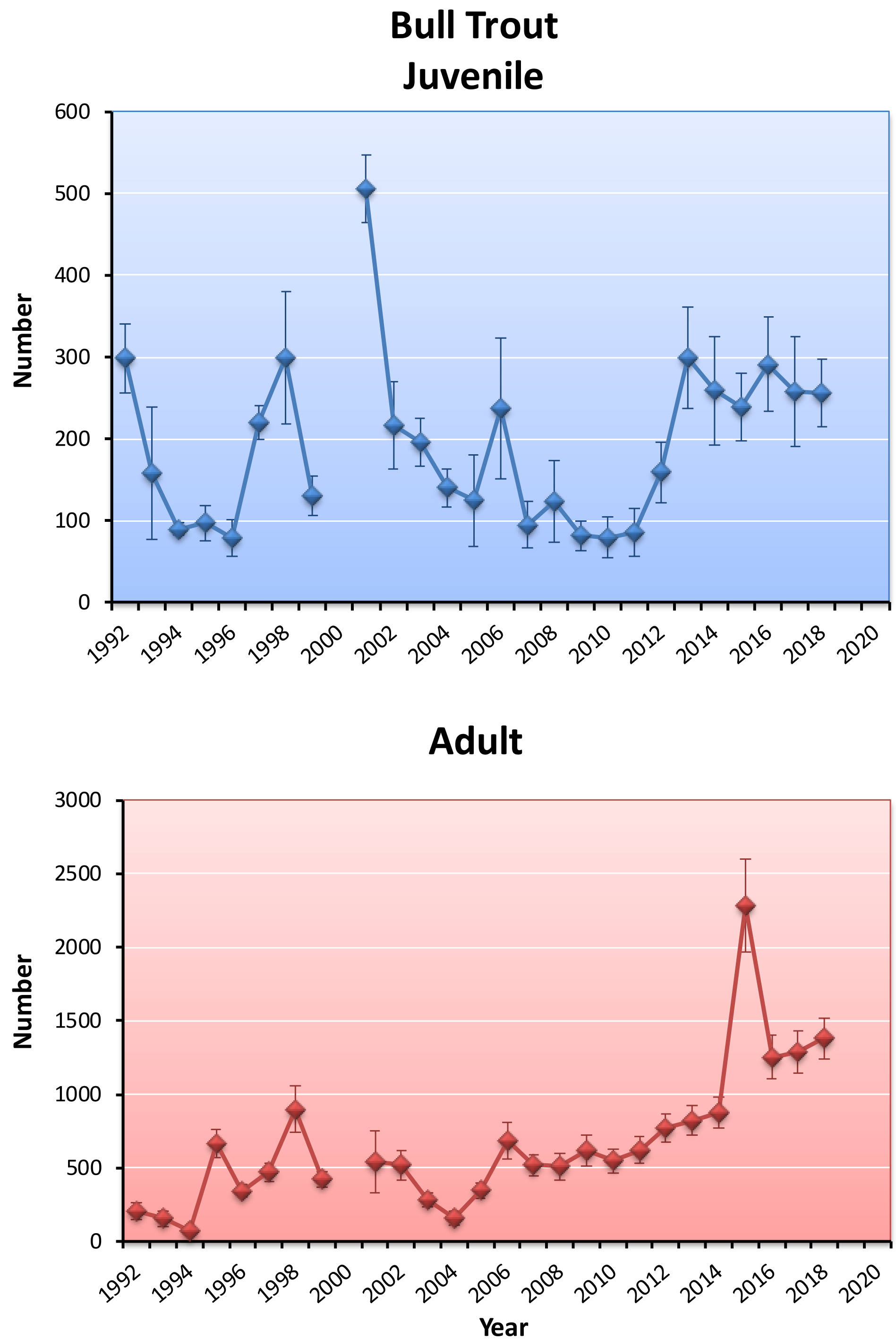

Figure 9. Numbers of juvenile (2-8 inches) and adult (>8 inches) bull trout within the Chiwawa River basin in August 1992-2018. Vertical bars indicate 95% confidence bounds.

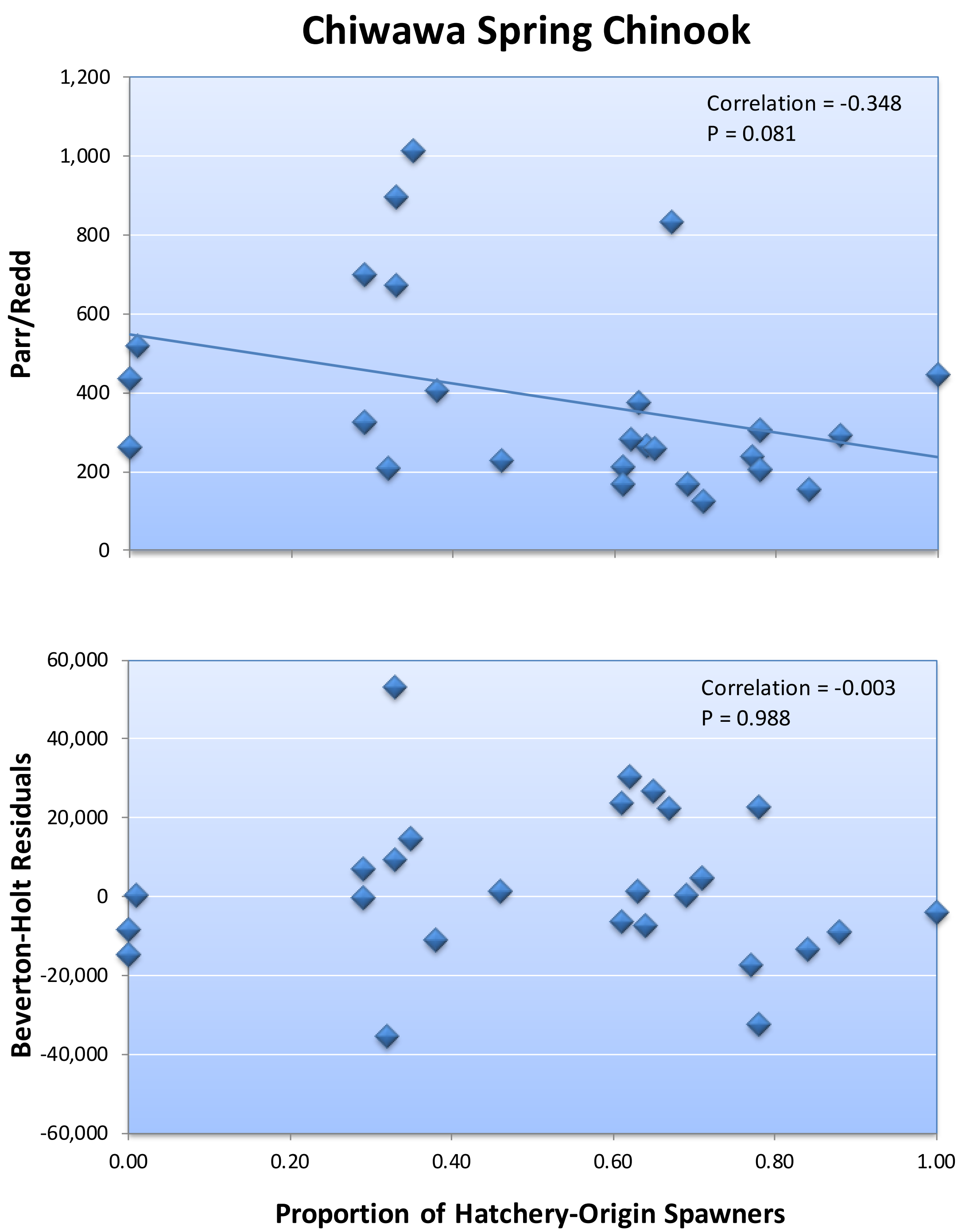

Figure 10. Relationship between juvenile productivity (parr/redd) and the proportion of hatchery-origin spawners (pHOS) (top figure) and the relationship between the residuals from the Beverton-Holt stock/recruitment relationship and pHOS (bottom figure).

Table 1. Description, location (river mile), and area (hectares) of land-class strata (reaches) used by age-0 Chinook salmon in the Chiwawa River basin, 2018. Reaches were classified according to geologic district, land-type association, valley-bottom type, stream state-type, and habitat type within the Cascade Ecoregion; MCV = moderately confined valley, CC = confined canyon, UCV = unconfined valley, NC = natural channel, EB = eroded banks, S = straight, G = glide, P = pool, R = riffle, and MC = multiple channel. See Hillman and Miller (2004) for definitions of stream state codes.

Reach	RM	Gradient	Geologic district	Landtype association	Valley bottom type	Stream state type	Habitat type	Area (ha)	
								Total	Sample
Chiwawa River									
1	0.00-3.77	0.007	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/EB	G	0.58	0.58
						NC/EB	P	1.36	1.04
						NC/EB	R	16.22	1.73
2	3.77-5.51	0.010	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	G	0.31	0.31
						NC/EB	P	0.65	0.23
						NC/EB	R	6.90	0.62
3	5.51-7.88	0.009	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/S	R	5.17	0.74
						NC/EB	G	0.13	0.13
						NC/EB	R	4.35	0.58
						MC	MC	0.27	0.27
4	7.88-8.90	0.007	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.37	0.26
						NC/EB	R	2.62	0.39
						MC	MC	0.45	0.45
5	8.90-10.83	0.011	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/EB	P	0.12	0.12
						NC/EB	R	8.58	0.95
6	10.83-11.80	0.008	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.41	0.41
						NC/EB	R	3.69	1.04
						MC	MC	0.33	0.33
7	11.80-20.03	0.001	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	1.71	0.92
						NC	P	5.65	0.53
						NC	R	0.87	0.33
						NC/EB	G	2.43	1.31
						NC/EB	P	6.33	1.64
						NC/EB	R	4.43	0.51
						MC	MC	4.11	1.89
8	20.03-25.42	0.003	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC/EB	G	2.78	1.08
						NC/EB	P	7.46	1.74
						NC/EB	R	5.30	1.36
						EB	P	0.20	0.20
						EB	R	0.28	0.28
						MC	MC	6.79	2.99
9	25.42-28.81	0.007	Glacial Drift over Swakane Gneiss	Glacial Valley	MCV Alluvial	NC	P	3.73	0.49
						NC	R	2.58	0.62
						MC	MC	3.14	0.52
10	28.81-31.11	0.011	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.63	0.37
						NC	R	2.40	0.75
						MC	MC	4.23	0.34

Table 1. Concluded.

Reach	RM	Gradient	Geologic district	Landtype association	Valley bottom type	Stream state type	Habitat type	Area (ha)	
								Total	Sampled
Trinity Side Channel									
10b	0.00-0.75	0.011	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.38	0.03
						NC	R	0.19	0.04
						NC	MC	0.14	0.14
Phelps Creek									
1	0.00-0.35	0.043	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	R	0.00	0.00
						NC	MC	0.05	0.05
Chikamin Creek[1]									
1	0.00-0.94	0.013	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	0.07	0.07
						NC	P	0.23	0.07
						NC	R	0.32	0.10
						MC	MC	0.12	0.12
Rock Creek									
1	0.00-0.73	0.020	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC	G	0.00	0.00
						NC	P	0.19	0.07
						NC	R	0.29	0.06
						MC	MC	0.06	0.06
Unnamed Creek									
1	0.00-0.05		Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.01	0.01
						NC	R	0.00	0.00
Big Meadow Creek									
1	0.00-0.35	0.025	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC	G	0.00	0.00
						NC	P	0.09	0.02
						NC	R	0.12	0.03
						NC	MC	0.05	0.05
Alder Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC	P	0.002	0.002
						NC	R	0.006	0.006
Brush Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.003	0.003
						NC	R	0.004	0.004
Clear Creek									
1	0.00-0.05		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.001	0.001
						NC	R	0.005	0.005
Y Creek									
1	0.00-0.05		Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC	P	0.000	0.000
						NC	R	0.000	0.000

[1] Includes the lower 0.2 miles of Minnow Creek.

Table 2. Estimated mean densities (fish/hectare and fish/m³), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-0 Chinook salmon in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m³)		
	Fish/ha	Fish/m³	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	121.5	0.038	2,207	±283	0.13	2,213	±325	0.15
2	239.6	0.054	1,883	±938	0.50	1,746	±1,007	0.58
3	104.2	0.031	1,034	±24	0.02	1,239	±24	0.02
4	298.8	0.065	1,028	±91	0.09	1,122	±105	0.09
5	34.0	0.008	296	±18	0.06	267	±26	0.10
6	138.4	0.040	613	±27	0.04	582	±40	0.07
7	1,219.8	0.208	31,142	±7,432	0.24	33,231	±4,808	0.14
8	606.0	0.099	13,823	±3,297	0.24	12,118	±5,061	0.42
9	870.7	0.163	8,228	±1,862	0.23	8,800	±1,334	0.15
10	2,282.9	0.622	18,195	±2,391	0.13	17,271	±2,657	0.15
Phelps Creek								
1	1,460.0	0.908	73	±0	0.00	73	±0	0.00
Chikamin Creek[1]								
1	2,695.9	1.255	1,995	±417	0.21	1,954	±263	0.13
Rock Creek								
1	3,764.8	1.174	2,033	±403	0.20	1,657	±804	0.49
Unnamed Creek								
1	1,545.5	0.370	17	±0	0.00	17	±0	0.00
Big Meadow Creek								
1	3,969.0	1.768	1,024	±359	0.35	845	±513	0.61
Alder Creek								
1	4,000.0	4.638	32	±0	0.00	32	±0	0.00
Brush Creek								
1	13,571.4	12.338	95	±0	0.00	95	±0	0.00
Clear Creek								
1	1,833.3	2.076	11	±0	0.00	11	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**698.4**	**0.148**	**83,729**	**±8,760**	**0.10**	**83,273**	**±7,726**	**0.09**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 3. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-1+ Chinook salmon in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	2.5	0.001	45	±16	0.36	47	±26	0.55
2	7.8	0.002	61	±10	0.16	55	±15	0.27
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	7.3	0.002	25	±0	0.00	26	±0	0.00
5	0.0	0.000	0	±0	0.00	0	±0	0.00
6	2.5	0.001	11	±0	0.00	10	±0	0.00
7	9.1	0.002	233	±160	0.69	256	±166	0.65
8	10.3	0.002	234	±194	0.83	209	±267	1.28
9	12.4	0.002	117	±82	0.70	129	±85	0.66
10	1.6	0.001	13	±12	0.92	13	±15	1.15
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**6.2**	**0.001**	**739**	**±266**	**0.36**	**745**	**±327**	**0.44**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 4. Summary of the five productivity models of juvenile (age-0) Chinook salmon in the Chiwawa River basin. Models are shown, including the number of parameters (*K*), AIC_c values, AIC_c difference scores (Δ_i), the likelihood of the model given the data (*£*($g_i|x$)), Akaike weights (w_i), and adjusted R^2 values. The sample size (*n*) for all models was 26. Models describe the relationship between juvenile Chinook numbers (dependent variable) and redd numbers (independent variable).

Model	K^a	AIC_c	Δ_i	*£*($g_i|x$)	w_i	*Adj* R^2
Beverton-Holt	3	-146.089	0.000	1.000	0.677	0.844
Smooth Hockey Stick	3	-144.313	1.776	0.411	0.278	0.833
Gamma[b]	4	-139.358	6.731	0.035	0.023	0.810
Ricker	3	-138.419	7.670	0.022	0.015	0.790
Cushing	3	-136.971	9.118	0.010	0.007	0.778

[a] ***K*** is the number of structural parameters in the model plus 1 for σ^2.
[b] The γ parameter in the Gamma model was greater than 0, which means that this model is nearly identical to the Ricker model.

Table 5. Estimated mean densities (fish/hectare and fish/m³), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-0 (<4 in) steelhead/rainbow in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	71.5	0.022	1,299	±251	0.19	1,271	±257	0.20
2	149.9	0.038	1,178	±179	0.15	1,218	±174	0.14
3	83.8	0.024	831	±74	0.09	965	±65	0.07
4	229.4	0.056	789	±160	0.20	970	±154	0.16
5	128.3	0.031	1,116	±47	0.04	993	±49	0.05
6	80.6	0.021	357	±36	0.10	315	±36	0.11
7	81.7	0.015	2,085	±1,064	0.51	2,334	±1,034	0.44
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	1,381.1	0.650	1,022	±402	0.39	1,013	±368	0.36
Rock Creek								
1	3,100.0	1.0.18	1,674	±710	0.42	1,437	±1,021	0.71
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	5,376.0	2.438	1,387	±420	0.30	1,165	±684	0.59
Alder Creek								
1	2,500.0	2.899	20	±0	0.00	20	±0	0.00
Brush Creek								
1	11,142.9	10.130	78	±0	0.00	78	±0	0.00
Clear Creek								
1	3,000.0	3.396	18	±0	0.00	18	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**98.9**	**0.021**	**11,854**	**±1,450**	**0.12**	**11,797**	**±1,686**	**0.14**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 6. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-1+ (4-8 in) steelhead/rainbow in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	47.6	0.015	865	±150	0.17	853	±160	0.19
2	95.8	0.024	753	±298	0.40	764	±300	0.39
3	26.7	0.008	265	±32	0.12	335	±32	0.10
4	24.4	0.005	84	±31	0.37	83	±17	0.20
5	26.6	0.006	231	±42	0.18	204	±45	0.22
6	33.4	0.009	148	±53	0.36	130	±56	0.43
7	16.9	0.003	432	±391	0.91	496	±414	0.83
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	89.2	0.040	66	±53	0.80	63	±48	0.76
Rock Creek								
1	118.5	0.037	64	±86	1.34	52	±91	1.75
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	941.9	0.439	243	±147	0.60	210	±185	0.88
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**26.3**	**0.006**	**3,151**	**±550**	**0.17**	**3,190**	**±581**	**0.18**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 7. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of steelhead/rainbow larger than 8 inches in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	0.1	0.000	1	±2	2.00	1	±3	3.00
2	0.4	0.000	3	±3	1.00	3	±4	1.33
3	0.2	0.000	2	±0	0.00	2	±0	0.00
4	0.0	0.000	0	±0	0.00	0	±0	0.00
5	0.0	0.000	0	±0	0.00	0	±0	0.00
6	0.0	0.000	0	±0	0.00	0	±0	0.00
7	0.5	0.000	13	±13	1.00	16	±13	0.81
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**0.2**	**0.000**	**19**	**±13**	**0.68**	**22**	**±14**	**0.64**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 8. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of juvenile bull trout (2-8 in) in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	0.1	0.000	1	±3	3.00	1	±3	3.00
2	0.0	0.000	0	±0	0.00	0	±0	0.00
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	0.0	0.000	0	±0	0.00	0	±0	0.00
5	0.0	0.000	0	±0	0.00	0	±0	0.00
6	0.0	0.000	0	±0	0.00	0	±0	0.00
7	0.0	0.000	0	±0	0.00	0	±0	0.00
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	6.7	0.001	63	±21	0.33	65	±46	0.71
10	13.8	0.006	110	±19	0.17	163	±28	0.17
Phelps Creek								
1	420.0	0.261	21	±13	0.62	21	±10	0.48
Chikamin Creek[1]								
1	14.9	0.008	11	±26	2.36	12	±36	3.00
Rock Creek								
1	92.6	0.030	50	±0	0.00	42	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**2.1**	**0.001**	**256**	**±41**	**0.16**	**304**	**±65**	**0.21**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 9. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of adult bull trout (>8 in) in reaches in the Chiwawa River basin, Washington, August 2018.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	1.0	0.000	18	±10	0.56	18	±26	1.44
2	3.6	0.001	28	±6	0.21	26	±26	1.00
3	0.9	0.000	9	±0	0.00	8	±0	0.00
4	2.3	0.001	8	±4	0.50	9	±5	0.56
5	2.1	0.001	18	±0	0.00	16	±0	0.00
6	1.1	0.000	5	±0	0.00	4	±0	0.00
7	11.5	0.002	294	±61	0.21	320	±144	0.45
8	9.8	0.002	224	±93	0.42	209	±169	0.81
9	28.6	0.005	270	±34	0.13	280	±89	0.32
10	62.2	0.015	496	±79	0.16	427	±80	0.19
Phelps Creek								
1	80.0	0.050	4	±0	0.00	4	±0	0.00
Chikamin Creek[1]								
1	4.1	0.002	3	±6	2.00	3	±6	2.00
Rock Creek								
1	5.6	0.001	3	±5	1.67	2	±5	2.50
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**11.5**	**0.002**	**1,380**	**±141**	**0.10**	**1,326**	**±256**	**0.19**

[1] Includes lower 0.2 miles of Minnow Creek.

APPENDIX A. Numbers of redds, eggs, age-0 Chinook salmon, parr per redd, and percent egg-to-parr survival in the Chiwawa River basin, brood years 1991-2017; NS = not sampled. Numbers of eggs were calculated as the number of redds times the mean fecundity of females collected for broodstock.

Brood Year	Chinook Salmon			Parr/Redd	Egg-to-parr survival (%)
	Redds	Eggs	Age-0 (parr)		
1991	104	478,400	45,483	437	9.5
1992	302	1,570,098	79,113	262	5.0
1993	106	556,394	55,056	519	9.9
1994	82	485,686	55,240	674	11.4
1995	13	66,248	5,815	447	8.8
1996	23	106,835	16,066	699	15.0
1997	82	374,740	68,415	834	18.3
1998	41	218,325	41,629	1,015	19.1
1999	34	166,090	NS	NS	NS
2000	128	642,944	114,617	895	17.8
2001	1,078	4,984,672	134,874	125	2.7
2002	345	1,605,630	91,278	265	5.7
2003	111	648,684	45,177	407	7.0
2004	241	1,156,559	49,631	206	4.3
2005	332	1,436,564	79,902	241	5.6
2006	297	1,284,228	60,752	205	4.7
2007	283	1,256,803	82,351	291	6.6
2008	689	3,163,888	106,705	155	3.4
2009	421	1,925,233	128,220	305	6.7
2010	502	2,165,628	141,510	282	6.5
2011	492	2,157,420	103,940	211	4.8
2012	880	3,716,240	149,563	185	4.4
2013	714	3,367,224	121,240	170	3.6
2014	485	1,961,825	111,224	229	5.7
2015	543	2,631,921	140,172	258	5.3
2016	312	1,393,704	102,106	327	7.3
2017	222	1,024,530	83,729	377	8.2
Average	**328**	**1,501,723**	**85,146**	**385**	**8.0**

APPENDIX B. Estimated numbers of salmonids (based on fish/ha) in the Chiwawa River basin, Washington, 1992-2018; NS = not sampled.

Survey year	Chinook salmon		Steelhead/Rainbow			Bull trout		Cutthroat trout
	Age-0	Age-1+	Age-0	Age-1+	>8 in[1]	2-8 in	>8 in	
1992[2]	45,483	563	4,927	2,533	1,869	299	208	NS
1993	79,113	174	4,004	2,860	768	158	156	NS
1994	55,056	18	1,410	5,856	67	90	76	NS
1995	55,241	13	7,357	9,517	140	97	664	NS
1996	5,815	22	4,245	11,849	78	79	343	NS
1997	16,066	5	8,823	6,905	48	220	472	56
1998	68,415	63	3,921	10,585	78	300	900	93
1999	41,629	41	5,838	22,130	33	130	423	80
2000	NS	NS	NS	NS	NS	NS	NS	NS
2001	114,617	69	45,727	10,623	420	505	542	108
2002	134,874	32	20,521	9,090	181	217	521	111
2003	91,278	134	18,020	6,179	49	196	282	52
2004	45,177	21	10,380	8,190	8	140	157	22
2005	49,631	79	11,463	6,188	48	125	346	23
2006	79,902	388	16,245	10,533	50	238	686	68
2007	60,752	41	14,073	8,448	77	95	520	47
2008	82,351	189	15,230	10,576	144	124	510	109
2009	106,705	54	17,179	5,629	85	82	618	128
2010	128,220	291	25,018	9,616	63	79	547	252
2011	141,510	967	39,446	14,903	65	86	621	240
2012	103,940	767	27,134	8,576	65	159	768	188
2013	149,563	852	21,682	7,253	76	299	820	358
2014	121,240	939	16,083	5,084	87	259	875	761
2015	111,224	620	10,208	754	18	239	2,286	292
2016	140,172	282	16,244	4,031	14	291	1,254	544
2017	102,106	526	17,296	6,923	20	258	1,284	562
2018	83,729	739	11,854	3,151	19	256	1,380	432

[1]During 1992-1993, numbers of steelhead/rainbow greater than 8 inches included both hatchery and wild rainbow trout. Thereafter, only wild trout were observed.
[2]Only the Chiwawa River was sampled in 1992. No tributaries were sampled in that year.

APPENDIX C. Proportion of total habitat available, fraction of all age-0 Chinook within each habitat type, and densities (fish/ha) and numbers of age-0 Chinook within each habitat type in the Chiwawa River basin, survey years 1992-2018; NS = not sampled.

Habitat	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Proportion of total habitat available											
Glide	0.10	0.09	0.10	0.10	0.10	0.09	0.09	0.09	NS	0.07	0.08
Pool	0.19	0.19	0.21	0.18	0.18	0.17	0.16	0.17	NS	0.15	0.16
Riffle	0.61	0.61	0.57	0.59	0.57	0.57	0.58	0.55	NS	0.49	0.48
M. Chan	0.10	0.11	0.12	0.14	0.14	0.17	0.17	0.19	NS	0.29	0.28
Fraction of all age-0 Chinook within habitat types											
Glide	0.07	0.03	0.02	0.01	0.02	0.01	0.01	0.01	NS	0.03	0.01
Pool	0.30	0.28	0.22	0.21	0.30	0.16	0.17	0.14	NS	0.23	0.24
Riffle	0.19	0.16	0.12	0.11	0.43	0.23	0.08	0.11	NS	0.18	0.15
M. Chan	0.45	0.53	0.64	0.67	0.24	0.60	0.74	0.74	NS	0.57	0.60
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	254	251	93	55	11	12	78	13	NS	351	187
Pool	584	1,049	619	541	82	122	607	257	NS	1,392	1,468
Riffle	116	188	124	91	38	52	79	62	NS	336	300
M. Chan	1,710	3,408	2,985	2,328	84	449	2,620	1,201	NS	1,820	2,069
Number of age-0 Chinook within habitat types											
Glide	2,967	2,458	857	623	137	130	837	157	NS	3,231	1,931
Pool	13,468	21,814	12,131	11,294	1,755	2,553	11,454	5,933	NS	25,890	32,612
Riffle	8,531	12,616	6,698	6,197	2,525	3,699	5,392	4,626	NS	20,629	19,754
M. Chan	20,517	42,225	35,370	36,965	1,396	9,682	50,728	30,912	NS	64,866	80,576

APPENDIX C. Continued.

Habitat	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Proportion of total habitat available											
Glide	0.07	0.07	0.08	0.08	0.07	0.09	0.08	0.08	0.08	0.07	0.07
Pool	0.17	0.16	0.16	0.16	0.17	0.23	0.22	0.23	0.18	0.23	0.23
Riffle	0.49	0.50	0.47	0.47	0.47	0.51	0.54	0.53	0.57	0.53	0.53
M. Chan	0.26	0.27	0.29	0.30	0.29	0.17	0.15	0.16	0.17	0.17	0.17
Fraction of all age-0 Chinook within habitat types											
Glide	0.02	0.01	0.01	0.03	0.02	0.03	0.02	0.02	0.04	0.01	0.02
Pool	0.23	0.07	0.19	0.31	0.46	0.40	0.36	0.34	0.34	0.41	0.37
Riffle	0.15	0.14	0.07	0.12	0.12	0.11	0.11	0.11	0.19	0.15	0.13
M. Chan	0.60	0.77	0.73	0.54	0.40	0.45	0.51	0.53	0.43	0.43	0.48
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	200	58	49	237	113	238	230	286	526	173	321
Pool	951	155	492	1,240	1,211	1,210	1,453	1,436	1,805	1,360	1,890
Riffle	216	101	60	166	118	156	175	200	330	221	281
M. Chan	1,626	1,008	1,057	1,147	603	1,872	2,993	3,293	2,515	2,061	3,190
Number of age-0 Chinook within habitat types											
Glide	1,884	540	442	2,498	1,120	2,668	2,371	3,164	6,122	1,535	2,822
Pool	21,091	3,183	9,626	26,754	28,851	34,314	39,382	44,765	48,846	42,209	55,651
Riffle	13,783	6,501	3,367	10,753	7,809	9,773	11,558	14,446	27,883	15,418	19,619
M. Chan	54,519	34,952	36,196	46,580	25,409	38,275	55,607	69,609	61,944	44,779	73,057

APPENDIX C. Concluded.

Habitat	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Proportion of total habitat available											
Glide	0.07	0.07	0.06	0.07	0.07						**0.08**
Pool	0.22	0.24	0.24	0.23	0.23						**0.19**
Riffle	0.54	0.53	0.54	0.54	0.53						**0.53**
M. Chan	0.17	0.16	0.16	0.16	0.17						**0.20**
Fraction of all age-0 Chinook within habitat types											
Glide	0.01	0.01	0.01	0.01	0.01						**0.02**
Pool	0.37	0.31	0.35	0.43	0.47						**0.31**
Riffle	0.11	0.05	0.08	0.12	0.08						**0.13**
M. Chan	0.51	0.63	0.56	0.44	0.44						**0.54**
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	133	66	114	146	119						**169**
Pool	1,569	1,300	1,628	1,446	1,417						**1,097**
Riffle	190	98	168	170	94						**163**
M. Chan	2,957	3,768	3,789	2,121	1,887						**1,930**
Number of age-0 Chinook within habitat types											
Glide	1,120	518	931	1,333	1,025						**1,670**
Pool	44,321	34,993	49,103	43,697	40,121						**27,147**
Riffle	13,085	6,017	11,550	11,840	6,097						**10,776**
M. Chan	62,713	69,969	78,589	45,234	37,819						**46,480**

Appendix C

Fish Trapping at the Chiwawa and Wenatchee Rotary Smolt Traps during 2018

Monitoring Juvenile Salmonids in the Wenatchee River basin:

Activities in the Chiwawa River and Lower Wenatchee River during 2018

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February 4, 2019

Table of Contents

List of Figures

List of Tables

Page

INTRODUCTION

Background

Monitoring and Evaluation

Productivity indicators in the freshwater environment provide data essential to inform evolving salmon and steelhead hatchery programs. In the Wenatchee River subbasin, the Juvenile Monitoring Component of the Monitoring and Evaluation Plan for PUD Hatchery Programs gather data directed at informing these productivity indicators (see Hillman et al. 2013). More specifically, this data directly addresses Objective 2 of the monitoring and evaluation framework:

"Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks."

Objectives

The Washington Department of Fish and Wildlife monitors juvenile salmonids in the Wenatchee River basin with the primary objective of estimating: natural productivity, migration timing, and age with size at migration. This has occurred at the tributary level (Chiwawa River since 1991) and population level (Wenatchee River since 1997). Target species include spring Chinook Salmon *Oncorhynchus tshawytscha* and summer steelhead *O. mykiss* in the Chiwawa River, and is expanded to include sockeye Salmon *O. nerka* and summer Chinook Salmon *O. tshawytscha* in the mainstem Wenatchee River.

Monitoring has primarily been conducted with rotary smolt traps that capture emigrating salmonids from spring through fall. In an effort to reduce biases in emigrant estimates, and to improve understanding of survival and movement during non-trapping periods (December through February), WDFW began remote sampling spring Chinook Salmon in the Chiwawa River Basin in 2012 and Nason Creek Basin in 2013.

Study Area

Chiwawa River

The Chiwawa River is a fourth-order river draining a 474-km^2 basin and has a mean annual discharge of 14.4 cubic meters per second (m^3/s); contributing about 15% of the mean annual discharge of the Wenatchee River. The Chiwawa basin is dominated by the snow melt cycle with peak discharge occurring May through July with occasional fall freshets (Figure 1). The Chiwawa River originates in the North Cascades and flows southeast for 60 km before joining the Wenatchee River. This confluence with the Wenatchee River is approximately 9km downstream of Lake Wenatchee and 76 km upstream of the Columbia River (Figure 2). The Chiwawa River basin is relatively natural, with 96% managed as part of the Wenatchee National Forest and the upper 32% designated wilderness.

Precipitation in the basin varies between 76 cm near the confluence and 356 cm at the peaks, while elevations range from 573 to 2,768 m. The river is dynamic with generally shallow pool riffle segments as it meanders through a U-shaped valley formed by ancient glaciers in the region. Gradients remain well under 1% for the majority of the river.

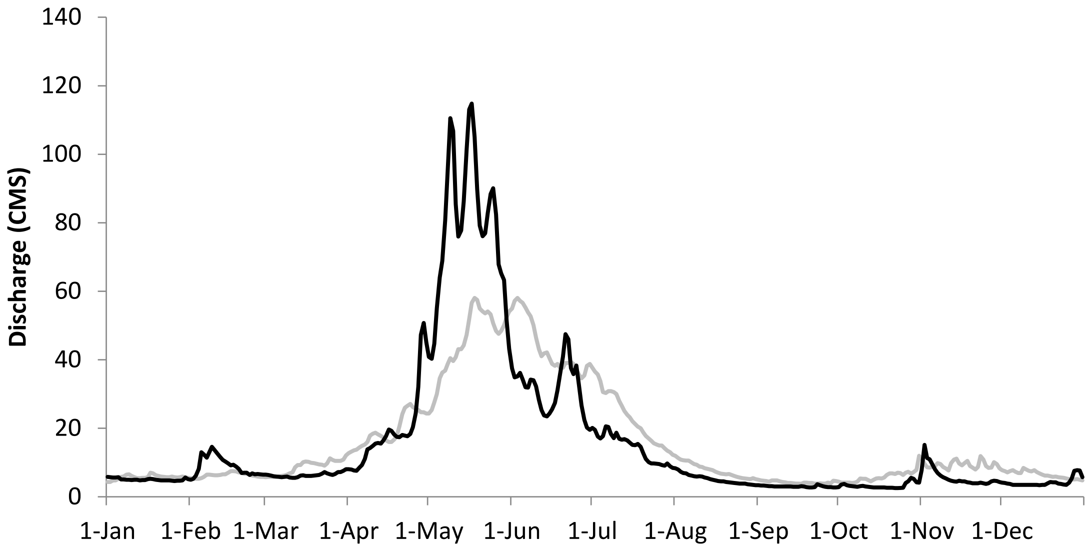

Figure 11. Discharge of the Chiwawa River at Plain, USGS gauge # 12456500. Black line represents 2018 discharge and grey line represents mean discharge from 2007-2017.

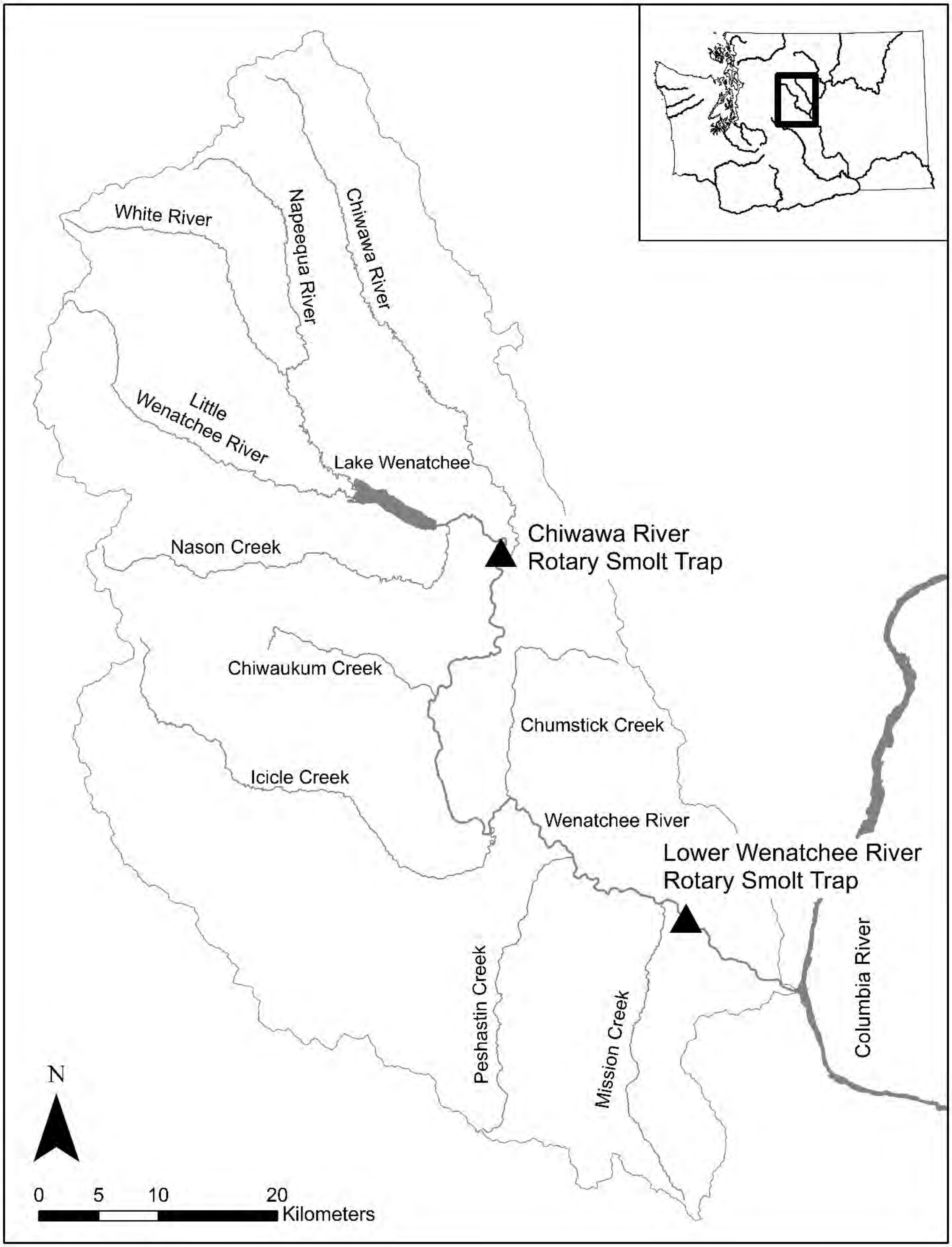

Figure 2. Wenatchee River basin (with rotary smolt trap locations).

Wenatchee River

The Wenatchee River is a fourth-order river draining a 3,437-km^2 basin and has a mean annual discharge of 91.4 m^3/s. The hydrograph is dominated by the snow melt cycle with peak discharge occurring May through July with occasional fall freshets (Figure 3). The mainstem originates at the outlet of Lake Wenatchee and flows southeast 84.5 km before joining the Columbia River, 753 km upstream of the Pacific Ocean (Figure 2). While most of the lowlands (17%) are private, the majority (83%) of basin is public land.

Precipitation in the basin varies from 22 cm near the Columbia River confluence to 381 cm at the crest of the Cascade Mountains with elevations ranging from 237 to 2,768 m. The Wenatchee River has a relatively low gradient except from rkm 40 – 64 where the river flows through a bedrock canyon (Tumwater Canyon) and has a gradient of approximately 9.8 meters per kilometer.

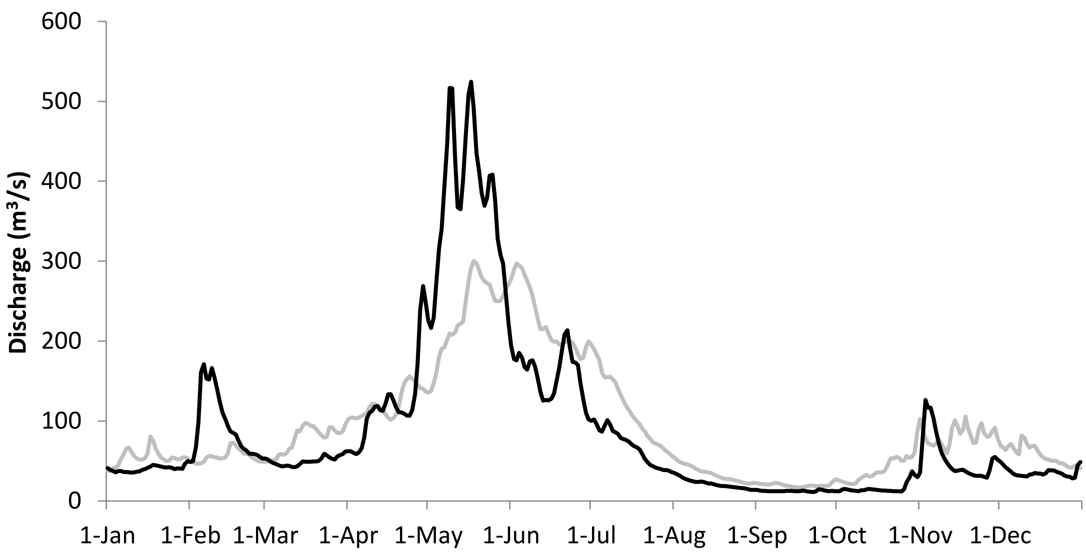

Figure 12. Discharge of the Wenatchee River at Monitor, USGS gauge # 12462500. Black line represents 2018 discharge and grey line represents mean discharge from 2007-2017.

METHODS

Rotary Smolt Traps

Trap Operations

The Chiwawa River trap consists of a single 2.4m cone and has been operating since 1991 at its current location, 0.6 km upstream from the confluence with the Wenatchee River. Trap operations usually begin in late February and continue until environmental conditions suspend operations in late fall. The Lower Wenatchee trap consists of two 2.4m cones and has been operating in its current location (rkm 12.5) since 2013. Trap operations usually begin in late January and continue until fall, when river conditions force its removal.

Operational procedures and techniques follow the standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch and Petersen (2000). The traps remain in operation 24 hours a day unless environmental condition (high/low flow, extreme temperature, and high debris), hatchery releases, mechanical failure or human recreational activities halt operations. During periods of high recreational activities in the spring and summer the Lower Wenatchee trap is pulled during daylight hours to minimize human danger.

Fish Sampling

At a minimum of once a day, all fish collected at the traps were identified to genus or species, enumerated, weighed, and fork length (FL) measured. All salmonids were classified as hatchery, wild, or unknown and visually classified as fry, parr, transitional, or smolt. All hatchery salmonids in the basin are marked (adipose fin-clip, coded-wire tags, or Passive Integrated Transponder (PIT). Target species (≥ 65 mm FL) were tagged using 12.5 mm FDX PIT tags and all PIT tagging information was uploaded to a regional PIT tag database (PTAGIS) maintained by the Pacific States Marine Fisheries Commission.

A combination of length, time of year, and trap location was used to determine race (spring or summer) of captured juvenile Chinook Salmon. All Chinook Salmon captured in the Chiwawa River trap were considered spring Chinook, regardless of size since summer Chinook Salmon spawning has not been documented upstream of the trap. All yearling (age-1) Chinook captured at the Lower Wenatchee River trap during the spring migration period were considered spring Chinook Salmon because spring Chinook Salmon are yearling migrants and summer Chinook Salmon are typically subyearling migrants. All subyearling fry and parr (age-0) Chinook captured at the Lower Wenatchee River trap during spring were considered summer Chinook Salmon.

Mark–Recapture Trials

Groups of marked juveniles were released during a range of stream discharges in order to determine trapping efficiencies under the varied flow regime. Natural origin fish were marked with a PIT tag if ≥65mm FL or stained with Bismarck Brown dye if <65 mm FL and hatchery origin fish were marked using a caudal fin clip. All marked fish were released evenly upstream on both sides of the river between 1800 hours and 2000 hours. Marked fish from the Lower Wenatchee River trap were transported and released 14.5 km upstream of the trap site while fish from the Chiwawa River trap were released 2.6 km upstream. Each trial was conducted over a four-day (96 hour) period to allow time for passage or capture. Target mark group sizes were based on historical data, location and species, ranging from 100 to over 500 individual fish. See appendix D for mark-recapture trails.

Emigrant Estimates

All emigration estimates were calculated using estimated daily trap efficiency derived from the regression formula using trap efficiency (dependent variable) and discharge (independent variable). Trap efficiency models used a modified Bailey estimator (recaptures + 1) in the calculation of efficiency as a method of bias correction. If a significant relationship ($R^2 > 0.5$ and $P < 0.05$) could not be found a pooled trap efficiency estimate was used. Estimates of emigrating spring Chinook were calculated with and without fry (<50mm FL) due to the uncertainty that these fish were actively migrating to the ocean (UCRTT, 2001). See appendices A and B for detailed equations and information on how the point estimate, variance, and standard error were calculated.

During minor breaks in operation (less than seven days), the number of individual fish collected was estimated. This estimate was calculated using the mean number of fish captured two days prior and two days after the break in operation. For major breaks in operations (greater than seven days), an estimate based on historical run timing was developed. This estimate of daily capture was incorporated into the overall emigration estimate.

Egg-to-emigrant Survival

The estimated total egg deposition (d) was calculated by multiplying the mean fecundity (f) of the brood spawners by the total number of redds (r) found during surveys (Hillman et al. 2015). Egg-to-emigrant survival (s) was calculated by dividing total emigrants (e) by estimated egg deposition (d).

Backpack Electrofishing

Sampling Procedure

From 2012 to present, WDFW has had a goal of PIT tagging 3,000 juvenile spring Chinook Salmon each year. In order to representatively tag the population throughout all reaches, the number of fish tagged in each reach was based on the reach specific abundance encountered during snorkeling surveys in late summer. See Appendix C for further explanation.

Detections and Calculations

Detections occur at PIT tag interrogation sites in and out of the basin as well as rotary smolt traps downstream of the sampling reaches. Calculations of non-trapping emigrant estimates are based on a flow-detection efficiency regression developed using mark-groups previously released to test smolt trap efficiencies. The total number of tagged fish (t) divided by the estimated total parr abundance (p), as based off of standard snorkeling techniques (Hillman et al. 2013), resulted in an overall tag rate (t_i). See Appendix C for further explanation.

RESULTS

Rotary Smolt Traps – Chiwawa

Trap Operation

The Chiwawa Trap operated between 5 March and 4 December 2018. During the trapping period, the trap was inoperable for 39 days due to high or low river discharge, debris, major hatchery releases, and mechanical issues. Throughout the trapping season the trap operated in two positions, the normal Upper position and low flow position.

Fish Sampling

A total of 27,434 individual fish were collected, with wild spring Chinook Salmon and steelhead comprising 42% and 2% of the total catch, respectively. Additionally, 9,750 hatchery spring Chinook and 379 hatchery steelhead were collected. Throughout the sampling period 9,568 PIT tags were deployed into wild spring Chinook and steelhead (9,133 and 435 respectively). Spring Chinook mortality for the season totaled 8 yearling, 18 subyearling parr, and 2 fry (0.2%, 0.3%, and 0.3%, respectively). Mortality of steelhead throughout the season totaled 1 (0.2%). The mean fork length (SD) of captured yearling and subyearling spring Chinook Salmon (fry excluded) was 92.9 (6.6) mm and 78.2 (11.6) mm, respectively (Table 1).

Table 11. Mean fork length (mm) and weight (g) of spring Chinook Salmon captured in the Chiwawa rotary smolt trap during 2018.

	Yearling transitional/smolts			Subyearling parr		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	92.9	6.6	3,535	78.2	11.6	7,061
Weight	8.6	2.0	3,488	5.4	2.2	5,519

Yearling Spring Chinook (Brood Year 2016)

Wild yearling spring Chinook Salmon were primarily captured in April (Figure. 4). A total of 3,539 yearling Chinook Salmon were captured and an estimated 3,687 would have been captured if the trap had operated without interruption. Two mark/recapture efficiency trials using PIT tags were conducted producing a mean trap efficiency of 17.9%. When combined with mark/recapture trials from 2016 and 2017 a significant relationship between trap efficiency and river flow ($R^2 = 0.500$; $P < 0.05$) was developed for the upper cone position. However, a pooled estimate was used for the low flow cone position due to low R^2 and non-significant P-value. Combining the estimates, the total number of wild yearling Chinook emigrating from the Chiwawa River in 2018 was estimated at 31,300 (95 CI = ±13,571). Smolt survival (SE) to McNary of those tagged fish was 14% (3%) using the Cormack-Jolly-Seber estimator.

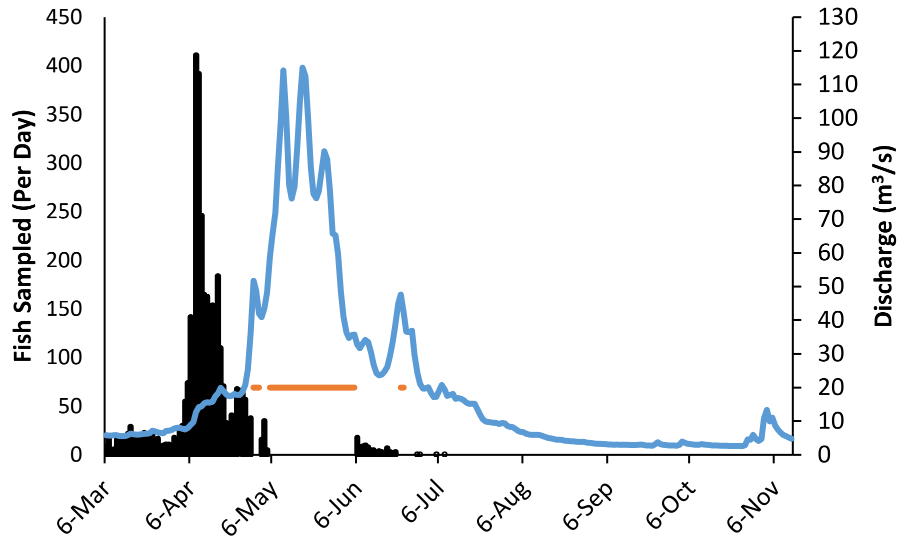

Figure 13. Daily catch of yearling spring Chinook Salmon at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Subyearling Spring Chinook (Brood Year 2017)

Wild subyearling spring Chinook Salmon were captured throughout the sampling period, with peak catches of parr in October and November and fry occurring in April, May, June and July (Figures 5 and 6, respectively). A total of 7,190 subyearling parr and 758 fry were captured with an estimated 7,256 subyearling parr and 846 fry had the trap operated without interruption. One mark/recapture efficiency trials were conducted at the upper cone position with a mean trap efficiency of 20.4%. There were also seven mark/recapture efficiency trails conducted at the new low flow cone position with a mean trap efficiency of 24.7%. Combining with 2016 and 2017 trials, a significant regression model was developed for the Upper cone position (R^2 = 0.59, P < 0.001). A pooled estimate was used for the Low Flow cone position due to low R^2 and high P-value. Based on capture efficiencies, the total number of wild subyearling (fry and parr) Chinook from the Chiwawa River basin was 53,568 (95% CI = ±26,878). Removing fry from the estimate, a total of 43,133 (±26,431) subyearling parr emigrated from the Chiwawa River basin in 2018.

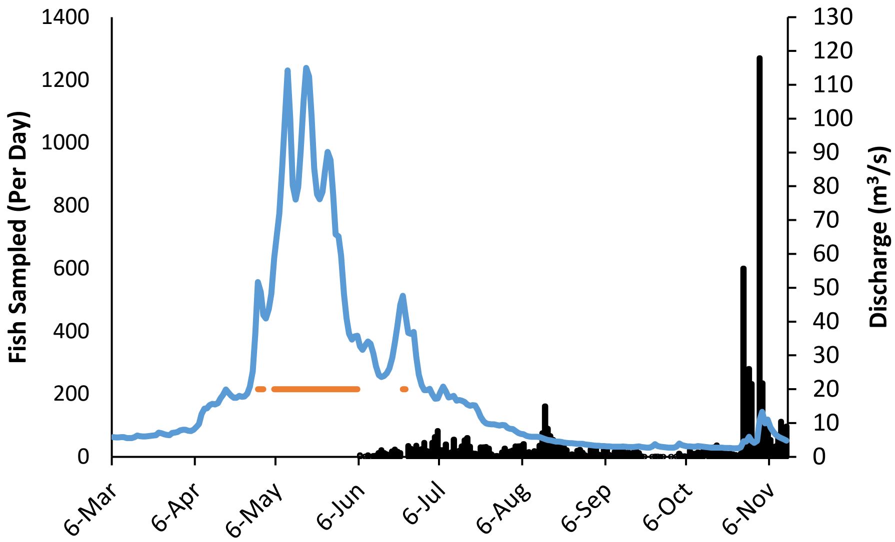

Figure 14. Daily catch of wild spring Chinook subyearling parr at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

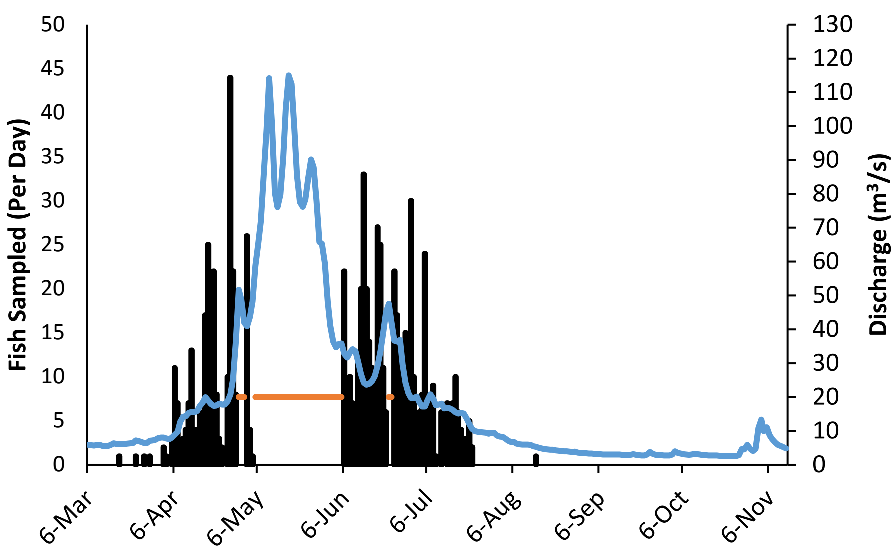

Figure 15. Daily catch of wild spring Chinook fry at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Summer Steelhead

During the trapping period, 147 steelhead transitional/smolts and 361 steelhead/rainbow parr and 18 steelhead/rainbow fry were captured. While collections occurred in moderate numbers throughout the year, peak collections occurred during April, June and November (Figure 7). The mean fork length (SD) of steelhead parr and transitional/smolts captured was 86.2 (25.8) and 169.9 (21.0) mm, respectively (Table 2).

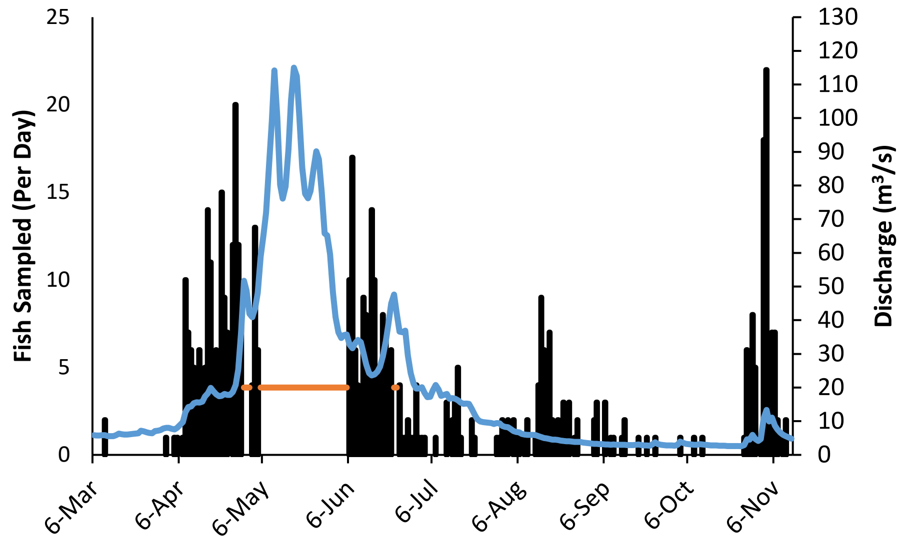

Figure 16. Daily catch of all wild steelhead at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 12. Mean fork length (mm) and weight (g) and of steelhead/rainbow captured in the Chiwawa rotary smolt trap during 2018.

	Transitional/smolts			Parr		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	169.9	21.0	146	86.2	25.8	357
Weight	49.2	22.1	142	8.8	10.4	346

Egg-to-emigrant Survival

For BY 2017, 254 redds were counted in the Chiwawa River Basin with an estimated 1,172,210 eggs being deposited. A total of 130,668 emigrants were estimated resulting in an egg-to-emigrant survival of 8.3% (Table 3). This is up from a five year moving average of 5.1%.

Table 13. Estimated egg deposition and egg-to-emigrant survival rates for Chiwawa River spring Chinook Salmon.

Brood Year	Number of redds	Estimated egg deposition	Estimated number: Sub-yearling	Estimated number: Non trapping	Estimated number: Yearling	Estimated number: Total emigrants	Egg-to-emigrant survival (%)
1992	302	1,570,098	25,818		39,723	65,541	4.2
1993	106	556,394	14,036		8,662	22,698	4.1
1994	82	485,686	8,595		16,472	25,067	5.2
1995	13	66,248	2,121		3,830	5,951	9.0
1996	23	106,835	3,708		15,475	19,183	18.0

Brood Year	Number of redds	Estimated egg deposition	Estimated number				Egg-to-emigrant survival (%)
			Sub-yearling	Non trapping	Yearling	Total emigrants	
1997	82	374,740	16,228		28,334	44,562	11.9
1998	41	207,675	2,855		23,068	25,923	11.9
1999	34	166,090	4,988		10,661	15,649	9.4
2000	128	642,944	14,854		40,831	55,685	8.7
2001	1,078	4,836,704	459,784		86,482	546,266	11.0
2002	345	1,605,630	93,331		90,948	184,279	11.5
2003	111	648,684	16,881		16,755	33,637	5.2
2004	241	1,156,559	44,079		72,080	116,158	10.0
2005	333	1,436,564	108,595		69,064	177,659	12.3
2006	297	1,284,228	62,922		45,050	107,972	8.4
2007	283	1,241,521	60,196		25,809	86,006	6.9
2008	689	3,163,199	85,161		35,023	120,184	3.8
2009	421	1,925,233	30,996		30,959	61,955	3.2
2010[a]	502	2,165,628	53,619		47,511	101,130	4.7
2011[a]	492	2,157,420	67,982	3,665	37,185	108,832	5.0
2012[a]	880	3,716,240	49,774	25,305	34,334	109,413	2.9
2013[a]	714	3,367,224	73,695	NA	39,396	113,091	3.4
2014[a]	462	1,868,790	77,510	NA	37,170	114,680	6.1
2015[a]	607	2,942,129	80,543	5,976	53,344	139,863	4.8
2016[a]	354	1,581,318	95,063	4,305	31,300	130,668	8.3
2017[a]	254	1,172,210	43,133	-	-	-	-
2018[a]	383	1,595,578	-	-	-	-	-

[a]calculated with Bailey model

Non-target Taxa

Bull trout (*Salvelinus confluentus*) also comprised a large proportion of incidental species captured. During the trapping period 286 bull trout (215 ≥ 300 mm FL and 71 <300 mm FL) were captured. Additionally, 78 westslope cutthroat trout (*O. clarki lewisi*), and 4 Eastern brook trout (*S. fontinalis*) were collected. In all, 208 bull trout and 66 westslope cutthroat trout were released with PIT tags. Additionally, 70 total (25 ≥ 300 mm FL and 45 <300 mm FL) mountain whitefish (*Prosopium williamsoni*) were released with PIT tags. Monthly and annual totals of all fish captured are presented in Appendix E and Appendix F, respectively.

Rotary Smolt Traps – Lower Wenatchee

Trap Operation

The Lower Wenatchee Trap operated between 21 March and 24 July 2018. During that time, the trap was inoperable for 18 days because of high and low river discharge, debris, elevated river temperature, large hatchery releases, and mechanical issues. Extreme river temperatures and low flows resulted in trapping operations being suspended for the season on 24 July. Throughout the season, the trap cones were operated in the lower position for all but the final two days of the season where it operated in an upper position.

Fish Sampling

A total of 139,689 individual fish were collected, with wild summer Chinook Salmon comprising 34% of the total catch. Additionally, 1,418 wild yearling spring Chinook Salmon, 51,068 hatchery yearling Chinook Salmon, 10,331 wild sockeye, 245 wild steelhead, and 349 hatchery steelhead were captured. Throughout the sampling period 1,243, 8,822, and 222 PIT tag were deployed into wild yearling spring Chinook, sockeye, and steelhead, respectively. Mortality for the season totaled 7 wild yearling spring Chinook, 347 subyearling summer Chinook, 82 sockeye, and 0 wild steelhead (0.5%, 0.6%, 0.8%, and 0%, respectively).

Yearling Spring Chinook (Brood Year 2016)

Wild yearling spring Chinook Salmon were primarily captured in April (Figure 8). Throughout the trapping period 1,418 spring Chinook were collected and an estimated 1,536 would have been collected had the trap operated without interruption. A combination of 2015, 2017 and 2018 trials were used to develop a significant relationship between discharge and trap efficiency (R^2 = 0.82, P < 0.02). This model was used to calculate an emigrant estimate of 99,045 (±22,234; 95% CI). The mean fork length (SD) of captured yearling Chinook was 98.1 (8.7) mm (Table 4).

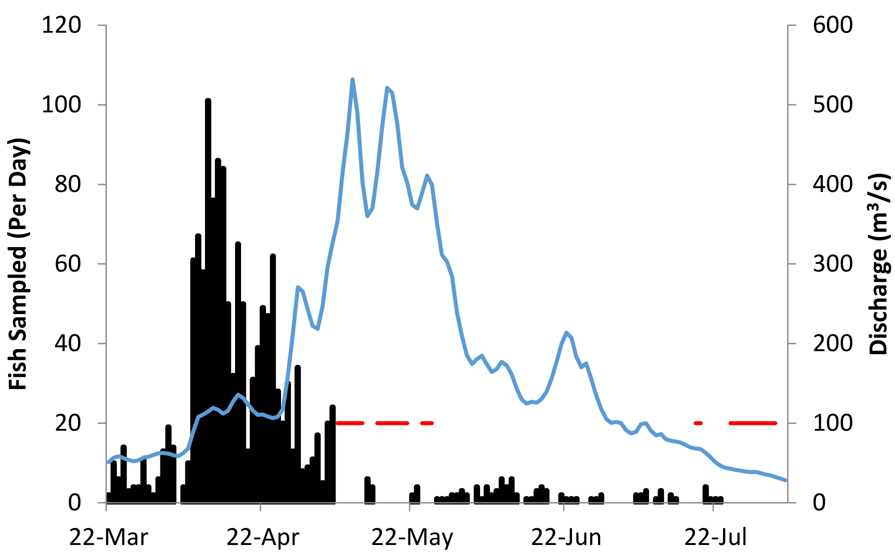

Figure 17. Daily capture of wild yearling Chinook Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 14. Mean fork length (mm) and weight (g) for wild yearling spring Chinook Salmon sampled at the Lower Wenatchee rotary trap during 2018.

	Mean	SD	N
Fork length	98.1	8.7	1,395
Weight	10.3	2.8	1,355

Wild Subyearling Summer Chinook (Brood Year 2017)

Wild subyearling summer Chinook dominated the catch (34%) with 47,283 fish being processed. Most were collected in June (Figure 9). An estimated 58,616 would have been captured had the trap operated without interruption. Over the season, five mark/recapture efficiency trials were carried out using Bismarck Brown dye. When combined with trials from 2017 a significant discharge efficiency relationship was developed (R^2 = 0.71, $P < 0.02$) and an emigrant estimate of 5,823,795 (±855,856 95% CI) was calculated. The mean fork length (SD) for captured subyearling parr and fry summer Chinook was 62.4 (10.5) and 42.0 (3.5), respectively (Table 5). Five summer Chinook were PIT tagged.

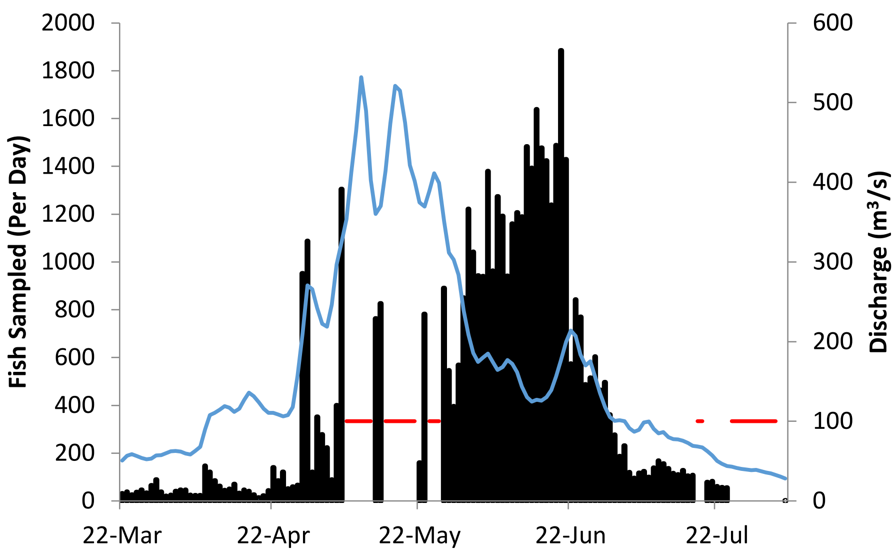

Figure 18. Daily capture of wild summer Chinook Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 15. Mean fork length (mm) and weight (g) of subyearling summer Chinook Salmon sampled at the Lower Wenatchee rotary smolt trap during 2018.

	Parr			Fry		
	Mean	SD	N	Mean	SD	N
Fork length	62.4	10.5	2,213	42.0	3.5	3,343
Weight	3.1	1.8	1,600	0.7	0.3	2,295

Wild Sockeye

A total of 10,331 juvenile sockeye were collected in the 2018 season and an estimated 10,381 had the trap operated without interruption. Almost all of these fish (99%) were collected in April (Figure 10). Four mark/recapture efficiency trials were conducted, however one had be to canceled due to high flow and debris. No significant model could be calculated ($R^2 = 0.39$, $P > 0.57$) so a pooled model was created using just the three trials from 2018. This model produced a 2018 emigrant population estimate for of 1,806,164 (±13,586,160; 95% CI). Smolt survival (SE) to McNary of those tagged fish was 66% (6) using the Cormack-Jolly-Seber estimator. In 2018, most were Age 1+ (98.9%), with the remaining Age 2+ (1.0%) and Age 0+ (0.1%) (Table 6). Mean fork length (SD) for captured sockeye was 83.0 (6.1) mm (Table 7).

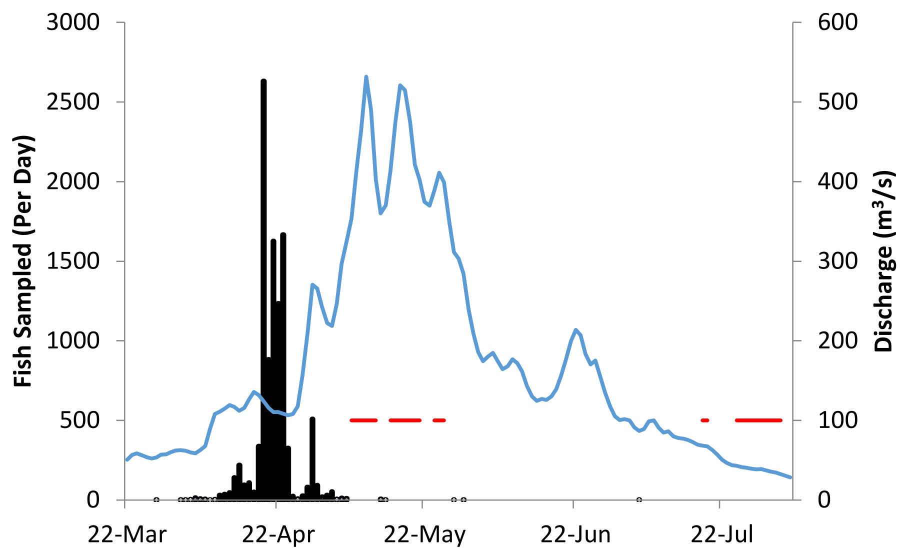

Figure 19. Daily capture of wild sockeye Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 16. Age structure and estimated number of wild sockeye smolts that emigrated from Lake Wenatchee in 2013-2018.

Run year	Proportion of Wild Smolts				Total Wild Smolts
	Age 0+	Age 1+	Age 2+	Age 3+	
2013	0.008	0.919	0.073	0.00	873,096
2014	0.003	0.948	0.049	0.00	1,275,027
2015	0.003	0.777	0.220	0.00	1,065,614
2016	0.046	0.895	0.059	0.00	208,250
2017	0.053	0.868	0.079	0.00	121,825
2018	0.001	0.989	0.010	0.00	1,806,164

Table 17. Mean fork length (mm) and weight (g) of wild sockeye Salmon smolts sampled at the Lower Wenatchee rotary smolt trap during 2018.

	Mean	SD	N
Fork length	83.0	6.1	8,873
Weight	5.1	1.7	1,317

Wild Summer Steelhead

Capture of wild steelhead at the Lower Wenatchee site for all life stages was low, totaling 245 fry, parr, and smolts combined and an estimated 288 collected had the trap operated without interruption. Peak catches of steelhead occurred in April (Figure 11). Due to the lack of fish no mark/recapture trials were conducted and no significant relationship could be determined. Thus, a combination of three trials from 2014 and 2016 were used to produce a pooled efficiency of 0.028. This pooled estimated was used to produce an emigrant estimate of 9,758 (±98,353) parr and smolt steelhead (excludes fry). If fry are included, the emigrant population was estimated to be 10,496 (± 105,785). Mean length (SD) of transitional/smolts and parr was 154.5 (44.2) and 97.0 (18.0) mm, respectively (Table 8).

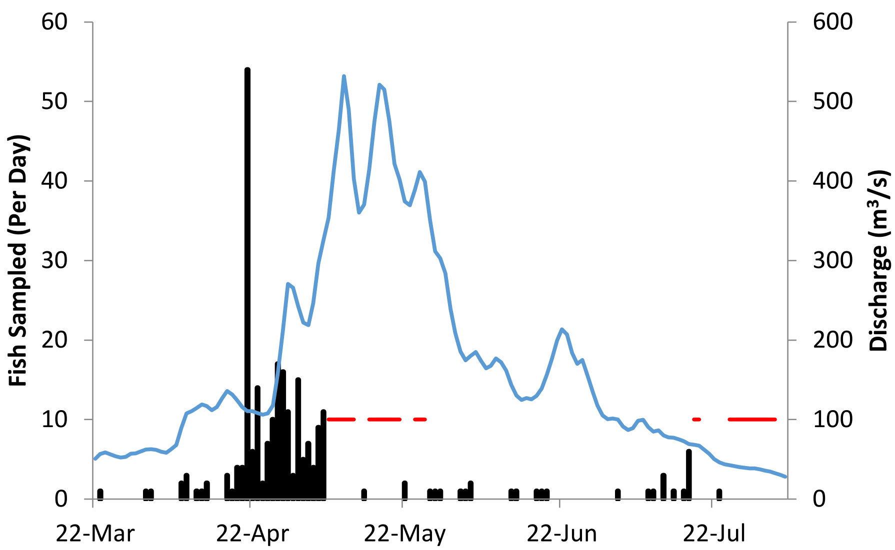

Figure 20. Daily capture of wild steelhead at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 18. Mean fork length (mm) and weight (g) of wild steelhead sampled at the Lower Wenatchee rotary smolt trap during 2018.

	Transitional/Smolt			Parr			Fry		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Fork length	154.5	44.2	206	97	18.0	21	28.4	4.2	5
Weight	56.0	21.6	156	10.5	6.1	21	0.2	0.1	3

Survival

For BY 2017, 430 spring Chinook Salmon redds were surveyed in the Wenatchee Basin producing an estimated 1,984,450 eggs. An estimate of 99,045 emigrants results in an estimated egg-to-emigrant survival of 3.48%. This is up from the last four year average of 1.74% (Table 9).

Table 19. Estimated egg deposition and egg-to-smolt survival rates for Wenatchee Basin spring Chinook Salmon.

Brood Year	Number of redds	Estimated egg deposition	Estimated number	
			Total emigrants	Egg-to-emigrant survival (%)
2000	350	1,758,050	76,643	4.36
2001	1,876	8,674,624	243,516	2.81
2002	1,139	5,300,906	165,116	3.11
2003	323	1,887,612	70,738	3.75
2004	555	2,663,445	55,619	2.09
2005	829	3,587,083	302,116	8.42
2006	588	2,542,512	85,558	3.37
2007	466	2,069,506	60,219	2.91
2008	1,411	6,479,312	82,137	1.27
2009	733	--	--	--
2010	968	--	--	--
2011	872	3,823,720	89,917	2.35
2012	1,704	7,195,992	67,973	0.94
2013	1,159	5,465,844	58,595	1.07
2014	677	2,698,015	36,752	1.36
2015	905	4,386,535	130,426	2.97
2016	638	2,849,946	99,045	3.48
2017	430	1,984,450	-	-
2018	549	2,287,134	-	-

For BY 2017, 3,908 summer Chinook Salmon redds were surveyed in the Wenatchee Basin, 93.1% being upstream of the Lower Wenatchee smolt trap. After extrapolating by the proportion of redds above the trap a total emigrant population of 6,254,015 was estimated resulting in an egg-to-emigrant survival of 37.47%. This is down from the five year moving average of 72.90% (Table 10).

Table 20. Estimated egg deposition and egg-to-emigrant survival rates for Wenatchee Basin summer Chinook Salmon.

Brood year	Peak total redd expansion	Estimated egg deposition	Redds above trap / total redds	Estimated number		
				Trap estimate	Total emigrants	Egg-to-emigrant survival (%)
1999	2,738	13,654,406	0.988	9,572,392	9,687,261	70.95
2000	2,540	13,820,140	0.983	1,299,476	1,321,567	9.56
2001	3,550	18,094,350	0.987	8,229,920	8,336,909	46.07
2002	6,836	37,488,624	0.977	13,167,855	13,470,716	35.93
2003	5,268	28,241,748	0.996	20,336,968	20,418,316	72.30
2004	4,874	26,207,498	0.989	14,764,141	14,926,547	56.96
2005	3,538	17,877,514	0.993	11,612,939	11,694,230	65.41
2006	8,896	45,663,168	0.979	9,397,044	9,594,382	21.01
2007	1,970	10,076,550	0.983	4,470,672	4,546,673	45.12
2008	2,800	14,302,400	0.978	4,309,496	4,404,305	30.79
2009	3,441	18,206,331	0.983	6,695,977	6,809,809	37.40
2010	3,261	16,184,343	0.957	--	--	--
2011	3,078	15,122,214	0.958	--	--	--
2012	2,504	12,021,704	0.930	9,333,214	9,986,539	83.07
2013	3,241	16,162,867	0.947	11,936,928	12,569,585	77.77
2014	3,458	16,556,904	0.959	14,157,778	14,738,247	89.02
2015	1,804	8,987,528	0.974	4,090,085	4,196,427	46.69
2016	2,797	12,371,131	0.893	7,593,243	8,405,720	67.95
2017	3,896	16,990,456	0.931	5,823,795	6,254,015	37.47
2018	1,498	6,438,404	-	-	-	-

Non-target Taxa

No westslope cutthroat trout or bull trout where sampled at the Lower Wenatchee Trap, however 5 Eastern Brook Trout were sampled. No PIT tags were applied to non-target taxa. Monthly and annual totals of all fish captured are presented in Appendix G and Appendix H, respectively.

Backpack Electrofishing

Fish Sampling

Between 1 October and 13 November 2018, WDFW personnel sampled the Chiwawa River. During this sampling, 3,800 subyearling Chinook were collected of which 3,737 received a PIT tag. The greatest concentration of juvenile Chinook occurred between rkm 21 and 40 which had a mean sample rate of one Chinook collected for every 24 seconds of sampling. Over the sample period 15 Chinook died resulting in a mortality rate of 0.3%. Additionally, 442 juvenile bull trout were collected, none of which received a PIT tag. Highest catch rates for bull trout were around rkm 47 and there was no bull trout mortality.

Between 7 September and 14 November 2018, WDFW personnel sampled Nason Creek with assistance from Yakima Nation. During this sampling, 2,648 subyearling Chinook were collected of which 2,524 received a PIT tag. The greatest concentration of juvenile Chinook occurred between rkm 6 and 17 which had a mean sample rate of one Chinook collected for every 27 seconds of sampling. Over the sampling period 17 Chinook died resulting in a mortality rate of 0.6%. Additionally, 8 juvenile bull trout were collected, none of which received a PIT tag. There was no bull trout mortality.

Detections and Calculations

Of the subyearling Chinook remotely tagged in the Chiwawa basin, there were 11 detections during the non-trapping season (30 November 2017 through 5 March 2018) at the lower Chiwawa PIT tag antenna array (Table 11). These detections were used in a significant flow efficiency model (R^2 = 0.754; $P > 0.001$) to produce a non-trapping emigration estimate for the Chiwawa basin of 4,305 (± 3,068; 95% CI).

Table 11. Number of remotely sampled subyearling spring Chinook in Chiwawa River and Nason Creek.

Sample location and year	Number collected	Number Pit tagged	Number caught at smolt trap in Fall of year tagged	Number detected at stream's downstream Pit tag antenna array during Non-trapping season	Number caught at smolt trap in Spring of following year
Chiwawa 2018	3,800	3,737	226	20	--
Chiwawa 2017	2,740	2,703	114	11	69
Chiwawa 2016	1,829	1,772	38	25	65
Chiwawa 2015	1,103	1,052	32	3	26
Chiwawa 2014	1,083	1,033	17	16	46
Nason 2018	2,648	2,524	8	74	--
Nason 2017	3,401	3,242	63	34	12
Nason 2016	828	802	9	26	11
Nason 2015	1,153	1,087	5	0	0
Nason 2014	1,908	1,816	27	12	4

DISCUSSION

Chiwawa River Rotary Smolt Trap

Over the last five years, the Chiwawa River smolt trap has usually been installed early March and in 2018 it was installed 6 March. During the trapping season of 6 March – 4 December the trap was inoperable for 39 days. Thirty-two of the inoperable days occurred during spring runoff when discharge was elevated. Current operable discharges are between 2.4 m^3/s and 50 m^3/s.

Significant discharge efficiency models were obtained for two of the three target species stages (wild spring Chinook subyearling and spring Chinook yearling) at the Chiwawa trap. A model to accurately estimate steelhead emigration continues to be difficult to develop due to low capture rates. We will continue to evaluate and improve this model when possible. The 2018 field season represented the second year we operated the cone in the new low flow position. We will continue to developed and improve our low-flow model for target species.

Lower Wenatchee River Rotary Smolt Trap

Historically, the smolt trap on the mainstem Wenatchee River has moved location numerous times due to poor trap efficiencies of target species and environmental factors causing abbreviated trapping seasons. At the lower Wenatchee site, the smolt trap has been able to operate into September in 2013, and October in 2014. This marks a relatively large increase in operational length over the old site (located 2.5 km downstream) which had an average trap removal date of 14 August. However, since 2014 low river discharge and elevated water temperatures throughout the summer and early fall have hindered the trapping season. In 2017 and 2018, the trap was removed in late July or early August.

In 2018, the Lower Wenatchee smolt trap's pontoons were replaced with longer, wider, and deeper pontoons which increased buoyancy and improved trap function at elevated river discharge. This has increased the range of discharges at which the trap can safely operate. Currently, the trap is able to operate between discharges of 28.3 and 382.3 m^3/s.

Significant discharge efficiency models were obtained for two of the four target species (wild spring Chinook and summer Chinook Salmon) at the Lower Wenatchee trap during the 2018 trapping season. The discharge efficiency model for sockeye was not significant and all efforts will be made to reestablish a significant model in 2019. Collections of wild steelhead continue to be inadequate for conducting mark–recapture trials. In 2019, we will continue to look for ways to improve our efficiency models for steelhead.

Backpack Electrofishing

Remote sampling was initiated in 2012 with the goal of releasing 3,000 PIT tagged subyearling spring Chinook to produce an emigrant estimate during the non-trapping winter season when the smolt traps are removed due to environmental conditions. Some success occurred early with PIT tag targets being met, however permit restrictions, environmental conditions, and personnel logistics hindered efforts in recent years. However, in 2018 we were able to adjust sampling effort and release 3,737 tagged Chinook. We will continue to refine and adapt our techniques to insure the best estimates are calculated.

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APPENDICES

Appendix A. Peterson Population and Variance Equations.

Trap efficiency was calculated using the following formula:

Trap efficiency = $E_i = R \ / \ Mi,$

Where E_i is the trap efficiency during time period *i*; M_i is the number of marked fish released during time period *i*; and R_i is the number of marked fish recaptured during time period *i*. The number of fish captured was expanded by the estimated daily trap efficiency (*e*) to estimate the daily number of fish migrating past the trap using the following formula:

Estimated daily migration = $\hat{N}_i = C_i / \hat{e}_i$

where N_i is the estimated number of fish passing the trap during time period *i*; C_i is the number of unmarked fish captured during time period *i;* and e_i is the estimated trap efficiency for time period *i* based on the regression equation.

The variance for the total daily number of fish migrating past the trap was calculated using the following formulas:

Variance of daily migration estimate = $$\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{\mathrm{MSE}\left(1 + \frac{1}{n} + \frac{\left(X_i - \overline{X}\right)^2}{\left(n-1\right)s_X^2}\right)}{\hat{e}_i^2}$$

where X_i is the discharge for time period *i*, and *n* is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; $R^2 > 0.5$), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $e_p = \sum R / \sum M$

The daily emigration estimate was calculated using the formula:

Daily emigration estimate = $\hat{N}_i = C_i / e_p$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

Variance for daily emigration estimate = $$\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{e_p(1 - e_p) / \sum M}{e_p^2}$$

The total emigration estimate and confidence interval was calculated using the following formulas:

Total emigration estimate = $\sum \hat{N}_i$

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

Appendix B. Bailey Population and Variance Equations.

Trap efficiency was calculated using the following formula:

Trap efficiency = $E_i = R+1\ /\ Mi,$

Estimated daily emigration = $\hat{N}_i = \dfrac{C_i + 1}{\hat{e}_i}$

The variance of the total population abundance was calculated as follows:

$$Var\left(\sum_{i=1}^{n}\hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i+1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i\sum_j Cov\left(\frac{(C_i+1)}{\hat{e}_i}, \frac{(C_j+1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A is the variance of the daily estimates where C_i is the number of fish caught in period *i*, e_i is the estimated trap efficiency for period *i*, and *Cov* is the between day covariance for days that the same linear model is used (part B). For a more details and derivation of Peterson and Bailey estimation methods see Murdoch et al. (2012).

Appendix C. Emigration during non-trapping periods.

A flow-efficiency regression model was developed for the lower Chiwawa River PIT tag interrogation site (CHL) using the same mark/recapture trials used for estimating efficiency at the smolt trap. This CHL model was used to calculate emigration outside of the trapping period by incorporating the tag rate into the Bailey estimator.

$$\text{Estimated daily emigration} = \left(\hat{N}_i = \frac{C_i + 1}{\hat{e}_i} \right) \Big/ t_i$$

Where t_i is equal to the tag rate = $t_i = \frac{t}{p}$

Appendix D: Mark–Recapture groups used to developing emigrant estimates. YCW = Yearling spring Chinook wild, YCH = Yearling spring Chinook hatchery, SKW = Sockeye wild, SUCH = summer Chinook wild, SBC = subyearling Chinook wild.

Species	Date	Position	Released	Recaptured	Bailey's Efficiency (%)	Discharge (m^3/s)
			Lower Wenatchee River rotary smolt trap			
YCH	17-Apr-15	Low	2,045	82	4.06	63.1
YCW	23-Mar-17	Low	191	3	2.09	106.2
YCW	01-Apr-17	Low	409	3	0.98	115.6
YCW	06-Apr-17	Low	231	1	0.87	141.6
YCW	10-Apr-18	Low	685	15	2.33	111.5
YCW	13-Apr-18	Low	496	12	2.62	116.4
SKW	27-Apr-13	Low	565	6	1.06	141.6
SKW	31-Mar-14	Low	322	1	0.62	83.1
SKW	04-Apr-14	Low	599	2	0.50	81.7
SKW	07-Apr-14	Low	633	2	0.47	99.6
SKW	16-Apr-14	Low	591	3	0.68	126.2
SKW	19-Apr-14	Low	385	4	0.78	130.4
SKW	23-Apr-14	Low	504	2	0.60	125.5
SKW	12-Apr-15	Low	540	2	0.56	73.9
SKW	16-Apr-18	Low	398	1	0.50	129.9
SKW	19-Apr-18	Low	456	5	1.32	120.3
SKW	22-Apr-18	Low	401	3	1.00	110.5
SUCH	15-Jun-17	Low	1,810	30	1.71	192.6
SUCH	24-Jun-17	Low	881	12	1.48	201.9
SUCH	29-May-18	Low	1001	3	0.40	302.9
SUCH	02-Jun-18	Low	1175	15	1.36	182.2
SUCH	06-Jun-18	Low	941	11	1.28	168.4
SUCH	12-Jun-18	Low	1026	14	1.46	139.0
SUCH	06-Jul-18	Low	587	11	2.04	89.2
			Chiwawa River rotary smolt trap			
YCW	06-Mar-16	Upper	132	15	12.1	14.7
YCW	09-Mar-16	Upper	106	12	12.3	15.8
YCW	12-Mar-16	Upper	126	14	11.9	15.1
YCW	02-Apr-16	Upper	178	11	6.7	23.8
YCW	04-Apr-16	Upper	240	13	5.8	34.4
YCW	24-Mar-17	Upper	150	20	14.0	8.1
YCW	28-Mar-17	Upper	150	31	21.3	7.8

Species	Date	Position	Released	Recaptured	Bailey's Efficiency (%)	Discharge (m^3/s)
YCW	30-Mar-17	Upper	149	21	14.8	9.3
YCW	16-Apr-17	Upper	123	8	7.3	15.0
YCW	21-Apr-17	Upper	269	20	7.8	17.6
YCW	26-Apr-17	Upper	212	28	13.7	21.8
YCW	29-Apr-17	Upper	164	22	14.0	22.7
YCW	10-Apr-18	Upper	154	18	12.3	14.6
YCW	06-Apr-18	Low Flow	159	38	24.5	9.0
SBC	16-Jun-16	Upper	265	21	7.9	17.6
SBC	26-Jun-16	Upper	241	32	13.3	17.7
SBC	01-Jul-16	Upper	326	34	10.4	24.9
SBC	07-Jul-16	Upper	246	34	13.8	14.5
SBC	11-Jul-16	Upper	80	13	16.3	14.0
SBC	27-Jul-16	Upper	101	22	21.8	12.1
SBC	04-Aug-16	Upper	209	96	45.9	8.2
SBC	10-Aug-16	Upper	162	51	31.5	6.5
SBC	12-Oct-16	Upper	199	73	36.7	5.7
SBC	17-Oct-16	Upper	185	37	20.0	10.9
SBC	28-Oct-16	Upper	200	22	11.0	16.8
SBC	04-Nov-16	Upper	156	17	10.9	11.8
SBC	12-Jul-17	Upper	113	16	15.0	21.5
SBC	01-Aug-17	Upper	138	32	23.9	8.7
SBC	09-Aug-17	Upper	94	14	16.0	7.0
SBC	15-Aug-17	Upper	100	40	41.0	5.8
SBC	06-Nov-18	Upper	98	20	21.4	8.4

Appendix E. Monthly collection information for the Chiwawa River smolt trap.

2018													
Species/Origin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Chinook													
Wild													
Yearling	--	--	396	2,994	56	91	2	0	0	0	0	0	3,539
Subyearling (non fry)	--	--	0	0	0	367	830	999	301	1,653	2,995	45	7,190
Subyearling fry	--	--	4	248	31	348	126	1	0	0	0	0	758
Hatchery yearling	--	--	0	9,744	5	0	1	0	0	0	0	0	9,750
Steelhead													
Wild													
Smolt	--	--	0	125	4	1	0	7	5	2	3	0	147
Parr	--	--	2	43	19	134	8	49	11	24	71	0	361
Fry	--	--	0	0	0	0	17	1	0	0	0	0	18
Hatchery	--	--	0	7	325	23	1	9	4	2	7	1	379
Coho													
Wild													
Smolt	--	--	0	0	0	0	0	0	0	0	0	0	0
Parr	--	--	0	0	0	0	0	0	0	0	0	0	0
Fry	--	--	0	0	0	1	0	0	0	0	0	0	1
Bull trout													
Juvenile	--	--	1	5	1	23	4	8	36	55	78	4	215
Adult	--	--	0	0	0	0	0	5	37	25	4	0	71
Westslope cutthroat trout	--	--	0	0	0	9	13	23	22	8	3	0	78
Eastern brook trout	--	--	0	0	0	0	0	0	0	1	3	0	4
Rainbow trout	--	--	0	0	0	0	0	1	2	2	0	0	5
Mountain whitefish	--	--	48	20	0	16	350	1,248	718	24	76	0	2,500
Longnose dace	--	--	3	59	18	327	168	345	786	432	100	14	2,252
Sculpin spp.	--	--	2	6	1	5	27	20	15	15	5	0	96
Dace spp.	--	--	0	0	0	0	0	0	1	0	0	0	1
Northern pikeminnow	--	--	0	0	0	0	8	44	11	0	0	0	63
Lamprey spp.	--	--	0	0	0	0	0	1	0	0	0	0	1
Sucker spp.	--	--	0	0	0	0	0	2	1	1	0	0	4
Redside shiner	--	--	0	0	0	0	0	0	1	0	0	0	1
Yellow perch	--	--	0	0	0	0	0	0	0	0	0	0	0

Appendix F. Annual collection information for the Chiwawa River smolt trap.

Species origin	2018	2017	2016	2015	2014	2013	2012
Chinook							
Wild							
Yearling	3,539	5,824	2,807	6,350	5,419	3,199	7,626
Subyearling	7,948	12,938	16,393	31,152	23,755	27,621	14,831
Hatchery	9,750	4,518	2,525	7,162	5,293	15,909	30,751
Steelhead							
Wild							
Smolt	147	244	195	259	49	85	183
Parr and Fry	379	837	1,522	3,004	1,889	1,949	1,738
Hatchery	379	3,907	1,518	3,151	290	1,539	1,664
Coho							
Wild							
Smolt	0	0	0	0	0	1	1
Parr and fry	1	0	3	38	12	0	0
Hatchery	0	0	0	0	1	10	3
Bull trout							
Juvenile	215	259	103	266	260	310	488
Adult	71	78	15	32	75	51	31
Westslope cutthroat trout	78	61	43	72	59	86	60
Eastern brook trout	4	1	3	8	12	13	66
Mountain whitefish	2,500	745	883	5,544	2,970	2,108	3,291
Longnose dace	2,252	861	979	2,663	2,633	2,257	1,762
Northern pikeminnow	63	58	69	331	5	71	34
Sculpin spp.	96	130	94	225	131	91	157
Sucker spp.	4	7	3	30	4	6	0
Dace spp.	1	28	16	NA	NA	NA	NA
Redside shiner	1	0	0	13	0	0	0
Yellow perch	0	0	1	0	0	0	0

Appendix G. Monthly collection information for the Lower Wenatchee River smolt trap.

	2018												
Species/Origin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Chinook													
Wild													
Yearling	--	--	60	1,170	109	58	21	0	--	--	--	--	1,418
Subyearling (non fry)	--	--	2	39	296	12,014	2,410	1	--	--	--	--	14,762
Subyearling fry	--	--	415	3,665	8,124	19,989	328	0	--	--	--	--	32,521
Hatchery yearling	--	--	0	49,877	1,178	13	0	0	--	--	--	--	51,068
Steelhead													
Wild													
Smolt	--	--	0	153	49	4	2	0	--	--	--	--	208
Parr	--	--	1	10	7	3	0	0	--	--	--	--	21
Fry	--	--	0	0	1	2	13	0	--	--	--	--	16
Hatchery	--	--	0	89	182	77	1	0	--	--	--	--	349
Sockeye													
Wild													
Smolt	--	--	1	10,193	128	0	1	0	--	--	--	--	10,323
Fry	--	--	0	3	5	0	0	0	--	--	--	--	8
Coho													
Wild													
Smolt	--	--	1	13	46	37	0	0	--	--	--	--	97
Parr	--	--	0	9	10	569	186	0	--	--	--	--	774
Fry	--	--	3	78	83	482	14	0	--	--	--	--	660
Hatchery	--	--	0	24,368	1,294	189	0	0	--	--	--	--	25,851
Unknown	--	--	0	0	0	0	0	0	--	--	--	--	0
Bull trout													
Juvenile	--	--	0	0	0	0	0	0	--	--	--	--	0
Adult	--	--	0	0	0	0	0	0	--	--	--	--	0
Westslope cutthroat trout	--	--	0	0	0	0	0	0	--	--	--	--	0
Eastern brook trout	--	--	0	1	4	0	0	0	--	--	--	--	5
Mountain whitefish	--	--	0	5	1	11	9	0	--	--	--	--	26
Lamprey spp.	--	--	12	176	105	390	70	0	--	--	--	--	753
Northern pikeminnow	--	--	0	8	19	30	18	0	--	--	--	--	75
Sucker spp.	--	--	0	10	12	38	17	0	--	--	--	--	77
Dace spp.	--	--	2	3	14	3	3	0	--	--	--	--	25
Longnose dace	--	--	6	13	17	57	169	7	--	--	--	--	269
Redside shiner	--	--	0	0	0	56	36	253	--	--	--	--	345
Sculpin spp.	--	--	1	5	7	2	8	2	--	--	--	--	25
Fathead minnow	--	--	0	0	7	0	1	0	--	--	--	--	8
Chiselmouth	--	--	0	0	0	1	0	0	--	--	--	--	1
3-Spine stickleback	--	--	0	0	0	2	1	0	--	--	--	--	3
Peamouth	--	--	0	0	0	0	0	0	--	--	--	--	0
Yellow bullhead	--	--	0	0	1	0	0	0	--	--	--	--	1

Appendix H. Annual collection information for the Lower Wenatchee River smolt trap.

Species/Origin	2018	2017	2016	2015	2014	2013
Chinook						
Wild						
Yearling	1,418	1,332	610	1,559	1,700	1,854
Subyearling	47,283	46,801	27,407	252,293	81,445	52,652
Hatchery	51,068	12,132	7,701	9,920	31,290	13,979
Steelhead						
Wild						
Smolt	208	52	88	231	80	173
Parr and fry	37	111	329	100	102	537
Hatchery	349	337	259	2,288	494	819
Sockeye						
Wild	10,331	1,046	1,346	4,178	7,678	4,520
Hatchery	0	0	0	0	0	72
Coho						
Wild						
Smolt	97	17	10	22	220	597
Fry and parr	1,434	685	135	4,972	393	923
Hatchery	25,851	3,724	219	6,566	16,908	12,960
Unknown	0	15	2,630	143	NA	NA
Bull trout						
Juvenile	0	0	0	0	3	6
Adult	0	0	0	0	0	0
Westslope cutthroat trout	0	0	0	1	3	0
Mountain whitefish	26	8	15	9	27	110
Lamprey spp.	753	1,307	1,497	283	292	762
Longnose dace	269	244	163	242	541	1,382
Sculpin spp.	25	51	56	52	128	242
Sucker spp.	77	192	269	51	134	240
Redside shiner	345	98	189	19	94	423
3-Spine stickleback	3	6	2	13	66	196
Dace spp.	25	40	133	NA	NA	NA
Fathead minnow	8	1	9	NA	NA	NA
Northern pikeminnow	75	83	552	12	37	39
Chiselmouth	1	7	66	6	69	10
Peamouth	0	0	0	3	9	10

Appendix D

Summary of PIT-Tagging Activities in the Wenatchee Basin, 2018

Appendix D. Numbers of fish captured, recaptured, PIT tagged, trap and handle mortality, shed tags, and total tags released in the Wenatchee River basin during January through November 2018.

Sampling Location	Species and Life Stage	Number collected	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
Chiwawa Trap	Wild Subyearling Chinook	7,948	285	5,692	20	6	5,686	0.25
	Wild Yearling Chinook	3,539	57	3,448	8	1	3,447	0.22
	Wild Steelhead/Rainbow	526	8	435	1	0	435	0.19
	Hatchery Steelhead/Rainbow	379	0	0	0	0	0	0.00
	Wild Coho	1	0	0	0	0	0	0.00
	Total	**12,394**	**350**	**9,575**	**29**	**7**	**9,568**	**0.24**
Chiwawa Remote (Electrofishing)	Wild Subyearling Chinook	3,800	39	3,737	15	0	3,737	0.39
	Wild Yearling Chinook	0	0	0	0	0	0	0.00
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**3,800**	**39**	**3,737**	**15**	**0**	**3,737**	**0.39**
Nason Creek Trap	Wild Subyearling Chinook	1,651	51	686	8	0	686	0.48
	Wild Yearling Chinook	301	13	296	5	0	296	1.66
	Wild Steelhead/Rainbow	699	6	513	7	0	513	1.00
	Hatchery Steelhead/Rainbow	733	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**3,384**	**70**	**1,495**	**20**	**0**	**1,495**	**0.59**
Nason Creek Remote (Electrofishing)	Wild Subyearling Chinook	2,648	88	2,524	17	0	2,524	0.64
	Wild Yearling Chinook	0	0	0	0	0	0	0.00
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**2,648**	**88**	**2,524**	**17**	**0**	**2,524**	**0.64**
White River Trap	Wild Subyearling Chinook	131	0	220	0	0	220	0.00
	Wild Yearling Chinook	225	2	106	0	0	106	0.00
	Wild Steelhead/Rainbow	4	0	2	0	0	2	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**360**	**2**	**328**	**0**	**0**	**328**	**0.00**
Lower Wenatchee Trap	Wild Subyearling Chinook	47,283	54	5	347	0	5	0.73
	Wild Yearling Chinook	1,418	1	1,243	7	0	1,243	0.49
	Wild Steelhead/Rainbow	245	0	222	0	0	222	0.00
	Hatchery Steelhead/Rainbow	349	0	1	1	0	1	0.28
	Wild Coho	1,531	0	3	4	0	3	0.26
	Hatchery Coho	25,851	0	0	4	0	0	0.01
	Wild Sockeye	10,331	11	8,822	82	0	8,822	0.79

Sampling Location	Species and Life Stage	Number collected	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
	Total	**87,008**	**66**	**10,296**	**445**	**0**	**10,296**	**0.51**
Total:	***Wild Subyearling Chinook***	***63,461***	***517***	***12,864***	***407***	***6***	***12,858***	***0.64***
	Wild Yearling Chinook	***5,483***	***73***	***5,093***	***20***	***1***	***5,092***	***0.36***
	Wild Steelhead/Rainbow	***1474***	***14***	***1172***	***8***	***0***	***1172***	***0.54***
	Hatchery Steelhead/Rainbow	***1461***	***0***	***1***	***1***	***0***	***1***	***0.07***
	Wild Coho	***1,532***	***0***	***3***	***4***	***0***	***3***	***0.26***
	Unknown Coho	***25,851***	***0***	***0***	***4***	***0***	***0***	***0.02***
	Wild Sockeye	***10,331***	***11***	***8,822***	***82***	***0***	***8,822***	***0.79***
Grand Total:		***109,593***	***615***	***27,955***	***526***	***7***	***27,948***	***0.48***

Appendix E

Wenatchee Steelhead Spawning Escapement Estimates, 2018

Estimates of Wenatchee Steelhead Redds and Spawners in 2018

Kevin See

January 09, 2019

Introduction

Redd counts are an established method to provide an index of adult spawners (Gallagher et al. 2007). In the Wenatchee and Methow subbasins, index reaches are surveyed weekly during the steelhead spawning season (Mar 12, 2018 - Jun 11, 2018) and non-index reaches are surveyed once during the peak spawning period. The goal of this work is to:

- Predict observer net error, using the model described in Murdoch et al. (2018).
- Use estimates of observer net error rates and the mean survey interval to estimate the number of redds in each index reach, using a Gaussian area under the curve (GAUC) technique described in Millar et al. (2012).
- Estimate the total number of redds in the non-index reaches by adjusting the observed counts with the estimated net error.
- Convert these estimates of redds in the mainstem areas (surveyed for redds) into estimates of spawners.
- Use PIT-tag based estimates of escapement for all tributaries in the Wenatchee, and combine those estimates with the redd-based estimates of spawners in the mainstem areas to estimate the total number of spawners in the Wenatchee.

Methods

Mainstem areas

The model for observer net error (observed redd counts / true number of redds) is fully described in Murdoch et al. (2018). It involves model averaging of the 2 best models that were fit to 43 data points collected in the Methow. Both models contained covariates for the observed redd density and mean thalweg CV as a proxy for channel complexity, while 1 each contained the log of total redd survey experience and discharge. Predictions were made using model averaged coefficients (based on AICc model weights) and the 2018 steelhead data. From these survey specific estimates of net error, a mean and standard error of net error was calculated for each reach. The standard deviation was calculated by taking the square root of the sum of the squared standard errors for all predictions within a reach.

Estimates of total redds were made for each index reach with a minimum of 2 and at least 3 using the GAUC model described in Millar et al. (2012) and Murdoch et al. (2018). The GAUC model was developed with spawner counts in mind. As it is usually infeasible to mark every individual spawner, only total spawner counts can be used, and an estimate of average stream life must be utilized to translate total spawner days to total unique spawners. However, in adapting this for redd surveys, two modification could be used. The first would fit GAUC models to data showing all visible redds at each survey, and use an estimate of redd life as the equivalent of spawner stream life. However, because conditions can lead to many redds not disappearing before the end of the survey season, the estimates of redd life can be biased low. The second method relies on the fact that individual redds can be marked, and therefore the GAUC model can be fit to new redds only. The equivalent of stream life thus the difference between survey numbers which can be fixed at 1. We utilized the second method for this analysis.

For non-index reaches, which were surveyed only once during peak spawning, the estimate of total redds was calculated by dividing the observed redds by the estimate of net error associated with that survey. This assumes that no redds were washed out before the non-index survey, and that no new redds appeared after that survey. As the number of redds observed in the non-index reaches ranged from 0 to 0, any violation of this assumption should not affect the overall estimates very much. Any index reaches that did not meet the thresholds described above were treated as non-index reaches, and the total observed redds in those reaches were divided by an estimate of net error for each reach.

To convert estimates of total redds into estimates of natural and hatchery spawners, total redds were multiplied by a fish per redd (FpR) estimate and then by the proportion of hatchery or wild fish. The fish per redd estimate was based on PIT tags from the branching patch-occupancy model (see below) observed to move into the lower or upper Wenatchee (below or above Tumwater dam). FpR was calculated as the ratio of male to female fish, plus 1. This was 1.66 above Tumwater dam, and 1.74 below Tumwater. Reaches W1 - W7 are below Tumwater, while reaches W8 - W10 are above Tumwater. Similarly, the proportion of hatchery and natural origin fish was calculated from the same group of PIT tags for areas above and below Tumwater. The proportion of hatchery origin fish was 0.29 above Tumwater dam, and 0.49 below Tumwater (Table 2).

Tributary areas

Estimates of escapement to various tributaries in the Wenatchee were made using a branching patch-occupancy model (Waterhouse, L. et al., *in prep*) based on PIT tag observations of fish tagged at Priest Rapids dam. All fish that escaped to the various tributaries were assumed to be spawners (i.e. pre-spawn mortality only occurs in the mainstem).

Total spawners

When summing spawner estimates from index reaches to obtain estimates of total spawners in the Wenatchee, an attempt was made to incorporate the fact that the reaches within a stream are not independent. Estimates of correlation between the reaches within a stream were made based on weekly observed redds. Because correlations are often quite high between reaches, this is a better alternative than to naively assume the standard errors between reaches are independent of one another. These estimates of correlation were combined with estimates of standard error for each index reach to calculate a covariance matrix for the Wenatchee index reaches where redds were found (W6, W8, W9, W10), which was used when summing estimates of spawners to estimate the total standard error. Failure to incorporate the correlations between reaches would result in an underestimate of standard error at the population scale. Non-index reaches were only surveyed once, so it is impossible to estimate a correlation coefficient between non-index reaches and index reaches. Therefore, they were assumed to be independent from the index reachs when summing the estimates of spawners. Because the estimates of tributary spawners were made separately (see above), they were also treated as independent when summing spawner estimates. The uncertainty in each step was carried through the entire analysis via the delta method (Casella and Berger 2002).

Prespawn Mortality

After translating estimates of redds to estimates of spawners by origin, we can then compare the spawner estimates to escapement estimates made using PIT tags, and estimate a prespawn mortality rate (Table 4). Taking the total PIT-tag based escapement estimate to the Wenatchee (after subtracting the 62 hatchery and 66 wild fish removed at Tumwater, as well as the 27 hatchery fish and 14 wild fish removed at Dryden, and the 0 and 0 deaths to hatchery and wild fish due to harvest), and subtracting the total estimate of spawners, including the tributaries, then dividing by the total escapement estimate provides an estimate of pre-spawn mortality across the entire Wenatchee population. We can also compare estimates of escapement from the "black box" above LWE (after subtracting 27 hatchery and 14 wild fish removed at Dryden) and the "black box" above Tumwater (after subtracting the 62 hatchery and 66 wild fish removed at Tumwater) to total estimates of spawners in mainstem areas below and above Tumwater dam. This allows us to estimate pre-spawn mortality in the mainstem above and below Tumwater, by origin.

Results

Redd estimates

The estimated net error observed redds and estimates of redds are shown in Table 1.

Table 1: Estimates of mean net error and total redds for each reach.

Reach	Type	Net.Error	Net.Error.CV	Redds.Counted	Redds.Est	Redds.CV
C1	Index	1	0	0	0	-
N1	Index	1	0	0	0	-
P1	Index	1	0	1	1	0
W1	Non-Index	-	-	0	0	-
W2	Non-Index	-	-	0	0	-
W2	Index	0.49	0.45	0	0	-
W3	Non-Index	-	-	0	0	-
W4	Non-Index	-	-	0	0	-
W5	Non-Index	-	-	0	0	-
W6	Non-Index	0.6	0.44	0	0	-
W6	Index	0.56	0.42	2	4	0.38
W8	Index	0.36	0.54	1	3	0.5
W9	Non-Index	0.69	0.46	0	0	-
W9	Index	0.59	0.34	8	14	0.5
W10	Non-Index	0.32	0.58	0	0	-
W10	Index	1	0.23	16	16	0.35
Total	**-**	**-**	**-**	**28**	**38**	**0.33**

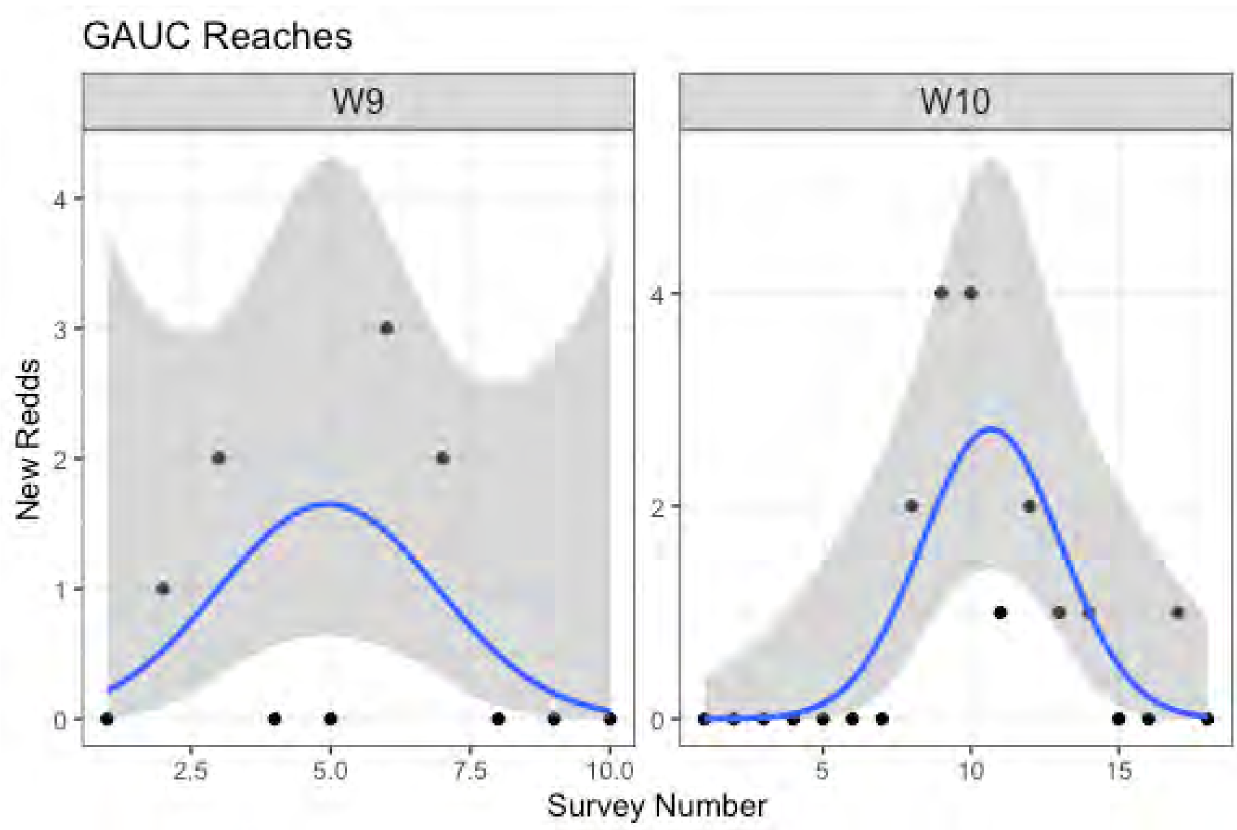

Figure 1: Plots of observed redd counts (black dots) through time for each index reach, and the fitted curve from the GAUC model (blue line) with associated uncertainty (gray).

Spawner estimates

Parameter estimates for fish / redd and proportion hatchery based on PIT tag data are shown in Table 2.

Table 2: Fish per redd and hatchery / natural origin proportion estimates.

Area	Fish / redd	FpR Std. Error	Prop. Hatchery	Prop Std. Error
Below TUM	1.66	0.14	0.292	0.0656
Mainstem above TUM	1.74	0.156	0.489	0.0729
Tribs above TUM	2.71	0.381	0.543	0.0734

Combining PIT tag-based estimates of spawners in the tributaries with adjusted redd-based estimates of spawners in the mainstem areas, Table 3 shows all of them, broken down by area and origin.

Table 3: Estimates (CV) of spawners by area and origin.

Area	Type	Hatchery	Natural
W1	Non-Index	0 (–)	0 (–)
W2	Index	0 (–)	0 (–)
W2	Non-Index	0 (–)	0 (–)
W3	Non-Index	0 (–)	0 (–)
W4	Non-Index	0 (–)	0 (–)
W5	Non-Index	0 (–)	0 (–)
W6	Index	2 (0.45)	5 (0.4)
W6	Non-Index	0 (–)	0 (–)
W8	Index	3 (0.53)	3 (0.53)
W9	Index	12 (0.53)	12 (0.53)
W9	Non-Index	0 (–)	0 (–)
W10	Index	14 (0.39)	14 (0.39)
W10	Non-Index	0 (–)	0 (–)
Icicle	Trib	24 (0.43)	49 (0.29)
Peshastin	Trib	0 (–)	80 (0.24)
Mission	Trib	0 (–)	54 (0.28)
Chumstick	Trib	8 (0.85)	16 (0.55)
Chiwaukum	Trib	20 (0.51)	20 (0.49)
Chiwawa	Trib	31 (0.43)	25 (0.46)
Nason	Trib	37 (0.34)	32 (0.35)
Little Wenatchee	Trib	0 (–)	6 (0.88)
White River	Trib	8 (1.08)	0 (–)
Total		**158 (0.46)**	**316 (0.34)**

Prespawn Mortality

The estimates of overall prespawn mortality within the Wenatchee population are shown in Table 4.

Table 4: Wenatchee pre-spawn mortality estimates. Includes estimates (standard error) of escapement, spawners, pre-spawn mortality, and CV of this rate, separated by origin.

Origin	Escapement	Spawners	Prespawn Mortality	CV
Hatchery	256 (38)	158 (73)	0.38	0.003031
Natural	392 (44)	316 (107)	0.19	0.003796

However, when focused on the mainstem areas above and below Tumwater, there was evidence for substantial prespawn mortality. For natural origin fish below Tumwater, we found that the estimates of escapement were smaller than the estimates of spawners, leading to negative estimates of pre-spawn mortality, but the escapement and spawner estimates had overlapping confidence intervals, so not too much should be made about higher spawner estimates compared to escapement. For the other groups, it appears prespawn mortality was quite high (Table 5).

Table 5: Wenatchee pre-spawn mortality estimates. Includes estimates (standard error) of escapement, spawners, pre-spawn mortality, and the standard error of this rate, separated by origin and mainstem areas above and below Tumwater dam.

Origin	Loc	Escapement	Spawners	Prespawn Mortality	SE
Natural	Mainstem above Tumwater	157 (26)	29 (9)	0.82	0.000404
Hatchery	Mainstem above Tumwater	164 (28)	29 (8)	0.82	0.000361
Natural	Mainstem below Tumwater	3 (10)	5 (2)	-0.46	1.21
Hatchery	Mainstem below Tumwater	41 (13)	2 (1)	0.95	0.000639

Discussion

Estimated net error rates in 2018 were similar to those in the net error model dataset.

The estimates of high prespawn mortality in the lower mainstem of the Wenatchee could be accurate, but it should be noted that many of the redd surveys failed to observe a single redd in many of the reaches (Table 1). Without any observed redds, any estimate of net error is moot, as the adjusted redd estimate will still be zero. So if all the redds were missed in some of those reaches, the estimate of total spawners in the lower mainstem should be higher, leading to a lower estimate of prespawn mortality. It is unclear whether that actually occurred, or if there were actually no redds this year in those reaches.

As for any negative estimates of pre-spawn mortality rates, this should be interpreted as evidence for very low levels of pre-spawn mortality. Overlapping confidence intervals between estimated escapement and estimated spawners mean that although we estimated more spawners than escapement, not too much should be made of that fact.

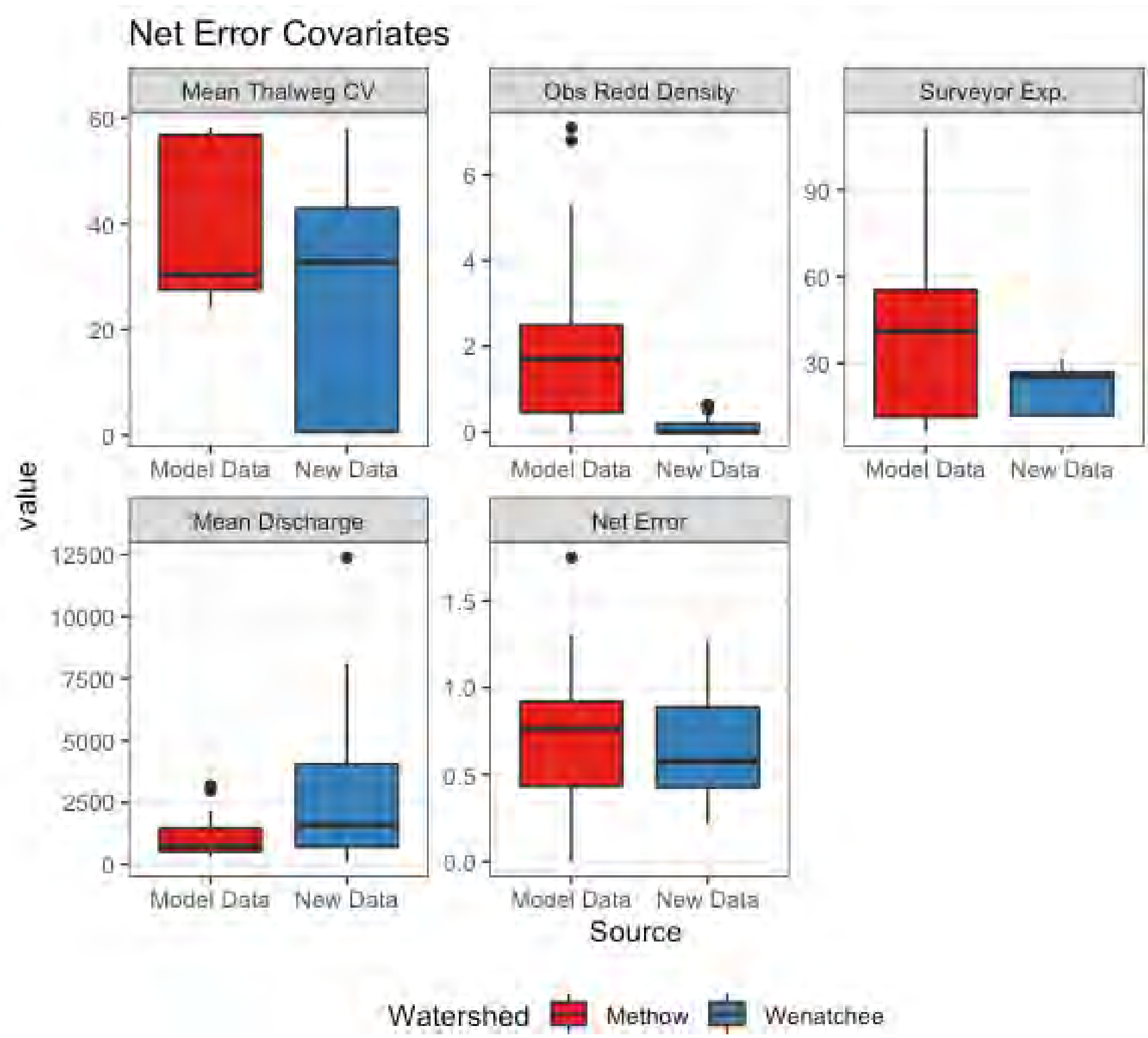

Figure 2: Net error covariate values from the study in the Methow and the predicted reaches in the Wenatchee.

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Appendix F

Genetic Diversity of Wenatchee Summer Steelhead

Examining the Genetic Structure of Wenatchee Basin Steelhead and Evaluating the Effects of the Supplementation Program

Developed for

Chelan County PUD

and the

Rock Island Habitat Conservation Plan Hatchery Committee

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17 January 2012

Table of Contents

Executive Summary

In 1997, Wenatchee River summer steelhead, as part of the upper Columbia River evolutionarily significant unit (ESU), were listed as threatened under the Endangered Species Act (ESA). To address concerns about effects of hatchery supplementation, the hatchery program for hatchery produced (HOR) summer steelhead to be planted in the Wenatchee River changed from using mixed ancestry broodstock collected in the Columbia River to using Wenatchee River broodstock collected in the Wenatchee River. Three monitoring and evaluation (M&E) indicators were developed to measure the genetic effects of hatchery production on wild fish populations. To address these indicators, temporal collections of tissue samples from Wenatchee River hatchery-produced (HOR) and natural origin (NOR) adults captured and sampled at Dryden and Tumwater dams and from NOR juveniles from three Wenatchee River tributaries and the Entiat River were surveyed for genetic variation with 132 genetic (SNPs) markers. Peshastin Creek (a Wenatchee River tributary) and the Entiat River served as no-hatchery-outplant controls, meaning they have stopped receiving HOR juvenile outplants. As per the M&E plan, we interrogated these data for the presence or absence of spatial and temporal trends in allele frequencies, genetic distances, and effective population size.

Allele frequencies – Changes to the summer steelhead hatchery supplementation program had no detectable effect on genetic diversity of wild populations. On average, HOR adults had higher minor allele frequencies (MAF) than NOR adults, which may simply reflect the mixed ancestry of HOR adults. Both HOR and NOR adults had MAF similar to juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants. This suggests that the hatchery program has had little effect on allele frequencies since broodstock sources changed in 1998.

Genetic distances – As intended, interbreeding of Wenatchee River HOR and NOR adults reduced the genetic differences between Wells Hatchery HOR adults and Wenatchee River NOR adults observed in the first few years after changing the broodstock collection protocol. Though there were detectable genetic differences between HOR and HOR adults, the magnitude of that difference declined over time. HOR adults were genetically quite different from NOR adults and juveniles based on pair-wise F_{ST} and principal components analysis (PCA), most likely because of the much smaller effective population size (N_b) in the hatchery population (see below). Pair-wise F_{ST} estimates and genetic distances between HOR and NOR adults collected the same year declined over time suggesting that the interbreeding of HOR and NOR adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year (the year fish were hatched, determined using scale-based age estimates) were inconclusive because of limitations of the data.

Effective population size (N_b) – Although the effective population size of the Wenatchee River hatchery summer steelhead program was consistently small, it does not appear to have caused a reduction in the effective population size of wild populations. On average, estimates of N_b were much lower and varied less for HOR adults than for NOR adults and juveniles. Estimates of N_b for HOR adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1997. There was no indication that this had any effect on N_b in NOR adults and juveniles; N_b estimates for NOR adults and juveniles were, on average, higher and varied considerably over the time period covered by our dataset (1998 – 2010) and showed no temporal trend.

Introduction

The National Marine Fisheries Service (NMFS) recognizes 15 Evolutionary Significant Units (ESU) for west coast steelhead (*Oncorhynchus mykiss*). The Upper Columbia ESU, which contains steelhead in the Wenatchee Basin, was listed as endangered under the Endangered Species Act (ESA) in 1997. Included in this listing were the Wells hatchery steelhead (program initiated in the late 1960s) that originated from a mixed group of native steelhead and are considered to be genetically similar to natural spawning populations above Wells Dam. Juvenile steelhead from Wells Fish Hatchery was the primary stock released into the Wenatchee River (Murdoch et al. 2003). The 1998 steelhead status review identified several areas of concern for this ESU including the risk of genetic homogenization due to hatchery practices and the high proportion (65% for the Wenatchee River) of hatchery fish present on the spawning grounds (Good et al. 2005). The Biological Review Team (BRT) further identified the relationship between the resident and anadromous forms of *O. mykiss* and possible changes in the population structure ('genetic heritage of the naturally spawning fish') in the basin as two areas requiring additional study. Furthermore, the West Coast Steelhead BRT (2003) recommended that stocks in the Wenatchee, Entiat, and Methow rivers, within the Upper Columbia ESU, be managed as separate populations.

A review of the presence of resident *O. mykiss* in the Upper Columbia ESU (Good et al. 2005) shows that rainbow trout are relatively abundant in upper Columbia River tributaries currently accessible to steelhead as well as in upriver tributaries unavailable to anadromous access by Chief Joseph and Grand Coulee dams (Kostow 2003). U.S. Fish and Wildlife Service (USFWS) biologists surveyed the abundance of trout and steelhead juveniles in the Wenatchee, Entiat, and Methow river drainages in the mid-1980s and found adult trout (defined as those with fork length > 20 cm) in all basins (Mullan et al. 1992). The results also supported the hypothesis that resident *O. mykiss* are more abundant in tributary or mainstem areas upstream of the areas used by steelhead for rearing. No samples of rainbow trout from the Wenatchee were available for this study.

In addition to the mixed ancestry Wells Hatchery steelhead, Skamania Hatchery (Washougal River steelhead ancestry) steelhead were also released into the Wenatchee River basin for several years in the late 1980s (L. Brown, Washington Dept. of Fish and Wildlife [WDFW], personal communication). In 1996, broodstock for the Wenatchee River steelhead program were collected from Priest Rapids Dam and Dryden (rkm 24.9) and Tumwater (rkm 52.6) dams on the Wenatchee River. Because of the ESA listing, broodstock collection after 1996 was restricted to the Wenatchee River in an effort to develop a localized broodstock (Murdoch et al. 2003). Thus, starting in 1998, all juvenile steelhead released into the Wenatchee River and Wenatchee River tributaries were offspring of only Wenatchee River captured broodstock.

In response to the need for evaluation of the supplementation program, both a monitoring and evaluation plan (Murdoch and Peven 2005) and the associated analytical framework (Hays et al. 2006) were developed for the Habitat Conservation Plans Hatchery Committee through the joint effort of the fishery co-managers (Confederated Tribes of the Colville Reservation [CCT], NMFS, USFWS, WDFW, and Yakama Nation [YN]) and Chelan County, Douglas County, and Grant County Public Utility Districts (PUD). These reports outline 10 objectives to be applied to various species assessing the impacts of hatchery operations mitigating the operation of Rock Island and Rocky Reach Dams. This report pertains to Wenatchee River basin steelhead (*O. mykiss*) and the steelhead supplementation program as addressed by objective 3, specifically the first three evaluation indicators.

> **Objective 3:** Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

> **3.1 Allele Frequency**
> **3.2 Genetic Distances Between Populations**
> **3.3 Effective Spawning Population**

To address these evaluation indicators the WDFW Molecular Genetics Lab (MGL) obtained pertinent tissue collections and samples, surveyed genetic variation with SNP markers using our standard laboratory protocols, and calculated the relevant genetic metrics and statistics. We used collections from both the Entiat River and Wenatchee River basins. Both have received hatchery plants from non-local stocks [i.e. Entiat was stocked with both Wenatchee and Wells program juveniles averaging 12K and 18K respectively during 1995-2001, and Wenatchee received on average 177K juveniles from the Wells program during 1995-2001; (Good et al. 2005)], and both have all or some part of the basin designated as natural production “reference” drainage – no hatchery outplanting (i.e., the entire Entiat Basin, and Peshastin Creek in the Wenatchee River basin) (Good et al. 2005).

Materials and methods

Sample collections

To address objectives 3.1 through 3.3, we obtained samples from hatchery (HOR, adipose fin clipped) and natural origin (NOR, adipose fin intact) adult summer steelhead captured at Dryden or Tumwater diversion dams in the summer and fall of 1997 through 2009 (excepting 2004 and 2005; Table 1). All or some fraction of these fish was later used as hatchery broodstock the calendar year following the sampling year. In order to keep things simple we have reported years as the spawning year, i.e., the calendar year the fish were spawned, not the calendar year they were captured.

To address objective 3.2, it was necessary to have samples from natural origin fish from each of the spawning populations in the basin. It is difficult to obtain adult samples from known spawning populations due to the life history and behavior of steelhead, without tributary weirs or some other blocking method of collection. The NOR adult samples used as broodstock collected from Dryden and Tumwater Dams were a mixed collection representing all of the spawning populations located upstream. Therefore to determine population substructure within the basin we obtained collections of juvenile fish from smolt traps located within tributaries representing three major populations in the basin and from the Entiat River (Chiwawa River, Nason Creek, and Peshastin Creek; Table 2). We also obtained two collections of juvenile fish caught in a smolt trap in the lower Wenatchee River. These, like the NOR adult collections, were a mixed collection presumably representing all populations located upstream. Fin tissue was taken from each fish and preserved in 95% ethanol.

Sample processing

Fin tissue samples were processed for 1468 HOR and NOR adult steelhead broodstock (Table 1) and for 1542 juvenile *O. mykiss* from the Wenatchee and Entiat Rivers (Table 2). Samples were genotyped at 152 single nucleotide polymorphism loci (SNPs, Tables 3, 4). We originally proposed to use microsatellites, but WDFW MGL and other regional genetic laboratories (Columbia River Inter-Tribal Fish Commission [CRITFC], Idaho Fish and Game [IDFG], USFWS) are moving toward using SNPs and they provide the same kinds of information with faster processing. Twenty SNP loci were developed to discriminate among trout species; 14 distinguish *O. mykiss* from coastal cutthroat trout (*O. clarkii clarkii*) and westslope cutthroat (*O. clarkii lewisi*), and 6 distinguish steelhead and coastal cutthroat from westslope cutthroat (Table 4). The remaining 132 SNP loci were developed to be used for population structure, parentage assignment, or other population genetic studies of *O. mykiss* (Table 3). These markers comprised the current standard set of SNP markers used for genetic studies of *O. mykiss* at WDFW MGL.

We used Qiagen DNEasy ® kits (Qiagen Inc., Valencia, CA), following the recommended protocol for animal tissues, to extract and isolate DNA from fin tissue. SNP genotypes were obtained through PCR and visualization on Fluidigm EP1 integrated fluidic circuits (chips). Protocols followed Fluidigm's recommendations for TaqMan SNP assays as follows: Samples were pre-amplified by Specific Target Amplification (STA) following Fluidigm's recommended protocol with one modification. The 152 assays were pooled to a concentration of 0.2X and mixed with 2X Qiagen Multiplexing Kit (Qiagen, Inc., Valencia CA), instead of TaqMan PreAmp Master Mix (Applied Biosystems), to a volume of 3.75µl, to which 1.25µl of unquantified sample DNA was added for a total reaction volume of 5µl. Pre-amp PCR was conducted on a MJ Research or Applied Biosystems thermal cycler using the following profile: 95°C for 15 min followed by 14 cycles of 95°C for 15 sec and 60°C for 4 minutes. Post-PCR reactions were diluted with 20µl dH_2O to a final volume of 25µl.

Specific SNP locus PCRs were conducted on the Fluidigm chips. Assay loading mixture contained 1X Assay Loading Reagent (Fluidigm), 2.5X ROX Reference Dye (Invetrogen) and 10X custom TaqMan Assay (Applied Biosystems); sample loading mixture contains 1X TaqMan Universal PCR Master Mix (Applied Biosystems), 0.05X AmpliTaq Gold DNA polymerase (Applied Biosystems), 1X GT sampling loading reagent (Fluidigm) and 2.1 µL template DNA. Four µL assay loading mix and 5 µL sample loading mix were pipetted onto the chip and loaded by the IFC loader (Fluidigm). PCR was conducted on a Fluidigm thermal cycler using a two step profile. Initial mix thermal profile was 70°C for 30min, 25°C for 5 min, 52.3° for 10 sec, 50.1°C for 1 min 50sec, 98°C for 5 sec, 96°C for 9 min 55 sec, 96°C for 15 sec, 58.6°C for 8 sec, and 60.1°C for 43 sec. Amplification thermal profile was 40 cycles of 58.6°C for 10 sec, 96°C for 5 sec, 58.6°C for 8 sec and 60.1°C for 43 sec with a final hold at 20°C.

The SNP assays were visualized on the Fluidigm EP1 machine using the BioMark data collection software and analyzed using Fluidigm SNP genotyping analysis software. To ensure all SNP markers were being scored accurately and consistently, all data were scored by two researchers and scores of each researcher were compared. Disputed scores were called missing data (i.e., no genotype).

Evaluation of loci

A two-tailed exact test of Hardy–Weinberg equilibrium (HWE) was performed for each locus in each collection or population using the Markov Chain method implemented in GENEPOP v4.1 (dememorization number 1000, 100 batches, 1000 iterations per batch; Raymond and Rousset 1995; Rousset 2008). Significance of probability values was adjusted for multiple tests using false discovery rate (Verhoeven et al. 2005). F_{IS}, a measure of the fractional reduction in heterozygosity due to inbreeding in individuals within a subpopulation and an additional indicator of scoring issues, was calculated according to Weir and Cockerham (1984) using GENEPOP v4.1. Allele frequencies were calculated using CONVERT v1.0 (Glaubitz 2004). Expected and observed heterozygosities were calculated using GDA v1.1 (Lewis and Zaykin 2001).

Allele frequencies, genetic distances and population differentiation

To evaluate Q1 of Objective 3.1 and 3.2, we evaluated trends and patterns in allele frequencies, genetic distances and population differentiation. To test for temporal patterns in allele frequencies, we compared sample or spawn year to two diversity metrics, allele frequency and observed heterozygosity, from each adult and juvenile collection. Each SNP locus had only one or two alleles, so we used the minor allele frequency (MAF) of each SNP locus for each adult collection and averaged across loci. We also calculated the average observed heterozygosity (Ho) for each SNP locus within each adult and juvenile collection. We examined the presence or absence of a temporal trend in average allele frequency and observed heterozygosity with logistic regression analysis in R (R Development Core Team 2009).

To partition genetic variance into temporal, spatial (juvenile) and origin (adult) fractions, we performed hierarchical analysis of molecular variance (AMOVA) using ARLEQUIN v3.0 (Excoffier et al. 2005) with 1,000 permutations. We performed this analysis separately for juvenile and adult collections. Juveniles were grouped by sampling location (tributary) and adults were grouped by origin (HOR or NOR). To estimate the magnitude of genetic differences among temporal and spatial collections we calculated pairwise F_{ST} estimates among collections using FSTAT (Goudet 1995) with 1000 permutations. Statistical significance was adjusted using false discovery rate (Verhoeven et al. 2005).

To evaluate the temporal changes in genetic relationships, we compared spawn year to within spawn year pairwise F_{ST} estimates between NOR and NOR adults using beta regression (Simas and Rocha 2010). We used beta regression because the dependent variable was bound by zero and one but not binomial. Analysis was performed in R (package "betareg", Cribari-Neto and Zeileis 2010), with a loglog link.

We used principal component analyses (PCA) to explore the relationship between the covariation among the SNP loci within each collection and genetic differentiation between HOR and NOR collections, and to determine if the degree of differentiation has changed with time. Since each SNP is represented by only two alleles, only one allele per SNP is necessary to fully describe the covariation among all SNPs. We used MATLAB® scripts (2007a, The Mathworks, Natlick, MA) to calculate the principal components from SNP allele frequencies using only the major allele (1-MAF) for each SNP. We defined the major allele as the allele with the higher mean frequency across all collections, regardless of its status within any individual collection. We conducted three PCA analyses using: (1) all adult samples, aggregated based on origin (HOR versus NOR) and spawn year (i.e., the year the adult fish were used as broodstock) (N = 1437, 22 collections), (2) same as #1, but with the addition of all juvenile samples (N = 2938, 37 collections), and (3) only those adults samples with available age information (Mike Hughes, WDFW, personal communication) aggregated based on origin, and spawn year or brood year (i.e., the year the fish were hatched) (N = 1313, 20 spawn-year or 25 brood-year collections).

Molecular differentiation between HOR and NOR adults within a year was calculated based on principal component scores using Euclidian distances. We calculated pair-wise Euclidian distances between HOR and NOR fish within a spawn year or brood year using the first three principal components, and standardized each distance by subtracting from it the mean Euclidian distance calculated across all pair-wise distances. We used Mahalanobis distances to calculate the variation among HOR and NOR collections (calculated separately), again using the first three principal components. Here, we calculated Mahalanobis distances as the Euclidian distances between each collection and the centroid of all collections (HOR and NOR combined), but the Euclidian distances are scaled based on the dispersion of collections around the centroid (i.e., the variance). Euclidian and Mahalanobis distances were calculated using MATLAB scripts.

Effective spawning population

To evaluate Q1 of Objective 3.3, we estimated N_e using the single-sample linkage disequilibrium methods implemented in the program LDNE (Waples and Do 2008). This method requires that you input the P_{crit} value, the minimum frequency at which alleles were included in the analysis, since results can be biased depending on this setting (Waples and Do 2010). SNP markers typically have only one or two alleles; if one of two alleles is excluded based on its frequency in the collection it essentially excludes the locus, reducing the overall dataset. Therefore, we used P_{crit} values ranging from 0.1 to 0.001 to evaluate whether trends in N_e changed given which loci were used. Confidence intervals were calculated using a jackknife procedure.

We calculated an estimate of N_e for all adult and juvenile collections individually. However, the intention of an integrated hatchery program such as the Wenatchee River steelhead hatchery program is that HOR and NOR fish are integrated and progress as a single population through intentional interbreeding in the hatchery and presumed natural interbreeding in the wild. Thus, we also combined annual HOR and NOR collections to calculate an overall N_e estimate as has been done in other genetic monitoring and evaluation analyses (e.g., Small et al. 2007, [Chinook salmon, *O. tshawytscha*]).

Estimates of N_e from linkage refer to the generations that produced the sample. To calculate the ratio of effective population size to census size (N_e/N), we obtained the number of fish spawned in the hatchery (1993 through 2006, i.e., those that produced the adipose fin clipped adults that returned to spawn in the Wenatchee River 1998 through 2010) and the estimated escapement of fish spawning naturally (HOR and NOR separately) for the same time period. Estimates of census population size in spawning tributaries was obtained by multiplying the fraction of redds counted within tributaries (Chad Herring ,WDFW, unpublished data) by the total Wenatchee River census population estimate (Andrew Murdoch, WDFW, unpublished data). To calculate N_e/N, we performed two analyses. First, for adults, we assumed a five year generation time for natural origin adults and a four year generation time for hatchery origin adults and divided the N_e estimate by the census population estimate from four or five years earlier. For juveniles, we assumed an age at outmigration of two years and divided the N_e estimates by the estimate of census population size for the appropriate tributary. Second, we used available adult age data to parse individuals into cohorts originating in brood years (rather than spawn years) and then used LDNE to estimate N_e from cohort collections. We performed both analyses to make full use of all available data; age data were not available for many adults, and because of variable survival and sampling not all cohorts had sufficient numbers of HOR and NOR adults. According to Luikart et al. (2010), estimates produced using linkage disequilibrium should be interpreted as something between effective population size (N_e) and the effective number of breeders (N_b). Using cohorts, the estimate produced by LDNE is clearly an estimate of N_b rather than N_e. In order to keep things simple, we have referred to all estimates as N_b.

Results and Discussion

Collections and samples received

From 1468 samples from HOR and NOR adult steelhead broodstock, 1437 produced sufficient genetic data for further analysis (Table 1). From 1542 samples from NOR juvenile steelhead from Wenatchee River tributaries and the Entiat River, 1501 produced sufficient genetic data for further analysis and were genetically identified as *O. mykiss* (Table 2). Samples genetically identified as *O. clarki* (2 samples from the Chiwawa River, 1 from the Entiat River) or *O. clarki*/*O. mykiss* hybrids (4 – lower Wenatchee River, 4 – Nason Creek, 4 – Chiwawa River, and 1 – Entiat River) were omitted from further analysis.

Evaluation of loci

Three loci showed deviations from HWE in 10 or more of 37 Wenatchee steelhead collections before correcting for multiple tests (AOmy016, AOmy051, AOmy252, Table A1) indicating possible scoring issues. These loci were omitted from further analysis. Nine of the remaining loci were monomorphic or nearly monomorphic in all collections (average MAF < 0.1, AOmy023, AOmy028, AOmy123, AOmy129, AOmy132, AOmy209, AOmy229, AOmy270, AOmy271, Table A1) contributing little or nothing to analytical power. These loci were also omitted from further analysis. No genetic data was available for collection 10FD due to poor PCR amplification at locus AOmy213 for the entire collection. AOmy213 had a relatively low MAF in most collections so rather than re-processing this collection at this locus or running different sets of loci for different tests, we omitted this locus from further analysis. Only six tests of deviation from HWE were significant after correcting for 4348 tests using false discovery rate. Two of these tests were in loci already omitted. The remaining four tests were spread among the remaining loci, indicating no more loci needed to be omitted from further analysis.

Objective 3.1, 3.2 – Allele frequencies and Genetic distances

Allele frequencies

Average MAF of SNP loci ranged from 0.00 to 0.60 in HOR adult collections and from 0.00 to 0.61 in NOR adult collections (Table A1). Observed heterozygosity ranged from 0.00 to 0.75 in HOR adult collections and from 0.01 to 0.67 in NOR adult collections. Juvenile collections produced similar ranges of MAF and Ho (Table A1). Average MAF and Ho of HOR adult collections appeared to be greater than those of natural origin collections. However, logistic regression analysis indicated there was no significant temporal trend in either diversity statistic (Figure 1). Similarly, there was no consistent temporal trend in MAF or Ho of juvenile collections (Figure 2). Both the Chiwawa River and Nason Creek, the two tributaries that currently still receive hatchery juvenile outplants, both appeared to have declining allele frequencies, but neither was statistically significant ($P > 0.90$). However, the power to detect significant trends was limited by the small sample sizes (n = 3 sample years).

Analysis of Molecular Variance

Analysis of molecular variance (AMOVA) of adult collections (i.e., temporal and origin structure) indicated most of the genetic variance was among individuals or among individuals within populations (99.04%). Most of the remaining variance was temporal variation within hatchery and natural origin groups (0.61%) with the remaining variation from origin (0.35%). AMOVA of juvenile collections (i.e., spatial structure) indicated most of the genetic variance was among individuals (98.44%) or among individuals within populations (0.94%). Most of the remaining variance existed among temporal collections within tributary collections (0.37%) with the smallest fraction as among tributary variance (0.24%). Thus, overall, there was more variability among years than among tributaries or origins, but no trend in the temporal variability.

Pair-wise F_{ST} *estimates*

HOR adults were genetically different that NOR adults as estimated by F_{ST} (full pair-wise table in Table A2, all pair-wise F_{ST} estimates with P-values ≤ 0.05 before correcting for multiple tests were significantly different from zero after correcting for multiple tests using false discovery rate). On average, HOR adult collections were as different from one another (mean F_{ST} = 0.011) as they were from NOR adult collections among years (mean F_{ST} = 0.009) or from NOR adult collections within years (mean F_{ST} = 0.010). Among year comparisons of NOR adult collections were, on average, nearly an order of magnitude lower (mean = 0.002). These patterns held whether spawn year or brood year (data not shown) was used to group individuals. Over time, within spawn year pair-wise F_{ST} estimates between HOR and NOR adults declined over time (β = -0.014, P = 0.0185; Figure 3), suggesting that the integration of hatchery and wild fish is slowly genetically homogenizing the groups. That relationship disappeared when adults were grouped by brood year (i.e., comparing fish produced the same year) and all brood years were used (β = -0.009, P = 0.615, data not shown). However, when the dataset was restricted to just those brood years when all typical (age at maturation frequency among all years > 0.10) age classes were present in the dataset (HOR = age 3, 4; NOR = age 4, 5, 6; brood years 1996-1998, 2004-2005) a non-significant (P = 0.278) negative relationship (β = -0.12) of F_{ST} and brood year was apparent. When the data were further restricted to just the years after the hatchery program changed to only collecting broodstock in the Wenatchee River (brood years 1998, 2004-2005), the slope was also negative (β = -0.09), but the relationship was not statistically significant (P = 0.962).

Within tributary among sample year pair-wise comparisons of juvenile collections were, on average, only very slightly smaller than comparisons among tributaries (0.005 vs. 0.006, respectively, Table 5, all pair-wise F_{ST} estimates with P-values ≤ 0.05 before correcting for multiple tests were significantly different from zero after correcting for multiple tests using false discovery rate). Nason Creek and Peshastin Creek on average showed higher among sample year F_{ST} estimates (0.010 and 0.007, respectively) than the Chiwawa or Entiat Rivers (0.004 and 0.002, respectively). The pair-wise comparison of the two collections of lower Wenatchee River smolts, presumably a mix of Chiwawa, Nason, Peshastin smolts and smolts from other spawning tributaries, was an order of magnitude smaller (F_{ST} = 0.0002), and not significantly different than zero (Table 5). There was no temporal trend in pair-wise comparisons of juvenile collections. However with, at most, four annual collections, detecting any temporal trend was unlikely. We also had no collections from years prior to 1998 (the first year of new hatchery program broodstock collecting protocols) with which to compare contemporary data, nor could we find any reports or papers containing pre-hatchery-program-change genetic comparisons among Wenatchee River tributary populations, making it impossible to determine whether or not changing the hatchery program has had any effect at all on population structure. However, these data will be useful for future studies.

Principal Components

Each principal component analysis (Figures 4, 5) indicated that the genetic structure among HOR collections differed from that among NOR collections, and that this difference has decreased with time. When adult fish were aggregated based on origin and spawn-year, there was a clear differentiation between HOR and NOR adult collections along PC 1, and a separation among HOR collections, differentiating the early spawn-years (1998 – 2003) from the later spawn-years (2004 – 2010) along PC 2 and PC 3, respectively (Figure 4). The pair-wise genetic distances between HOR and NOR collections from the same spawn year (i.e., the HOR and NOR fish used as broodstock within the same year) decreased from the largest distance in 1998 to small distances in 2009 and 2010, although the smallest distance occurred in 2004 (Figure 4, top right). That is, within hatchery broodstock, the genetic difference between HOR and NOR fish decreased, on average, from 1998 to 2010, and the decrease appeared to be a mutual convergence of NOR fish shifting right along PC 1 and HOR fish shifting downward along PC 2 and PC 3. This increasing similarity in adult fish mirrored that seen in within year pair-wise F_{ST} estimates between HOR and NOR adults which also declined over time (Figure 3).

Overall, there was considerably more genetic variation among the HOR collections than there was among the NOR collections with average Mahalanobis distances (distance between each collection and the overall centroid [0,0,0]) among the HOR and NOR collections being 4.2 and 1.5, respectively. Since each NOR collection was generally composed of 3-4 brood-years, while HOR collections rarely were composed of more than two brood-years, we attributed the lower year-to-year genetic variability of the NOR broodstock to the greater homogenizing effect of including four or more brood-years compared with only two brood years for the HOR broodstock.

Including the 15 juvenile collections, along with the 22 adult collections, did not materially alter the principal component structure (Figure 6), although the total genetic variation accounted for by the three principal components decreased from 44% using only the adults to 33% when juveniles were included. For the most-part, the juvenile fish appeared intermediate between HOR and NOR fish, but there was greater overlap in principal component scores (and therefore greater genetic similarity) of the juvenile and NOR collections, than of the juvenile and HOR collections. The average Euclidian distance between the juvenile and HOR collections was 0.49, compared to 0.23 between the juvenile and NOR collections, which was no different than 0.23 and 0.22 for the within juvenile and NOR collections, respectively.

By using the available adult age data, we were able to compare the genetic differentiation among the same set of fish when they are aggregated by origin (hatchery versus natural) and brood-year (year fish were hatched) with aggregates based on origin and spawn-year (year adult fish were spawned). A brood-year analysis compares within a year the genetic diversity generated from hatchery broodstock with that naturally produced in the spawning grounds. A spawn-year analysis compares the HOR and NOR genetic diversity that was mixed among cohorts of the parental generations. The same basic pattern of genetic structure that we have seen in spawn-year analyses (Figure 4, Figure 6, and the right side of Figure 5) also occurred in the brood-year analysis (left side of Figure 5). That is, from Figure 5 we saw (1) that HOR and NOR fish were differentiated from each other; (2) there was considerably more genetic variation (temporal variation) among the hatchery-origin collections than there was among the natural-origin collections (for brood-year, Mahalanobis distances = 5.18 and 0.75, respectively; for spawn-year, Mahalanobis distances = 4.25 and 1.25, respectively), and (3) that the genetic distances between HOR and NOR collections were lower in the more recent brood- and spawn-years, than in the earlier brood- and spawn-years (Figure 7; $R^2 = 0.41$ or 41%, $P < 0.05$). This indicated that the HOR and NOR fish used as broodstock in 2010 were more similar to each other than they were at the inception of the new hatchery program.

The relationship between genetic distance and brood-year was not the same as the relationship between genetic distance and spawn-year. For brood-year, although the slope was negative (i.e., trending downward or decreased differentiation with time) and the two most-recent brood years (2005-2006) showed relatively small HOR and NOR adult differentiation, the negative slope was not significantly different from zero and the regression accounted for only 7% of the variation. This was likely the result of insufficient sampling of certain age classes from many brood years (especially from NOR adults) due to two un-processed sample years (2005 and 2006).

Objective 3.3 – Effective spawning population

There was no difference in the temporal trends in estimates of N_b with P_{crit} set from 0.1 to 0.001 (Figure 8, data not shown for all collections), so we have reported only results with $P_{crit} = 0.001$, i.e., the full genetic dataset. Using either spawn-year or brood year, estimates of NOR adult N_b were higher and varied more than those of HOR adults (Figures 9, 10), concordant with the PCA analysis. Estimates for HOR adults ranged from 17 to 174 (by spawn year, mean = 65) or from 6 to 130 (by brood year, mean = 39). Estimates for NOR adults ranged from 36 to 982 (by spawn year, mean = 405) or from 59 to 2966 (by brood year, mean = 645). Many N_b estimates for NOR adults had confidence intervals extending to infinity on the upper bound. This reflected the difficulty in obtaining precise estimates of N_b for large populations (Waples and Do 2010).

Estimates of N_b for HOR steelhead dropped by approximately half from 1994, when broodstock were still collected at Wells Hatchery, to 1998, when the program used Wenatchee River trapped adults only, suggesting an effect of changing broodstock collection practices, which began in 1997 (Figures 8, 9). Since 1997, the hatchery population N_b remained at a relatively stable lower level (Figures 8, 9, and 10). There was no obvious change in N_b for NOR steelhead since 1993; the N_b estimate for 1993 was the largest, however the confidence interval overlapped estimates from many other years. The temporal trend in N_b estimates from combined collections mirrored those of the HOR collections alone, though estimates using combined collections were slightly larger (Figure 11).

As with N_b estimates, estimates of the ratio of N_b/N for NOR adults varied more than those of HOR adults (Figures 12, 13). However, using spawn year, i.e., mixtures of cohorts, the average N_b/N ratio for HOR adults was equal to that of NOR adults (mean $N_b/N = 0.26$), whereas when using brood year, the average N_b/N ratio for NOR adults was double that of HOR adults (NOR average =0.40, HOR average = 0.20). This is likely a consequence of the homogenizing effect of mixed cohorts. Estimates of N_b for HOR adults using spawn year were close to those estimated using brood year because of the lower diversity in age at maturation, whereas for NOR, grouping by brood year produces different estimates than when grouping by spawn year because of higher diversity in age at maturation. Regardless of which estimate was used, there was no temporal trend in N_b/N for either NOR or HOR adults.

Summary

On average, HOR adults had higher minor allele frequencies (MAF) than NOR adults, and both had similar MAF as juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants suggesting that the hatchery program has had little effect on allele frequencies since 1998.

HOR adults were genetically quite different from NOR adults and juveniles based on pair-wise F_{ST} and principal components analysis (PCA), most likely because of the much smaller effective population size (N_b) in the hatchery population. Pair-wise F_{ST} estimates and genetic distances between HOR and NOR adults collected the same year declined over time suggesting that the interbreeding of HOR and NOR adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year (the year fish were hatched, determined using scale-based age estimates) were inconclusive because of limitations of the data.

On average, estimates of N_b were much lower and varied less for HOR adults than for NOR adults and juveniles. Estimates of N_b for HOR adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1997. There was no indication that this had any effect on N_b in NOR adults and juveniles; N_b estimates for NOR adults and juveniles were, on average, higher and varied considerably over the time period covered by our dataset (1998 – 2010) and showed no temporal trend. Small N_b sizes increase the risk of loss of genetic diversity due to inbreeding and random effects (genetic drift). The N_b of the hatchery component of the population may be increased by spawning more families, using specific mating designs, and minimizing variance in reproductive success. However, given the apparent lack of effects overall, changes to the hatchery protocol may not be necessary.

Overall, hatchery practices appear to have had little effect on natural origin Wenatchee summer steelhead neutral genetic diversity or N_b. We cannot accurately assess their effects on population structure at this time. However, it is interesting to note that when juvenile collections are analyzed separately from adult collections, Peshastin Creek, which has received fewer hatchery outplants in the past and is currently a refuge from hatchery outplants, is genetically different than other tributaries and the Entiat River (data not shown). On the other hand, the Entiat River, which is also a refuge from hatchery outplants and is not a tributary of the Wenatchee River, is genetically very similar to Nason Creek and the Chiwawa River, both Wenatchee River tributaries. This suggests, though it does not conclude, that within basin population structure may have existed before summer steelhead hatchery production began in the upper Columbia River and that the population structure was eliminated by hatchery influence long before 1998.

Acknowledgements

We thank Chad Herring, Clint Deason, John Walters and the numerous technicians that sampled these thousands of fish. We thank Sonia Peterson and Sarah Bell for help in the laboratory and thank Maureen Small for help with some analyses. The project was implemented with funding from the Chelan Co. PUD and Washington State general funds.

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Figures

Figure 1. Observed average minor allele frequencies (MAF) and observed heterozygosities (Ho) of 119 SNP loci from 11 annual collections of hatchery-produced (HOR) and natural origin (NOR) adult steelhead from the Wenatchee River. Trend lines are from a logistic regression. Note the X axis does not cross the Y axis at the origin. Neither the slopes nor the intercepts were statistically significant.

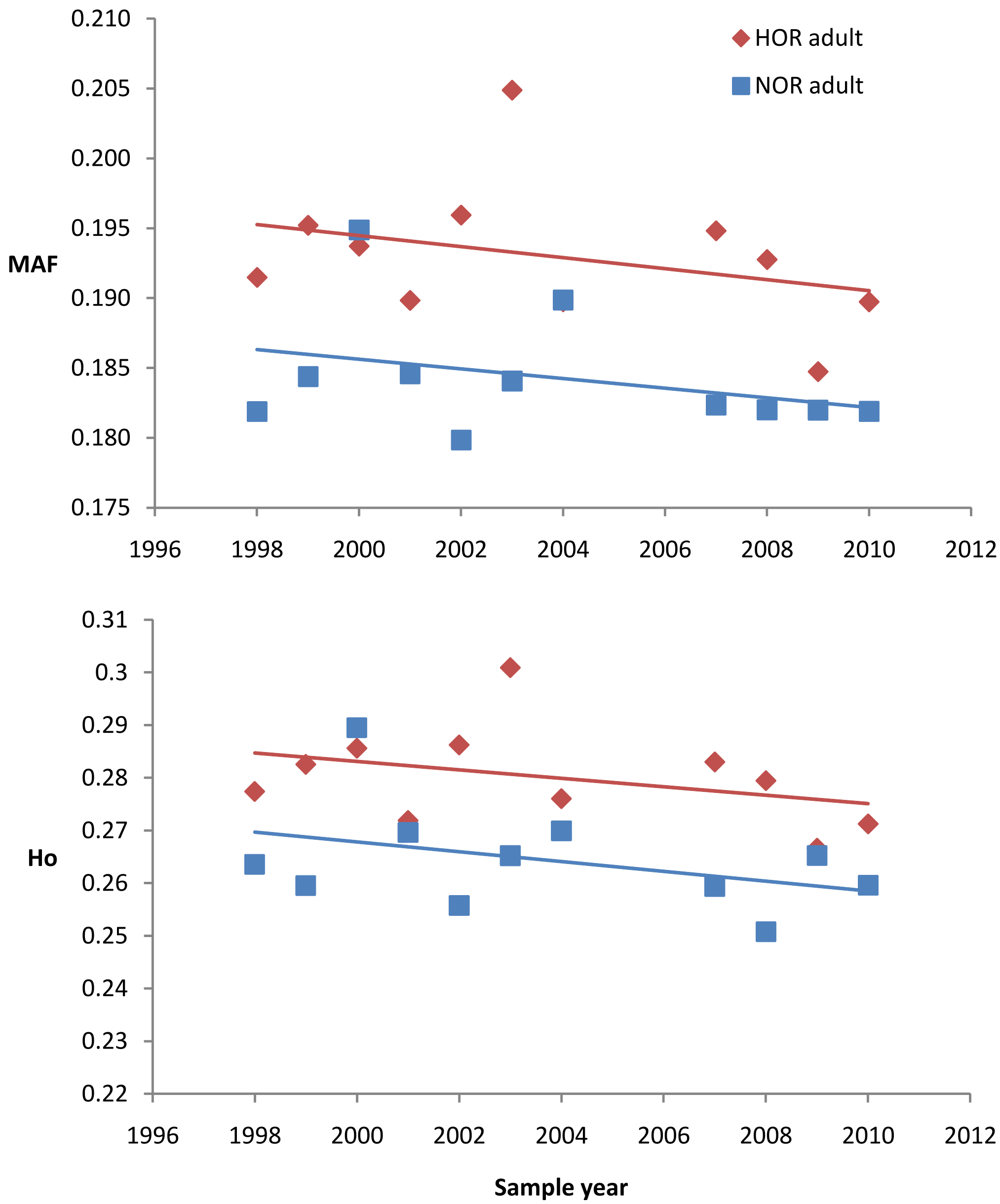


Figure 2. Observed average minor allele frequencies (MAF) and observed heterozygosities (Ho) of 119 SNP loci from 15 collections of natural origin juvenile steelhead from Wenatchee River tributaries, the lower Wenatchee River and the Entiat River. There were no consistent temporal trends in MAF or Ho in these collections.

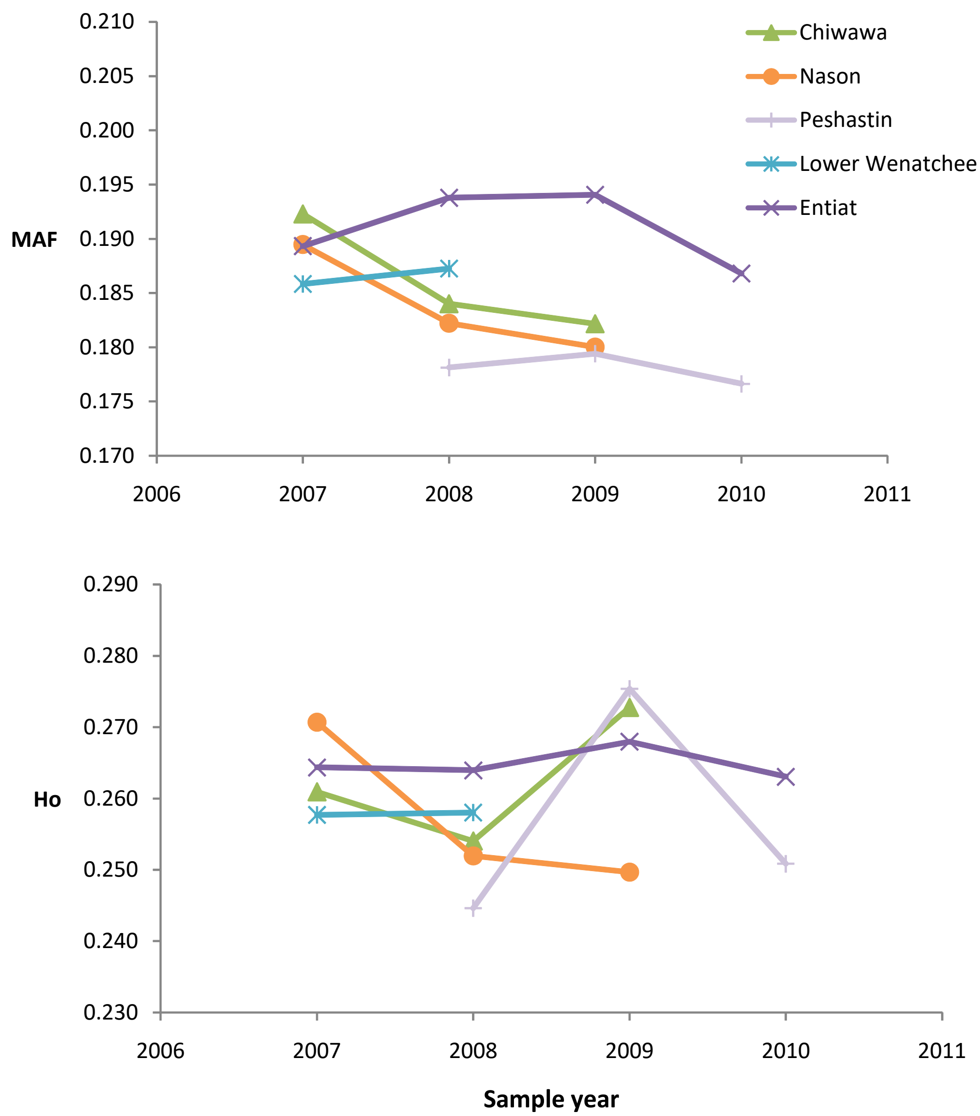


Figure 3. The relationship of time with pairwise F_{ST} estimates between hatchery-produced (adipose fin clipped) and natural origin (unclipped) adults of the same sample year. The line is the prediction based on beta regression.

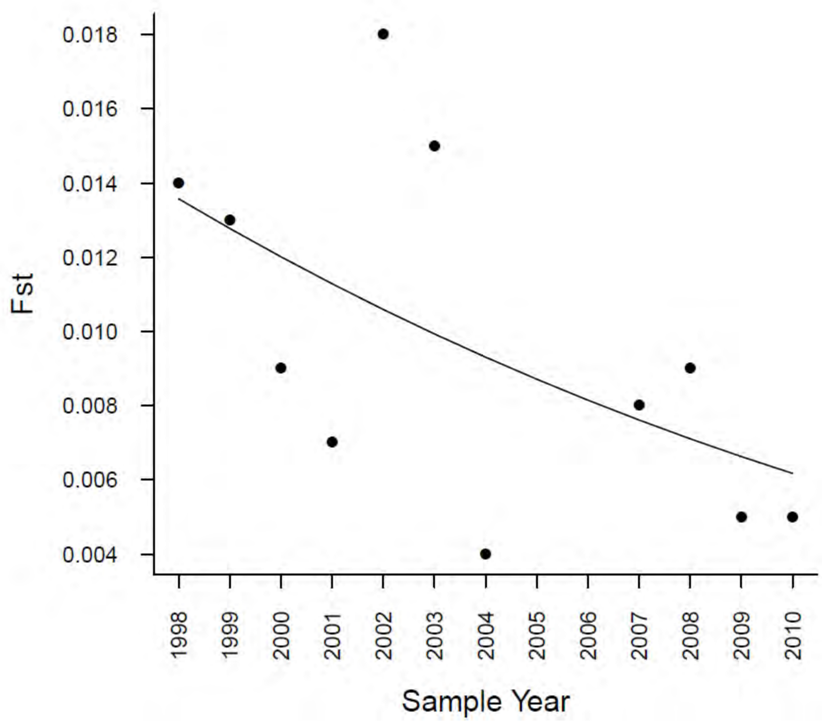


Figure 4. Principal component (PC) 1 versus 2 (top left), PC 1 versus 3 (bottom left), and PC 2 versus 3 (bottom right) based on an analysis using all adults aggregated into origin and spawn-year collections. Natural-origin spawn-years are shown in italicized typeface. The percentage within the label of each axis convey the percent of total genetic variance that is accounted for by that axis. Taken together, the three principal components account for 44% of the total SNP variation. Top right shows pairwise Euclidian distances versus spawn-year, with zero distance equal to average distance across all pairwise distances. Blue line is least-squares fit with $R^2 = 0.45$.

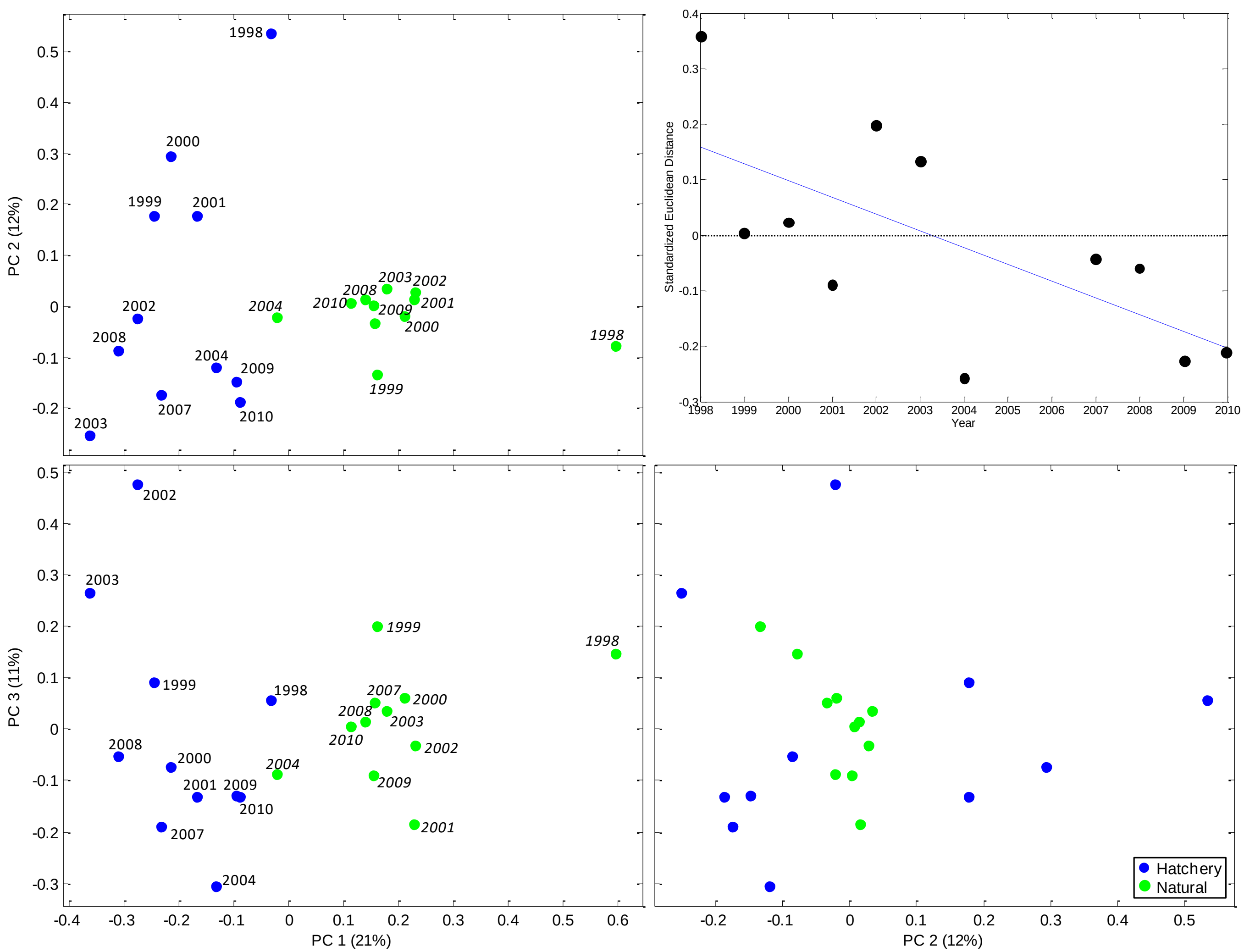


Figure 5. Principal components (PC) 1 versus 2 (top) and 3 (bottom) for adults aggregated into brood-year (BY; left) and spawn-year (SY; right). Spawn-year analysis is the same as in Figure x1, except fewer individuals per collection were included (see methods). Note that for the SY analysis here PC 2 and 3 are similar to PC 3 and 2, respectively, in Figure x1. Only BY1995 (earliest year with paired hatchery-natural data), BY2000 (extreme PC 1 score), and BY2006 (latest year with paired hatchery-natural data) are labeled. Hatchery- and natural-origin individuals from BY1995, BY2000, and BY2006, returned to spawn (spawn-year) in 1999 (hatchery)/1999-2001 (natural), 2003-2004 (hatchery)/2004 and 2007 (natural), and 2009-2010 (hatchery)/2010 (natural), respectively. These years are labeled in the upper right figure. Only 4 year-old BY 2006 natural-origin fish are represented in the SY 2010 collection.

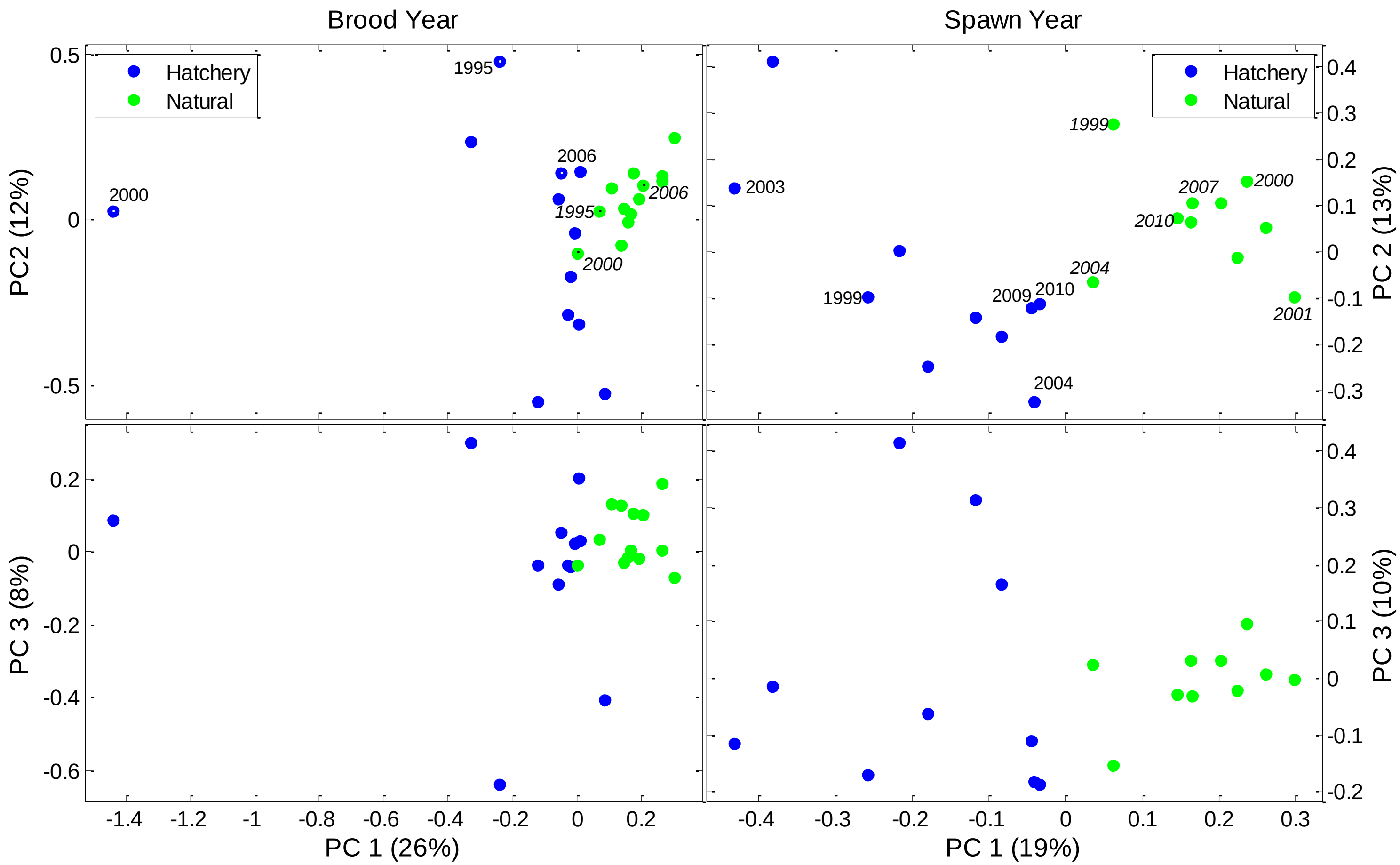


Figure 6. Principal component (PC) 1 versus 2 (top) and PC 1 versus 3 (bottom) based on an analysis using all adult and juvenile fish aggregated into age (juvenile versus adult), origin (hatchery versus adult) and spawn-year collections.

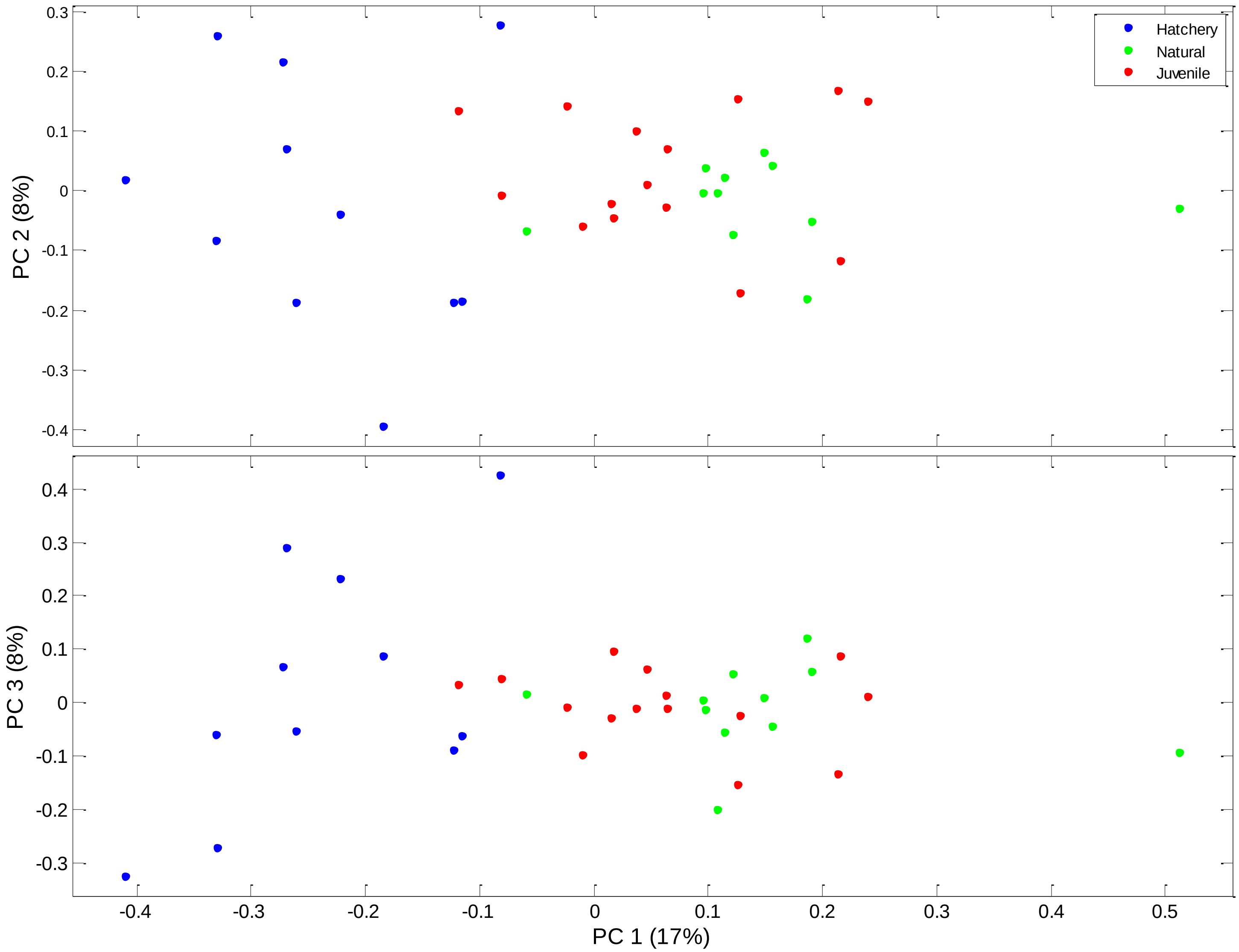


Figure 7. Pairwise Euclidian distances versus brood-year (top) and spawn-year (bottom), with zero distance equal to average distance across all pairwise distances. Blue lines are least-squares fits, which is not significant (slope = 0) for brood-year, but significant (slope > 0) for spawn-year.

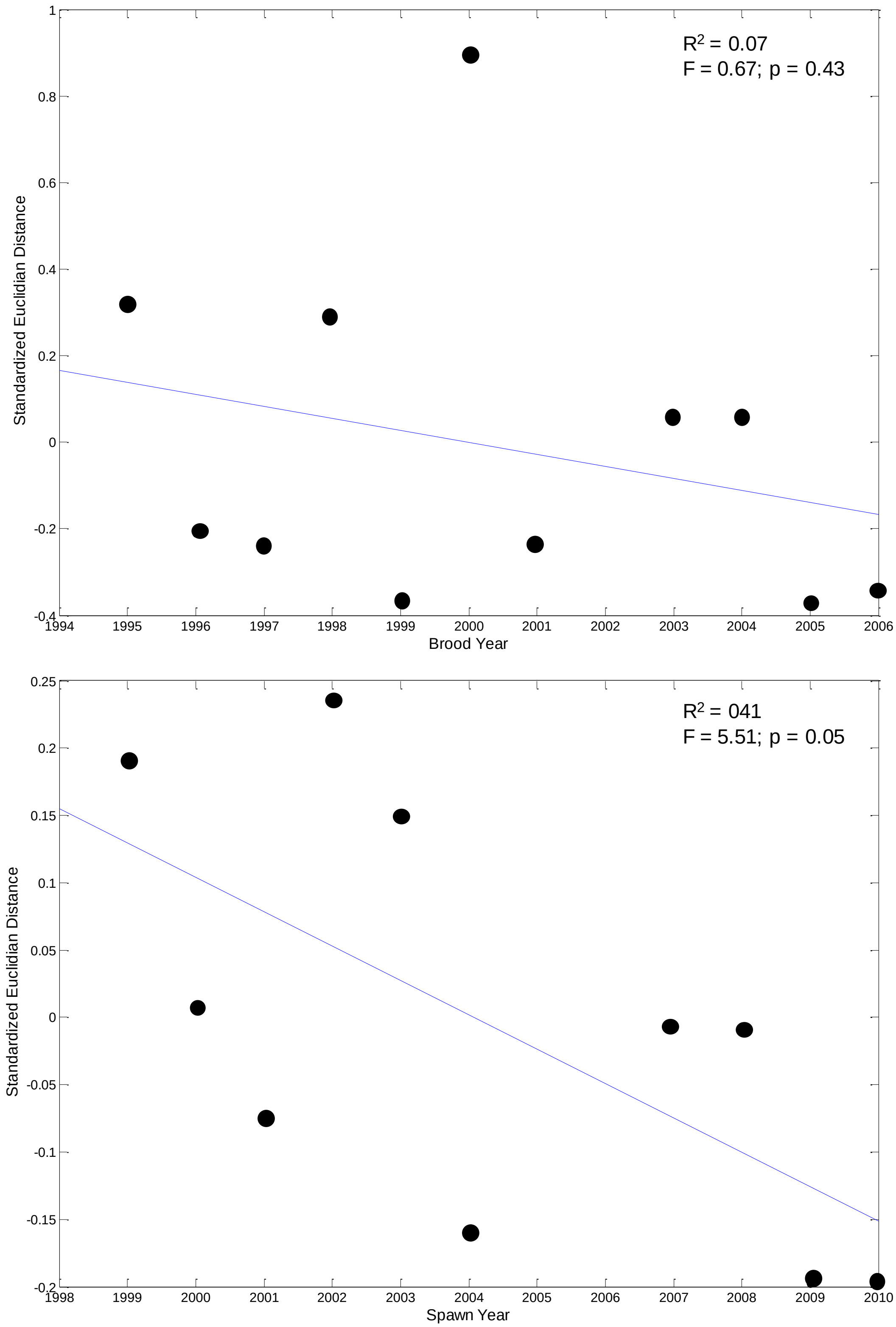


Figure 8. Effective population size estimates (N_b) from Wenatchee River adult hatchery-produced steelhead annual collections calculated using single sample methods implemented in the program LDNE (Waples and Do 2008). Each line connects annual estimates of N_b estimated with a different value of P_{crit}, the smallest allelic proportion allowed during analysis. With SNP data, omitting an allele omits the locus. Estimates of N_b changed very little when P_{crit} varied from 0.1 to 0.001. Setting P_{crit} = 0.001 forced the use of all available loci.

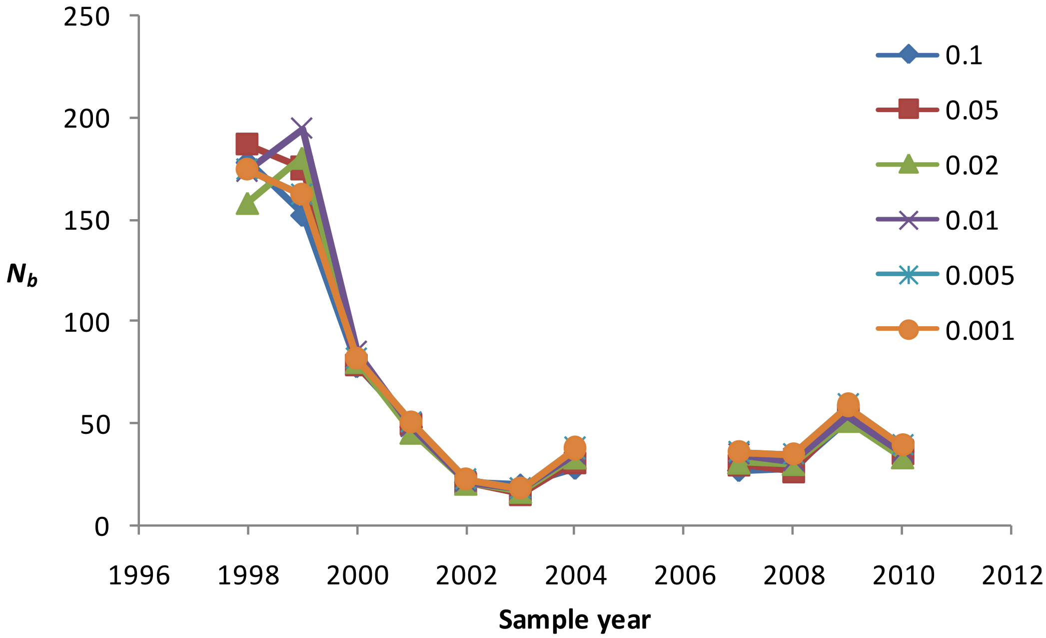


Figure 9. Estimates of Wenatchee River steelhead effective number of breeders (N_b) estimated using the single sample methods incorporated in the program LDNE (Waples and Do 2008). Estimates of N_b refer to parental (and even grantparental) generations. N_b data were plotted against their estimated parental brood year. We assumed a 5 year generation time for natural origin adults (NOR), a 4 year generation time for hatchery-produced adults (HOR) and an age of smolt outmigration of age 2 for smolt collections from Wenatchee River tributaries (Chiwawa River, Nason Creek, Peshastin Creek), the lower Wenatchee River, and the Entiat River. Bars represent the 95% confidence interval estimated by jackknife procedure. Bars that exceed the upper limit of the Y axis are labeled with the upper bound (Inf. = infinity).

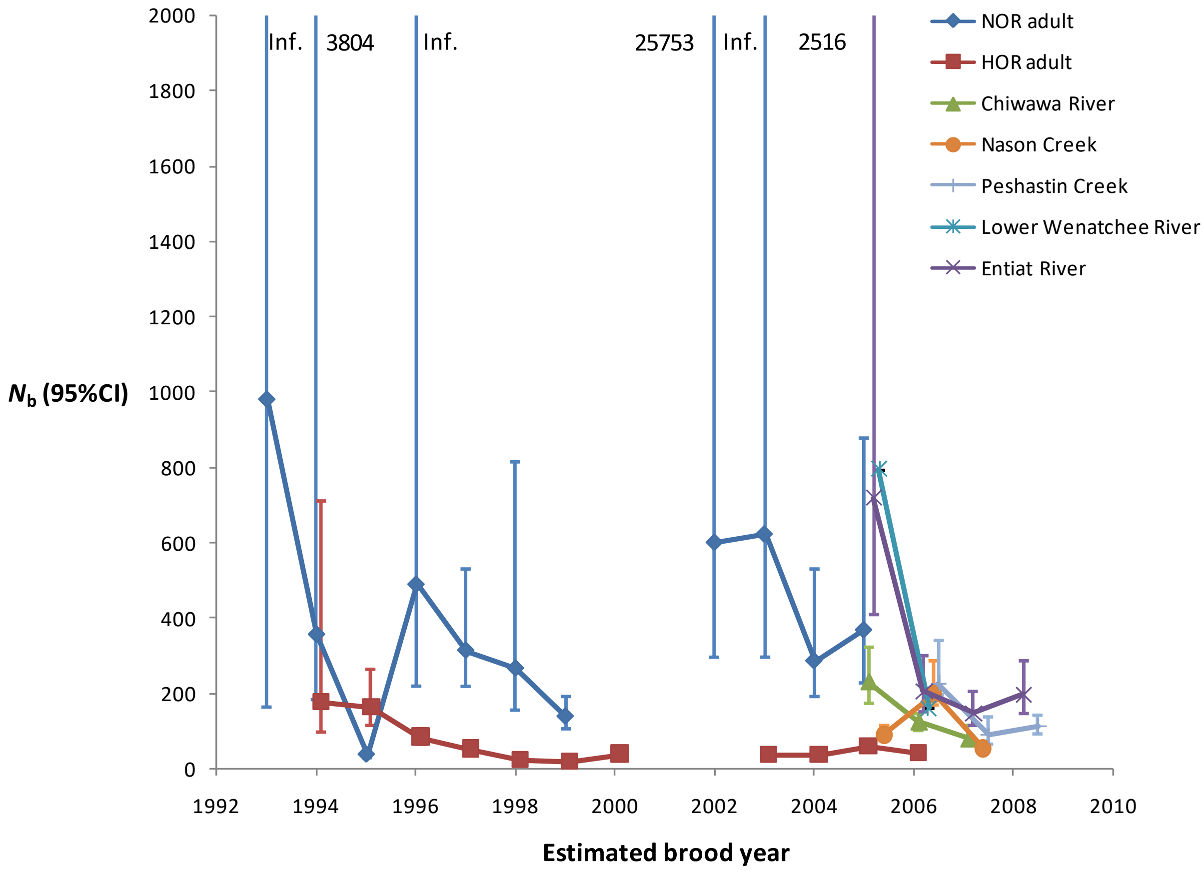


Figure 10. Estimates of N_b for collections of hatchery-produced (HOR) and natural origin (NOR) Wenatchee River summer steelhead grouped by brood year rather than spawn year. Brood year was estimated using scale-based age data. Error bars that extend past the top of the chart are all bounded by infinity.

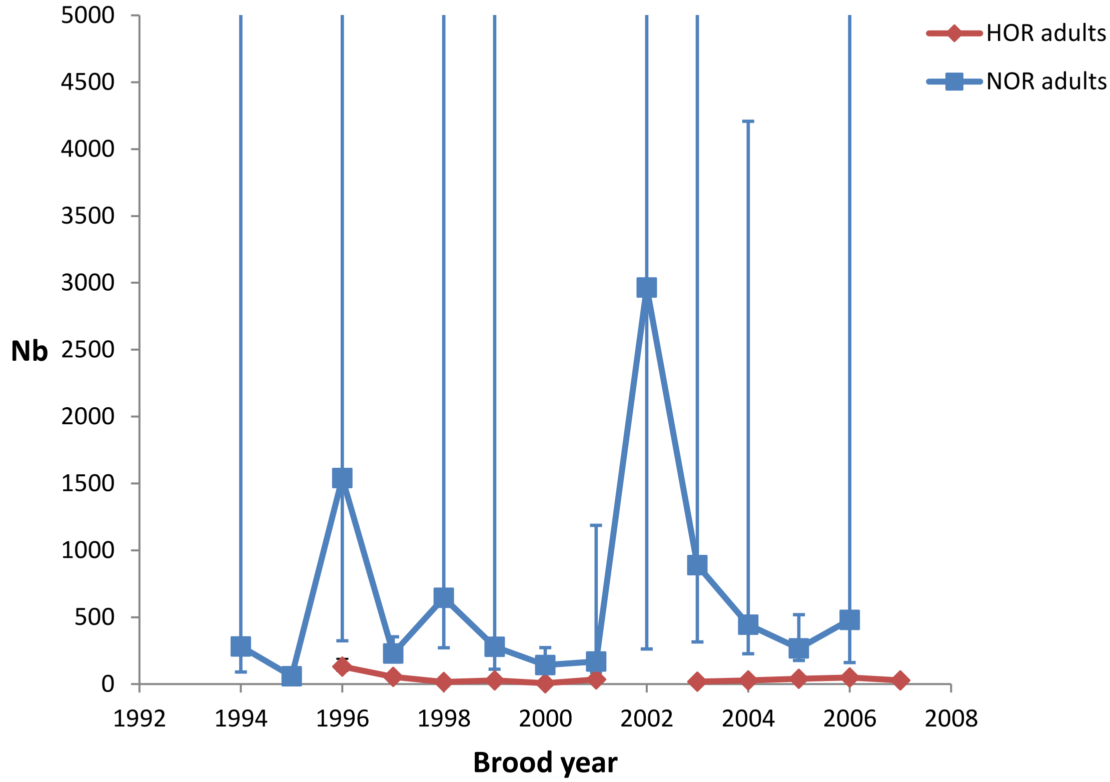


Figure 11. Estimates of N_b for combined annual adult hatchery-produced (HOR) and natural origin (NOR) steelhead and for HOR adults alone. The temporal patterns are similar, though estimates from combined collections are larger than those from HOR collections alone.

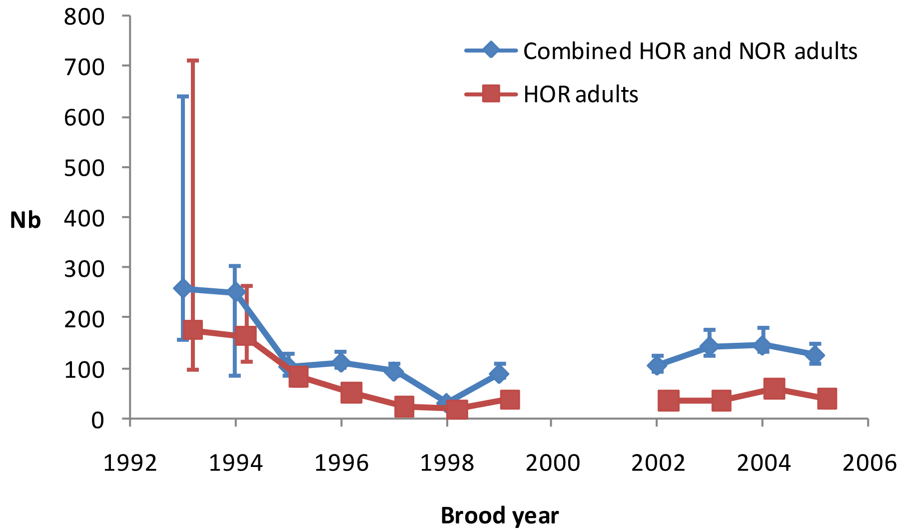


Figure 12. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead grouped by spawn year. The average N_b/N ratios are not different, though in later years NOR adults appear to have lower N_b/N ratios.

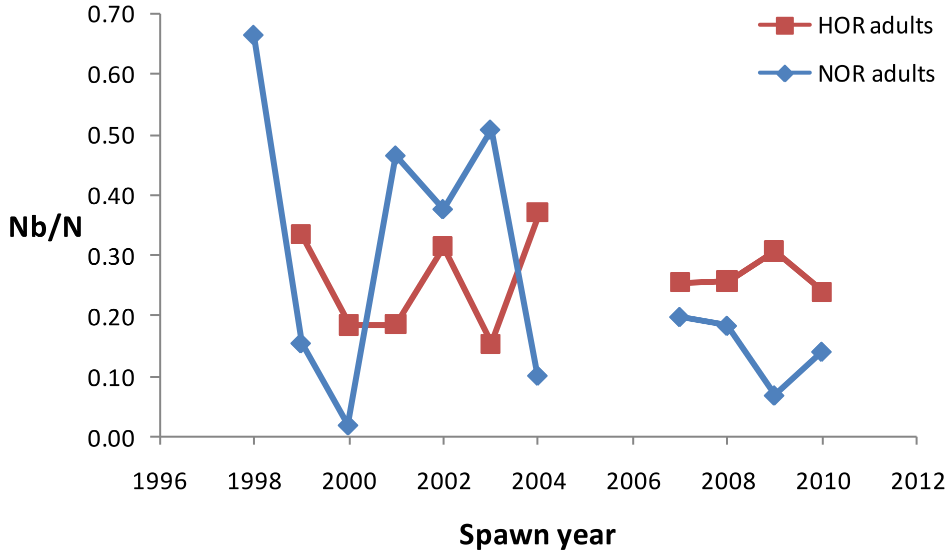
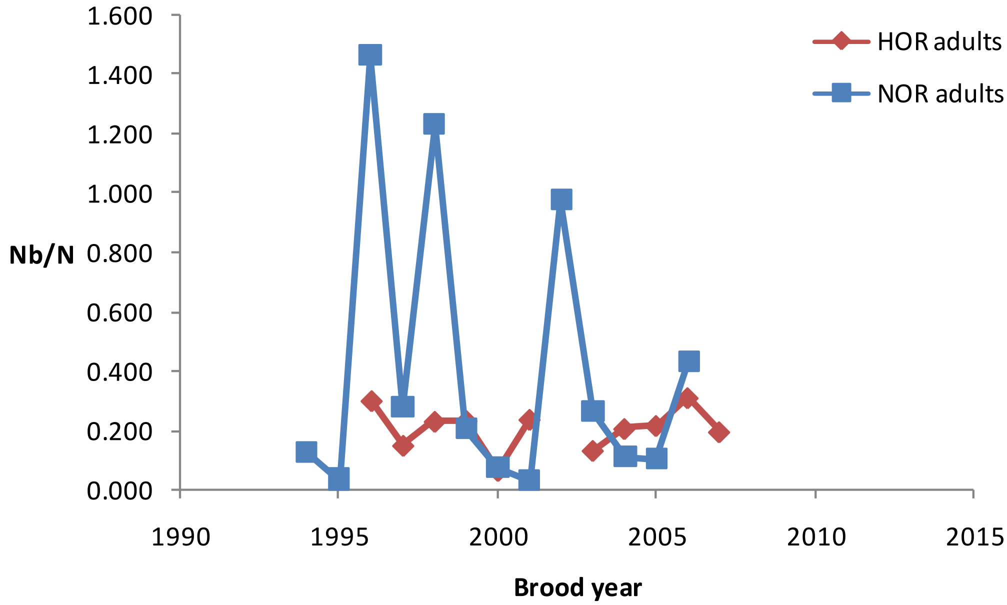


Figure 13. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead collections with individuals grouped in brood years rather than spawn years. Individual brood year was estimated using scale-based age data.



Tables

Table 1. Samples of adult steelhead collected for Wenatchee Program broodstock and used for genetic monitoring and evaluation.

Origin	Sampling Location	Year spawned	WDFW Collection code	Samples (N)	Unused Samples[a]
Hatchery	Dryden/Tumwater Dams	1998	98AE	32	4
		1999	98LJ	62	2
		2000	99NE	60	5
		2001	00DQ	99	1
		2002	01MS	64	
		2003	02NP	89	
		2004	03KW	61	
		2007	06CW	64	1
		2008	08AG	56	
		2009	09AV	74	
		2010	10FE	76	1
			Total	737	14
Natural	Dryden/Tumwater Dams	1998	98AF	30	5
		1999	99AA	51	1
		2000	99ND	33	3
		2001	00DP	50	
		2002	01MR	95	
		2003	02NO	50	
		2004	03KV	71	3
		2007	06CX	74	
		2008	08AF	74	1
		2009	09AU	82	2
		2010	10FD	90	2
			Total	700	17

[a]Samples were not used if they had incomplete (≤ 80% or 95 of 119 loci) or duplicate genotypes.

Table 2. Samples of natural origin juvenile steelhead and rainbow trout collected from four Wenatchee basin rivers or creeks and the Entiat River.

Sampling Location	Collection Year	WDFW Collection Code	Samples (N)	Unused samples[a]
Chiwawa River	2007	07AO	127	5
	2008	08CG	143	1
	2009	09NF	35	2
Entiat River	2007	07AL	134	4
	2008	08CI	82	4
	2009	09NC	74	1
	2010	10OX	82	1
Lower Wenatchee River	2007	07AM	139	5
	2008	08CE	98	2
Nason Creek	2007	07AN	81	4
	2008	08CF	133	6
	2009	09NG	103	2
Peshastin Creek	2008	08CH	142	2
	2009	09NE	34	1
	2010	10OY	94	1
		Total	1501	41

[a]Samples were not used if they were genetically identified as cutthroat trout or cutthroat/rainbow trout hybrids, or if they had incomplete (≤ 80% or 95 of 119 loci) or duplicate genotypes.

Table 3. List of 132 general use, diploid single nucleotide polymorphic (SNP) loci genotyped in Wenatchee River basin and Entiat River steelhead.

WDFW Name	Locus Name	Allele 1	Allele 2	Reference
AOmy005	Omy_aspAT-123	T	C	(Campbell et al. 2009)
AOmy014	Omy_e1-147	G	T	(Sprowles et al. 2006)
AOmy015	Omy_gdh-271	C	T	(Campbell et al. 2009)
AOmy016	Omy_GH1P1_2	C	T	(Aguilar and Garza 2008)
AOmy021	Omy_LDHB-2_e5	T	C	(Aguilar and Garza 2008)
AOmy023	Omy_MYC_2	T	C	(Aguilar and Garza 2008)
AOmy027	Omy_nkef-241	C	A	(Campbell et al. 2009)
AOmy028	Omy_nramp-146	G	A	(Campbell et al. 2009)
AOmy047	Omy_u07-79-166	G	T	WDFW - S. Young unpubl.
AOmy051	Omy_121713-115	T	A	(Abadía-Cardoso et al. 2011)
AOmy056	Omy_128693-455	T	C	(Abadía-Cardoso et al. 2011)
AOmy059	Omy_187760-385	A	T	(Abadía-Cardoso et al. 2011)
AOmy061	Omy_96222-125	T	C	(Abadía-Cardoso et al. 2011)
AOmy062	Omy_97077-73	T	A	(Abadía-Cardoso et al. 2011)
AOmy063	Omy_97660-230	C	G	(Abadía-Cardoso et al. 2011)
AOmy065	Omy_97954-618	C	T	(Abadía-Cardoso et al. 2011)
AOmy067	Omy_aromat-280	A	T	WSU - J. DeKoning unpubl.
AOmy068	Omy_arp-630	G	A	(Campbell et al. 2009)
AOmy071	Omy_cd59-206	C	T	WSU - J. DeKoning unpubl.
AOmy073	Omy_colla1-525	C	T	WSU - J. DeKoning unpubl.
AOmy079	Omy_g12-82	T	C	WSU - J. DeKoning unpubl.
AOmy081	Omy_gh-475	C	T	(Campbell et al. 2009)
AOmy082	Omy_gsdf-291	T	C	WSU - J. DeKoning unpubl.
AOmy089	Omy_hsp90BA-193	C	T	(Campbell and Narum 2009)
AOmy094	Omy_inos-97	C	A	WSU - J. DeKoning unpubl.
AOmy095	Omy_mapK3-103	A	T	CRITFC - N. Campbell unpubl.
AOmy096	Omy_mcsf-268	T	C	WSU - J. DeKoning unpubl.
AOmy100	Omy_nach-200	A	T	WSU - J. DeKoning unpubl.

AOmy107	Omy_Ots249-227	C	T	(Campbell et al. 2009)
AOmy108	Omy_oxct-85	A	T	WSU - J. DeKoning unpubl.
AOmy110	Omy_star-206	A	G	WSU - J. DeKoning unpubl.
AOmy111	Omy_stat3-273	G	Deletion	WSU - J. DeKoning unpubl.
AOmy113	Omy_tlr3-377	C	T	WSU - J. DeKoning unpubl.
AOmy117	Omy_u09-52-284	T	G	WDFW - S. Young unpubl.
AOmy118	Omy_u09-53-469	T	C	WDFW - S. Young unpubl.
AOmy120	Omy_u09-54.311	C	T	WDFW - S. Young unpubl.
AOmy123	Omy_u09-55-233	A	G	WDFW - S. Young unpubl.
AOmy125	Omy_u09-56-119	T	C	WDFW - S. Young unpubl.
AOmy129	Omy_BAMBI4.238	T	C	WDFW - S. Young unpubl.
AOmy132	Omy_G3PD_2.246	C	T	WDFW - S. Young unpubl.
AOmy134	Omy_Il-1b-028	T	C	WDFW - S. Young unpubl.
AOmy137	Omy_u09-61.043	A	T	WDFW - S. Young unpubl.
AOmy151	Omy_p53-262	T	A	CRITFC - N. Campbell unpubl.
AOmy173	BH2VHSVip10	C	T	Pascal & Hansen unpubl.
AOmy174	OMS00003	T	G	(Sánchez et al. 2009)
AOmy176	OMS00013	A	G	(Sánchez et al. 2009)
AOmy177	OMS00018	T	G	(Sánchez et al. 2009)
AOmy179	OMS00041	G	C	(Sánchez et al. 2009)
AOmy181	OMS00052	T	G	(Sánchez et al. 2009)
AOmy182	OMS00053	T	C	(Sánchez et al. 2009)
AOmy183	OMS00056	T	C	(Sánchez et al. 2009)
AOmy184	OMS00057	T	G	(Sánchez et al. 2009)
AOmy185	OMS00061	T	C	(Sánchez et al. 2009)
AOmy186	OMS00062	T	C	(Sánchez et al. 2009)
AOmy187	OMS00064	T	G	(Sánchez et al. 2009)
AOmy189	OMS00071	A	G	(Sánchez et al. 2009)
AOmy190	OMS00072	A	G	(Sánchez et al. 2009)
AOmy191	OMS00078	T	C	(Sánchez et al. 2009)
AOmy192	OMS00087	A	G	(Sánchez et al. 2009)

AOmy193	OMS00089	A	G	(Sánchez et al. 2009)
AOmy194	OMS00090	T	C	(Sánchez et al. 2009)
AOmy195	OMS00092	A	C	(Sánchez et al. 2009)
AOmy196	OMS00094	T	G	(Sánchez et al. 2009)
AOmy197	OMS00103	A	T	(Sánchez et al. 2009)
AOmy198	OMS00105	T	G	(Sánchez et al. 2009)
AOmy199	OMS00112	A	T	(Sánchez et al. 2009)
AOmy200	OMS00116	T	A	(Sánchez et al. 2009)
AOmy201	OMS00118	T	G	(Sánchez et al. 2009)
AOmy202	OMS00119	A	T	(Sánchez et al. 2009)
AOmy203	OMS00120	A	G	(Sánchez et al. 2009)
AOmy204	OMS00121	T	C	(Sánchez et al. 2009)
AOmy205	OMS00127	T	G	(Sánchez et al. 2009)
AOmy206	OMS00128	T	G	(Sánchez et al. 2009)
AOmy207	OMS00132	A	T	(Sánchez et al. 2009)
AOmy208	OMS00133	A	G	(Sánchez et al. 2009)
AOmy209	OMS00134	A	G	(Sánchez et al. 2009)
AOmy210	OMS00153	T	G	(Sánchez et al. 2009)
AOmy211	OMS00154	A	T	(Sánchez et al. 2009)
AOmy212	OMS00156	A	T	(Sánchez et al. 2009)
AOmy213	OMS00164	T	G	(Sánchez et al. 2009)
AOmy215	OMS00175	T	C	(Sánchez et al. 2009)
AOmy216	OMS00176	T	G	(Sánchez et al. 2009)
AOmy218	OMS00180	T	G	(Sánchez et al. 2009)
AOmy220	Omy_1004	A	T	(Hansen et al. 2011)
AOmy221	Omy_101554-306	T	C	(Abadía-Cardoso et al. 2011)
AOmy222	Omy_101832-195	A	C	(Abadía-Cardoso et al. 2011)
AOmy223	Omy_101993-189	A	T	(Abadía-Cardoso et al. 2011)
AOmy225	Omy_102505-102	A	G	(Abadía-Cardoso et al. 2011)
AOmy226	Omy_102867-443	T	G	(Abadía-Cardoso et al. 2011)
AOmy227	Omy_103705-558	T	C	(Abadía-Cardoso et al. 2011)

AOmy228	Omy_104519-624	T	C	(Abadía-Cardoso et al. 2011)
AOmy229	Omy_104569-114	A	C	(Abadía-Cardoso et al. 2011)
AOmy230	Omy_105075-162	T	G	(Abadía-Cardoso et al. 2011)
AOmy231	Omy_105385-406	T	C	(Abadía-Cardoso et al. 2011)
AOmy232	Omy_105714-265	C	T	(Abadía-Cardoso et al. 2011)
AOmy233	Omy_107031-704	C	T	(Abadía-Cardoso et al. 2011)
AOmy234	Omy_107285-69	C	G	(Abadía-Cardoso et al. 2011)
AOmy235	Omy_107336-170	C	G	(Abadía-Cardoso et al. 2011)
AOmy238	Omy_108007-193	A	G	(Abadía-Cardoso et al. 2011)
AOmy239	Omy_109243-222	A	C	(Abadía-Cardoso et al. 2011)
AOmy240	Omy_109525-403	A	G	(Abadía-Cardoso et al. 2011)
AOmy241	Omy_110064-419	T	G	(Abadía-Cardoso et al. 2011)
AOmy242	Omy_110078-294	A	G	(Abadía-Cardoso et al. 2011)
AOmy243	Omy_110362-585	G	A	(Abadía-Cardoso et al. 2011)
AOmy244	Omy_110689-148	A	C	(Abadía-Cardoso et al. 2011)
AOmy245	Omy_111005-159	C	T	(Abadía-Cardoso et al. 2011)
AOmy246	Omy_111084-526	A	C	(Abadía-Cardoso et al. 2011)
AOmy247	Omy_111383-51	C	T	(Abadía-Cardoso et al. 2011)
AOmy248	Omy_111666-301	T	A	(Abadía-Cardoso et al. 2011)
AOmy249	Omy_112301-202	T	G	(Abadía-Cardoso et al. 2011)
AOmy250	Omy_112820-82	G	A	(Abadía-Cardoso et al. 2011)
AOmy252	Omy_114976-223	T	G	(Abadía-Cardoso et al. 2011)
AOmy253	Omy_116733-349	C	T	(Abadía-Cardoso et al. 2011)
AOmy254	Omy_116938-264	A	G	(Abadía-Cardoso et al. 2011)
AOmy255	Omy_117259-96	T	C	(Abadía-Cardoso et al. 2011)
AOmy256	Omy_117286-374	A	T	(Abadía-Cardoso et al. 2011)
AOmy257	Omy_117370-400	A	G	(Abadía-Cardoso et al. 2011)
AOmy258	Omy_117540-259	T	G	(Abadía-Cardoso et al. 2011)
AOmy260	Omy_117815-81	C	T	(Abadía-Cardoso et al. 2011)
AOmy261	Omy_118175-396	T	A	(Abadía-Cardoso et al. 2011)
AOmy262	Omy_118205-116	A	G	(Abadía-Cardoso et al. 2011)

AOmy263	Omy_118654-91	A	G	(Abadía-Cardoso et al. 2011)
AOmy265	Omy_120255-332	A	T	(Abadía-Cardoso et al. 2011)
AOmy266	Omy_128996-481	T	G	(Abadía-Cardoso et al. 2011)
AOmy267	Omy_129870-756	C	T	(Abadía-Cardoso et al. 2011)
AOmy268	Omy_131460-646	C	T	(Abadía-Cardoso et al. 2011)
AOmy269	Omy_98683-165	A	C	(Abadía-Cardoso et al. 2011)
AOmy270	Omy_cyp17-153	C	T	WSU - J. DeKoning unpubl.
AOmy271	Omy_ftzf1-217	A	T	WSU - J. DeKoning unpubl.
AOmy272	Omy_GHSR-121	T	C	CRITFC - N. Campbell unpubl.
AOmy273	Omy_metA-161	T	G	CRITFC - N. Campbell unpubl.
AOmy274	Omy_UBA3b	A	T	(Hansen et al. 2011)

Primer and probe sequences for unpublished loci available by request.

Table 4. List of 20 species identification single nucleotide polymorphic (SNP) loci genotyped in Wenatchee River basin and Entiat River steelhead.

		Expected genotype			
WDFW Name	Locus Name	*O. mykiss*	*O. clarkii clarkii*	*O. clarkii lewisi*	Reference
ASpI001	Ocl_Okerca	T	C	C	(McGlauflin et al. 2010)
ASpI002	Ocl_Oku202	A	C	C	(McGlauflin et al. 2010)
ASpI003	Ocl_Oku211	G	T	T	(McGlauflin et al. 2010)
ASpI004	Ocl_Oku216	C	C	A	(McGlauflin et al. 2010)
ASpI005	Ocl_Oku217	C	C	A	(McGlauflin et al. 2010)
ASpI006	Ocl_SsaHM5	A	A	G	(McGlauflin et al. 2010)
ASpI007	Ocl_u800	T	C	C	(McGlauflin et al. 2010)
ASpI008	Ocl_u801	A	T	T	(McGlauflin et al. 2010)
ASpI009	Ocl_u802	C	C	T	(McGlauflin et al. 2010)
ASpI010	Ocl_u803	C	T	T	(McGlauflin et al. 2010)
ASpI011	Ocl_u804	G	G	C	(McGlauflin et al. 2010)
ASpI012	Omy_B9_228	A	A	C	(Finger et al. 2009)
ASpI013	Omy_CTDL1_243	C	A	A	(Finger et al. 2009)
ASpI014	Omy_F5_136	C	G	G	(Finger et al. 2009)
ASpI016	Omy_myclarp404-111	T	G	G	CRITFC - S. Narum - unpubl.
ASpI017	Omy_myclgh1043-156	C	T	T	CRITFC - S. Narum - unpubl.
ASpI018	Omy_Omyclmk436-96	A	C	C	CRITFC - S. Narum - unpubl.
ASpI019	Omy_RAG11_280	T	A	A	(Sprowles et al. 2006)
ASpI020	Omy_URO_302	T	C	C	(Finger et al. 2009)
ASpI021	Omy_BAC-F5.238	C	G	G	WDFW - S. Young unpubl.

Primer and probe sequences for unpublished loci available by request.

Table 5. Pairwise F_{ST} estimates for collections from Wenatchee River tributaries and the Entiat River (below diagonal) and associated bootstrap estimated *P*-values (above diagonal).

		Chiwawa River			Nason Creek			Peshastin Creek			Lower Wenatchee River		Entiat River			
Population	Year	2007	2008	2009	2007	2008	2009	2008	2009	2010	2007	2008	2007	2008	2009	2010
Chiwawa	2007		**0.000**	**0.003**	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**	**0.001**	**0.001**	**0.000**	**0.001**	**0.000**	**0.000**
River	2008	0.004		**0.004**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	2009	0.004	0.003		**0.000**	**0.001**	0.061	**0.000**	**0.001**	**0.000**	0.086	**0.050**	**0.022**	0.108	**0.005**	**0.045**
Nason	2007	0.011	0.010	0.007		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Creek	2008	0.007	0.007	0.005	0.009		**0.003**	**0.000**	**0.002**	**0.000**	0.079	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**
	2009	0.007	0.007	0.003	0.014	0.006		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Peshastin	2008	0.010	0.011	0.008	0.013	0.010	0.013		**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Creek	2009	0.005	0.005	0.006	0.010	0.007	0.008	0.003		**0.002**	**0.002**	**0.047**	**0.028**	**0.004**	**0.005**	**0.001**
	2010	0.010	0.011	0.008	0.015	0.008	0.011	0.003	0.003		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Lower Wenatchee	2007	0.003	0.003	0.000	0.005	0.008	0.007	0.009	0.010	0.008		0.112	**0.020**	**0.012**	**0.002**	**0.017**
River	2008	0.002	0.005	0.002	0.003	0.004	0.005	0.007	0.009	0.006	0.000		**0.049**	0.459	**0.047**	**0.002**
Entiat	2007	0.005	0.006	0.002	0.005	0.006	0.005	0.005	0.007	0.006	0.001	0.002		0.451	0.173	**0.000**
River	2008	0.004	0.004	0.000	0.007	0.005	0.007	0.008	0.009	0.011	0.002	0.001	0.000		0.644	**0.002**
	2009	0.005	0.006	0.002	0.003	-0.001	0.003	0.002	0.003	0.004	0.003	0.002	0.002	0.000		**0.028**
	2010	0.005	0.006	0.003	0.006	0.004	0.006	0.006	0.008	0.009	0.002	0.003	0.003	0.003	0.002	

P-values in bold were significant at $\alpha = 0.05$ after correcting for multiple tests using false discovery rate.

Appendix G

NPDES Hatchery Effluent Monitoring, 2018

NPDES COMPLIANCE SUMMARY

WDFW facilities requiring discharge reports include Chelan Hatchery, Chelan Falls Hatchery, Eastbank Hatchery, Chiwawa Ponds, Similkameen Hatchery, Dryden Acclimation Pond, and Priest Rapids Hatchery. Not included in the request are facilities which are no longer operated under WDFW including Wells Hatchery, Methow Hatchery, and the Twisp/Chewuch acclimation facilities. Carlton Acclimation Pond permit became inactive January 2014.

Below are tables detailing NPDES discharge data for Washington Department of Fish and Wildlife (WDFW) operated facilities in the upper Columbia River. The monitoring period is for January 1, 2018 through December 31, 2018.

There were no violations reported at the NPDES permitted facilities during the period January 1, 2018 through December 31, 2018.

NPDES MONITORING FOR WDFW FACILITIES.

WDFW hatcheries monitor discharge in accordance with the National Pollutant Discharge Elimination System (NPDES) Upland Fin Fish Hatching and Rearing General Permit. The permit is administered by the Washington Department of Ecology under jurisdiction of the United States Environmental Protection Agency. The current permit was issued April 1, 2016 and expires March 31, 2021.

Facilities are exempted from sampling during any month that pounds of fish on hand fall below 20,000 lbs and pounds of feed used fall below 5,000 lbs, with the exception of offline settling basin discharges, which are monitored once per month when ponds are in use and discharging to receiving waters. Inactive permitted facilities retain a permit but are not required to monitor discharges because pounds of fish and pounds of feed remain below monitoring guidelines set by the permit.

Sampling at facilities covered under the current NPDES General Permit include the following parameters:

FLOW	Measured in millions of gallons per day (MGD) discharge.
SS EFF	Average net settleable solids in the hatchery effluent, measured in ml/L.
TSS COMP	Average net total suspended solids, composite sample (6 x/day) of the hatchery effluent, measured in mg/L.
TSS MAX	Maximum daily net total suspended solids, composite sample (6 x/day) of the hatchery effluent, measured in mg/L.
FLOW PA	Average gallons per day into the pollution abatement (PA) pond.
SS PA	Maximum settleable solids in the PA pond discharge, measured in ml/L.
TSS PA	Maximum total suspended solids in the PA pond discharge, effluent grab measured in mg/L.
SS DD	Settleable solids discharged during drawdown for fish release. One sample per pond drawdown, measured in ml/L.

Eastbank Hatchery
NPDES Permit Number WAG13-5011

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	lbs of Fish	lbs of Feed
2018	JAN	29.72	0.00	0.0	0.0	5000	0.00	10.8	21,817	4,396
	FEB	29.72	0.00	0.2	0.4	5000	0.00	4.6	28,452	12,728
	MAR	14.87	0.00	1.2	1.2	7000	0.01	5.0	34,566	3,311
	APR	13.80	0.00	0.0	0.0	5000	0.00	19.5	27,548	5,109
	MAY	15.51	0.00	0.0	0.0	5000	0.00	11.0	21,639	8,093
	JUN	18.74	0.00	0.4	0.4	10000	0.00	9.6	32,598	9,813
	JUL	18.74	0.00	0.0	0.0	5000	0.10	9.0	42,716	8,031
	AUG	18.74	0.00	0.0	0.0	8000	0.10	26.2	41,599	8,286
	SEP	18.09	0.00	0.0	0.0	8000	0.10	28.8	40,581	9,072
	OCT	18.09	0.00	0.0	0.0	8000	0.10	8.4	46,980	10,525
	NOV	21.10	0.00	0.0	0.0	7000	0.30	21.6	52,550	5,216
	DEC	18.00	0.00	0.0	0.0	4000	0.00	26.4	36,659	2,510

Chiwawa Ponds - Chiwawa River
NPDES Permit Number WAG13-5015

		FLOW	SS EFF	TSS COMP	TSS MAX	lbs of Fish	lbs of Feed	SS DD	TSS DD
2018	JAN	3.79	0.00	1.2	1.2	9,604	243		
	FEB	4.02	0.00	-0.6	-0.6	8,802	132		
	MAR	3.24	0.00	-1.4	-1.4	8,800	132	0.03	5
	APR	3.51	0.00	1.2	1.2	9,312	704	0.03	6.4
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	4.50	0.00	1.4	1.4	6,551	88		
	OCT	4.18	0.00	0.8	0.8	6,546	484		
	NOV	3.64	0.00	-0.4	0.0	6,543	440		
	DEC	4.04	0.00	0.2	0.2	8,357	308		

Chiwawa Ponds - Wenatchee River
NPDES Permit Number WAG13-5015

		FLOW	SS EFF	TSS COMP	TSS MAX	lbs of Fish	lbs of Feed	SS DD	TSS DD
2018	JAN	6.00	0.00	3.2	3.2	14,529	1,221	0.03	2.8
	FEB	5.10	0.00	0.8	0.8	19,855	781	0.03	2.8
	MAR	3.11	0.00	0.4	0.4	15,200	1,767		
	APR	1.62	0.00	0.4	0.4	20,671	1,686	0.03	10.5
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	No Monitoring				0	0		
	OCT	No Monitoring				0	0		
	NOV	5.57	0.00	0.0	0.0	16,730	1,198		
	DEC	6.95	0.00	-1.0	-1.0	16,717	1,308		

Similkameen Hatchery
NPDES Permit Number WAG13-5007

		FLOW	SS EFF	TSS COMP	TSS MAX	lbs of Fish	lbs of Feed	SS DD	TSS DD
2018	JAN	5.93	0.00	0.0	0.0	13,673	0		
	FEB	5.90	-0.25	-0.6	-0.6	14,242	0		
	MAR	5.90	0.00	1.4	1.4	15,637	3,080		
	APR	9.60	-0.14	0.8	0.8	21,096	3,476	0.2	49.2
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	No Monitoring				0	0		
	OCT	7.20	0.00	0.8	0.8	7,012	69		
	NOV	7.20	0.10	0.2	0.2	8,161	704		
	DEC	7.20	0.00	-0.2	-0.2	8,695	264		

Chelan Hatchery
NPDES Permit Number WAG13-5006

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	lbs of Fish	lbs of Feed
2018	JAN	4.50	0.00	0.0	0.0	68000	0.00	0.0	14,472	5,803
	FEB	4.50	0.00	0.3	0.4	68000	0.00	3.6	18,761	3,903
	MAR	7.00	0.00	0.8	0.8	68000	0.00	5.6	30,569	8,137
	APR	3.70	0.00	-0.4	-0.4	68000	0.00	3.4	7,278	2,261
	MAY	5.30	0.00	0.0	0.0	68000	0.00	2.4	27,712	925
	JUN	2.99	0.00	0.2	0.2	68000	0.00	0.6	3,730	1,865
	JUL	8.00	0.00	1.2	1.2	68000	0.00	0.8	7,496	2,268
	AUG	6.50	0.03	0.2	0.4	68000	0.01	1.0	9,096	2,677
	SEP	8.04	0.01	0.0	0.0	68000	0.01	3.0	17,914	4,314
	OCT	5.86	0.00	-0.4	-0.4	68000	0.01	3.0	21,000	9,984
	NOV	6.41	0.00	0.0	0.0	68000	0.01	9.2	7,176	3,850
	DEC	3.70	0.05	0.2	0.2	68000	0.01	1.4	8,200	2,961

Chelan Falls Hatchery
NPDES Permit Number WAG13-7019

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	lbs of Fish	lbs of Feed
2018	JAN	12.80	0.00	0.5	0.6	857	0.00	0.2	29,894	4,862
	FEB	12.80	0.00	0.4	0.4	857	0.00	1.0	41,655	6,742
	MAR	12.80	0.00	1.6	1.6	857	0.00	0.8	43,317	8,165
	APR	12.80	0.00	-3.6	-3.6	857	0.00	0.2	52,251	10,205
	MAY	No Monitoring							0	0
	JUN	No Monitoring							0	0
	JUL	No Monitoring							0	0
	AUG	No Monitoring							0	0
	SEP	No Monitoring							0	0
	OCT	No Monitoring							0	0
	NOV	6.30	0.00	-0.6	-0.6	3000	0.05	0.4	30,000	4,611
	DEC	6.40	0.00	-0.2	-0.2	3000	0.05	1.2	35,600	5,412

Dryden Acclimation Pond
NPDES Permit Number WAG13-5014

		FLOW	SS EFF	TSS COMP	TSS MAX	lbs of Fish	lbs of Feed	SS DD	TSS DD
2018	JAN	No Monitoring				0	0		
	FEB	No Monitoring				0	0		
	MAR	14.40	0.00	0.2	0.2	25,857	1,320		
	APR	13.18	0.00	-0.2	-0.2	27,067	1,760	0.00	0.6
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	No Monitoring				0	0		
	OCT	No Monitoring				0	0		
	NOV	No Monitoring				0	0		
	DEC	No Monitoring				0	0		

Priest Rapids
NPDES Permit Number WAG13-7013

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	lbs of Fish	lbs of Feed	SS DD	TSS DD
2018	JAN	16.30	0.00	0.4	0.4	**	**	**	7,545	0		
	FEB	12.90	0.00	0.6	0.6	**	**	**	8,542	727		
	MAR	15.45	0.00	0.2	0.2		0.01	27.60	14,136	17,980		
	APR	27.96	0.00	0.6	0.6		0.00	50.00	35,655	22,440		
	MAY	52.82	0.00	0.4	0.4		0.00	85.60	87,751	47,036	0.00	5.6
	JUN	30.64	0.00	3.2	3.2		0.00	47.50	66,127	20,541	0.00	3.2
	JUL	No Monitoring							0	0		
	AUG	No Monitoring							0	0		
	SEP	61.70	No Monitoring						0	0		
	OCT	No Monitoring							0	0		
	NOV	No Monitoring							0	0		
	DEC	52.32	0.00	0.6	0.8	**	**	**	8,181	0		

**PA pond - No discharge this month

Appendix H

Steelhead Stock Assessment at Priest Rapids Dam, 2016-2017

Priest Rapids Dam 2016-2017 Adult Upper Columbia River Steelhead Run-Cycle Stock Assessment Report

Introduction

Upper Columbia River (UCR) steelhead stock assessment sampling at Priest Rapids Dam (PRD) in 2016 is authorized through extension of the Endangered Species Act (ESA) Section 10 Permit 1395 (NMFS 2003). Permit authorizations include interception and biological sampling of up to 10 percent of the UCR steelhead passing PRD to determine upriver population size, estimate hatchery to wild ratios, determine age class contribution and evaluate the need for managing hatchery steelhead consistent with ESA recovery objectives, which include fully seeding spawning habitat with naturally produced UCR steelhead supplemented with artificially propagated enhancement steelhead (NMFS 2003).

Stock Assessment

The 2016 steelhead sampling at Priest Rapids Dam began 6 July and concluded 7 November. Sampling consisted of operating the Priest Rapids Off-Ladder Trap (OLAFT), located on the left bank Priest Rapids Dam, 8 hours per day, up to three days per week, for a total of 54 sampling days. Steelhead were trapped, handled and released in accordance with Section 2.1 and 2.2.1 of the National Marine Fisheries Service (NMFS) Biological Opinion for ESA Permit 1395 (NMFS 2003). The cumulative sample rate attained during 2016 totaled 21.9%.

The Washington Department of Fish and Wildlife (WDFW) sampled 1,416 steelhead from the 2016/2017 run-cycle passing PRD, totaling 6,507 steelhead, for an overall sampling rate of 21.8%. Of the 1,416 steelhead sampled, 1,085 (76.6%) were hatchery origin and 331 (23.4%) were wild origin. The estimated 2016-2017 run- cycle total wild steelhead return was 1,516 representing 50.1% of the 1986-2015 average and about 32.3% of the most recent 5-year average (Table 1).

Based on external marks and external and internal tags, 1,085 hatchery origin steelhead were sampled at Priest Rapids Dam during the 2016 return cycle and included an estimated, 11.1% Wenatchee hatchery-origin steelhead and 74.5% "above Wells Dam" hatchery origin steelhead [1/] (Table 2), while 6.2% of the hatchery origin steelhead sampled could not be assigned to a specific hatchery program. Ringold FH origin steelhead represented about 8.2% of the hatchery sample (Table 2).

1/- Defined as "above Wells Dam" because some hatchery origin, adipose-clipped steelhead released into the Methow and Okanogan rivers from the Wells FH and Winthrop NFH have the same marks and are indistinguishable from one another.

Table 1. Priest Rapids Dam adult steelhead returns and stock composition, 1974-2015.

Run-cycle[1/]	Hatchery	Wild	Wild percent	Total run
1974				2,950
1975				2,560
1976				9,490
1977				9,630
1978				4,510
1979				8,710
1980				8,290
1981				9,110
1982				10,770
1983				32,000
1984				26,200
1985				34,010
1986	20,022	2,342	10.5	22,364
1987	9,955	4,058	29.0	14,013
1988	7,530	2,670	26.2	10,200
1989	8,033	2,685	25.1	10,718
1990	6,252	1,585	20.2	7,837
1991	11,169	2,799	20.0	13,968
1992	12,102	1,618	11.8	13,720
1993	4,538	890	16.4	5,428
1994	5,880	855	12.7	6,735
1995	3,377	993	22.7	4,370
1996	7,757	843	9.8	8,600
1997	8,157	785	8.8	8,942
1998	4,919	928	15.9	5,847
1999	6,903	1,374	16.6	8,277
2000	9,023	2,341	20.6	11,364
2001	24,362	5,715	19.0	30,077
2002	12,884	2,983	18.8	15,867
2003	14,890	2,837	16.0	17,729
2004	15,670	2,985	16.0	18,655
2005	10,352	3,127	23.2	13,479
2006	8,738	1,677	16.1	10,415
2007	12,160	3,097	20.3	15,257
2008	13,528	3,030	18.3	16,558
2009	32,557	7,439	18.6	39,996
2010	18,784	7,647	28.9	26,431
2011	15,910	4,896	23.5	20,806
2012	13,908	3,284	19.1	17,192
2013	10,415	4,657	30.9	15,072
2014	13,836	5,930	30.0	19,766
2015	9,583	4,720	33.0	14,303
1986-2015 average	**11,773**	**3,027**	**19.9**	**14,338**

Run-cycle[1/]	Hatchery	Wild	Wild percent	Total run
2011-2015 average	**12,731**	**4,697**	**27.3**	**17,428**

[1/] A return cycle is the combined total of steelhead passing PRD from 1 June – 30 November during year (x), plus steelhead passing PRD between 15 April and 31 May on year (x+1).

Table 2. Origin classification of steelhead sampled at Priest Rapids Dam, 6 July – 7 November 2016.

Steelhead Origin																			
Wild			Hatchery																
Wild			Wenatchee			Above Wells						Ringold		Unk. Hat.					
Criteria			Criteria			Criteria						Criteria		Criteria			Total	Total	Total
NS	NM	Total	CWT	AD+CWT	Total	AD+CWT	CWT	AD	LV	PED	Total	AD+RV	Total	SD	NM	Total	Wild	Hatchery	Total
x	x	331	x		60	x					120	x	89	x	x	68	331	1,085	1,416
				x	60		x				15								
								x			672								
									x		1								
										x	0								
Total		**331**			**120**						**808**		**89**			**68**	**331**	**1,085**	**1,416**
%Hatchery					**11.1**						**74.5**		**8.2**			**6.2**		**100.0**	
%Total		**23.4**			**8.5**						**57.1**		**6.3**			**4.7**	**23.4**	**76.6**	

Reconciliation of salt water age of wild and hatchery steelhead sampled at Priest Rapids Dam during 2016 was accomplished through scale sample analysis. Salt-age analysis of the 2016 UCR steelhead run-cycle provides an estimated hatchery-origin return dominated by 1- salt and 2-salt age composition of 10.2% and 89.3%, respectively (Table 3). Natural origin steelhead salt ages were 20.2% and 77.9% for salt ages 1 and 2, respectively. Three-salt age fish only represented approximately 0.8% of the combined hatchery/wild sample (Table 3).

Table 3. Salt-water age composition of 2016 – 2017 return cycle Upper Columbia River steelhead sampled at Priest Rapids Dam, corrected by scale age/origin determination.

	Origin					
	Hatchery		Wild		Combined	
Salt-age	*N*	%	*N*	%	*N*	%
1-salt	111	10.2	65	20.2	176	12.5
2-salt	973	89.3	250	77.9	1,223	86.7
3-salt	5	0.5	6	1.9	11	0.8
4-salt	0	0	0	0	0	0
Total	**1,089**		**321**		**1,410**	

Freshwater residency of naturally produced Upper Columbia River steelhead present in the 2016-2017 run cycle were dominated by age-2 freshwater fish (68.8%), and was lower than the 1986-2015 average of 74.7% (Table 4).

Table 4. 2016 return year freshwater age of wild Upper Columbia River steelhead sampled at Priest Rapids Dam during steelhead stock assessment activities, compared to July – November 1986-2015 average.

Freshwater age	2016-2017 run cycle		1986-2015 proportion	
	N	%	*N*	%
1.x	22	7.6	603	7.5
2.x	198	68.8	6,027	74.7
3.x	64	22.2	1,370	17.0
4.x	4	1.4	70	0.9
5.x	0	0	3	>0.1
Total	**288**		**8,073**	

Wild and hatchery origin steelhead exhibited similar saltwater growth in the 2016 run-cycle. Wild 1and 2-salt adults were slightly larger than their hatchery cohorts (Table 5). Age 1and 2-salt wild and hatchery steelhead observed in the 2016-2017 adult run-cycle return past PRD were comparable in size to the 1986-2015 run-cycle average (Table 5).

Table 5. Average fork length of 1-salt and 2-salt, Upper Columbia River steelhead sampled at Priest Rapids Dam during July – November 2016 and the period between 1986-2015.

	Average fork length (cm)			
	2016-2017 run cycle		1986-2015 run cycle	
Salt age	Wild	Hatchery	Wild	Hatchery
x.1	58.4	57.1	59.5	58.4
x.2	71.8	70.5	71.8	71.0

Appendix I

Bull Trout Take Associated with the Wenatchee Batch Biological Opinion for the Wenatchee River Sub-basin Hatchery Programs, 2018

2018 Annual USFWS Report of Incidental Take of Bull Trout Associated with the Chelan and Grant County PUD Hatchery Programs in Wenatchee River Subbasin

Introduction

Implementation of Wenatchee River sub-basin spring and summer Chinook and summer steelhead hatchery programs, monitoring and evaluation, and adult management activities in 2018 were authorized through Endangered Species Act (ESA) Section 10(a)(1)(A) Permits 18118 (Nason Creek spring Chinook; NMFS 2015), 18120 (White River spring Chinook; NMFS 2015), 18121 (Chiwawa spring Chinook; NMFS 2015), and 18583 (Wenatchee summer steelhead; NMFS 2017) and extension of Section 10(a)(1)(B) Permit 1347 (Wenatchee summer Chinook) NMFS 2003). Additionally, incidental take of bull trout (*Salvelinus confluentus*) associated with these programs and activities is detailed in the Section 7 consultation Biological Opinion (BiOp) with the United States Fish and Wildlife Service (USFWS) No. 01EWFW00-2013-F-0444.

Permit authorizations include broodstock collection, juvenile releases, nutrient enhancement, juvenile smolt trapping, adult management, and monitoring and evaluation activities. Hatchery programs and their related activities covered under these permits are:

- Chiwawa River Spring Chinook (Chelan County PUD)
- Nason Creek Spring Chinook (Grant County PUD)
- White River Spring Chinook (Grant County PUD)
- Wenatchee River Summer Chinook (Grant and Chelan County PUDs)
- Wenatchee River Summer Steelhead (Chelan County PUD)

Reasonable and Prudent Measures Related to Bull Trout Impacts

Under the terms and conditions for bull trout, the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize and monitor the impacts of take of bull trout likely to be caused by the proposed implementation of the hatchery programs and related activities:

RPM 1. Minimize incidental take resulting from operation of the Chiwawa Weir for spring Chinook salmon broodstock collection or any other activity.
RPM 2. Minimize incidental take resulting from tangle netting for spring Chinook salmon broodstock collection in Nason Creek.
RPM 3. Minimize incidental take due to adverse ecological interactions associated with smolt releases and residualism.
RPM 4. Minimize incidental take associated with nutrient enhancement.
RPM 5. Minimize incidental take associated with monitoring, research, and evaluation activities for all programs.
RPM 6. Minimize potential for incidental take through effective implementation of adaptive management.

Reporting Requirements

In order to monitor the impacts of implementation of the reasonable and prudent measures, an annual report shall be prepared describing the progress of the proposed Project, and impacts to the bull trout (50 CFR § 402.14(I)(3)). The report shall be submitted to the Central Washington Field Office. The annual reporting required shall list and describe the following information relative to each RPM above (with the exception of RPM 6, which is a compendium of the previous five years activities):

1) RPM 1:

a) Narrative description of any adjustments to Chiwawa Weir operations relative to planned operations for broodstock collection at this facility, especially measures that change the schedule of weir operation. This includes deviations, if any, from the broodstock collection activities described in the Broodstock Collection Protocol for the reporting year.

b) Schedule of operation, including:
   - i) Seasonal period of operation (start date, end date, total days of operation).
   - ii) Daily periods of operation (clock time and total hours of operation).
   - iii) Maximum water temperature during each day of operation.

c) Total number of bull trout encountered, segregated into numbers of adult, sub-adult, and juvenile life stages, by day of operation. Specify the criteria used to segregate by life stage.

d) For bull trout captured when water temperature is greater than 15° C, a qualitative description of their condition and behavior upon release. Evaluate the relationship of water temperature at time of capture and bull trout condition at release, stratifying capture temperature into two classes; (1) water temperature greater than 18° C, and (2) water temperature greater than 15° C, but less than 18° C.

e) If a bull trout mortality occurs:
   - i) A detailed description of the circumstances surrounding the mortality.
   - ii) A detailed description of alternative or additional measures implemented to reduce risk of additional mortalities.

2) RPM 2:

f) Specific locations where reconnaissance snorkels and tangle netting occurred.

g) The netting schedule (dates and hours-per-location of net sets) and number of personnel participating for each set.

h) Number of bull trout observed during snorkeling and captured during netting, segregated into adult, sub-adult, and juvenile life stages.

i) For captured bull trout, a qualitative description of their condition and behavior upon release.

3) RPM 3:

j) Narrative description of estimated migration speed and conversion rates at downstream monitoring locations, with a qualitative comparison of performance to long-term values.

4) RPM 4:
   k) List or map displaying where carcasses were distributed within bull trout spawning areas, the approximate number of carcasses distributed by site, and when carcasses were placed.

5) RPM 5:
   a) Numbers of bull trout captured by smolt trap and by date, stratified by life stage (juvenile, sub-adult, and adult). Specify the criteria used to segregate by life stage.
   b) Numbers of injuries and mortalities observed, and narrative description of circumstances surrounding mortalities.
   c) A narrative description of adaptive management adjustments to trap operations and their apparent efficacy in minimizing trapping-related adverse effects to bull trout.
   d) A detailed description of any electrofishing activities that encounter bull trout, which includes:
      i) Purpose of the electrofishing activity.
      ii) Protocol used (reference) and deviations, if any, from the referenced protocol.
      iii) Water temperature and conductivity.
      iv) Number of bull trout encountered by life stage. Specify the criteria used to segregate by life stage, and if electroshocking occurs where resident bull trout may be present, segregate resident from migratory bull trout and specify criteria used.
      v) A qualitative description of bull trout condition and behavior upon release.
      vi) Narrative description of circumstances surrounding mortalities.

6) RPM 6:
   a) Every five years provide a cumulative report focused on the components of this program for which five-year average incidental take limits have been specified.
   b) The primary purposes of the five-year summaries are to help the Service determine if adjustments to this incidental take statement and the accompanying biological opinion are needed and to inform future adaptive management of the hatchery programs.
   c) To accomplish these objectives, the report should focus on:
      i) How successfully programs could be implemented while conforming to incidental take limits,
      ii) Incidental take exceedances if any,
      iii) Recommendations for addressing incidental take exceedances, especially new or enhanced conservation measures, or rationale for an increased take limit, including relevant new information.
      iv) Issues (especially recurring issues) that were encountered, and
      v) The relative effectiveness of conservation measures and terms and conditions.

7) Deviations from the proposed Project description, other than those specified in 1-6 above, if any, for all five hatchery programs.

8) Implementation of any conservation recommendations.

Results

RPM 1:

Chiwawa Weir operations detailed in the 2018 Broodstock Collection Protocols approved by the HCP Hatchery Committees and the PRCC Hatchery Subcommittee established a 24 hour up/24 hour down schedule from about June 1 through August 15 not to exceed 20 cumulative trapping days and/or 93 bull trout encounters (WDFW, 2018).

A total of 99 bull trout were trapped in six days of trapping Table 1. All bull trout were removed from the trap daily, sampled and PIT tagged by WDFW staff, and loaded into a transport truck and hauled/released into the Chiwawa River at approximately 10 KM upstream of the weir near Meadow Creek. All fish appeared healthy and dispersed immediately. No known mortalities related to trapping, handling, hauling, and release occurred. No modifications to the proposed 2018 operations were requested.

Table 1. Bull trout encounters by date during spring Chinook broodstock collections at the Chiwawa Weir in 2018.

Date	Max daily water temp. (°C)	Number Captured[2]			Mortalities			Comments
		Juvenile	Sub-adult	Adult	Juvenile	Sub-adult	Adult	
6/27	9.6	0	0	15	0	0	0	
6/29	11.0	0	0	22	0	0	0	One recap (previously PIT tagged) fish with gill injury.
7/01	12.1	0	0	17	0	0	0	
7/03	12.0	0	0	19	0	0	0	One fish with extra anal fin?
7/05	14.5	0	0	10	0	0	0	
7/07	13.7	0	0	16	0	0	0	
Total	**12.2[1]**	**0**	**0**	**99**	**0**	**0**	**0**	

[1] Average of maximum daily water temperature.
[2] All fish were sampled by WDFW staff for fork, POH, DNA, and PIT tagged if not previously tagged.

RPM 2:

In 2018, tangle netting for spring Chinook broodstock for the Nason Creek program in Nason Creek did not occur.

RPM 3:

Estimates of post release survival and travel times (mean travel days) for the Nason Creek and Chiwawa River spring Chinook, Wenatchee summer Chinook, and Wenatchee summer steelhead hatchery programs can be found summarized in the 2018 annual report for Monitoring and Evaluation of the Chelan and Grant PUDs Hatchery Programs (Hillman et al., 2019).

RPM 4:

No nutrient enhancement or natural area carcass distributions covered by this permit were conducted in 2018.

RPM 5:

In 2018, juvenile smolt traps were operated in Nason Creek, the White River, the Chiwawa River, and the lower Wenatchee River by the Yakama Nation (Nason and White) and the Washington Department of Fish and Wildlife (Chiwawa and lower Wenatchee). A total of 311 bull trout were collected in 2018. Of those bull trout captured, 0.3%, 8.1%, and 91.6% were caught in Nason Creek, the White River, and the Chiwawa River, respectively (Table 2). No bull trout were encountered in the lower Wenatchee River smolt trap in 2018. All bull trout were allowed to recover and released immediately downstream of trap locations. No complications or mortalities were observed.

Table 2. Summary of bull trout encountered at Wenatchee River sub-basin smolt traps funded by Chelan and/or Grant PUDs in 2018.

Trap Location	Number Trapped			Mortalities			Ave. max daily water temp (^oC)
	Juvenile	Sub-adult	Adult	Juvenile	Sub-adult	Adult	
Lower Wenatchee	No Bull trout were encountered in the lower Wenatchee smolt trap in 2018						
Nason Creek	0	0	1	0	0	0	3.7
White River	24	0	1	0	0	0	9.6
Chiwawa River	216	0	69	0	0	0	7.1
Total	**240**	**0**	**71**	**0**	**0**	**0**	

Of the 311 bull trout collected in 2018, lengths were taken from 264 (254 Chiwawa, 9 Nason, and 1 White River; Table 3). Of the fish sampled, 223 (84.4%) were ≤300 mm with 3.4% (N=9) >500 mm. Collection dates and individual lengths of bull trout collected are available in Appendix 1.

Table 3. Number of bull trout by size range (in 100-mm increments) collected at Wenatchee River sub-basin smolt traps in 2018.

Trap location	Number within length range						No data
	≤ 100	101 ≤ 200	201 ≤ 300	301 ≤ 400	401 ≤ 500	>500	
Lower Wenatchee	No Bull trout were encountered in the lower Wenatchee smolt trap in 2018						
Nason Creek	0	0	0	0	0	1	
White River	1	4	3	0	1	0	15
Chiwawa River	0	121	94	18	13	8	32
Total	**1**	**125**	**97**	**18**	**14**	**9**	**47**

In addition to juvenile smolt trapping, electrofishing activities were conducted in Nason Creek and the Chiwawa River in an effort to collect and PIT tag juvenile spring Chinook to evaluate overwinter movement and survival of spring Chinook within the Wenatchee River sub-basin.

Electrofishing activities occurred between 1 October and 15 November in the Chiwawa River and between 4 September and 15 November in Nason Creek. A total of eight juvenile bull trout were collected in Nason Creek and 442 in the Chiwawa River (Table 4). No mortalities occurred and all fish were released unharmed within the reach in which they were collected. No bull trout were sampled or tagged during these activities. Daily catch by location including shocker settings, water temperatures, waypoints, etc. can be found in Appendix 2.

Table 4. Number of bull trout encountered during 2018 electrofishing activities in the Wenatchee River sub-basin.

Tributary	Number	Mortality	Shocker Settings: Ave. volts	Shocker Settings: Ave. frequency	Total shocking seconds	Min/max water temp. (ºC)
Nason Creek	8	0	345	34.3	88,982	3.5 – 14.0
Chiwawa River	442	0	375	40.5	116,011	3.0 – 10.0
Total	**450**	**0**			**204,993**	

All backpack electrofishing activities and equipment were consistent with NMFS' June 2000 Backpack Electrofishing Guidelines.

RPM 6:

Not applicable for 2018. The first five-year summary report will be in 2023.

RPM 7:

No deviations in the proposed project descriptions occurred in 2018.

RPM 8:

For 2018, no Conservation Recommendations identified in the Biological Opinion were implemented.

References

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NMFS. 2000. National Marie Fisheries Service Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. Protected Resources Division, Portland Oregon.

NMFS (National Marine Fisheries Service). 2003. Section 10(a)(1)(b) Permit for takes of endangered/threatened species. Incidental Take Permit 1347 for the artificial propagation of unlisted salmon. Portland, OR.

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NMFS (National Marine Fisheries Service). 2015. Section 10(a)(1)(A) Permit for takes of endangered/threatened species. Direct Take Permit 18120 for the artificial propagation and monitoring and evaluation of White River spring Chinook salmon. Portland, OR.

NMFS (National Marine Fisheries Service). 2015. Section 10(a)(1)(A) Permit for takes of endangered/threatened species. Direct Take Permit 18121 for the artificial propagation and monitoring and evaluation of Chiwawa River spring Chinook salmon. Portland, OR.

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Tonseth, M. 2018. Final Upper Columbia River 2018 BY Salmon and 2019 BY Steelhead Hatchery Program Management Plan and Associated Protocols for Broodstock Collection, Rearing/Release, and Management of Adult Returns.

USFWS. 2017. United States Fish and Wildlife Service Biological Opinion No. 01EWFW00-2013-F-0444 for Wenatchee River Spring Chinook Salmon, Summer Chinook Salmon, and Steelhead Hatchery Programs. U.S. Fish and Wildlife Service, Wenatchee, Washington, November 27, 2017. 333p.

Appendix 1

Juvenile Smolt Trapping Bull Trout Encounters in the Wenatchee River Sub-basin in 2018

Table 1. Collection dates and lengths of adult and juvenile bull trout encountered at Wenatchee River sub-basin smolt traps funded by Chelan and Grant PUDs in 2018.

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Lower Wenatchee	No Bull trout were encountered in the lower Wenatchee smolt trap in 2018						
Nason Creek	10-Nov			X	600	0	3.7
White River	2-May	X			NDC	0	7.7
White River	28-Jun	X			NDC	0	9.9
White River	2-Jul	X			140	0	9.5
White River	12-Jul	X			NDC	0	13.5
White River	11-Aug	X			61	0	14.7
White River	13-Aug	X			100	0	13.5
White River	18-Aug	X			NDC	0	13.9
White River	18-Aug	X			NDC	0	13.9
White River	31-Aug	X			NDC	0	13.7
White River	2-Sep	X			NDC	0	13.3
White River	3-Sep	X			NDC	0	13.8
White River	8-Sep	X			NDC	0	12.4
White River	11-Sep	X			NDC	0	11.5
White River	11-Sep	X			NDC	0	11.5
White River	18-Sep	X			209	0	10.6
White River	30-Sep			X	500	0	10.2
White River	4-Oct	X			NDC	0	8.1
White River	6-Oct	X			NDC	0	8.5
White River	11-Oct	X			248	0	8.3
White River	21-Oct	X			300	0	6.1
White River	23-Oct	X			200	0	5.9
White River	6-Nov	X			NDC	0	5.8
White River	9-Nov	X			NDC	0	3.2
White River	10-Nov	X			138	0	3.6
White River	12-Nov	X			168	0	2.7
Chiwawa River	13-Mar	X			164	0	1.0
Chiwawa River	8-Apr	X			136	0	5.0
Chiwawa River	9-Apr	X			203	0	6.0
Chiwawa River	10-Apr	X			200	0	4.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	12-Apr	X			133	0	6.0
Chiwawa River	18-Apr	X			130	0	5.0
Chiwawa River	3-May	X			131	0	7.5
Chiwawa River	6-Jun	X			147	0	9.0
Chiwawa River	8-Jun	X			142	0	8.0
Chiwawa River	8-Jun	X			159	0	8.0
Chiwawa River	8-Jun	X			179	0	8.0
Chiwawa River	9-Jun	X			163	0	8.0
Chiwawa River	10-Jun	X			147	0	8.0
Chiwawa River	11-Jun	X			149	0	7.0
Chiwawa River	12-Jun	X			153	0	8.5
Chiwawa River	12-Jun	X			169	0	8.5
Chiwawa River	15-Jun	X			139	0	9.5
Chiwawa River	15-Jun	X			149	0	9.5
Chiwawa River	15-Jun	X			150	0	9.5
Chiwawa River	16-Jun	X			152	0	9.0
Chiwawa River	16-Jun	X			153	0	9.0
Chiwawa River	16-Jun	X			169	0	9.0
Chiwawa River	17-Jun	X			157	0	9.5
Chiwawa River	20-Jun	X			157	0	11.0
Chiwawa River	20-Jun	X			158	0	11.0
Chiwawa River	20-Jun	X			160	0	11.0
Chiwawa River	20-Jun	X			161	0	11.0
Chiwawa River	21-Jun	X			139	0	9.0
Chiwawa River	24-Jun	X			134	0	10.0
Chiwawa River	29-Jun	X			165	0	10.0
Chiwawa River	3-Jul	X			163	0	11.0
Chiwawa River	12-Jul	X			138	0	13.5
Chiwawa River	21-Jul	X			144	0	11.0
Chiwawa River	27-Jul	X			178	0	14.0
Chiwawa River	6-Aug			X	335	0	17.0
Chiwawa River	7-Aug			X	465	0	16.0
Chiwawa River	8-Aug	X			119	0	14.5
Chiwawa River	11-Aug	X			185	0	15.0
Chiwawa River	13-Aug	X			269	0	14.0
Chiwawa River	13-Aug			X	392	0	14.0
Chiwawa River	15-Aug	X			226	0	12.0
Chiwawa River	16-Aug			X	530	0	12.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	17-Aug	X			200	0	13.5
Chiwawa River	19-Aug			X	NDC	0	13.5
Chiwawa River	20-Aug	X			291	0	13.0
Chiwawa River	25-Aug	X			284	0	11.0
Chiwawa River	31-Aug	X			244	0	12.5
Chiwawa River	1-Sep	X			224	0	12.0
Chiwawa River	3-Sep	X			220	0	12.0
Chiwawa River	4-Sep	X			200	0	11.0
Chiwawa River	4-Sep	X			250	0	11.0
Chiwawa River	5-Sep			X	NDC	0	11.0
Chiwawa River	5-Sep			X	NDC	0	11.0
Chiwawa River	5-Sep			X	NDC	0	11.0
Chiwawa River	5-Sep			X	NDC	0	11.0
Chiwawa River	6-Sep	X			211	0	10.0
Chiwawa River	6-Sep	X			234	0	10.0
Chiwawa River	6-Sep	X			254	0	10.0
Chiwawa River	6-Sep			X	378	0	10.0
Chiwawa River	7-Sep	X			183	0	12.0
Chiwawa River	7-Sep	X			211	0	12.0
Chiwawa River	7-Sep	X			229	0	12.0
Chiwawa River	7-Sep			X	437	0	12.0
Chiwawa River	8-Sep	X			188	0	12.0
Chiwawa River	8-Sep	X			277	0	12.0
Chiwawa River	8-Sep	X			296	0	12.0
Chiwawa River	8-Sep			X	NDC	0	12.0
Chiwawa River	9-Sep	X			187	0	12.0
Chiwawa River	9-Sep	X			244	0	12.0
Chiwawa River	9-Sep	X			275	0	12.0
Chiwawa River	9-Sep			X	530	0	12.0
Chiwawa River	10-Sep	X			160	0	12.0
Chiwawa River	10-Sep	X			260	0	12.0
Chiwawa River	10-Sep			X	480	0	12.0
Chiwawa River	11-Sep	X			170	0	11.0
Chiwawa River	11-Sep	X			200	0	11.0
Chiwawa River	11-Sep	X			222	0	11.0
Chiwawa River	11-Sep			X	360	0	11.0
Chiwawa River	11-Sep			X	450	0	11.0
Chiwawa River	12-Sep			X	NDC	0	9.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	13-Sep	X			NDC	0	9.5
Chiwawa River	13-Sep			X	NDC	0	9.5
Chiwawa River	14-Sep	X			246	0	9.5
Chiwawa River	14-Sep	X			250	0	9.5
Chiwawa River	14-Sep	X			274	0	9.5
Chiwawa River	14-Sep			X	368	0	9.5
Chiwawa River	15-Sep	X			204	0	8.5
Chiwawa River	15-Sep	X			233	0	8.5
Chiwawa River	15-Sep			X	NDC	0	8.5
Chiwawa River	15-Sep			X	NDC	0	8.5
Chiwawa River	16-Sep	X			229	0	8.5
Chiwawa River	16-Sep			X	NDC	0	8.5
Chiwawa River	16-Sep			X	NDC	0	8.5
Chiwawa River	17-Sep	X			220	0	7.0
Chiwawa River	17-Sep			X	400	0	7.0
Chiwawa River	18-Sep	X			248	0	7.0
Chiwawa River	18-Sep	X			280	0	7.0
Chiwawa River	18-Sep			X	330	0	7.0
Chiwawa River	18-Sep			X	400	0	7.0
Chiwawa River	18-Sep			X	550	0	7.0
Chiwawa River	19-Sep	X			250	0	9.5
Chiwawa River	19-Sep	X			270	0	9.5
Chiwawa River	19-Sep			X	340	0	9.5
Chiwawa River	19-Sep			X	350	0	9.5
Chiwawa River	19-Sep			X	370	0	9.5
Chiwawa River	19-Sep			X	400	0	9.5
Chiwawa River	19-Sep			X	450	0	9.5
Chiwawa River	19-Sep			X	480	0	9.5
Chiwawa River	20-Sep			X	300	0	9.5
Chiwawa River	20-Sep			X	425	0	9.5
Chiwawa River	21-Sep			X	523	0	9.5
Chiwawa River	21-Sep			X	528	0	9.5
Chiwawa River	22-Sep			X	440	0	11.0
Chiwawa River	22-Sep			X	542	0	11.0
Chiwawa River	23-Sep	X			245	0	9.5
Chiwawa River	23-Sep	X			271	0	9.5
Chiwawa River	23-Sep			X	402	0	9.5
Chiwawa River	23-Sep			X	446	0	9.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	24-Sep			X	NDC	0	7.0
Chiwawa River	27-Sep			X	NDC	0	13.0
Chiwawa River	28-Sep	X			240	0	9.0
Chiwawa River	29-Sep			X	332	0	9.0
Chiwawa River	29-Sep			X	467	0	9.0
Chiwawa River	30-Sep	X			218	0	9.0
Chiwawa River	1-Oct	X			270	0	9.0
Chiwawa River	1-Oct			X	350	0	9.0
Chiwawa River	1-Oct			X	400	0	9.0
Chiwawa River	1-Oct			X	520	0	9.0
Chiwawa River	2-Oct			X	NDC	0	13.5
Chiwawa River	2-Oct			X	NDC	0	13.5
Chiwawa River	2-Oct			X	NDC	0	13.5
Chiwawa River	2-Oct			X	NDC	0	13.5
Chiwawa River	2-Oct			X	NDC	0	13.5
Chiwawa River	3-Oct	X			176	0	7.5
Chiwawa River	3-Oct	X			208	0	7.5
Chiwawa River	3-Oct	X			272	0	7.5
Chiwawa River	3-Oct			X	NDC	0	7.5
Chiwawa River	3-Oct			X	NDC	0	7.5
Chiwawa River	3-Oct			X	NDC	0	7.5
Chiwawa River	3-Oct			X	NDC	0	7.5
Chiwawa River	3-Oct	X			NDC	0	7.5
Chiwawa River	4-Oct	X			201	0	5.5
Chiwawa River	4-Oct	X			222	0	5.5
Chiwawa River	4-Oct	X			272	0	5.5
Chiwawa River	4-Oct			X	NDC	0	5.5
Chiwawa River	5-Oct	X			213	0	6.5
Chiwawa River	5-Oct			X	NDC	0	6.5
Chiwawa River	6-Oct	X			224	0	6.0
Chiwawa River	6-Oct			X	463	0	6.0
Chiwawa River	7-Oct	X			221	0	6.5
Chiwawa River	7-Oct	X			250	0	6.5
Chiwawa River	8-Oct	X			196	0	6.5
Chiwawa River	8-Oct	X			196	0	6.5
Chiwawa River	8-Oct	X			203	0	6.5
Chiwawa River	8-Oct	X			217	0	6.5
Chiwawa River	8-Oct			X	NDC	0	6.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	9-Oct	X			200	0	5.5
Chiwawa River	10-Oct	X			200	0	0.0
Chiwawa River	10-Oct			X	NDC	0	0.0
Chiwawa River	11-Oct			X	380	0	6.5
Chiwawa River	12-Oct	X			240	0	6.5
Chiwawa River	14-Oct	X			240	0	3.0
Chiwawa River	15-Oct	X			194	0	3.0
Chiwawa River	15-Oct			X	NDC	0	3.0
Chiwawa River	16-Oct			X	NDC	0	4.5
Chiwawa River	17-Oct	X			200	0	4.5
Chiwawa River	17-Oct	X			250	0	4.5
Chiwawa River	18-Oct	X			215	0	4.5
Chiwawa River	20-Oct	X			245	0	3.5
Chiwawa River	24-Oct	X			185	0	4.5
Chiwawa River	26-Oct	X			177	0	7.0
Chiwawa River	26-Oct	X			224	0	7.0
Chiwawa River	26-Oct	X			228	0	7.0
Chiwawa River	26-Oct	X			232	0	7.0
Chiwawa River	26-Oct	X			257	0	7.0
Chiwawa River	27-Oct	X			177	0	6.0
Chiwawa River	27-Oct	X			195	0	6.0
Chiwawa River	27-Oct	X			204	0	6.0
Chiwawa River	27-Oct	X			217	0	6.0
Chiwawa River	27-Oct	X			227	0	6.0
Chiwawa River	28-Oct	X			195	0	7.0
Chiwawa River	28-Oct	X			197	0	7.0
Chiwawa River	28-Oct	X			198	0	7.0
Chiwawa River	28-Oct	X			204	0	7.0
Chiwawa River	29-Oct	X			176	0	5.0
Chiwawa River	29-Oct	X			188	0	5.0
Chiwawa River	29-Oct	X			188	0	5.0
Chiwawa River	29-Oct	X			217	0	5.0
Chiwawa River	30-Oct	X			156	0	4.0
Chiwawa River	30-Oct	X			188	0	4.0
Chiwawa River	30-Oct	X			195	0	4.0
Chiwawa River	30-Oct	X			204	0	4.0
Chiwawa River	30-Oct	X			213	0	4.0
Chiwawa River	31-Oct	X			182	0	5.0

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	31-Oct	X			187	0	5.0
Chiwawa River	31-Oct	X			192	0	5.0
Chiwawa River	31-Oct	X			210	0	5.0
Chiwawa River	31-Oct	X			223	0	5.0
Chiwawa River	31-Oct	X			224	0	5.0
Chiwawa River	31-Oct			X	327	0	5.0
Chiwawa River	1-Nov	X			185	0	7.0
Chiwawa River	1-Nov	X			201	0	7.0
Chiwawa River	1-Nov	X			205	0	7.0
Chiwawa River	1-Nov	X			208	0	7.0
Chiwawa River	1-Nov			X	372	0	7.0
Chiwawa River	2-Nov	X			184	0	7.0
Chiwawa River	2-Nov	X			212	0	7.0
Chiwawa River	3-Nov	X			154	0	6.5
Chiwawa River	3-Nov	X			181	0	6.5
Chiwawa River	3-Nov	X			182	0	6.5
Chiwawa River	3-Nov	X			186	0	6.5
Chiwawa River	3-Nov	X			191	0	6.5
Chiwawa River	3-Nov	X			193	0	6.5
Chiwawa River	3-Nov	X			194	0	6.5
Chiwawa River	3-Nov	X			203	0	6.5
Chiwawa River	3-Nov	X			236	0	6.5
Chiwawa River	3-Nov	X			239	0	6.5
Chiwawa River	3-Nov	X			259	0	6.5
Chiwawa River	4-Nov	X			192	0	6.0
Chiwawa River	4-Nov	X			194	0	6.0
Chiwawa River	4-Nov	X			198	0	6.0
Chiwawa River	5-Nov	X			181	0	5.5
Chiwawa River	5-Nov	X			204	0	5.5
Chiwawa River	5-Nov	X			204	0	5.5
Chiwawa River	5-Nov	X			220	0	5.5
Chiwawa River	5-Nov	X			241	0	5.5
Chiwawa River	6-Nov	X			193	0	5.0
Chiwawa River	7-Nov	X			203	0	3.5
Chiwawa River	8-Nov	X			173	0	3.0
Chiwawa River	9-Nov	X			236	0	2.0
Chiwawa River	10-Nov	X			164	0	1.5
Chiwawa River	10-Nov	X			179	0	1.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	11-Nov	X			185	0	1.5
Chiwawa River	11-Nov	X			194	0	1.5
Chiwawa River	11-Nov	X			206	0	1.5
Chiwawa River	11-Nov	X			214	0	1.5
Chiwawa River	11-Nov	X			221	0	1.5
Chiwawa River	11-Nov	X			248	0	1.5
Chiwawa River	12-Nov	X			201	0	1.0
Chiwawa River	13-Nov	X			170	0	1.0
Chiwawa River	13-Nov	X			181	0	1.0
Chiwawa River	13-Nov	X			192	0	1.0
Chiwawa River	13-Nov	X			193	0	1.0
Chiwawa River	13-Nov	X			196	0	1.0
Chiwawa River	13-Nov	X			198	0	1.0
Chiwawa River	13-Nov	X			202	0	1.0
Chiwawa River	14-Nov	X			177	0	1.5
Chiwawa River	14-Nov	X			179	0	1.5
Chiwawa River	14-Nov	X			195	0	1.5
Chiwawa River	15-Nov	X			162	0	2.0
Chiwawa River	15-Nov	X			187	0	2.0
Chiwawa River	15-Nov	X			190	0	2.0
Chiwawa River	15-Nov	X			192	0	2.0
Chiwawa River	16-Nov	X			178	0	4.0
Chiwawa River	16-Nov	X			179	0	4.0
Chiwawa River	16-Nov	X			189	0	4.0
Chiwawa River	16-Nov	X			219	0	4.0
Chiwawa River	16-Nov			X	417	0	4.0
Chiwawa River	17-Nov	X			182	0	2.5
Chiwawa River	17-Nov	X			184	0	2.5
Chiwawa River	17-Nov	X			201	0	2.5
Chiwawa River	17-Nov			X	NDC	0	2.5
Chiwawa River	19-Nov	X			162	0	0.0
Chiwawa River	19-Nov	X			178	0	0.0
Chiwawa River	19-Nov	X			188	0	0.0
Chiwawa River	19-Nov	X			197	0	0.0
Chiwawa River	22-Nov	X			197	0	2.0
Chiwawa River	23-Nov	X			216	0	22.0
Chiwawa River	24-Nov	X			168	0	1.0
Chiwawa River	27-Nov	X			144	0	1.5

Trap Location	Date	Number Trapped[1]			Fork length (mm)[2]	Mortalities	Max daily water temp
		Juvenile	Sub-adult	Adult			
Chiwawa River	28-Nov	X			163	0	2.0
Chiwawa River	28-Nov	X			175	0	2.0
Chiwawa River	28-Nov	X			178	0	2.0
Chiwawa River	28-Nov	X			210	0	2.0
Chiwawa River	29-Nov	X			142	0	2.5
Chiwawa River	29-Nov	X			163	0	2.5
Chiwawa River	29-Nov	X			175	0	2.5
Chiwawa River	29-Nov	X			189	0	2.5
Chiwawa River	29-Nov			X	600	0	2.5
Chiwawa River	30-Nov	X			160	0	3.5
Chiwawa River	30-Nov	X			177	0	3.5
Chiwawa River	30-Nov	X			201	0	3.5
Chiwawa River	1-Dec	X			207	0	2.5
Chiwawa River	2-Dec	X			175	0	1.5
Chiwawa River	3-Dec	X			182	0	1.5
Chiwawa River	4-Dec	X			227	0	0.5

[1] Bull trout are only classified as juvenile or adult; X=1 fish.
[2] NDC = No data collected.

Appendix 2

Electrofishing Bull Trout Encounters in the Wenatchee River Sub-basin in 2018

Table 1. Electrofishing duration by location and bull trout encounters in the Nason Creek in 2018.

Date	Reach	Bull Trout			Shocker Settings			Release GPS Waypoints		Temps		Additional Notes
		Caught	Tagged	Morts	Volts	Frequency	Shocker Seconds	Latitude	Longitude	Tagging	Release	
4-Sep-18	N3A	4	0	0	375	35	3,921	47.776880	-120.920684	11.0	11.0	
5-Sep-18	N3B	2	0	0	375	35	3,859	47.777349	-120.894956	13.0	13.0	
10-Sep-18	N3C	1	0	0	400	35	5,652	47.784035	-120.87599	13.0	13.0	
10-Sep-18	N3D	0	0	0	300	35	2,906	47.786827	-120.858891	13.0	14.0	
11-Sep-18	N3E	0	0	0	400	40	3,668	47.783504	-120.846186	12.0	12.0	
16-Sep-18	N3E Cont.	0	0	0	375	35	983	47.786827	-120.858891	10.0	10.0	
20-Sep-18	N3E Extra	0	0	0	300	35	2,161	47.7854630	-120.8473860	11.0	11.0	
24-Sep-18	N3C Extra	0	0	0	375	35	3,279	47.784035	-120.87599	10.0	10.0	
27-Sep-18	N3B Extra	0	0	0	375	30	1,147	47.779696	-120.88066	7.0	7.0	
14-Nov-18	N3E Extra x2	0	0	0	375	35	2,200	47.785247	-120.847403	2.5	2.5	
	N3 Total	7	0	0			29,776					
11-Sep-18	N2A	0	0	0	300	30	3,478	47.780038	-120.838023	12.0	12.0	
12-Sep-18	N2B	0	0	0	300	35	2,869	47.773683	-120.821403	12.0	12.0	
12-Sep-18	N2C	0	0	0	375	35	4,438	47.768203	-120.804671	13.0	13.0	
13-Sep-18	N2D	1	0	0	300	35	3,769	47.767986	-120.785138	13.0	13.0	
15-Sep-18	N2E	0	0	0	375	35	6,222	47.767612	-120.774093	10.0	10.0	
24-Sep-18	N2D Cont.	0	0	0	300	35	1,730	47.767986	-120.785138	9.0	9.0	
24-Sep-18	N2E Cont.	0	0	0	300	35	1,774	47.7676020	-120.7773370	9.0	9.0	

Date	Reach	Bull Trout			Shocker Settings			Release GPS Waypoints		Temps		Additional Notes
		Caught	Tagged	Morts	Volts	Frequency	Shocker Seconds	Latitude	Longitude	Tagging	Release	
25-Sep-18	N2C Extra	0	0	0	300	35	3,217	47.769499	-120.801499			Thermometer broken
31-Oct-18	N2E Extra	0	0	0	375	35	2,120	47.767533	-120.771421	7.0	7.0	Shocking for SHR for Moran
	N2 Total	1	0	0			29,617					
17-Sep-18	N1A	0	0	0	375	35	5,380	47.767696	-120.758700	13.0	13.0	
17-Sep-18	N1B	0	0	0	300	35	3,848	47.761894	-120.742989	13.0	13.0	
18-Sep-18	N1C	0	0	0	300	35	3,950	47.765692	-120.728339	9.0	9.0	
19-Sep-18	N1D	0	0	0	300	35	2,285	47.771125	-120.721606	12.0	12.0	Lots of sections too deep to shock
19-Sep-18	N1E	0	0	0	375	35	2,882	47.7916660	-120.7147450	13.0	13.0	
20-Sep-18	N1F	0	0	0	375	30	5,461	47.791634	-120.714774	12.5	12.5	
26-Sep-18	N1B Extra	0	0	0	300	30	3,148	47.761894	-120.742989	11.0	11.0	
27-Sep-18	N1F Extra	0	0	0	375	30	647	47.800701	-120.716908	14.0	14.0	
15-Nov-18	N1F Extra x2	0	0	0	375	35	1,988	47.798291	-120.71536	3.5	3.5	
	N1 Total	0	0	0			29,589					
4 Sept - 15 Nov Totals		**8**	**0**	**0**			**88,982**					

Table 2. Electrofishing duration by location and bull trout encounters in the Chiwawa River in 2018.

Date	Reach Long Name	Bull Trout			Shocker Settings			Release GPS Waypoints		Temps		Additional Notes
		Caught	Tagged	Morts	Volts	Amps	Shocker Seconds	Latitude	Longitude	Tagging	Release	
4-Oct-18	Phelps	19	0	0	350	40	2,300	48.067092	-120.84919	6	6	also did the beaver pond side channel
15-Oct-18	Alpine Meadows Down	27	0	0	375	35	3,638	48.046563	-120.83538	8	8	also did the side channel that spans most of the section as well
16-Oct-18	Alpine Meadows Up	37	0	0	375	35	4,426	48.049407	-120.83864	8	8	
17-Oct-18	Between Alpine and Phelps	26	0	0	375	35	2,849	48.060117	-120.84201	5	5	
	Chiwawa 10 - Alpine Meadows	109	0	0			13,213					
8-Oct-18	19 Mile Up	20	0	0	400	35	3,674	48.023818	-120.82891	7	7	
8-Oct-18	19 Mile Down	59	0	0	375	40	4,307	48.015745	-120.82995	7	7	
18-Oct-18	Between Atkinson and 19 Mile	19	0	0	375	35	3,871	48.009162	-120.82374	5.5	5.5	Decent side channel that we did not shock but is probably good
	Chiwawa 9 - 19Mile CG	98	0	0			11,852					
1-Oct-18	Atkinson Up	40	0	0	375	30	4,279	48.00005	-120.81833	9	9	
2-Oct-18	Atkinson Down	18	0	0	375	25	3,264	47.997564	-120.8175	8	8	Not a lot of good shockable stuff in this section
3-Oct-18	Riverbend Up	21	0	0	375	40	4,932	47.959263	-120.79249	7	7	Flows at 130, anything higher would be tough in some of the areas
4-Oct-18	Riverbend Down	21	0	0	375	40	4,047	47.960271	-120.78349	7	7	
10-Oct-18	Schaefer Cr CG Down	14	0	0	375	35	3,190	47.97471	-120.80421	8	8	
10-Oct-18	Rock Creek Up	17	0	0	375	35	4,448	47.967817	-120.80085	8	8	Split fish on computer into part A and B. This Row is total (combined)
16-Oct-18	Above Schaefer CR CG UP	9	0	0	375	35	2,539	47.976044	-120.80763	6.5	6.5	
6-Nov-18	Atkinson Up Recap Run	37	0	0	375	35	3,869	47.998491	-120.81673	5.5	5.5	Re shocking the area in hopes of recaps

Date	Reach Long Name	Bull Trout			Shocker Settings			Release GPS Waypoints		Temps		Additional Notes
		Caught	Tagged	Morts	Volts	Amps	Shocker Seconds	Latitude	Longitude	Tagging	Release	
7-Nov-18	Rock Creek Up Recap Run	7	0	0	375	30	3,147	47.967817	-120.80085	3	3	Re shocking the area in hopes of recaps
	Chiwawa 8 - RiverbendAtkinson	184	0	0			33,715					
9-Oct-18	Log Jam Down	9	0	0	375	35	5,179	47.934136	-120.75359	8	8	
9-Oct-18	Log Jam Up	10	0	0	375	35	5,233	47.937795	-120.75815	8	8	
11-Oct-18	Finner Creek	8	0	0	375	35	3,641	47.948835	-120.7719	7	7	
11-Oct-18	Below Finner Creek	8	0	0	375	35	3,433	47.947719	-120.76816	7	7	
22-Oct-18	Huckleberry Ford CG Down	0	0	0	375	40	4,200	47.896501	-120.71087	5.5	5.5	
22-Oct-18	Huckleberry Ford CG Up	2	0	0	375	35	6,455	47.898961	-120.72098	6.5	6.5	Some of the best habitat for flows at ~100 CFS, lots of slow mossy boulders
5-Nov-18	Log Jam Up Recap Run	7	0	0	375	35	2,888	47.936245	-120.7554	5	5	Shocking for analog Recaps, flows ~350 CFS and tough to shock
8-Nov-18	Below Finner Creek Recap Run	4	0	0	375	30	2,598	47.94789	-120.7685	3	3	Re shocking the area in hopes of recaps
	Chiwawa 7 - Upstream Grouse	48	0	0			33,627					
23-Oct-18	Grouse Downstream	0	0	0	375	35	5,280	47.893586	-120.69732	5	5	
	Chiwawa 6 - Grouse Hike in	0	0	0			5,280					
25-Oct-18	Meadow Creek	2	0	0	375	30	3,528	47.867359	-120.69264	6	6	Also shocked Meadow Creek, about 60 of the SBC were in Meadow Creek
	Chiwawa 5 - Meadow CG	2	0	0			3,528					
24-Oct-18	Old Road Up	0	0	0	375	35	4,634	47.854352	-120.68392	5.5	5.5	

Date	Reach Long Name	Bull Trout			Shocker Settings			Release GPS Waypoints		Temps		Additional Notes
		Caught	Tagged	Morts	Volts	Amps	Shocker Seconds	Latitude	Longitude	Tagging	Release	
	Chiwawa 4	0	0	0			4,634					
2-Oct-18	Hatchery Release Bridge	0	0	0	375	30	2,244	47.841792	-120.66564	10	10	
	Chiwawa 3 - 2nd bridge	0	0	0			2,244					
13-Nov-18	C2 Forest Road	1	0	0	375	35	3,757	47.821853	-120.63938	1	1	
	Chiwawa 2	1	0	0			3,757					
29-Oct-18	Release Bridge Down	0	0	0	375	35	1,440	47.796656	-120.63708	6	6	
30-Oct-18	FS Road 6121	0	0	0	375	35	2,721	47.810079	-120.64728	5.5	5.5	
	Chiwawa 1 - Town	0	0	0			4,161					
Chiwawa Total Oct1 - Nov15 (23Days)		**442**	**0**	**0**			**116,011**					

Appendix J

Wenatchee Sockeye Salmon Spawning Escapement, 2018

PUBLIC UTILITY DISTRICT NUMBER 1 OF CHELAN COUNTY
Natural Resource Division
Fish and Wildlife Department
327 N. Wenatchee Ave., Wenatchee WA 98801 (509) 663-8121

March 30, 2019

To: HCP Hatchery Committee

From: Catherine Willard and Scott Hopkins

Subject: 2018 Wenatchee Sockeye Mark/Recapture-Based Sockeye Escapement Estimates to Tributaries

Introduction

In 2018, the Chelan County Public Utility District (District) estimated sockeye escapement to tributaries based on mark-recapture methodology. The purpose of this document is to report the spawning escapement estimates for the Little Wenatchee and White River subbasins. This information is used to track and/or estimate viable salmonid population parameters (VSP): abundance, productivity, spatial structure, and diversity (McElhaney et al. 2000).

Methods

Mark-Recapture Method:

Detection efficiencies of the in-stream arrays were calculated for the Little Wenatchee River and White River in 2018. The in-stream arrays include a series of upstream and downstream coils (Figure 1). Combined, these coils represented the upstream and downstream detection arrays, respectively. Overall detection efficiency P_{all} of the arrays was calculated based on observed detection probabilities of individual arrays:

$$P_{all} = 1 - (1 - P_{array\ 1})(1 - P_{array\ 2})$$

where the probability of missing a fish on both the upstream P_{array1} and downstream P_{array2} arrays were combined for an overall efficiency P_{all} (Connolly et al. 2008).

Adult sockeye salmon were tagged at adult fishways within the Columbia River and at Tumwater Dam. Additionally, adult returns that were PIT tagged as juveniles were used in the analyses. Total passage of adult sockeye salmon through Tumwater Dam was obtained from Columbia River Data Access in Real Time (DART 2018). Resulting tag files were queried in PTAGIS (2018), providing detection histories for each study fish.

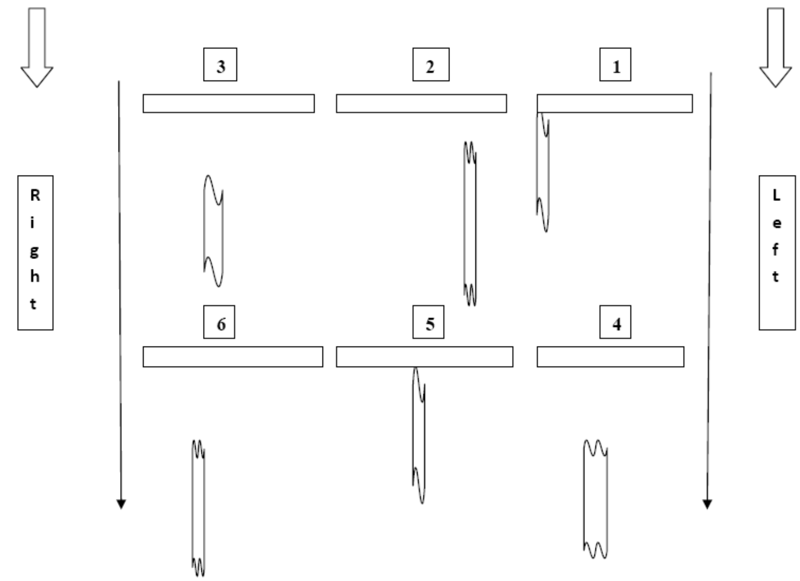

Figure 1. Schematic of a PIT array configuration.

Resulting data from passage at Tumwater Dam, mark and recapture using PIT tags, and detection efficiency estimates can provide estimation of escapement to spawning tributaries. Assumptions include: (1) the study population is “closed,” i.e., no individuals die or emigrate between the initial mark and subsequent recaptures; (2) tags are not lost and detections are correctly identified; (3) all individuals have the same probability of being detected, and (4) the number of recapture events are proportional to the total population. Lastly, it was assumed that PIT-tagging efforts at Tumwater have negligible influence on fish behavior and tagged individuals behave similarly to untagged individuals. The resulting escapement rate, adjusted for detection efficiency, was then applied to the total population as such:

$$Escapement = \left(\frac{\left(\frac{Obs_{LWN}}{Eff_{LWN}} + \frac{Obs_{WTL}}{Eff_{WTL}} \right)}{PITs_{TUM}} \right) \times Counts_{TUM}$$

where the PIT tag detections (*Obs*) at the Little Wenatchee (*LWN*) and White River (WTL) were adjusted for detection efficiency (*Eff*), compared to the number released (*PITs*) at Tumwater Dam (*TUM*), and the resulting proportion was applied to the population observed (*Counts*) passing Tumwater Dam.

Results

Sockeye Salmon Mark-Recapture Method

Fishway enumeration at Tumwater Dam indicated that 13,975 adult sockeye salmon passed the facility during the 2018 migration, which was an insufficient return to open a recreational fishery in Lake Wenatchee for 2018. PIT tags were implanted in 424 fish at Tumwater and 125 fish were PIT-tagged before passing Tumwater; 38 fish were subsequently detected at the Little Wenatchee PIT tag array and 405 fish were subsequently detected at the White River PIT tag array (Table 1). Based on the recapture of PIT-tagged adult sockeye and assigned detection efficiency, total estimated escapement from Tumwater Dam to the Little Wenatchee River was 974 adult sockeye and 10,411 adult sockeye to the White River (Table 2).

Table 1. Number of adult sockeye salmon PIT-tagged, released, and detected upstream of Tumwater Dam in 2009 through 2018, and mark/recapture based tributary escapement estimates. Obs. = observed, D.E. = detection efficiency, Est = estimated (Obs./D.E.), and NA = not available.

Year	Number of PIT-tagged adults detected or tagged at Tumwater[1]	White River			Little Wenatchee River			Chiwawa River Obs.	Nason Creek Obs.
		Obs.	*D.E. (p_{all})*	*Est*	Obs.	*D.E. (p_{all})*	*Est*		
2009	1,085	381	0.406	*939*	38	0.971	*39*	37	7
2010	1,164	571	0.900[2]	*635*	67	1.000	*67*	3	1
2011	484	40	NA[3]	*NA*	84	--	*0*	0	0
2012	1,154	410	0.943	*435*	74	0.987	*75*	0	0
2013	719	152	NA[3]	*NA*	55	0.818	*67*	0	0
2014	1,729	848	0.999	*848*	76	1.000	*76*	0	3
2015[4]	950	371	0.999	*371*	50	1.000	*50*	69	4
2016	1,420	743	0.994	*748*	130	1.000	*130*	2	1
2017	778	600	0.998	*601*	68	1.000	*68*	8	0
2018[5]	549	405	0.990	*409*	35	0.915	*38*	3	0

[1] Also includes fish detected downstream of release point (fallbacks).
[2] Detection efficiency p_{all} = 0.406 in 2009 was assigned from 2010 data.
[3] Technical difficulties with the White River PIT array prevented the calculation of detection efficiency and a mark-recapture based escapement estimate.
[4] In 2015, 45 sockeye salmon were detected in Chiwaukum Creek.
[5] In 2018, 2 sockeye salmon were detected in Chiwaukum Creek.

Table 2. Estimated escapement of adult sockeye salmon to Little Wenatchee and White rivers based on mark-recapture events, in-stream detection efficiency, and adult enumeration at Tumwater Dam, 2009-2017.

Year	Tumwater count	Recreational harvest	Little Wenatchee	White River	Combined	Escapement
2009	16,034	2,285	576	13,876	14,452	0.901
2010	35,821	4,129	2,062	19,542	21,604	0.603
2011[1]	18,634	0	2,431	14,582	17,013	0.913
2012	66,520	12,107	4,607	23,866	28,473	0.428
2013[1]	29,015	6,262	2,426	14,294	16,720	0.576
2014	99,898	16,281	4,319	49,021	53,340	0.534
2015	51,435	7,916	2,707	20,097	22,804	0.443
2016	73,697	14,630	6,747	38,802	45,549	0.618
2017	23,854	0	2,085	18,436	20,521	0.860
2018	13,975	0	974	10,411	11,384	0.815
Average	**42,888**	**6,361**	**2,893**	**22,293**	**25,186**	**0.669**

[1] Escapement was calculated using AUC counts for the Little Wenatchee River and a linear regression relationship to the Little Wenatchee River for the White River.

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Appendix K

Genetic Diversity of Wenatchee Sockeye Salmon

Assessing the Genetic Diversity of Lake Wenatchee Sockeye Salmon And Evaluating The Effectiveness Of Its Supportive Hatchery Supplementation Program

Developed for

Chelan County PUD

and the

Habitat Conservation Plan's Hatchery Committee

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Executive Summary

Nine spawning populations of sockeye (*Oncorhynchus nerka*) salmon have been identified in Washington, including stocks in the Lake Wenatchee basin (SaSI 5800) (Washington Department of Fisheries et al. 1993). Lake Wenatchee sockeye are classified as an Evolutionary Significant Unit (ESU), and consists of sockeye salmon that spawn primarily in tributaries above Lake Wenatchee (the White River, Napeequa River, and Little Wenatchee Rivers). Since 1990, the Wenatchee Sockeye Program has released juveniles into Lake Wenatchee to supplement natural production of sockeye salmon in the basin. The program's broodstock are predominantly natural-origin sockeye adults returning to the Wenatchee River captured at Tumwater Dam (Rkm 52.0), where a net-pen system is used to house both maturing adults and juveniles prior to release into Lake Wenatchee to over-winter.

Previous genetic studies have generally found a lack of concordance between population genetic relationships and their geographic distributions. These studies indicate that the nearest geographic neighbors of sockeye salmon populations are not necessarily the most genetically similar. Specifically for the Columbia River Basin, sockeye from Lake Wenatchee, Okanogan River, and Redfish Lake may be more closely related to a population from outside the Columbia River (depending on marker used) then to each other.

In this study we investigated the temporal and spatial genetic structure of Lake Wenatchee sockeye collections, without regard to sockeye populations outside of the Lake Wenatchee area. Our primary objective here was to determine if the Wenatchee Sockeye Program affected the natural Lake Wenatchee sockeye population. More specifically, we were tasked to determine if the genetic composition of Lake Wenatchee sockeye population had been altered by a supplementation program that was based on the artificial propagation of a small subset of that population. Using microsatellite DNA allele frequencies, we investigated population differentiation between temporally replicated collections of natural-origin Lake Wenatchee sockeye and program broodstock. We analyzed thirteen collections of Lake Wenatchee sockeye (Table 1), eight temporally replicated collections of natural-origin Lake Wenatchee sockeye (N=786) and five temporally replicated collections of Wenatchee Sockeye Program broodstock (N=248). Paired natural – broodstock collections were available from years 2000, 2001, 2004, 2006, and 2007.

Conclusions

We observed that allele frequency distributions were consistent over time, irrespective of collection origin, resulting in small and statistically insignificant measures of genetic differentiation among collections. We interpreted these results to indicate no year-to-year differences in allele frequencies among natural-origin or broodstock collections. Furthermore, there were no observed difference between pre- and post-supplementation collections. Therefore, we accepted our null hypothesis that the allele frequencies of the broodstock collections equaled the allele frequencies of the natural collections, which equaled the allele frequency of the donor population. Given the small differences in genetic composition among collections, the genetic model for estimating N_e produced estimates with extremely large variances, preventing the observation of any trend in N_e.

Introduction

A report titled "Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs" was prepared July 2005 by Andrew Murdoch and Chuck Peven for the Chelan PUD Habitat Conservation Plan's Hatchery Committee. This report outlined 10 objectives to be applied to various species assessing the impact (positive or negative) of hatchery operations mitigating the operation of Rock Island Dam. This current study pertains only to Lake Wenatchee sockeye and objective 3:

> *Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.*

In order to evaluate cause and effect of hatchery supplementation, WDFW Molecular Genetics Lab surveyed genetic variation of Lake Wenatchee sockeye. The conceptual approach for this project follows that of a parallel study regarding the Wenatchee River spring Chinook supplementation program (Blankenship et al. 2007). We determined the genetic diversity present in the Lake Wenatchee sockeye population by analyzing temporally replicated collections spanning 1989 – 2007, which included collections from before and following the inception of the Wenatchee Sockeye Program. Documenting the genetic composition of the Lake Wenatchee sockeye population is necessary to assess the effect of the hatchery program on the Lake Wenatchee population. In addition, this work provides a genetic baseline for future projects requiring genetic data. See study objectives below for specific details about how this project addresses Murdoch and Peven (2005) objective 3.

Lake Wenatchee Sockeye Salmon

Nine spawning populations of sockeye (*Oncorhynchus nerka*) salmon have been identified in Washington (Washington Department of Fisheries et al. 1993): 1) Baker

River, 2) Ozette Lake, 3) Lake Pleasant, 4) Quinault Lake, and 5) Okanogan River (classified as native stock); 6) Cedar River (classified as non-native stock); 7) Lake Wenatchee, classified as mixed stock); 8) Lake Washington/Lake Sammamish tributaries; and 9) Lake Washington beach spawners (classified as unknown origin). Chapman et al. (1995) listed four additional spawning aggregations of sockeye salmon that appear consistently in Columbia River tributaries: the Methow, Entiat, and Similkameen Rivers; and Icicle Creek in the Wenatchee River drainage.

Located in north central Washington, the Wenatchee River basin drains a portion of the eastern slope of the Cascade Mountains, including high mountainous regions of the Cascade crest. The headwater area of the Wenatchee River is Lake Wenatchee, a typical low productivity oligotrophic or ultra-oligotrophic sockeye salmon nursery lake (Allen and Meekin 1980, Mullan 1986, Chapman et al. 1995). Sockeye salmon bound for Lake Wenatchee enter the Columbia River in April and May and arrive at Lake Wenatchee in late July to early August (Chapman et al. 1995; Washington Department of Fisheries et al. 1993). The run timing of Lake Wenatchee sockeye salmon, classified as an Evolutionary Significant Unit (ESU), appears to have become earlier by 6 - 30 days during the past 70 years (Chapman et al. 1995; Quinn and Adams 1996). Additionally, scale pattern analysis suggests Wenatchee sockeye migrate past Bonneville Dam earlier than the sockeye bound for the Okanogan River (Fryer and Schwartzberg 1994). The Wenatchee population spawns from mid-September through October in the Little Wenatchee, White, and Napeequa Rivers above Lake Wenatchee (Washington Department of Fisheries et al. 1993), peaking in late September (Chapman et al. 1995). Limited beach spawning is believed to occur in Lake Wenatchee (L. Lavoy pers. com.; Mullan 1986), although Gangmark and Fulton (1952) reported two lakeshore seepage areas in Lake Wenatchee that were used by spawning sockeye salmon. Sockeye salmon fry enter Lake Wenatchee between March and May (Dawson et al. 1973), and typically rear in the lake for one year before leaving as smolts (Gustafson et al. 1997; Peven 1987).

Both the physical properties of the habitat and ecological/biological factors of the sockeye populations differ between the Lake Wenatchee ESU and the geographically proximate Okanogan ESU. For example: 1) Different limnology is encountered by sockeye salmon in Lakes Wenatchee and Osoyoos; 2) Lake Wenatchee sockeye predominantly return at ages four and five (a near absence of 3-year-olds), where a large percentage of 3-year-olds return to the Okanogan population; and 3) the apparent one month separation in juvenile outmigration-timing between Okanogan- and Wenatchee-origin fish (Gustafson et al. 1997 and references therein).

Sockeye Artificial Propagation In Lake Wenatchee

The construction of Grand Coulee Dam completely blocked fish passage to the upper Columbia River, and 85% of sockeye salmon passing Rock Island Dam between 1935 and 1936 were estimated to be from natural stocks bound for areas up-river to Grand Coulee Dam (Mullan 1986; Washington Department of Fisheries et al. 1938). To compensate for loss of habitat resulting from Grand Coulee Dam, the federal government initiated the Grand Coulee Fish-Maintenance Project (GCFMP) in 1939 to maintain fish runs in the Columbia River above Rock Island Dam. Between 1939 and 1943, all sockeye salmon entering the mid-Columbia River were trapped at Rock Island Dam, and over 32,000 mixed Lake Wenatchee, Okanogan River, and Arrow Lake adult sockeye salmon were released into Lake Wenatchee (Gustafson et al. 1997 Appendix Table D-2). In addition to adult relocation, between 1941 and 1969 over 52.8 million fry descended from original spawners collected at Rock Island and Bonneville Dams, were released into Lake Wenatchee (Gustafson et al. 1997 Appendix Table D-2).

No releases of artificially-reared sockeye salmon occurred in the Wenatchee watershed during the years 1970 to 1989 (Gustafson et al. 1997 Appendix Table D-2). Since 1990, the Wenatchee Sockeye Program has released juveniles into Lake Wenatchee to supplement natural production of sockeye salmon in the basin. Sockeye adults returning to the Wenatchee River are captured at Tumwater Dam (Rkm 52.0) and transferred to Lake Wenatchee net pens until mature. The Wenatchee Sockeye Program goals are 260 adults with an equal sex ratio, <10% hatchery-origin returns (identified by coded wire tags), and the adults removed for broodstock account for <10% of the run size. Fish are spawned at Lake Wenatchee and their gametes are taken to Rock Island Fish Hatchery

Complex (i.e., Eastbank) for fertilization and incubation. Fry are returned to the Lake Wenatchee net -pens after they are large enough to be coded wire tagged, and are housed in the pens until fall (one year after spawning), when they are liberated into the lake to over-winter. For brood years 1991 – 2004 an average of 218,683 (std. dev. = 71,090) pen-reared Lake Wenatchee-origin juvenile sockeye salmon have been released yearly into Lake Wenatchee.

Previous Genetic Studies

Protein (allozyme) variation – Surveying genetic variation at 12 allozyme loci, Utter et al. (1984) reported moderate population structure among 16 sockeye collections from southeast Alaska through the Columbia River Basin, including Okanogan and Wenatchee stocks, with an apparent genetic association between upper Fraser River and Columbia River sockeye salmon. Winans et al. (1996) surveyed variation at 55 allozyme loci for 25 sockeye salmon and two kokanee collections from 21 sites in Washington, Idaho, and British Columbia, and reported the lowest level of allozyme variability of any species of Pacific salmon and a highest level of inter-population differentiation. Furthermore, these authors reported that there was no clear relationship between geographic and genetic differentiation among the populations within there study. Other studies corroborate the results of Winans et al. (1996), finding a lack of discernible geographic patterning for sockeye salmon populations in British Columbia, Alaska, and Kamchatka (Varnavskaya et al. 1994, Wood et al. 1994, Wood 1995). These studies indicate that the nearest geographic neighbors of sockeye salmon populations are not necessarily the most genetically similar, which contrasts with the other Pacific salmon species that exhibit concordance between geographic and genetic differentiation (Utter et al. 1989, Winans et al. 1994, Shaklee et al. 1991). As part of the comprehensive status review of west coast sockeye salmon (Gustafson et al. 1997), NMFS biologists collected new allozyme genetic information for 17 sockeye salmon populations and one kokanee population in Washington and combined these data for analysis with the existing Pacific Northwest sockeye salmon and kokanee data from Winans et al. (1996). Results of the updated study were consistent with Winans et al. (1996), with no clear concordance between geographic and genetic distances. Sockeye salmon from Lake Wenatchee, Redfish Lake, Ozette Lake, and Lake Pleasant are very distinct from other collections in the study, and Columbia River populations were not necessarily most closely related to each other. Gustafson et al. (1997) also examined between-year variability within a collection location and found low levels of statistical significance among the five Lake Wenatchee collections included in the study (For 10 pair-wise comparisons using sum-G test, five were statistically significant). Lake Wenatchee brood year 1987 accounted for three of the significant comparisons, which were driven by unusually high frequencies of two allozyme alleles (ALAT*95 and ALAT*108) (Winans et al. 1996). Nevertheless, Gustafson et al. (1997) conclude that, in general, temporal variation at a locale was considerably less than between-locale variation.

Nucleic acid variation - Beacham et al. (1995) reported levels of variation in nuclear DNA of *O. nerka* using minisatellite probes. They analyzed 10 collections, including a sample from Lake Wenatchee. Cluster analysis showed the Lake Wenatchee sample was different from all the other collections, including those from the Columbia River. Using a similar molecular technique, Thorgaard et al. (1995) examined the use of multi-locus DNA fingerprinting (i.e., banding patterns) to discriminate among 14 sockeye salmon and kokanee populations. Dendrograms based on analysis of banding patterns produced different genetic affinity groups depending on the probes used. While none of the five DNA probes showed a close relationship between Lake Wenatchee and Okanogan River sockeye salmon, if information from all probes were combined, *O. nerka* from Redfish Lake, Wenatchee, and Okanogan were separate from kokanee of Oregon and Idaho and a sockeye salmon sample from the mid-Fraser River.

Study Objective

We documented temporal variation in genetic diversity (i.e., heterozygosity and allelic diversity), and investigated population differentiation between temporally replicated collections of natural-origin Lake Wenatchee sockeye and program broodstock, using microsatellite DNA allele frequencies. Temporally replicated collections from the same location can also be used to estimate effective population size (N_e). If populations are "ideal", the census size of a population is equal to the "genetic size" of the population.

Yet, numerous factors lower the "genetic size" below census, such as, non-equal sex ratios, changes in population size, and variance in the numbers of offspring produced from parent pairs. N_e is thought to be between 0.10 and 0.33 of the estimated census size (Bartley et al. 1992; RS Waples pers. comm.), although numerous observations differ from this general rule. N_e can be calculated directly from demographic data, or inferred from observed differences in genetic variance over time. Essentially, when calculated from genetic data, N_e is the estimated size of an "ideal" population that accounts for the genetic diversity changes observed, irrespective of abundance.

We will address the hypotheses associated with Objective 3 in Murdock and Peven (2005) using the following four specific tasks:

Task 1 - Document the observed genetic diversity.

Task 2 - Test for population differentiation among Lake Wenatchee collections and the associated supplementation program.

Task 2 was designed to address two hypotheses listed as part of Objective 3 in Murdoch and Peven (2005):

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop}}$.
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Murdoch and Peven (2005) proposed these two hypotheses to help evaluate supplementation programs through a "Conceptual Process" (Figure 5 in Murdoch and Peven 2005). There are two components to the first hypothesis, which must be considered separately for Lake Wenatchee sockeye. The first component involves comparisons between natural-origin populations from Lake Wenatchee to determine if there have been changes in allele frequencies through time starting with the donor population. Documenting a change does not necessarily indicate that the supplementation program has directly affected the natural-origin fish, as additional tests would be necessary to support that hypothesis. The intent of the second component is to determine if the hatchery produced populations have the same genetic composition as the naturally produced populations.

Task 3 - Calculate N_e using the temporal method for multiple samples from the same location to document trend.

Task 4 - Compare N_e estimates with trend in census size for Lake Wenatchee sockeye.

Methods and Materials

Sampling

Thirteen collections of Lake Wenatchee sockeye were analyzed, eight temporally replicated collections of natural Lake Wenatchee sockeye (N=786) and five temporally replicated collections of Wenatchee Sockeye Program broodstock (N=248) (Table 1). Paired natural – broodstock collections were available from years 2000, 2001, 2004, 2006, and 2007 (Table 1). All collections were made at Tumwater Dam on the Wenatchee River. Note that collections classified as broodstock were predominantly natural-origin sockeye. A majority of the genetic samples were from dried scales. The tissue collections from 2006 and 2007 were fin clips stored immediately in ethanol after collection. DNA was extracted from stored tissue using Nucleospin 96 Tissue following the manufacturer's standard protocol (Macherey-Nagel, Easton, PA, U.S.A.).

Laboratory Analysis

Polymerase chain reaction (PCR) amplification was performed using 17 fluorescently end-labeled microsatellite marker loci, *One* 2 (Scribner et al 1996) *One* 100, 101, 102, 105, 108, 110, 114, and 115 (Olsen et al. 2000), *Omm* 1130, 1135, 1139, 1142, 1070, and 1085 (Rexroad et al. 2001), *Ots* 3M (Banks et al. 1999) and *Ots* 103 (Small et al. 1998). PCR reaction volumes were 10 µL, with the reaction variables being 2 µL 5x PCR buffer (Promega), 0.6 µL $MgCl_2$ (1.5 mM) (Promega), 0.2 µL 10 mM dNTP mix (Promega), and 0.1 µL *Go Taq* DNA polymerase (Promega). Loci were amplified as part of multiplexed sets, so primer molarities and annealing temperatures varied. Multiplex one had an annealing temperature of 55°C, and used 0.09 Molar (M) *One* 108, 0.06 M *One* 110, and 0.11 M *One* 100. Multiplex two had an annealing temperature of 53°C, and used 0.08 M *One* 102, 0.1 M *One* 114, and 0.05 M *One* 115. Multiplex three had an annealing temperature of 55°C, and used 0.08 M *One* 105 and 0.07 M *Ots* 103. Multiplex four had an annealing temperature of 53°C, and used 0.09 M *Omm* 1135 and 0.08 M *Omm* 1139. Multiplex five had an annealing temperature of 60°C, and used 0.2 M *Omm* 1085, 0.09 M *Omm* 1070, and 0.05 M *Ots* 3M. Multiplex six had an annealing temperature of 48°C, and used 0.06 M *One* 2, 0.08 M *Omm* 1142, and 0.08 M *Omm* 1130. *One* 101 was run in isolation with a primer molarity of 0.06. Thermal cycling was conducted on either PTC200 (MJ Research) or GeneAmp 9700 thermal cyclers as follows: 94°C (2 min); 30 cycles of 94°C for 15 sec., 30 sec. annealing, and 72°C for 1 min.; a final 72°C extension and then a 10°C hold. PCR products were visualized by denaturing polyacrylamide gel electrophoresis on an ABI 3730 automated capillary analyzer (Applied Biosystems). Fragment analysis was completed using GeneMapper 3.7 (Applied Biosystems).

Genetic data analysis

Assessing within collection genetic diversity - Heterozygosity measurements were reported using Nei's (1987) unbiased gene diversity formula (i.e., expected heterozygosity) and Hedrick's (1983) formula for observed heterozygosity. Both tests were implemented using the microsatellite toolkit (Park 2001). For each locus and collection FSTAT version 2.9.3.2 (Goudet 1995) was used to assess Hardy-Weinberg equilibrium, where deviations from the neutral expectation of random associations among alleles were calculated using a randomization procedure. Alleles were randomized among individuals within collections (4160 randomizations for this dataset) and the F_{IS} (Weir and Cockerham 1984) calculated for the randomized datasets were compared to the observed F_{IS} to obtain an unbiased estimation of the probability that the null hypothesis was true. The 5% nominal level of statistical significance was adjusted for multiple tests (Rice 1989). Genotypic linkage disequilibrium was calculated following Weir (1979) using GENETIX version 4.05 (Belkhir et al. 1996). Statistical significance of linkage disequilibrium results was assessed using a permutation procedure implemented in GENETIX for each locus by locus combination within each collection.

Assessing among collection genetic differentiation - The temporal stability of allele frequencies was assessed by the randomization chi-square test implemented in FSTAT version 2.9.3.2 (Goudet 1995). Multi-locus genotypes were randomized between collections. The G-statistic for observed data was compared to G-statistic distributions from randomized datasets (i.e., null distribution of no differentiation between collections). Population differentiation was also investigated using pairwise estimates of F_{ST}. Multi-locus estimates of pairwise F_{ST}, estimated by a "weighted" analysis of variance (Weir and Cockerham, 1984), were calculated using GENETIX version 4.05 (Belkhir et al.1996). F_{ST} was used to quantify population structure, the deviation from statistical expectations (i.e., excess homozygosity) due to non-random mating between populations. To determine if the observed F_{ST} estimate was consistent with statistically expectations of no population structure, a permutation test was implemented in GENETIX (1000 permutations).

Effective population size (N_e) – Estimates of the effective population size were obtained using a multi-collection temporal method (Waples 1990a). The temporal method assumes that cohorts are used, but we did not decompose the collection year samples into their respective cohorts using age data. Therefore, N_e estimates that pertain to individual year classes of breeders are not valid; however the harmonic mean over all samples will estimate an N_e that pertains to the time period from which the collections are derived. Comparing samples from years *i* and *j*, Waples' (1990a) temporal method estimates the effective number of breeders ($\hat{N}_{b(i,j)}$) according to:

$$\hat{N}_{b(i,j)} = \frac{b}{2(\hat{F} - 1/\tilde{S}_{i,j})}$$

The standardized variance in allele frequency ($\hat{F}$) is calculated according to Pollack (1983). The parameter b is calculated analytically from age structure information and the number of years between samples (Tajima 1992). The age-at-maturity information required to calculate b was obtained from ecological data (Hillman et al. 2007). The harmonic mean of sample sizes from years *i* and *j* is $\tilde{S}_{i,j}$. The harmonic mean over all pairwise estimates of $\hat{N}_{b(i,j)}$ is $\tilde{N}_b$. SALMONNb (Waples et al. 2007) was used to calculate $\tilde{N}_b$.

Results and Discussion

In this section we combine our presentation and interpretations of the genetic analyses. Additionally, this section is organized based on the task list presented in the study plan.

Task 1 - Document the observed genetic diversity.

Substantial genetic diversity was observed over all Lake Wenatchee sockeye collections analyzed (Table 1), with heterozygosity estimates over all loci having a mean of 0.79. Genetic diversity was consistent with expected Hardy-Weinberg random mating genotypic proportions for all collections. The F_{IS} observed for each collection was not statistically significant given the distribution of F_{IS} generated using a randomization procedure. Additionally, there were no statistically significant associations observed between alleles across loci (i.e., linkage equilibrium) (data not shown). We concluded from these results that the genetic data from each collection was consistent with statistical expectations for random association of alleles within and between loci. In other words, each collection represents samples from a single gene pool (i.e., populations), and the genetic diversity observed has no detectable technical artifacts or evidence of natural selection.

Task 2 - Test for differentiation among Lake Wenatchee collections and the associated supplementation program.

We explicitly tested the hypothesis of no significant differentiation within natural-origin or broodstock collections from Lake Wenatchee using a randomization chi-square test. The null hypothesis for these tests was that the allele frequencies from two different populations were drawn from the same underlying distribution. We show the results for the pairwise comparisons among eight temporally replicated natural-origin collections from Lake Wenatchee (28 pairwise tests), and report all tests were non-significant (Table 2A). Similarly, for five temporally replicated broodstock collections, 10 of 10 pairwise tests were non-significant (Table 2B). We also tested if natural-origin and broodstock collections were differentiated from each other over time, and report that 40 of 40 tests were non-significant (Table 2C). The nominal level of statistical significance ($\alpha = 0.05$) was adjusted for multiple comparisons using strict Bonferroni correction (Rice 1989). Yet, there are perhaps slight differences between paired natural-broodstock collections. Note that the p-values for comparisons regarding 2006 and 2007 paired collections are lower than for comparisons regarding 2000, 2001, and 2004. The small sample sizes for broodstock collections in 2006 and 2007 may not have been random samples from the Lake Wenatchee sockeye population.

Given the consistencies observed for allele frequency distributions over time, metrics of population structure were expected to be small. This was the case, as the estimated F_{ST} over all thirteen collections was 0.0003. This observed value fell within the distribution of F_{ST} values expected if there were no population structure present (permutation test p-value 0.12). Analysis of the paired natural-broodstock collections corroborated this result. Pairwise estimates of F_{ST} were 0.000 for years 2000, 2001, 2004, and 2007, and 0.002 for 2006. All five estimates were non-significant. Essentially, all 13 sockeye collections could be considered samples from the same population. Given these results, it is valid to combine all collections for statistical analysis. Therefore, we did not calculate genetic distances among any collections, as it is inappropriate to estimate distances that are effectively zero.

Conclusions

We interpret these data to indicate that there appears to be no significant year-to-year differences in allele frequencies among natural-origin or broodstock collections, nor are there observed differences between collections pre- and post-supplementation. As a result, we accept the null hypothesis that the allele frequencies of the broodstock collections equal the allele frequencies of the natural collections, which equals the allele frequency of the donor population. Furthermore, the observed genetic variance that can be attributed to among collection differences was negligible.

Task 3 - Calculate N_e using the temporal method for multiple samples from the same location to document trend.

The fundamental parameter for inferring N_e using genetic data is the standardized variance in allele frequency ($\hat{F}$) (Pollack 1983). Methods estimate N_e from observed changes in $\hat{F}$ over temporally replicated collections from the same location. Yet, as previously shown, there were no statistically significant differences detected in allele frequencies. The underlying model for estimating N_e produced estimates with extremely large variances, given small temporal differences in $\hat{F}$, which rendered any trend in N_e unobservable. Table 3 shows N_e estimates calculated using temporally replicated natural collections.

Task 4 - Compare N_e estimates with trend in census size for Lake Wenatchee sockeye.

See Task 3

Acknowledgements

We would like to thank Jeff Fryer (CRITFC) for providing critical collections of natural-origin sockeye from Lake Wenatchee. We would like to thank Norm Switzler for collection curation and Ken Warheit and Denise Hawkins for helpful comments regarding this project. This project was funded by Chelan County PUD and the Washington State General Fund.

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Table 1 Lake Wenatchee sockeye collections analyzed. MNA is the mean number of alleles per locus, Hz is unbiased heterozygosity, Obs Hz is observed heterozygosity, and HW is the p-value of the null hypothesis of random association of alleles (i.e., Hardy – Weinberg equilibrium). For reference, the nominal level of statistical significance at $\alpha = 0.05$ is 0.0002 after correction for multiple tests.

Year	Collection Code	Tissue Type	Source	N	MNA	Hz	Obs Hz	HW
1989	89[1]	Scales	Natural	96	14.35	0.792	0.791	0.424
1990	90[1]	Scales	Natural	96	13.19	0.793	0.779	0.131
2000	00AAE	Scales	Broodstock	96	12.31	0.787	0.776	0.213
2000	00[1]	Scales	Natural	96	11.76	0.801	0.826	0.868
2001	01AAS	Scales	Broodstock	53	9.47	0.788	0.793	0.392
2001	01[1]	Scales	Natural	96	14.35	0.786	0.794	0.456
2002	02[1]	Scales	Natural	96	14.53	0.794	0.777	0.780
2004	04[1]	Scales	Natural	96	14.65	0.798	0.803	0.704
2004	04AAV	Scales	Broodstock	43	14.35	0.796	0.795	0.051
2006	06CN	Tissue	Broodstock	38	14.59	0.793	0.785	0.688
2006	06CO	Tissue	Natural	96	14.53	0.806	0.803	0.408
2007	07EE	Tissue	Broodstock	18	14.00	0.790	0.790	0.221
2007	07EF	Tissue	Natural	96	14.35	0.789	0.800	0.347

[1] Samples taken from scale cards provided by Jeff Fryer (CRITFC)

Table 2 Allelic differentiation for Lake Wenatchee sockeye collections. A single analysis tested (pairwise) the allelic differentiation between all thirteen collections; however p-values for G-statistics are partitioned in the table by A) natural-origin, B) broodstock, and C) natural versus broodstock. Underlined values are for paired natural-broodstock collections from the same year. For reference, the nominal level of statistical significance at $\alpha = 0.05$ is 0.0006 after correction for multiple tests. No significant values were observed.

A) Natural-Origin Collections

	89	90	00	01	02	04	06CO	07EF
89		0.257	0.359	0.531	0.331	0.127	0.031	0.263
90			0.953	0.148	0.753	0.903	0.077	0.283
00				0.328	0.527	0.607	0.604	0.400
01					0.209	0.081	0.127	0.093
02						0.085	0.707	0.235
04							0.312	0.577
06CO								0.435
07EF								

B) Broodstock Collections

	00AAE	01AAS	04AAV	06CN	07EE
00AAE		0.189	0.090	0.008	0.058
01AAS			0.122	0.020	0.116
04AAV				0.008	0.031
06CN					0.326
07EE					

C) Natural vs. Broodstock

	89	90	00	01	02	04	06CO	07EF
00AAE	0.027	0.309	<u>0.572</u>	0.018	0.041	0.012	0.093	0.040
01AAS	0.115	0.471	0.160	<u>0.219</u>	0.519	0.049	0.654	0.133
04AAV	0.136	0.219	0.210	0.423	0.208	<u>0.328</u>	0.037	0.153
06CN	0.029	0.004	0.053	0.007	0.022	0.004	<u>0.019</u>	0.001
07EE	0.099	0.229	0.053	0.015	0.093	0.178	0.090	<u>0.037</u>

Table 3 Estimation of N_e for temporally replicated natural-original sockeye collections. Above the diagonal are pairwise estimates of N_e, where negative values mean sampling variance can account for genetic variance observed (i.e., genetic drift unnecessary). Below the diagonal are variances for pairwise estimates of N_e. Absent variance values (denoted by **-**) were too large for SalmonNb to display.

Collection	89	90	00	01	02	04	06CO	07EF
89		-3936.6	-1414	-2636.3	671.4	1871.1	1066.1	1951.2
90	2.59E+09		-1490.3	3649.1	-31144	-6808.4	817.6	93190.2
00	1.40E+09	4.45E+09		-592.2	-6842.2	-667.1	-1736.9	-1350.1
01	1.21E+09	1.47E+09	2.33E+09		977.1	6160.4	387.8	2531.5
02	1.91E+09	1.33E+09	1.16E+09	2.29E+09		1495.6	-848.5	3213.6
04	2.21E+09	3.62E+09	4.08E+09	1.27E+09	1.14E+09		896.6	2155.3
06CO	1.34E+09	1.39E+09	1.73E+09	**-**	4.51E+09	1.2E+09		3278.6
07EF	2.15E+09	1.51E+09	1.18E+09	1.68E+09	**-**	1.36E+09	2.65E+09	

Appendix L

Wenatchee Spring Chinook Redd Estimates, 2018

Spring Chinook Redd Estimates - 2018

Upper Wenatchee

Kevin See

January 09, 2019

Goals

Redd counts are an established method to provide an index of adult spawners (Gallagher et al. 2007). In the Wenatchee subbasins, spawning reaches are surveyed weekly during the spring Chinook spawning season (Jul 10, 2018 - Sep 29, 2018). The goals of this work are to:

- Estimate the true number of redds in each spawning reach with uncertainty.
- Summarize the number of redds at the tributary and population scale.

Methods

Data

Data were collected on the number of new redds during each survey (usually conducted about every week during the spawning season). Covariates such as surveyor experience, mean thalweg CV and redd density (observed redds / km) were also collected on the reach scale to make predictions of surveyor error.

Surveyor Error

From the results of a previous study on spring Chinook, similar to the one outlined in Murdoch et al. (2018) for steelhead, we had a model that predicted surveyor net error (ratio of identified redds to true redds) based on covariates such as the surveyor's total experience with spawning ground surveys, the mean thalweg CV and the observed redd density (redds/km). This model suggests that increasing experience and observed redd density lead to higher net error, while increasing the stream complexity (mean thalweg CV) leads to lower net error.

Because the net error model is a linear model, and therefore not constrained to be between 0 and 1 (less than 1 implies an underestimate of the number of redds, while net error greater than 1 implies an overestimate due to false identifications), we examined the values of the predictive covariates and compared them to the values used to fit the net error model. Several values were outside the range of the model dataset (See Figure 1). Surveyor experience was often much higher than the model dataset range, and observed redd densities were often lower. These lead to opposing effects in the net error model, so the predicted observer errors were in line with the observed error rate in the model dataset, so we proceeded with the analysis.

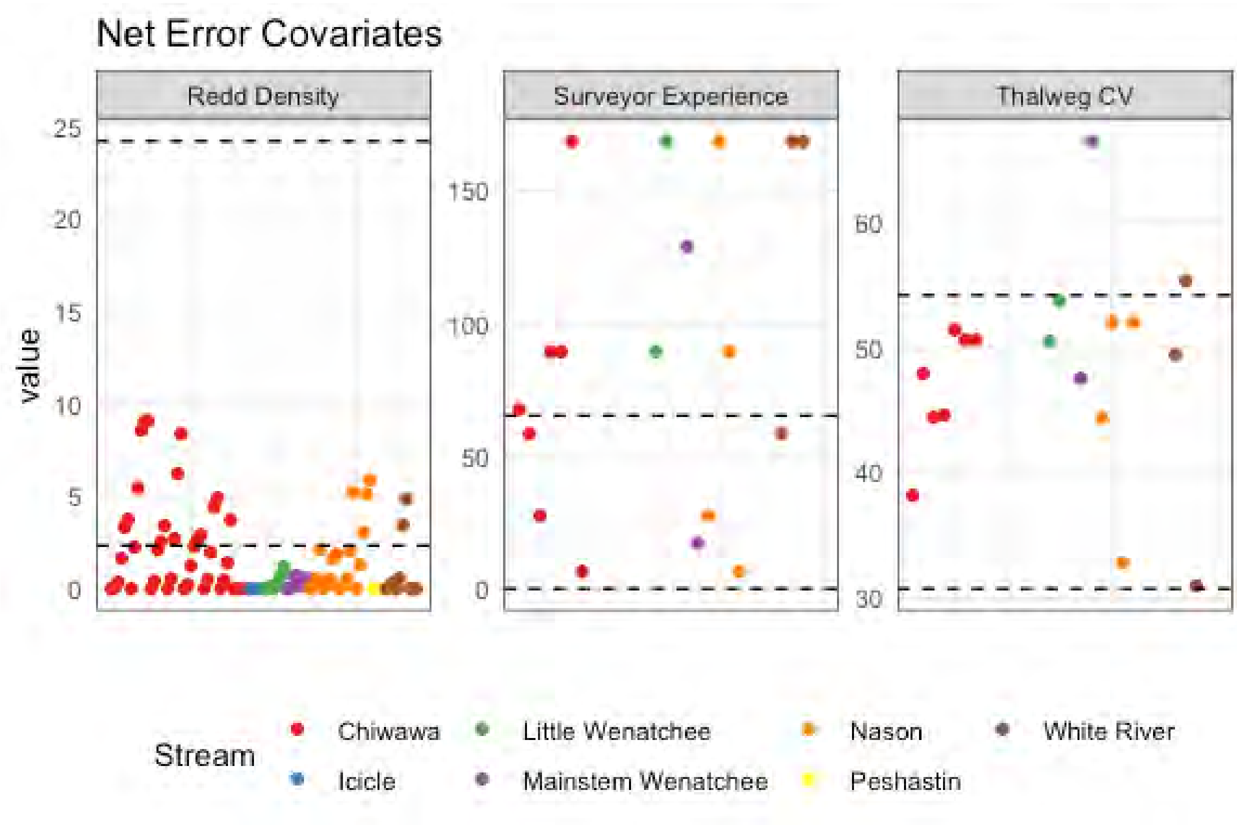

Figure 1: Values of the covariates for the net surveyor error model, colored by stream. Dashed lines depict the range of values from the data set used to develop the net error model.

Total Redds

Estimates of total redds were made for each reach using the Gaussian area under the curve (GAUC) model described in Millar et al. (2012). The GAUC model was developed with spawner counts in mind. As it is usually infeasible to mark every individual spawner, only total spawner counts can be used, and an estimate of average stream life must be utilized to translate total spawner days to total unique spawners. However, in adapting this for redd surveys, individual redds can be marked, and therefore we fit the GAUC model to new redds only. The equivalent of stream life thus becomes survey number with a standard error of zero. We fit these models to reach-scale data, which did pose several challenges for a few reaches. We did not make GAUC estimates for reaches that had fewer than 5 observed redds, or less than 3 weeks with at least one new redd observed.

When summing GAUC estimates at the reach-scale to obtain estimates at the stream scale, an attempt was made to incorporate the fact that the reaches within a stream are not independent. Estimates of correlation between the reaches within a stream were made based on weekly observed redds. This method may not be perfect, since spawners may use certain reaches preferentially at different times in the season, but it may be the best we can do. Because correlations are often quite high between reaches, this is a better alternative than to naively assume the standard errors between reaches are independent of one another. These estimates of correlation were combined with GAUC estimates of standard error for each reach to calculate a covariance matrix for the reaches within each stream, which was used when summing estimates of total redds to estimate the standard error at the stream-scale. Failure to incorporate the correlations between reaches would result in an underestimate of standard error at the stream scales. Different streams (and therefore reaches in different streams) were assumed to be independent.

Results

Surveyor Error

Predictions of net error are shown in Figure 2. Most predictions were less than one, implying some redds may have been missed. A few surveys had predictions of net error greater than one, implying some redds identified by surveyors were false redds.

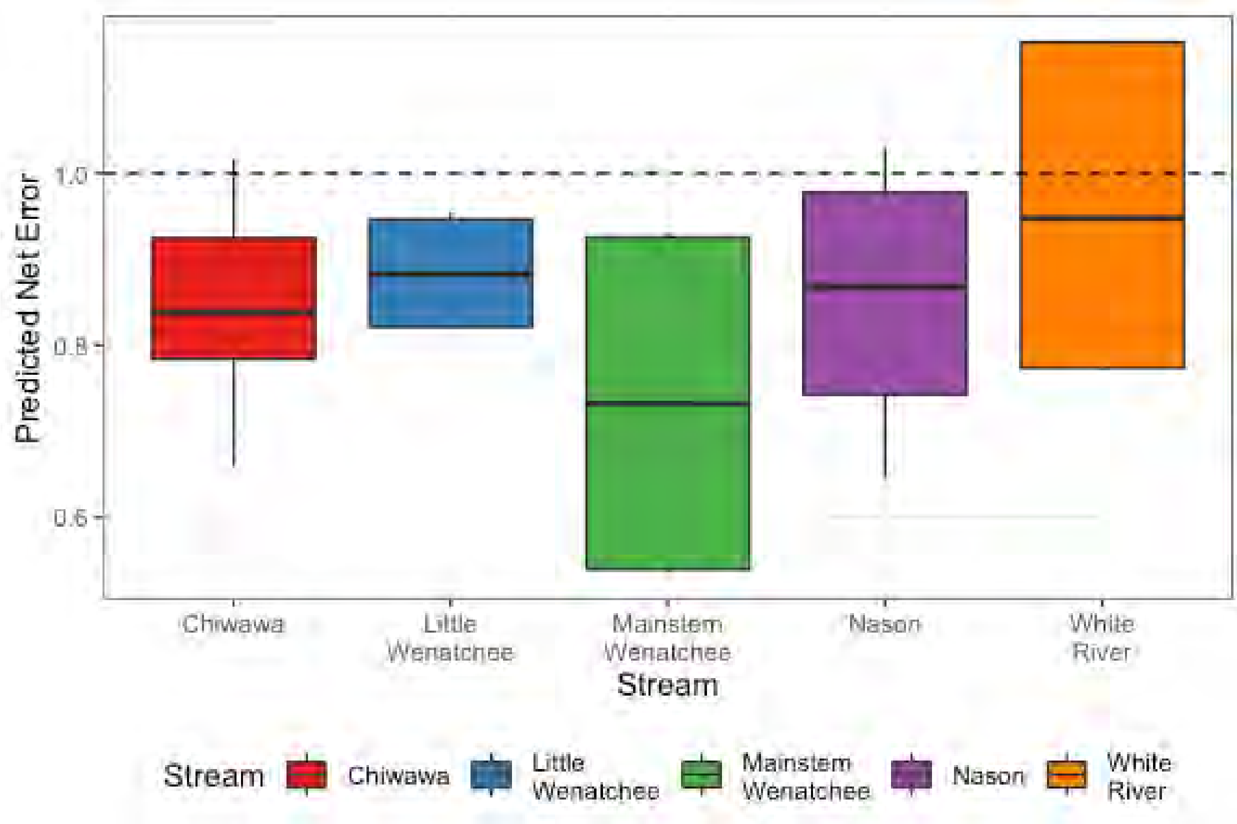

Figure 2: Boxplots showing predicted net error by stream. Dashed line shows no error.

Total Redds

Redds were estimated at the reach scale using the GAUC method whenever possible, and simply dividing the total number of observed redds by the predicted net error when not. For a few small tributary reaches, no estimates of observer error were made and instead the small number of observed redds was assumed to be observed without error. The estimates at the reach scale are displayed in Table 1. The curves that were fit in the GAUC process are shown in Figure 3. The results are summarized at the stream and population scale in Table 2.

Table 1: Estimates of total redds by reach.

Stream	Reach	Type	GAUC	Obs. Redds	Mean Net Error	Est. Redds	SE	CV
Chiwawa	C1	Major	Y	73	0.91	80	7.6	0.09
Chiwawa	C2	Major	Y	158	0.83	191	23.34	0.12
Chiwawa	C3	Major	Y	8	0.77	10	2.57	0.26
Chiwawa	C4	Major	Y	31	0.92	34	4.18	0.12
Chiwawa	C5	Major	Y	14	0.83	17	2.47	0.15
Chiwawa	C6	Major	Y	30	1	30	5.22	0.17
Chiwawa	C7	Major	Y	8	0.68	12	2.72	0.23
Chiwawa	K1	Minor	N	6	–	6	–	–
Chiwawa	R1	Minor	N	3	–	3	–	–
Chiwawa	S1	Minor	N	0	–	0	–	–
Icicle	I1	Minor	N	1	–	1	–	–
Icicle	I2	Minor	N	2	–	2	–	–
Icicle	I3	Minor	N	0	–	0	–	–
Little Wenatchee	L2	Major	N	1	0.82	1	0.41	0.41
Little Wenatchee	L3	Major	Y	7	0.95	7	1.52	0.22
Mainstem Wenatchee	A1	Minor	N	0	–	0	–	–
Mainstem Wenatchee	W10	Major	N	15	0.93	16	5.82	0.36
Mainstem Wenatchee	W9	Major	Y	5	0.54	9	3.24	0.36
Nason	N1	Major	Y	15	0.76	20	5.55	0.28
Nason	N2	Major	Y	14	0.97	14	2.94	0.21
Nason	N3	Major	Y	38	1	38	40.86	1.08
Nason	N4	Major	Y	23	0.67	34	5.1	0.15

Peshastin	D1	Minor	N	0	–	0	–	–
Peshastin	P1	Minor	N	2	–	2	–	–
Peshastin	P2	Minor	N	0	–	0	–	–
White River	H2	Major	N	3	0.77	4	1.16	0.29
White River	H3	Major	Y	17	0.95	18	3	0.17
White River	H4	Major	N	0	1.15	0	0	–
White River	Q1	Minor	N	0	–	0	–	–
White River	T1	Minor	N	0	–	0	–	–

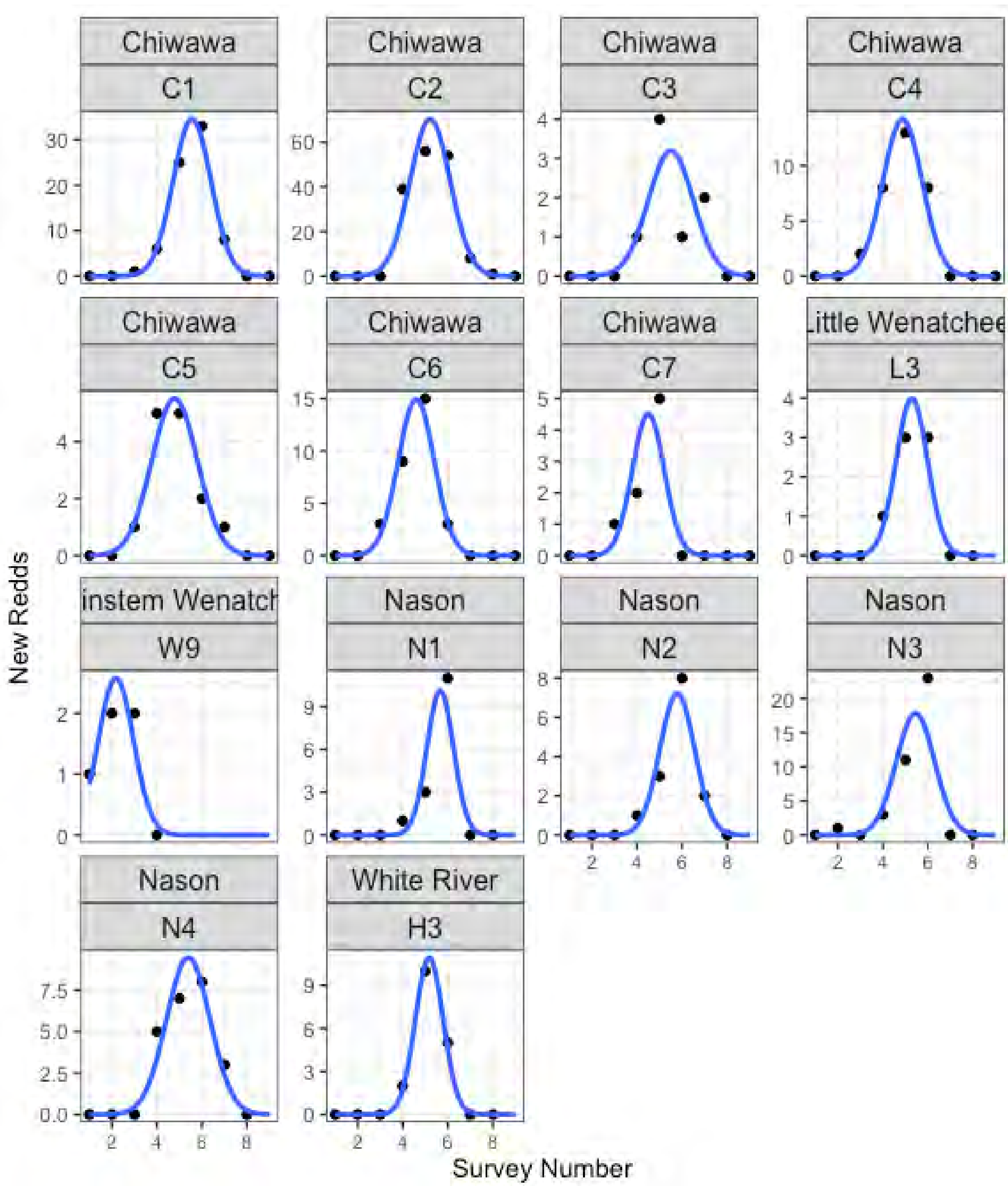

Figure 3: Observed new redds by survey number and reach. Blue curve depicts the GAUC fitted curve.

Table 2: GAUC results at stream and population scale. Mean net error is the mean of net error estimates, weighted by the number of observed redds in each reach.

Stream	Obs. Redds	Mean Net Error	Est. Redds	Std. Err.	CV
Chiwawa	331	0.87	383	44.62	0.12
Icicle	3	–	3	0	0
Little Wenatchee	8	0.93	8	1.52	0.19
Mainstem Wenatchee	20	0.83	25	3.24	0.13
Nason	90	0.87	106	53.47	0.5
Peshastin	2	–	2	0	0
White River	20	0.92	22	3	0.14
Total	474	–	549	69.8	0.13

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Appendix M

Genetic Diversity of Chiwawa River Spring Chinook Salmon

Assessing the Genetic Diversity of Natural Chiwawa River Spring Chinook Salmon and Evaluating the Effectiveness of its Supportive Hatchery Supplementation Program

Developed for

Chelan County PUD

and the

Habitat Conservation Plan's Hatchery Committee

Developed by
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March 30, 2007

Table of Contents

Executive Summary

The main objective of this study was to determine the potential impacts of the Chiwawa River Supplementation Program on natural spring Chinook in the upper Wenatchee system. We did this by investigating population differentiation between temporally replicated Chiwawa River natural and hatchery samples from the Wenatchee River watershed using microsatellite DNA allele frequencies and the statistical assignment of individual fish to specific populations. Additionally, to assess the genetic effect of the hatchery program, we investigated the relationship between census and effective population sizes using collections obtained before and after the supplementation program. In this summary, we briefly describe the salient results contained within this report; however, each "Task" within the Results/Discussion section below contains extended coverage for each topic along with an expanded interpretation of each result.

Overall, we observed substantial genetic diversity within collections, with heterozygosities equal to roughly 80%, over thirteen microsatellite markers. Microsatellite allele frequencies among temporally replicated collections from the same population (i.e., location) were variable, resulting in significant genetic differentiation among these collections. However, these difference are likely the result of salmon life history in this area, as four-year-old Chinook comprise a majority of returns each year. That is, the genetic tests are detecting the differences of contributing parents from each cohort, rather than a hatchery effect.

Analysis of Chiwawa River Collections

To assess the multiple competing hypotheses regarding population differentiation within and among Chiwawa River collections, we found it necessary to organized the Chiwawa genetic data into three data sets: (1) fish origin (hatchery versus natural), (2) spawning location (hatchery broodstock versus in-river (natural) spawners), and (3) four "treatment" groups (1. hatchery-origin hatchery broodstock, 2. hatchery-origin natural spawner, 3. natural-origin natural spawner, and 4. natural-origin hatchery broodstock). We conducted separate analyses using each of the three data sets, with each analysis touching on some aspect of the components necessary to move through the Conceptual Process outlined by Murdoch and Peven (2005).

Origin Dataset – We report that allele frequencies within and between natural- and hatchery-origin collections are significantly different, but there does not appear to be a robust signal indicating that the recent natural-origin collections have diverged greatly from the pre- or early post-supplementation collections. Genetic drift will occur in all populations, but does not appear to be a major factor affecting allele frequencies within the Chiwawa collections.

Spawning Location Dataset – There are significant allele frequency differences within and between hatchery broodstock and natural spawner collections. However, in recent years the allele frequency differences between the hatchery broodstock and natural spawner collections have declined. Furthermore, based on linkage disequilibrium, there is a genetic signal that is consistent with increasing homogenization of allele frequencies within hatchery broodstock collections, but a similar homogenization within the natural spawner collection is not apparent. These data suggest that there exists consistent year-to-year variation in allele frequencies among hatchery and natural spawning collections, but there is a trend toward homogenization of the allele frequencies of the natural- and hatchery-origin fish that compose the hatchery broodstock.

Four Treatment dataset – Although there are signals of allelic differentiation among Chiwawa River collections, there are no robust signs that these collections are substantially different from each other. We used two different analyses to measure the degree of genetic variation that exists among individuals and collections within the Chiwawa River. First, we conducted a principal component analysis using all Chiwawa samples with complete genotypes (i.e., no missing alleles from any locus). Although the first two principal component axes account for only 10.5% of the total molecular variance, a substantially greater portion of that variance is among individual fish, regardless of their identity, rather than among hatchery and natural collections. The variances in principal component scores among individuals are 11 and 13 times greater than the variance in scores among collections.

Secondly, using an Analysis of Molecular Variance (AMOVA), we were able to determine how best to group populations, with "best" being defined as that grouping that accounts for the greatest proportion of among group (i.e., population) variance. Furthermore, by partitioning molecular variance into different hierarchical components, we are able to determine what level accounts for the majority of the molecular variance. The AMOVA results clearly show that nearly all molecular variation, no matter how the data are organized, resides within a collection. The percentage of total molecular variance occurring within collections ranged from 99.68% to 99.74%. These results indicate that the significant differences among collections of Chiwawa fish account for less than one percent of the total molecular variance, and these differences cannot be attributed to fish origin or spawning location.

Effective Population Size (N_e)

The contemporary estimate of N_e calculated using genetic data combined for Chiwawa natural-origin spawners (NOS) and hatchery-origin spawners (HOS) Chinook is N_e=386.8, which is slightly larger than the pre-hatchery N_e we estimated using demographic data from 1989 – 1992. Additionally, the N_e /N ratio calculated using 386.8 for N_e and the arithmetic mean yearly census of NOS and HOS Chinook from 1989 – 2005 for N is 0.40. These results suggest the N_e has not declined during the period of Chiwawa Hatchery Supplementation Program operation.

Analysis Of Upper Wenatchee Tributary Collections

We compared genetic data for spring Chinook collected from the major spawning aggregates of the Wenatchee River. We observed significant differences in allele frequencies among temporally replicated collections within populations, and among populations within the upper Wenatchee. However, these differences account for a very small portion of the overall molecular variance, and these populations overall are very similar to each other. Of all the populations within the Wenatchee River, the White River appears to be the most distinct. Yet, this distinction is more a matter of detail than of large significance, as the median F_{ST} between White River collections and all other collections (except the Little Wenatchee collection; see Results/Discussion) is less than 1.5% among population variance. We consider the implications of these results in the Conclusion section that follows the Results/Discussion section. Additionally, there is no evidence that the Chiwawa River Supplementation Program has changed the allele frequencies in the Nason Creek and White River populations, despite the presence of hatchery-origin fish in both these systems.

Introduction

Murdoch and Peven (2005) outlined 10 objectives to assess the impact (positive or negative) of hatchery operations mitigating the operation of Rock Island Dam. Two objectives relate to monitoring the genetic integrity of populations:

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

This study addresses Objective 3 (above), and documents analyses and results WDFW completed for populations of spring Chinook (*Oncorhynchus tshawytscha*) in the Wenatchee River watershed. This study was not intended to specifically address Objective 5 (above); however, genetic data provide results relevant to Objective 5. The critical component of Objective 3 is to determine if hatchery supplementation has effected change. Furthermore, change in this context means altering census size and/or genetic marker allele frequencies; we did not attempt to measure changes in fitness. Perhaps a more meaningful rewording of Objective 3 is, "Did the hatchery supplementation program succeed at increasing the census size of a target population while leaving genetic integrity intact?" In order to evaluate cause and effect of hatchery supplementation, we surveyed and compared genetic variation in samples collected before and after potential effects from the Chiwawa Hatchery Supplementation Program. Samples were acquired from the primary spawning aggregates in the upper Wenatchee River watershed: Nason Creek, Little Wenatchee River, White River, and Chiwawa River. Hatchery samples were acquired from programs that could potentially affect genetic composition of Wenatchee stocks, the integrated Chiwawa River stock (local stock), Leavenworth National Fish Hatchery spring Chinook (Carson Stock – non local), and Entiat NFH (Carson Stock – non local). Additionally, the genetic markers used were the Genetic Analysis of Pacific Salmonids (GAPS) (Seeb et al. in review) standardized microsatellites, so all data from the Wenatchee study will be available for inclusion in the GAPS Chinook coastwide microsatellite baseline.

History of Artificial Propagation

Artificial propagation in the upper Columbia River began in 1899 when hatcheries were constructed on the Wenatchee and Methow rivers (Mullan 1987). These initial operations were small, with the Tumwater Hatchery on the Wenatchee River releasing several hundred thousand fry, and the Methow River hatchery producing few Chinook salmon before it was closed in 1913 (Craig and Suomela 1941, Nelson and Bodle 1990). The Leavenworth State Hatchery operated in the Wenatchee River Basin between 1913 and 1931 using eggs from non-native stocks (Willamette River spring-run and lower Columbia Chinook hatchery fall-run). These early attempts at hatchery production were largely unsuccessful for spring-run Chinook (WDF 1934). Between 1931 and 1939, no Chinook salmon hatcheries were in operation above Rock Island Dam (Rkm 730).

In 1938, the last salmon was allowed to pass upstream through the uncompleted Grand Coulee Dam (Rkm 959). To mitigate the loss of habitat, adult Chinook salmon were trapped, under the auspices of the Grand Coulee Fish Maintenance Project (GCFMP), at Rock Island Dam beginning in May 1939, and relocated into three of the remaining accessible tributaries to the upper Columbia River: the Wenatchee, Entiat, and Methow Rivers. GCFMP transfers continued through the autumn of 1943. Spring- and summer/fall-run fish were differentiated at Rock Island Dam based on a 9 July cutoff date for Chinook arrivals at Rock Island Dam (Fish and Hanavan 1948). Spring-run adults collected at Rock Island Dam (pre 9 July fish) were either transported to Nason Creek on the Wenatchee River to spawn naturally (1939-43), or to the newly constructed Leavenworth NFH (1940) for holding and subsequent spawning (1940-43). Eggs were incubated on site or transferred to the Entiat NFH (1941) and Winthrop NFH (1941). In 1944 spring-run adults were allowed to freely pass Rock Island Dam. The GCFMP did not differentiate among late-run stocks (post 9 July fish) passing Rock Island Dam. Late-run offspring reared at the Leavenworth NFH, Entiat NFH, and Winthrop NFHs were an amalgamation of summer and fall upper Columbia River populations (Fish and Hanavan 1948). Late-run fish were transplanted into the upper and lower Wenatchee, Methow, and Entiat Rivers.

After 1943, the Winthrop NFH continued to use local spring-run Chinook for hatchery production, while the other NFHs largely focused on summer-run Chinook salmon. Renewed emphasis on spring run production in the mid-1970s saw the inclusion of local and non-local eggs (Carson NFH stock, Klickitat River stock, and Cowlitz River stock) to the NFHs. In the early 1980s, imports of non-native eggs were reduced significantly, and thereafter the Leavenworth, Entiat, and Winthrop NFHs have relied on adults returning to their facilities for their egg needs (Chapman et al. 1995). Regarding late-run Chinook, due to the variety of methods employed to collect broodstock at dams, hatcheries, or the result of juvenile introductions into various areas, Chinook populations and runs (i.e., summer and fall) have been mixed considerably in the upper Columbia system over the past five decades (reviewed in Chapman et al. 1994).

Washington Department of Fish and Wildlife (WDFW) operates two facilities producing spring-run Chinook, the Methow Fish Hatchery (MFH) owned by Douglas County PUD that began operation in 1992 and Eastbank Fish Hatchery (EFH) owned by Chelan County PUD that began operation in 1989. Both programs were designed to implement supplementation (supportive breeding) programs for naturally spawning populations on the Methow and Wenatchee Rivers, respectively (Chapman et al. 1995). As part of the Rock Island Mitigation Agreement between Chelan County Public Utility District and the fishery management parties (RISPA 1989), a supplementation (supportive breeding) program was initiated in 1989 on the Chiwawa River to mitigate smolt mortality resulting from the operation of Rock Island Hydroelectric Project. EFH uses broodstock collected at a weir on the Chiwawa River, although in recent years hatchery fish have been collected at Tumwater Dam. Similarly, the MFHC uses returning adults collected at weirs on the Methow River and its tributaries, the Twisp and Chewuch Rivers (Chapman et al. 1995; Bugert 1998). Although low run size and trap efficiency has resulted in most broodstock being collected from the hatchery outfall or in some years Wells Dam, progeny produced from these programs are reared at and released from satellite sites on the tributaries where the adults were collected. Numerous other facilities have reared spring-run Chinook salmon on an intermittent basis.

Previous Genetic Studies – Population differentiation

Waples et al. (1991a) examined 21 polymorphic allozyme loci in samples from 44 populations of Chinook salmon in the Columbia River Basin. These authors reported three major clusters of Columbia River Basin Chinook salmon: 1) Snake River spring- and summer-run Chinook salmon, and mid and upper Columbia River spring-run Chinook salmon, 2) Willamette River spring-run Chinook salmon, 3) mid and upper Columbia River fall- and summer-run Chinook salmon, Snake River fall-run Chinook salmon, and lower Columbia River fall- and spring-run Chinook salmon. Utter et al. (1995) examined allele frequency variability at 36 allozyme loci in samples of 16 upper Columbia River Chinook populations. Utter et al. (1995) indicated that spring-run populations were distinct from summer- and fall-run populations, where the average genetic distance between spring-run and late-run Chinook were about eight times the average of genetic distances between samples within each group. Additionally, allele frequency differences among spring-run populations were considerably greater than that among summer- and fall-run populations in the upper Columbia River. Utter et al. (1995) also reported hatchery populations of spring-run Chinook salmon were genetically distinct from natural spring-run populations, but hatchery populations of fall-run Chinook salmon were not genetically distinct from natural fall-run populations.

As part of an evaluation of the relative reproductive success for the Chiwawa River supplementation program, Murdoch et al. (2006), used eleven microsatellite loci to assess population differentiation among spring Chinook salmon population samples in the upper Wenatchee River. Murdoch et al. (2006) reported a >99% accuracy of correctly identifying spring-run and fall-run Chinook from the Wenatchee River. They also reported slight, but significantly different genetic variation among wild spring populations and between wild and hatchery stocks. Yet, since the spring-run populations are genetically similar, identifying individuals genetically from the upper tributaries of the Wenatchee River was difficult. This result is exemplified in their individual assignment results, where < 8% of spring-run individuals, hatchery or wild, were correctly assigned using their criterion of an LOD (log of odds) score greater than 2. Murdoch et al. (2006) also reported contemporary natural spring Chinook show heterozygote deficit and low linkage disequilibrium (LD), while contemporary hatchery spring Chinook show heterozygote excess and high LD.

Williamson et al. (submitted) have continued the work of Murdoch et al. (2006) by analyzing Chiwawa River demographic data from 1989 – 2005 to estimate the proportions of recruits that were produced by Chinook with hatchery or wild origin. In an "ideal" population, the genetic size (i.e., effective size or N_e) and the census size are equal; however various demographic factors such as unequal sex ratios and variance in reproductive success among individuals reduces the genetic size below the census size. It is generally thought that the genetic size is approximately 10-33% the census size (Bartley et al. 1992; RS Waples pers. comm.), although values have been reported outside this range (Araki et al. 2007; Arden and Kapuscinski 2003; Heath et al. 2002). Despite being difficult to estimate, the effective population size in many respects is a more important parameter to know than census size, because N_e determines how genetic diversity is distributed within populations and how the forces of evolution (i.e., forces that change genetic diversity over time) will affect the genetic variation present.

Williamson et al. (submitted) used demographic data to 1) investigate the effect of unequal sex ratio on genetic diversity, 2) investigate the effect of variation in reproductive success on genetic diversity, 3) investigate the effect of fluctuations in population size on genetic diversity, and 4) estimate the effective population size, using the inbreeding method (Ryman and Laikre 1991). Most importantly, they use demographic data from 1989 – 2000 to assess the impact of the Chiwawa Hatchery Supplementation Program on the effective population size of natural-origin Chiwawa River spring Chinook. They estimate that the N_e of naturally spawning Chiwawa Chinook (i.e., both hatchery- and wild-origin fish on the spawning grounds) from 1989 –

1992 was $N_e = 2683$ and in 1997 – 2000 was $N_e = 989$. They compare spawning ground N_e to estimates calculated from combined broodstock and naturally spawning Chinook demographic data. The combined inbreeding N_e estimate from 1989 – 1992 was $N_e = 147$ and in 1997 – 2000 was $N_e = 490$. Williamson et al. (submitted) argue that since the combined N_e estimate is lower than the naturally spawning estimate, the supplementation program has had a negative impact on the Chiwawa River N_e.

Williamson et al. (submitted) also present genetic data for Chinook recovered on spawning grounds in upper Wenatchee River tributaries in 2004 and 2005. These genetic data are derived from the Murdoch et al. (2006) study. They compare samples collected from Chiwawa River (i.e., hatchery and wild), White River, Nason Creek, and Leavenworth Hatchery. Additionally, they include a 1994 Chiwawa River wild smolt sample for comparison with the 2004 brood year. Williamson et al. (submitted) report statistically significant genetic differentiation among Chiwawa River, White River and Nason Creek. Additionally, they report that the 1994 and 2004 Chiwawa River wild samples are not statistically different, but the 2004 Chiwawa wild and hatchery collections are statistically different.

Study Objectives

This study investigated within and among population genetic diversity to assess the effect of the Chiwawa Hatchery's supplemental program on the natural Chiwawa River spring Chinook population. Differences among temporal population samples, the census size, heterozygosity, and allelic diversity were documented. We investigated population differentiation between the Chiwawa River natural and hatchery samples, and among all temporally replicated samples from the Wenatchee River watershed using microsatellite DNA allele frequencies and the statistical assignment of individual fish to specific populations. To assess the genetic effect of the hatchery program, correlation between census and effective population sizes were investigated using temporally replicated samples obtained before and after the supplementation program operation. To address the hypotheses associated with Objective 3 in Murdock and Peven (2005) we developed eleven specific “Tasks” (Blankenship and Murdoch 2006), to which we analyzed specific genetic data. We present the results from these analyses specific to each individual Task.

Methods and Materials

Tissue collection and DNA extraction

We analyzed thirty-two population collections of adult spring Chinook salmon (*Oncorhynchus tshawytscha*) obtained from the Wenatchee River between 1989 and 2006 (Table 1). Nine collections of natural Chinook adults from the Chiwawa River (n=501), and nine collections of Chiwawa Hatchery Chinook (n=595) were collected at a weir located in the lower Chiwawa River. The 1993 and 1994 Chiwawa Hatchery samples are smolt samples from the 1991 and 1992 hatchery brood years, respectively. Additional samples were collected from upper Wenatchee River tributaries, White River, Little Wenatchee River, and Nason Creek. Six collections of natural White River Chinook (n=179), one collection from the Little Wenatchee (n=19), and six collections from Nason Creek (n=268) were obtained. Single collections were obtained for Chinook spawning in the mainstem Wenatchee River and Leavenworth National Fish Hatchery. An additional out-of-basin collection from Entiat River was also included in the analysis. Samples collected in 1992 or earlier are scale samples. All other samples were either fin clips or operculum punches, stored immediately in ethanol after collection. DNA was extracted from stored tissue using Nucleospin 96 Tissue following the manufacturer’s standard protocol (Macherey-Nagel, Easton, PA, U.S.A.).

Laboratory analysis

We performed polymerase chain reaction (PCR) amplification on each fish sample using the 13 fluorescently end-labeled microsatellite marker loci standardized as part of the GAPS project (Seeb et al. in review). GAPS genetic loci are: *Ogo*2, *Ogo*4 (Olsen et al. 1998); *Oki*100 (unpublished); *Omm*1080 (Rexroad et al. 2001); *Ots*201b (unpublished); *Ots*208b, *Ots*211, *Ots*212, and *Ots*213 (Grieg et al. 2003); *Ots*3M, *Ots*9 (Banks et al.

1999); *Ots*G474 (Williamson et al. 2002); *Ssa*408 (Cairney et al. 2000). PCR reaction volumes were 10 μL, and contained 1 μL 10x PCR buffer (Promega), 1.0 μL MgCl2 (1.5 mM final) (Promega), 0.2 μL 10 mM dNTP mix (Promega), and 0.1 units/mL Taq DNA polymerase (Promega). Loci were amplified as part of multiplexed sets, so primer molarities and annealing temperatures varied. Multiplex one had an annealing temperature of 50°C, and used 0.37 Molar (M) *Oki*100, 0.35 M *Ots*201b, and 0.20 M *Ots*208b, and 0.20 M *Ssa*408. Multiplex two had an annealing temperature of 63°C, and used 0.10 M *Ogo*2, and 0.25 M of a non-GAPS locus (*Ssa* 197). Multiplex three had an annealing temperature of 56°C, and used 0.18 M *Ogo*4, 0.18 M *Ots*213, and 0.16 M *Ots*G474. Multiplex four had an annealing temperature of 53°C, and used 0.26 M *Omm*1080, and 0.12 M *Ots*3M. Multiplex five had an annealing temperature of 60°C, and used 0.30 M *Ots*212, 0.20 M *Ots*211, and 0.10 M *Ots*9. Thermal cycling was conducted on either a PTC200 thermal cycler (MJ Research) or GeneAmp 9700 (Applied Biosystems) as follows: 95°C (2 min); 30 cycles of 95°C for 30 sec., 30 sec. annealing, and 72°C for 30 sec.; a final 72°C extension and then a 10°C hold. PCR products were visualized by electrophoresis on an ABI 3730 automated capillary analyzer (Applied Biosystems). Fragment analysis was completed using GeneMapper 3.7 (Applied Biosystems). Standardization of genetic data to GAPS allele standards was conducted following Seeb et al. (in review).

Genetic data analysis

Assessing within population genetic diversity - Heterozygosity measurements are reported using Nei's (1987) unbiased gene diversity formula (i.e., expected heterozygosity) and Hedrick's (1983) formula for observed heterozygosity. Both tests are implemented using the microsatellite toolkit (Park 2001). We used GENEPOP version 3.4 (Raymond and Rousset 1995) to assess Hardy-Weinberg equilibrium (HWE), where deviations from the neutral expectation of random associations among alleles are calculated using a Markov chain method (5000 iterations in this study) to obtain unbiased estimates of Fisher's exact test. Global estimates of F_{IS} according to Weir and Cockerham (1984) were calculated using GENEPOP version 3.4. Genotypic linkage disequilibrium was calculated following Weir (1979) using GENEPOP version 3.4.

Linkage results for population collections are reported as the proportion of pairwise (locus by locus) tests that are significant (alpha = 0.01). Linkage disequilibrium is considered statistically significant if more than 5% of the pairwise tests based on permutation are significant for a collection.

Within- and among-population genetic differentiation – The temporal stability of allele frequencies within populations, and pairwise differences in allele frequencies among populations were assessed using several different procedures. First, we tested for differences in allele frequencies among populations defined in Table 1 using a randomization chi-square test implemented in GENEPOP version 3.4 (Raymond and Rousset 1995). This procedure tests for differences between pairs of populations where alleles are randomized between the populations (i.e., genic test). The null hypothesis for this test is that the allele frequency distributions between two populations are the same. A low p-value should be interpreted as the allele frequency distributions being compared are unlikely to be samples drawn from the same underlying distribution.

Second, to graphically describe allele frequency differences among populations we conducted a nonmetric multidimensional scaling analysis using allele-sharing distance matrices from two different data sets. Pairwise allele-sharing distances are calculated as 1 – (mean over all loci of the sums of the minima of the relative frequencies of each allele common to a pair of populations). To calculate the allele-sharing distances for each pair of populations we used PowerMarker v3.25 (Liu and Muse 2005). Nonmetric multidimensional scaling is a technique designed to construct an n-dimensional "map" of populations, given a set of pairwise distances between populations (Manly 1986). The output from this analysis is a set of coordinates along n-axes, with the coordinates specific to the number of n-dimensions selected. To simplify our analysis we selected a 2-dimensional analysis to represent the relative positions of each population in a typical bivariate plot. The goodness of fit between the original allele-sharing distances and the pairwise distances between all populations along the 2-dimensional plot is measured by a "stress" statistic. Kruskal (in Rohlf 2002) developed a five-tier guide for evaluating stress levels, ranging from a perfect fit (stress=0) to a poor fit (stress=0.40). We conducted the nonmetric multidimensional scaling analysis for one data set containing Chiwawa natural- and hatchery-origin collections, and another data set containing Chiwawa broodstock and in-river spawner collections. We used the mdscale module in MATLAB R2006b (The Mathworks 2006) to generate the nonmetric multidimensional scaling coordinates.

We examined the geographic and temporal structure of populations in the upper Wenatchee (Chiwawa River, Nason Creek, and White River, only) using a series of analyses of molecular variance (AMOVAs). Here, we defined an AMOVA as an analysis of variance of allele frequencies, as originally designed by Cockerham (1969), but implemented in Arlequin v2.1 (Schneider et al. 2000). These analyses permit populations to be aggregated into groups, and molecular variance is then partitioned into within collections, among collections, but within groups, and among group components. With this approach, we were able to determine how best to group populations, with "best" being defined as that grouping that accounts for the greatest proportion of among group variance. Furthermore, by partitioning molecular variance into three different hierarchical components, we are able to determine what level accounts for the majority of the molecular variance.

Finally, we explored the partitioning of molecular variance between among-individuals and among-populations using a principal component analysis and multi-locus estimates of pairwise F_{ST}, estimated by a "weighted" analysis of variance (Weir and Cockerham, 1984). Principal component analysis is a data-reduction technique whereby the correlation structure among variables can be used to combine variables into a series of multivariate components, with each original variable receiving a weighted value for each component based on its correlation with that component. Here, we used a program written by Warheit in MATLAB R2006b (The Mathworks 2006) that treats each allele for each locus as a single variable (13 loci = 26 alleles or variables), and these 26 "variables" were arranged into 26 components, with each component accounting for a decreasing amount of molecular variance. Estimates of F_{ST} were calculated using GENETIX version 4.05 (Belkhir et al.1996). To determine if the F_{ST} estimates were statistically different from random (i.e., no structure), 1000 permutations were implemented in GENETIX version 4.05 (Belkhir et al.1996).

Effective population size (N_e) – Estimates of the effective population size were obtained using two methods, a multi-collection temporal method (Waples 1990), and a single-collection method (Waples 2006) using linkage disequilibrium data. The temporal method assumes that cohorts are used, but we did not decompose the collection year samples into their respective cohorts using age data. Therefore, N_e estimates that pertain to individual year classes of breeders are not valid; however the harmonic mean over all samples will estimate the contemporary N_e. Comparing samples from years *i* and *j*, Waples' (1990) temporal method estimates the effective number of breeders ($\hat{N}_{b(i,j)}$) according to:

$$\hat{N}_{b(i,j)} = \frac{b}{2(\hat{F} - 1/\hat{S}_{i,j})}$$

The standardized variance in allele frequency ($\hat{F}$) is calculated according to Pollack (1983). The parameter b is calculated analytically from age structure information and the number of years between samples (Tajima 1992). The age-at-maturity information required to calculate b was obtained from Murdoch et al. (2006) for this analysis. They observed for Chiwawa Hatchery Chinook that 8.6% matured at age 2, 4% at age 3, 87% at age 4, and 0.4% at age 5. For Chiwawa natural Chinook, Murdoch et al. (2006) observed that 1.8% matured at age 3, 81.6% at age 4, and 16.7% at age 5. The harmonic mean of sample sizes from years *i* and *j* is $\tilde{S}_{i,j}$. Over all pairwise comparisons the harmonic mean of all $\hat{N}_{b(i,j)}$ is $\tilde{N}_b$, the contemporary estimate of the effective population size (N_e). SALMONNb (Waples et al. 2007) was used to calculate $\tilde{N}_b$. As suggested by authors, alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

The method of Waples (2006) uses linkage disequilibrium (i.e., mean squared correlation of allele frequencies at different gene loci) as a means of estimating effective population size (N_e) from a single sample. While this method is biased in some cases where N_e /N ratio is less the 0.1 and the sample size is less than the true N_e, it has been shown to produce comparable results to the temporal method. Burrows' delta method is used to estimate LD, and a bias corrected estimate of N_e is calculated after eliminating alleles with frequency less than 0.05. This test was implemented using LDN_e (Do and Waples unpublished). In age-structured species, N_e estimates based on LD are best interpreted as the effective number of breeders (N_b) that produced the sample (Waples 2006). N_b should be multiplied by the mean generation length (i.e., 4 in this case) to obtain an overall estimate of N_e based on an N_b estimate. We analyzed collections categorized by spawning location (i.e., hatchery broodstock or in-river) and did not analyze collections categorized by origin (i.e., hatchery or natural). Waples' (2006) method estimates N_e from observed LD, therefore the corresponding N_e estimates for the hatchery collections would be low and the estimates for the natural collections would be high. Yet, since the supplementation program is integrated, and hatchery fish can spawn naturally, we feel it inappropriate to analyze the hatchery and natural samples as if they were separate, which would essentially partition all the LD into the hatchery samples.

Each collection has an N_b estimate and an associated confidence interval. If the confidence interval includes infinity, it means that sampling error accounts for all the LD observed (i.e., empirical LD is less than expected LD). The usual interpretation is that there is no evidence for any disequilibrium caused by genetic drift in a finite number of parents. Since the LD method estimates the number of breeders that contributed to the sample being analyzed, in order to calculate an N_e /N ratio, the appropriate census size must be used. The census size used to derive a ratio was the estimate four years prior to the collection analyzed using LD, which assumed a strict four-year-old lifecycle, although the observed proportion of four-year-olds was approximately 85% each year. The census numbers (Table 2) used to calculate the ratios for Chiwawa broodstock and in-river spawners were combined NOS (natural-origin spawners) and HOS (hatchery-origin spawners) census estimates.

Individual assignment – A population baseline file was constructed containing all 1704 individual Chinook from 34 population collections (Table 1; Chiwawa origin data set plus all samples from other populations). All individuals in the baseline had geneotypes that included nine or more loci. Individual Chinook were assigned to their most likely population of origin based on the partial Bayesian criteria of Rannala and Mountain (1997), using a "jack-knife" procedure, where each individual to be assigned was removed from the baseline prior to the calculation of population likelihoods. This procedure was implemented in a program written by Warheit in MATLAB R2006b (The Mathworks 2006). Two assignment criteria were used, 1) the population with the largest posterior probability for an individual was the "most-likely" population of origin (i.e., all individuals assigned to a collection), and 2) an assignment was consider valid only if the posterior probability was greater than or equal to 0.9. Please note that while the analysis used 34 population collections to assign Rannala and Mountain likelihoods for each individual, these likelihoods were aggregated based on "population" (i.e., Chiwawa, Nason, White, and so on) and posterior probabilities were calculated for population location, rather than individual collections.

Results and Discussion

In this section we combine our presentation and interpretations of the genetic analyses. Additionally, this section will be organized based on the task list presented in the study plan. Overall conclusions are provided following this section.

<u>Task 1:</u> Determine trend in census size for Chiwawa River spring Chinook.

Census data from 1989 – 2005 are provided in Table 2 for the Chiwawa Hatchery broodstock and spring Chinook present in the Chiwawa River. The demographic data for naturally spawning Chinook are based on redd sampling and carcass surveys, while broodstock data are based on Chiwawa hatchery records. As the supplementation program is integrated by design, we also present the proportion of natural-origin broodstock (pNOB) incorporated into the hatchery, in addition to the number of natural-origin (NOS) and hatchery-origin (HOS) spawners present in Chiwawa River. The census size fluctuated yearly, and a general reduction in census size was observed in the mid to late 1990's. This trend was apparent in both the broodstock and in the river. The arithmetic mean census size from 1989 – 2005 for the Chiwawa Hatchery (i.e., broodstock) was N=87.5 per year. The arithmetic mean census size from 1989 – 2005 for the Chiwawa River (i.e., NOS and HOS combined) was N=961.9 per year. For collection years when adult Chiwawa hatchery-origin fish would have been absent in the Chiwawa River (1989 – 1992), the arithmetic mean of natural Chiwawa Chinook census size is N=962.7. We will use this number as the baseline census size to assess if census size has changed. We used two different values for the contemporary census size in the Chiwawa River, NOS only and NOS + HOS. Additionally, we used collection years 2002 – 2005 for the contemporary NOS and HOS estimates, as these are the most recent data and the number of years included for estimation is the same as the pre-hatchery estimate above (i.e., four years). For NOS only, the arithmetic mean census size from 2002 – 2005 was N=536.0. For total census size (i.e., NOS and HOS combined), the arithmetic mean census size from 2002 – 2005 was N=1324.0. For the demographic data presented here, the contemporary census size is larger than the census estimate derived from the years prior to hatchery operation.

<u>Task 2:</u> Document the observed genetic diversity.

Genetic Diversity Categorized By Origin

For Chiwawa River collections categorized by origin (Table 1A), substantial genetic diversity was observed, with heterozygosity estimates over all loci, having a mean of 0.80. Genetic diversity was consistent with expected Hardy-Weinberg random mating genotypic proportions for ten of the eighteen collections. Eight of the nine Chiwawa natural collections were consistent with HWE, and two of nine Chiwawa Hatchery collections were consistent with HWE. F_{IS} is observed to be slight for all Chiwawa population collections, suggesting individuals within collections do not show excessive homozygosity.

The deviations from HWE observed were generally associated with hatchery collections. The two smolt collections (i.e., 1993 and 1994) showed significant deviations from HWE, which may be a function of non-random hatchery practices involving the contributing natural-origin parental broodstocks (i.e., 1991 and 1992 cohort). Deviations from HWE in the remaining hatchery collections may be the result of few individuals being represented in the broodstock (see below).

Additionally, linkage disequilibrium (LD) was also common for Chiwawa hatchery-origin collections and minimal for Chiwawa natural-origin collections. The random association of alleles between loci (i.e., linkage equilibrium) is expected under ideal conditions. LD is observed when particular genotypes are encountered more than expected by chance. Laboratory artifacts (e.g. null alleles) or physical linkage of loci on the same chromosome can cause LD, but the LD we observed was not associated with certain locus combinations, which you would expect if either artifacts or physical linkage were the cause of LD. LD was observed for seven of the nine hatchery-origin collections. As with the deviations from HWE, the high LD in the 1993 and 1994 hatchery-origin collections may be a result of non-random hatchery practices. The substantial LD observed in the hatchery-origin adult collections (collection years 2000, 2001, 2004, and 2006) might be the result of small parental broodstock sizes contributing to those returning adults. During the mid 1990's, the Chiwawa broodstock size was low, with zero individuals collected in 1995 and 1999; so fewer individuals would be contributing to the hatchery adult returns than the natural. This idea is corroborated by the lower LD observed for the 2005 hatchery-origin collection, which had a contributing parental broodstock size in 2001 (i.e., the major contributing parental generation) approximately eight times as large as the previous few collection years (Table 2). LD reappears in the 2006 Chiwawa hatchery-origin collection, which had a contributing parental broodstock size (i.e., for the most-part, the 2002 hatchery brood year) five times lower (Table 2) than that of the 2005 collection.

While seven of nine hatchery-origin collections showed significant LD, only one natural origin collection showed LD, and for this collection, only 10% of the loci-pairs were in disequilibrium (Table 1). The fact that LD predominated in the hatchery samples, suggests that variance in reproductive success (i.e., overrepresentation of particular parents) is higher in the hatchery-origin than in natural-origin collections.

Genetic Diversity Categorized By Spawning Location

For upper Wenatchee River collections categorized by spawning location (Table 1B), substantial genetic diversity was observed, with heterozygosity estimates over all loci, having a mean of 0.79 and ranging from a low of 0.69 (1993 White River) to 0.85 (1993 Little Wenatchee). Genetic diversity was consistent with HWE for nineteen of twenty-nine population collections. For the collections that departed from HWE, seven were from the Chiwawa River, one was from Leavenworth Hatchery, one was the Wenatchee mainstem collection of hatchery-origin – naturally spawning fish, and one was from the White River. F_{IS} is observed to be slight for all population collections except the 1993 White River collection (10% heterozygote deficit) (Table 1B). Collections deviating with HWE generally correlated with collections having high LD. Twelve population collections showed a proportion of pairwise linkage disequilibrium tests (across all loci) greater than 5% (Table 1B), eight of which were Chiwawa collections.

Starting in 1996, spawning location collections are composed of both natural- and hatchery-origin samples. The LD seen in the later spawning location collections may be caused by an admixing effect (i.e., mixing two populations), where random mating has not had the chance to freely associate alleles into genotypes. Interestingly, there appears to be a trend of reducing LD through time within the broodstock collections (Table 1B), which suggests that a "homogenizing" effect is taking place within the Chiwawa River. This observation is discussed more fully in Task 3 below.

<u>Task 3:</u> Test for population differentiation among collections within the Chiwawa River and associated supplementation program.

Introduction

Task 3 was designed to address two hypotheses listed as part of Objective 3 in Murdoch and Peven (2005):

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop}}$.
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Murdoch and Peven (2005) proposed these two hypotheses to help evaluate the Chiwawa supplementation program through the "Conceptual Process" (Figure 5 in Murdoch and Peven 2005; repeated here as Figure 1). There are two components to the first hypothesis, which must be considered separately. The first component involves comparisons between natural-origin populations in the Chiwawa to determine if there have been changes in allele frequencies or genetic distances, through time starting with the donor population. Documenting a change does not necessarily indicate that the supplementation program has directly affected the natural origin fish, as additional tests would be necessary to support that hypothesis. The intent of the second component is to determine if the hatchery produced populations have the same genetic composition as the naturally produced populations.

Although on the surface these two components and their associated comparisons may appear simple, from a hypothesis-testing perspective the analyses are complicated by the fact that natural-origin fish may have had hatchery-origin parents, and hatchery-origin fish may have had natural-origin parents. As such, we organized the Chiwawa genetic data into three data sets: (1) fish origin (hatchery versus natural), (2) spawning location (hatchery broodstock versus in-river (natural) spawners), and (3) four "treatment" groups (1. hatchery-origin hatchery broodstock, 2. hatchery-origin natural spawner, 3. natural-origin natural spawner, and 4. natural-origin hatchery broodstock). We conducted separate analyses using each of the three data sets, with each analysis touching on some aspect of the components necessary to move through the Conceptual Process (Figure 1).

Hatchery- Versus Natural-Origin

We address the following questions with the origin data set:

1. Are there changes in allele frequencies and allele sharing distances in the natural-origin collections from pre-supplementation to today?
2. Are there changes in allele frequencies and allele sharing distances in the hatchery-origin collections from early supplementation to today?
3. Are there significant differences in allele frequencies and large allele sharing distances between hatchery- and natural-origin adults from a collection year, and has this pattern changed through time?

Genic Differentiation Tests – We explicitly tested the hypothesis of no significant differentiation within natural- or hatchery-origin collections from the Chiwawa River using a randomization chi-square test. We show the results for the pairwise comparisons among natural-origin collections from the Chiwawa River populations in the first block of the second page of Table 3. Ten of the 36 (28%) pairwise comparisons have highly significant allele frequency differences, while only 12 of the 36 comparisons (33%) showed no significant differences. Eight of these 12 comparisons involved the 1996 collection, which included only eight samples and therefore provided little power to differentiate allele frequencies. If we exclude the 1996 collection, only 14% of the pairwise comparisons showed no significant differences, and here all but one of these comparisons involved the 1989 collection. The 1989 collection appeared to be the least differentiated collection in the natural-origin data set in that all pairwise comparisons were either not significant, or only mildly significant at the nominal critical value. No comparisons involving the 1989 collection were significant using a Bonferroni-corrected critical value, and 1989 is the only natural-origin collection in our data set that can be classified as "pre-supplementation."

We can interpret these results to indicate that although there appears to be significant year-to-year differences in allele frequencies among post-supplementation collections, the allele frequencies between each post-supplementation collection and the 1989 pre-supplementation collection are not greatly different. However, the level of differentiation does increase from the early post-supplementation years to the more recent years (2001, 2004-2006), although the statistical level of this significance never exceeds the Bonferroni-corrected critical value. Finally, sample sizes were also small for the 1989 collection (n = 36) and we cannot eliminate a reduction in power as a contributing factor for the lack of significance for these tests.

As with the hatchery-origin collections, most pairwise comparisons of allele frequencies between hatchery-origin samples were significant (Table 3, first page, upper block). Out of the 36 pairwise comparisons, all but three are significant at some level, and most comparisons are highly significant. Similar to the natural-origin analysis, the non-significant results were limited to comparisons involving the 1996, which included only eight samples.

As a result of this analysis *we reject the hypothesis that there was no significant differentiation among natural- or hatchery-origin collections from the Chiwawa River*. Furthermore, the allele frequencies of the hatchery-origin collections are significantly different from those of natural-origin collections (Table 3, first page, second block). For those fish collected in the same year, allele frequencies are significantly different between hatchery- and natural-origin collections, although in 2005 the level of significance was below the Bonferroni critical value (Table 3). The next step is to examine the pattern of allelic differentiation to discover first if there is a trend among the data, and second, if this trend suggests that the allele frequency differences among Chiwawa River natural-origin fish collections has been affected by the hatchery-origin fish.

Allele-sharing and Nonmetric Multidimensional Scaling – We constructed a pairwise allele-sharing distance matrix for all hatchery- and natural-origin collections from the Chiwawa River and subjected this matrix to a nonmetric multidimensional scaling analysis, restricting the analysis to two dimensions (Figure 2). The stress statistic for this analysis is 0.09, a value Kruskal (in Rohlf 2002) listed as a good to excellent fit between the actual allele-sharing distances and the Euclidean (straight-line) distances in the plot.

In other words, Figure 2 is a good visual representation of the allele sharing distance matrix; collections with a high percentage of alleles shared will be closer to each other than collections with a lower percentage of alleles shared.

With the exception of the two outlier years (1996 and 1998) the Chiwawa natural-origin collections form a tight cluster indicating an overall common set of shared alleles among these collections. Even if we ignore the 1996 and 1998 hatchery-origin collections, there appears to be a greater variance in shared alleles among the Chiwawa hatchery-origin collections than the natural-origin collections (Figure 2). In fact, the median percentage of alleles shared among the Chiwawa natural-origin collections is 76% compared with 69% alleles shared among the Chiwawa hatchery-origin collections.

Also, there appears to be a convergence in allele sharing distances (i.e., a decrease in allele frequency differences) between the hatchery- and natural-origin fish from the late 1980s/early 1990s to 2006. The series of red arrows in Figure 2 represent the progression of change in hatchery-origin allele sharing distances from 1996 (first adult hatchery origin fish in our analysis) to 2006 and this progression is decidedly in the direction of the natural-origin cluster. However, the most recent natural-origin collections (2001, 2004-2006) appear to have pulled closer to the hatchery-origin collections, compared with the 1989 natural-origin collection (note the close proximity of the 2000 and 1989 natural-origin collections). Nevertheless, the cluster of natural-origin collections adjacent to the hatchery-origin collections in Figure 2 also includes the 1993 natural-origin collection. Qualitatively, it appears that the initial hatchery-origin and natural-origin collections were more different from each other in terms of the percentage of shared alleles than are the most recent hatchery- and natural-origin collections. This may have been a result of a non-random sample of natural-origin fish that was used as broodstock in the initial years of the supplementation program (see discussion in Task 2 concerning deviations from HWE and linkage disequilibrium).

That being said, we do need to emphasize that Figure 2 is dominated by five outlier collections (two each from the 1996 and 1998 collections, and the 1994 smolt collection).

The 1996 and 1998 collections are characterized by small samples sizes, and the 1994 smolt collection has nearly all pairs of loci in linkage disequilibrium (Table 1). If we eliminate these five outlier groups, both the hatchery- and natural-origin collections form a relatively tight cluster. Excluding the five outliers, the median percentage of shared alleles among all pairwise combinations of Chiwawa hatchery versus Chiwawa natural collections is 76%. This compares with a median pairwise percentage of 79% among only Chiwawa natural-origin collections. That is, there are nearly as many alleles shared between the hatchery-origin and natural-origin collections as there are among the natural-origin collections themselves. There is also a narrowing of differences between natural- and hatchery-origin fish from the same collection years from 1993 (76% shared alleles) through 2006 (83% shared alleles).

If allelic differentiation among collections is a function of genetic drift, we would expect a positive correlation between the number of years between two collections and the allele sharing distance. That is, if genetic drift is the primary cause of allele frequency differences between two collections, the greater the number of years between the two collections the larger the allele-sharing distance. For both the natural- and hatchery-origin collections we examined the relationship between the number of years between a pair of collections and the collections' allele-sharing distance (Figure 3). Although the relationship between time interval and allele distance appears to be a positive function in the natural collections, the slope of the regression line is 0.0017, and is not significantly different from zero. Furthermore, the correlation coefficient (r^2) equals 0.1068, which means that the time interval between collections accounts for only 10% of the pairwise differences in allelic distance. The hatchery-origin collections do show a significantly positive slope (0.0037; $p = 0.0254$) and a regression coefficient nearly three times greater than that for the natural-origin collections. However, the correlation coefficient is still relatively small ($r^2 = 0.3290$), indicating that the time interval between collections accounts for one-third of the pairwise differences in allelic distance. The results suggest that if genetic drift is a factor in allelic differentiation between collections, it is only a minor factor, and appears to have affected the hatchery-origin collections more than the natural-origin collections.

If four-year-old fish dominate each collection year, we would expect a closer relationship among collections that are spaced at intervals of four years. The average percentage of alleles shared between two natural-origin collections that are separated by four years or a multiple of four years is 81%, compared with 78% for natural-origin collections separated by years that are not divisible by four. Likewise, for hatchery-origin collections the average percentage of alleles shared is 80% and 75% for collections separated by years divisible and not divisible by four, respectively. Although the percent differences described above are relatively small, they are consistent with the idea that allelic differences between collections are a function of year-to-year variability among different cohorts of four year-old fish.

Summary – The allele frequencies within and between natural- and hatchery-origin collections are significantly different, but there does not appear to be a robust signal indicating that the recent natural-origin collections have diverged greatly from the pre- or early post-supplementation collections. Genetic drift will occur in all populations, but does not appear to be a major factor with the Chiwawa collections. We propose that the differences among collections are a function of differences in allele frequencies among cohorts of the four year-old fish that dominate each collection.

Hatchery Broodstock Versus Natural (In-River) Spawners

We address the following questions with the spawner data set:

1. Are there changes in allele frequencies and allele sharing distances in the natural spawning collections from pre-supplementation to today?
2. Are there changes in allele frequencies and allele sharing distances in the hatchery broodstock collections from early supplementation to today?
3. Are there significant differences in allele frequencies and large allele sharing distances between hatchery and natural spawning adults from a collection year, and has this pattern changed through time?

Genic Differentiation Tests – For the most part there are significant differences in allele frequencies among collections for both the hatchery broodstock and natural spawners (Table 4), and these differences are consistent with the origin data set (Table 3). There are four collection years with paired samples (2001, 2004-2006) where we can compare allele frequency differences between the hatchery broodstock and natural spawners, within the same year. The 2001 hatchery broodstock and natural spawner collections have significantly different allele frequencies, but the level of significance decreased from 2001 to 2004, and become non-significant in 2005 and 2006 (Table 4). This indicates that by 2005, the hatchery broodstock and natural spawners collections were effectively sampling from the same population of fish. Additionally, the percentage of alleles shared between the hatchery broodstock and the natural spawners increased from 76% in 2001 to 86% in 2006 (allele sharing distance matrix, not shown). From this analysis, we conclude that although there are year-to-year differences in allele frequencies within the natural and hatchery spawner collections, *there appears to be a convergence of allele frequencies within collection-year, between the natural and hatchery spawner populations*.

Linkage Disequilibrium – Linkage disequilibrium is the correlation of alleles between two loci, and can occur for several reasons. If two loci are physically linked on the same chromosome, than alleles from each of these loci should be correlated. However, linkage between two loci can occur as a result of population bottlenecks, small population sizes, and natural selection. If any of these conditions had occurred or were occurring within the Chiwawa River system, we would expect to find substantial linkage disequilibrium in many or perhaps all Chiwawa collections. However, many Chiwawa collections, especially the natural-origin collections, do not show linkage disequilibrium (Table 1), and it would appear that the linkage disequilibrium within certain Chiwawa collections is not a function of the processes listed above. Linkage disequilibrium can also result if the collection is composed of an admixture. That is, if two or more reproductively isolated populations are combined into a single collection, the collection will show linkage disequilibrium. Each broodstock and natural spawning collection is composed of natural- and hatchery-origin fish. If these hatchery- and natural-origin fish are drawn from the same population, the spawning collections should not show substantial linkage disequilibrium. However, if the hatchery- and natural-origin fish are from different populations (i.e., full hatchery – natural integration has not been achieved), the spawning collections should show substantial linkage disequilibrium.

There are only three Chiwawa spawning collections that are not composed of both hatchery- and natural-origin samples: 1989 (natural-origin, natural spawner), 1993 (natural-origin, hatchery broodstock), and 2001 (natural-origin, natural spawner). Of the 10 spawning collections with both hatchery- and natural-origin fish, seven show significant linkage disequilibrium. Two of the three collections that did not show linkage disequilibrium are the 1996 and 1998 hatchery broodstock collections, which are composed of only seven natural- and six hatchery-origin fish, and two natural- and 19 hatchery-origin fish, respectively. Within the hatchery broodstock collections with linkage disequilibrium, the percent of loci pairs showing linkage decreased from 32% in 2000 to 13% in 2001 and 2004, to only 1% and 5% in 2005 and 2006, respectively (Table 1). If the homogenization of allele frequencies of natural- and hatchery-origin fish was increasing from 2000 to 2006, we would expect a decrease in linkage disequilibrium among the broodstock collections. This is what occurred within the hatchery broodstock collections, but did not occur within the natural spawner collections, where the percent of loci pairs showing linkage was 18% in 2004, 6% in 2005, and 10% in 2006 (Table 1). Furthermore, the 2001 natural spawner collection, with no hatchery-origin component showed linkage disequilibrium with 9% of loci pairs.

There is no correlation between percent of loci pairs showing linkage disequilibrium and percent of broodstock composed of hatchery-origin fish ($r^2 = 0.0045$). Furthermore, the natural spawner and hatchery broodstock collections were each composed of roughly the same average percentage of hatchery-origin fish (57% and 53%, respectively). If the decrease in linkage disequilibrium among the hatchery broodstock collections from 2000 to 2006 was a result of a homogenization of allele frequencies of natural- and hatchery-origin fish in the broodstock, the same degree of homogenization did not occur within the natural spawner collections. This would occur if natural- and hatchery-origin fish spawning within the river remain segregated, either by habitat or by fish behavior.

Summary – As with the origin data set, there are significant allele frequency differences within and between hatchery broodstock and natural spawner collections. However, in recent years the allele frequency differences between the hatchery broodstock and natural spawner collections has declined. Furthermore, based on linkage disequilibrium, there is a genetic signal that is consistent with increasing homogenization of allele frequencies within hatchery broodstock collections, but a similar homogenization within the natural spawner collection is not apparent. These data suggest that there exists consistent year-to-year variation in allele frequencies among hatchery and natural spawning collections, but there is a trend toward homogenization of the allele frequencies of the natural- and hatchery-origin fish that compose the hatchery broodstock.

Four Treatment Groups

Analyses of genetic differences between hatchery (broodstock) and natural spawner collections is confounded by the fact that each these two groups are composed of fish of natural- and hatchery-origin. To understand the effects of hatchery supplementation on *natural-origin fish that spawn naturally*, we needed to divide the Chiwawa data set into four mutually exclusive groups: (1) hatchery-origin hatchery broodstock, (2) hatchery-origin natural spawner, (3) natural-origin hatchery broodstock, and (4) natural-origin natural spawner, with each group consisting of multiple collection years, for a total of 25 different groups.

Allele-sharing and Nonmetric Multidimensional Scaling –As with previous analyses discussed above, we constructed a pairwise allele-sharing distance matrix for all collections from each of these treatment groups and subjected this matrix to a nonmetric multidimensional scaling analysis, restricting the analysis to two dimensions. Figure 4 shows that five outlier groups dominate the allele-sharing distances within this data set. These outlier groups are also present in Figure 2, as discussed above, and Figure 2 and 4 resemble each other because the same fish are included in each analysis. The difference between Figures 2 and 4 is that in Figure 4 the fish are grouped into collection year and the four treatment groups, rather than collection year and two treatment groups (hatchery- versus natural-origin).

Figure 4 does not provide useful resolution of the groups within the polygon, because the outlier groups dominate the allele sharing distances. We removed the five outlier groups from Figure 4, recalculated the allele sharing distances and subjected this new matrix to a multidimensional scaling analysis (Figure 5). Figure 5 shows separation among the 2001, 2004-2006 collections, but this separation does not necessarily indicate that within-year collections are more similar to each other than any collection is to a collection from another year. For example, the 2006 natural-origin natural spawner and the 2005 natural-origin hatchery broodstock collections share 81% alleles, while the 2006 natural-origin natural spawner and 2006 hatchery-origin hatchery broodstock collections share 75% alleles. There does not appear to be any discernable pattern of change in allele-sharing distance among the collections relevant to pre- or post-supplementation. Although the 1989 pre-supplementation natural-origin collection appears distinct (Figure 5), the 1993 natural-origin hatchery broodstock collection appears quite similar to the 2005 and 2006 natural-origin collections (Figure 5). The 1993 natural-origin hatchery broodstock collection, although not technically pre-supplementation, is composed of fish whose ancestry cannot be traced to any Chiwawa hatchery fish. Therefore, there is no clear pattern of allele sharing change from pre-supplementation to recent collections.

There does appear to be some change in the average percentage of alleles shared within the 2001 to 2006 collections, with an increase from 74% in 2001 and 2004 to 78% and 79% in 2005 and 2006, respectively. The results provided by this analysis are consistent with the results presented in the origin and spawner data sets. That is, there are allele frequency and allele sharing differences among the collections, but analyses do not strongly suggest that these differences are a function of the supplementation program. Furthermore, there is also a weak signal that the hatchery and natural collections within the most recent years are more similar to each other than in the previous years.

Overall Genetic Variance – Although there are signals of allelic differentiation among Chiwawa River collections, there are no robust signs that these collections are substantially different from each other. We used two different analyses to measure the degree of genetic variation that exists among individuals and collections within the Chiwawa River. First, we conducted a principal component analysis using all Chiwawa samples with complete genotypes (i.e., no missing alleles from any locus). Although the first two principal component axes account for only 10.5% of the total molecular variance, a substantially greater portion of that variance is among individual fish, regardless of their identity, rather than among hatchery and natural collections (Figure 6). The variances in principal component scores among individuals are 11 and 13 times greater than the variance in scores among collections, along the first and second axes, respectively.

Second, we conducted a series of analyses of molecular variance (AMOVA) to ascertain the percentage of molecular variance that could be attributed to differences among collections. We organized these analyses to test also for differences in the hierarchical structure of the data. That is, we tested for differences among collections using the following framework:

- No organizational structure – all 25 origin-spawner collections considered separately
- Origin-spawner collections organized into 10 collection year groups
- Origin-spawner collections organized into 2 breeding location groups (hatchery versus natural)
- Origin-spawner collections organized into 2 origin groups (hatchery versus natural)
- Origin-spawner collections organized into the 4 origin-spawner groups

It is clear from this analysis that nearly all molecular variation, no matter how the data are organized, resides within a collection (Table 5). The percentage of total molecular variance occurring within collections ranged from 99.68% to 99.74%. The among group variance component was limited to less than 0.26% and in all organizational structures, except “no structure,” the among group percentage was not significantly greater than zero. Furthermore, none of the organizational structures provided better resolution than “no structure” in terms of accounting for molecular variance within the data set. *These results indicate that if there are significant differences among collections of Chiwawa fish, these differences account for less than one percent of the total molecular variance, and these differences cannot be attributed to fish origin or spawning location.*

Summary and Conclusions

We reject the null hypothesis that the allele frequencies of the hatchery collections equal the allele frequencies of the natural collections, which equals the allele frequency of the donor population. Furthermore, because the allele-sharing distances are not consistent within and among collections years, we also reject the second stated hypothesis discussed above. However, there is an extremely small amount of genetic variance that can be attributed to among collection differences. The allelic differentiation that does exist among collections does not appear to be a function of fish origin, spawning location, genetic drift, or collection year. Figure 5 and related statistics does suggest that hatchery and natural collections in 2005 and 2006 are more similar to each other than previous years’ collections, and this would be expected in a successful integrated hatchery supplementation program.

Since each of these collection years are generally composed of four-year-old fish, the differentiation among these collections for the most part is differentiation among specific cohorts. The slightly greater percentage of alleles shared among collections that are separated in time by multiples of four years, compared with collections that are not separated in time as such, suggests that cohort differences may be the most important factor accounting for differences in allele frequencies among collections.

<u>Task 4:</u> Develop a model of genetic drift.

See Task 3

<u>Task 5:</u> Analyze spring Chinook population samples from the Chiwawa River and Chiwawa Hatchery from multiple generations.

See Task 3

<u>Task 6:</u> Analyze among population differences for upper Wenatchee spring Chinook.

Supplementation of the Chiwawa River spring Chinook population may affect populations within the Wenatchee River watershed other than the Chiwawa River stock. If the stray rate for Chiwawa hatchery-origin fish is greater than that for natural-origin fish, an increase in gene flow from the Chiwawa population into other populations may result. If this gene flow is high enough, Chiwawa River fish may alter the genetic structure of these other populations. Records from field observations indicate that hatchery-origin fish are present in all major spawning aggregates (A.R Murdoch, unpublished data), and these fish are successfully reproducing (Blankenship et al 2006). The intent of this task is to investigate if there have been changes to the genetic structure of the spring Chinook stocks within upper Wenatchee tributaries during the past 15-20 years, and if changes have occurred, are they a function of the Chiwawa River Supplementation Program? Therefore, we ask the following two questions:

1. Are allele frequencies within populations in the upper Wenatchee stable through time? That is, is there significant allelic differentiation among collections within upper Wenatchee populations?
2. Are the recent collections from the upper Wenatchee populations more similar to the Chiwawa population than earlier collections from the same populations?

For this task we analyzed natural spawning collections from the White River (natural-origin), Little Wenatchee River (natural-origin), Nason Creek (natural-origin), and

Wenatchee mainstem (hatchery-origin), and hatchery collections from Leavenworth NFH and Entiat River NFH (Table 1). We also included in the analysis the natural- and hatchery-origin collections from the Chiwawa River. There are no repeated collections from Leavenworth, Entiat, Little Wenatchee, and Wenatchee mainstem (Table 1), so for many of the analyses we have limited our discussion to the Chiwawa River, White River, and Nason Creek collections. Furthermore, genetic structure of the Little Wenatchee collection, which consisted of only 19 samples, was unexpectedly quite different from the other collections. For example, the F_{ST} statistic measures the percent of total molecular variation that can be attributed to differences between populations. The median F_{ST} for all pairwise combinations of collections from all populations, except Little Wenatchee (33 populations, 528 individual F_{ST} statistics) equals 0.010 (1%), with a range of 0.000 to 0.037 (Table 6). The median F_{ST} for the Little Wenatchee paired with all other collections (33 individual F_{ST} statistics) equals 0.106 (10.6%), with a range of 0.074 to 0.121. The ten-fold increase in the F_{ST} statistic indicates that either the Little Wenatchee spring Chinook is unique among the upper Wenatchee River stocks, or this 1993 collection is somehow aberrant. Therefore, we exclude the Little Wenatchee collection from many other analyses.

Population Differentiation – Table 3 provides the levels of significance for all pairwise genic differentiation tests. Most between-collection comparisons are highly significant, with no pattern of increasing or decreasing differentiation with time, and no differences when comparisons are made with Chiwawa hatchery- versus Chiwawa natural-origin fish. For example, excluding the outlier 1996 and 1998 Chiwawa hatchery- and natural-origin collections, Nason Creek showed highly significant allele frequency differences between the Chiwawa hatchery- and natural-origin collections at 100% and 86% of the comparisons, respectively. The same comparisons with the White River produced 100% and 93% highly significant allele frequency comparisons, respectively. Allele frequencies between Nason Creek and White River were likewise differentiated from each other.

The collection allele frequencies within the upper Wenatchee system are significantly different, and these differences do not appear to change as a function of time (Table 3). Nason Creek shows greater within-population year-to-year variation in allele frequencies than does the White River, with 47% of the pairwise comparisons showing highly significant differences, compared with only 13% for the White River. However, the 2005 and 2006 collections from the White River appear to be somewhat more differentiated from not only each other, but from the earlier collections from the White River.

Despite the high degree of temporal and spatial structure suggested by the genic differentiation tests, as described above for within-Chiwawa analysis (Task 3), most of the genetic variation within this data set occurs within populations, rather than between populations (Table 6). The F_{ST} values for most population comparisons are between 0.01 and 0.02, indicating 1% to 2% among-population variance, with the remaining 98% to 99% variance occurring within populations. The White River shows the highest median F_{ST} among the natural-origin collections, equal to 0.014, compared with 0.009 for both the Nason Creek and Chiwawa natural-origin collections. The median F_{ST} for the Chiwawa hatchery-origin collections (0.012) was higher than that for the Chiwawa natural-origin collections.

Table 7 summarizes the information from the F_{ST} analyses, under five different temporal and spatial scenarios. Under all scenarios, over 99% of the molecular variance is within populations. There is significantly greater spatial structure among populations ("Origin") in 2005 and 2006 than from 1989 to 1996. That is, there appears to be more spatial structure among the Chiwawa hatchery-origin, Chiwawa natural-origin, White River, and Nason Creek now, than in 1989 to 1996, despite the potential homogenizing and cumulative effect of hatchery strays. However, we stress that the amount of molecular variance associated with the among population differences, despite being significantly greater than 0.00%, is limited to only 0.43%.

Allele-sharing and Nonmetric Multidimensional Scaling – As in the Chiwawa River data discussed above, we constructed an allele-sharing distance matrix and then subjected that matrix to a multidimensional scaling analysis (Figure 7). Consistent with all previously discussed multidimensional scaling analyses, the 1996 and 1998 adult, and the 1994 smolt collections are outliers. There is clear separation between the White River collections and all other natural-origin and Chiwawa hatchery-origin collections, indicating that there are more alleles shared among the Nason Creek and Chiwawa collections, than with the White River collections. Furthermore, there is a slight separation between the Chiwawa natural-origin natural spawner collections and Nason Creek collections, suggesting different groups of shared alleles between these populations. There is more variation in the allele-sharing distances among collections involved with the Chiwawa hatchery (origin or broodstock) than any of the natural-origin collections, even if we exclude the 1994, 1996, and 1998 collections. This suggests that there is more year-to-year variation in the composition of hatchery-origin and hatchery broodstock than within natural-origin populations throughout the upper Wenatchee. All Wenatchee mainstem fish are hatchery-origin, and if these fish are from the Chiwawa Supplementation Program (rather than from Leavenworth), it is not unexpected that this collection would be plotted within the Chiwawa polygon (Figure 7).

Assignment of Individual to Populations – Finally, we conducted individual assignment tests whereby we assigned each individual fish to a population, based on a procedure developed by Rannala and Mountain (1997) (Table 8 and 9). Individual fish may be correctly assigned to the population from which they were collected, or incorrectly assigned to a different population. Incorrect assignments may occur if the fish is an actual migrant (i.e., source population different from population where collected), or because the genotype for that fish matches more closely with a population different from its source. If there are many individuals from a population incorrectly assigned to populations other than its source population, that original population is either unreal (i.e., an admixture), or there is considerable gene flow between that population and other populations. Furthermore, in assigning individuals to populations, we can either accept the assignment with the highest probability, regardless of how low that probability may be, or we can establish a more stringent criterion, such as to not accept an assignment unless the posterior probability is equal to or greater than 0.90. This value is roughly equal to having the likelihood of the most-likely population equal to 10 times that of the second most-likely population.

We provide a summary of the assignments in Tables 8 and 9. On average, nearly 50% of the fish are assigned incorrectly if we accept all assignments (Table 8), but the incorrect assignment rate drops to roughly 10% when we accept only those assignments with probabilities greater than 0.90. However, with this more stringent criterion, nearly 64% of the fish go unassigned. These results indicate that the allele frequency distributions for these populations are very similar, and it would be very difficult to assign an individual fish of unknown origin to the correct population. If all fish are assigned, there is a 50% chance, overall, of a correct assignment. If you accept only those assignment with the 0.90 criterion, nearly two-thirds of the fish would be unassigned, but there is a 90% chance of correctly assigning those fish that are indeed assigned.

Of all the populations in the data set, there are fewer errors associated with assigning fish to the White River. If all fish are assigned (Table 8), 72% of those fish assigned to the White River, are actually from the White River (115 fish out of a total of 159 fish assigned to the White River). This compares to a rate of only 52% and 53% for Nason Creek and Chiwawa natural-origin, respectively, and 60% for the Chiwawa hatchery-origin collections. With the 0.90 criterion (Table 9), 89% of the fish assigned to the White River, are actually from the White River, compared with 70% and 65% for Nason Creek and Chiwawa natural origin, respectively, and 81% for the Chiwawa hatchery origin.

When all fish are assigned, most of the incorrectly assigned fish from Nason Creek and White River are assigned to Chiwawa River, at roughly equal frequencies to the hatchery- and natural-origin populations. Incorrectly assigned fish to other populations occur at a slightly higher rate in Nason Creek than in the White River. However, when only those fish meeting the 0.90 criterion are assigned (Table 9), incorrectly assigned fish from Nason Creek are distributed among White and Chiwawa Rivers, as well as Leavenworth NFH, and the Entiat NFH. Mis-assignment to the Chiwawa hatchery-origin was the highest among the Nason Creek collections, equal to nearly 14%. This contrasts with the White River where mis-assignments do not exceed 7% anywhere, and there is a roughly even distribution of mis-assignments among Nason Creek and Chiwawa River collections.

Summary and Conclusions – There is little geographic or temporal structure among populations within the upper Wenatchee systems. Among population molecular variance is limited to 1% or less. The little variance that can be attributed to among populations indicates that the White River is more differentiated from the Chiwawa and Nason populations than these populations are from each other. Furthermore, although we cannot rule out a hatchery effect on the Nason Creek and White River populations, there is no indication there has been any temporal changes in allele frequencies within these populations that can be attributed directly to the Chiwawa River Supplementation Program. In fact, Table 7 weakly suggests that there is more differentiation among these populations now, than there was before or at the early stages of Chiwawa supplementation.

Therefore, returning to our two original questions, there are significant differences in allele frequencies among collections within populations, and among populations within the upper Wenatchee spring Chinook stocks. However, these differences account for a very small portion of the overall molecular variance, and these populations overall are very similar to each other. There is no evidence that the Chiwawa River Supplementation Program has changed the allele frequencies in the Nason Creek and White River populations, despite the presence of hatchery-origin fish in both these systems. Finally, of all the populations within the Wenatchee River, the White River appears to be the most distinct. Yet, this distinction is more a matter of detail than of large significance, as the median F_{ST} between White River collections and all other collections (except the Little Wenatchee) is less than 1.5% among population variance.

Task 7: Calculate the inbreeding effective population size using demographic data for each sample year, and document the ratio of census to effective size.

This analysis was completed by Williamson et al. (submitted).

Task 8: Calculate LD N_b using genetic data for each sample year, and document the ratio of census to effective size.

We report N_e estimated for the Chiwawa River collections based on the bias correction method of Waples (2006) implemented in LDNe (Do and Waples unpublished). N_e estimates based on LD are best interpreted as the effective number of breeders (N_b) that produced the sample (Waples 2006).

For collections categorized by spawning location (i.e., hatchery broodstock or natural), estimates of N_b are shown in Table 10. Considering the hatchery broodstock, N_b estimates range from 30.4 (1996) to 274.3 (2005). To obtain N_e /N ratios, the N_b estimate is multiplied by four (i.e., mean generation length) and divided by the total in river (i.e., NOS [natural-origin spawners] plus HOS [hatchery-origin spawners]) census data from four years prior (i.e., major cohort; see Table 2). The observed N_e /N ratios for the broodstock collections range from 11% to 54% of the census estimate, excluding the 2000 collection which is 106%. A ratio greater than one is possible under special circumstances, and certain artificial mating schemes within hatcheries can inflate N_e above N; yet, it is unknown if this is the case for this collection. While no direct comparisons are possible, the N_b estimates reported by Williamson et al. (submitted) for Chiwawa broodstock collections from 2000 – 2003 are similar in magnitude to our estimates. For Chiwawa natural spawner collections, the N_b estimates range from 5.2 (1989) to 231.5 (2005), with observed N_e /N ratios of 22% - 48% of the census estimate.

Task 9: **Calculate N_b using the temporal method for multiple samples from the same location.**

Estimates of effective number of breeders (N_b) derived from Waples' (1990) temporal method are shown in Tables 11-13. Eight collection years were used for the Chiwawa broodstock collections (Table 11). The harmonic mean of all pairwise estimates of N_b ($\tilde{N}_b$) was 269.4. This estimate is the contemporary N_e for Chiwawa broodstock collections. For the five collection years of Chiwawa in-river spawners (Table 12), the estimated $\tilde{N}_b$ = 224.2. This estimate is the contemporary N_e for Chiwawa River natural spawner collections. Since the Chiwawa Supplementation Program is integrated by design, we also performed another estimation of N_e using composite hatchery and natural samples. There are paired samples from 2004-2006. We combined genetic data for hatchery (HOS) and natural (NOS) origin fish from 2004 – 2006 to create a single Chiwawa River natural spawner sample for each year. The three composite samples from 2004 – 2006 were then analyzed using the temporal method (Table 13), resulting in a $\tilde{N}_b$ = 386.8. This estimate is the contemporary N_e for Chiwawa River.

Williamson et al. (submitted) estimated N_e using Waples' (1990) temporal method for Chinook captured in 2004 and 2005, and used age data to decompose brood years into consecutive cohorts from 2000 – 2003. They report for Chiwawa broodstock a $\tilde{N}_b$ = 50.4. This estimate is not similar to our Chiwawa broodstock estimate. However, if we analyze the hatchery-origin Chinook only, our estimate is $\tilde{N}_b$ = 80.1 for collection years 1989 – 2006 (data not shown). Williamson et al. (submitted) report for Chiwawa naturally spawning Chinook a $\tilde{N}_b$ = 242.7, which is slightly higher than our estimate for in-river spawners from 1989 – 2006, but lower than our estimate from combined NOS and HOS Chinook from 2004 – 2006 collection years.

Task 10: Use available data and the Ryman-Laikre and Wang-Ryman models to determine the expected change of N_e for natural spring Chinook salmon in the Wenatchee River due to hatchery operation.

N_e is generally thought to be between 0.10 and 0.33 of the estimated census size (Bartley et al. 1992; RS Waples pers. comm.). We used this range to generate an estimate of N_e for Chiwawa natural spawners prior to hatchery operation. For brood years 1989 – 1992, the arithmetic mean census size was N=962.7 (Table 2), resulting in an estimated N_e ranging from 96.3 – 317.7. The contemporary estimate of N_e calculated using genetic data for the Chiwawa in-river spawners is N_e=224.2 (Table 12), falling in the middle of the pre-hatchery range. The N_e /N ratio calculated using 224.2 and the arithmetic census of NOS Chinook from 1989 – 2005 is 0.42. A more appropriate contemporary N_e to compare with the pre-hatchery estimate (i.e., 96.3 – 317.7) is the combined NOS and HOS estimate from natural spawners, since the supplementation program is integrated. As discussed above, the contemporary estimate of N_e calculated using genetic data for Chiwawa NOS and HOS Chinook is N_e=386.8 (Table 13), which is slightly larger than the pre-hatchery range, suggesting the N_e has not declined during the period of hatchery operation. The N_e /N ratio calculated using 386.8 and the arithmetic census of NOS and HOS Chinook from 1989 – 2005 is 0.40. These results suggest the Chiwawa Hatchery Supplementation Program has not resulted in a smaller N_e for the natural spawners from the Chiwawa River.

Williamson et al. (submitted) argued that since their combined (i.e., broodstock and natural) N_e estimate was lower than the naturally spawning estimate, the supplementation program likely had a negative impact on the Chiwawa River N_e. We disagree with this interpretation of these data. Since the natural spawning component is mixed hatchery and natural ancestry, the N_e estimates from natural spawning data are the results that bear on possible hatchery impacts. The census data show the population declined in the mid 1990's and rebounded by 2000 (Table 2). This trend is reflected in the N_e results, as shown above, and Williamson et al. (submitted) clearly show in their Table 4 the N_e was lower in 2000 (N_e = 989) than it was in 1992 (N_e = 2683). Yet, the important comparison they make in our view was the natural spawning N_e versus the natural only component N_e (i.e., hypothetically excluding hatchery program). Williamson et al. (submitted) report the 1989 – 1992 N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) was essentially the same as the natural only component estimate, 2683 and 2776, respectively. This result is not surprising since no HOS fish were present between 1989 – 1992. They also report that the 1997 – 2000 N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) was N_e =989, while the natural-origin estimate of N_e in 1997 – 2000 was N_e = 629. Since the natural-origin estimate of 629 is lower than 989, the N_e estimate from all in-river spawners, we argue that their analysis of demographic data show the N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) is larger only if the hatchery Chinook in the river are ignored.

Task 11: Use individual assignment methods to determine the power of self-assignment for upper Wenatchee River tributaries.

See "Assignment of Individual to Populations" in Task 6

Conclusions

Has the Chiwawa Hatchery Supplementation Program succeeded at increasing the census size of the target population while leaving genetic integrity intact? This is an important question, as hatcheries can impact natural populations by reducing overall genetic diversity (Ryman and Laikre 1991), reducing the fitness of the natural populations through relaxation of selection or inadvertent positive selection of traits advantageous in the hatchery (Ford 2002; Lynch and O'Hely 2001), and by reducing the reproductive success of natural populations (McLean et al. 2003). The census data presented here show that the current natural spawning census size is similar to the pre-supplementation census size. Despite large numbers of hatchery-origin fish on the Chiwawa River spawning grounds, the genetic diversity of the natural-origin collections appear unaffected by the supplementation program; heterozygosities are high, and contemporary N_e is similar (perhaps slightly higher) than pre-supplementation N_e. We did find significant year-to-year differences in allele frequencies in both the origin and spawner datasets, but these differences do not appear to be related to fish origin, spawning area, or genetic drift. However, we do suggest that cohort differences may be the most important factor accounting for differences in allele frequencies among collections.

The main objective of this study was to determine the potential impacts of the hatchery program on natural spring Chinook in the upper Wenatchee system. We did this by analyzing temporally replicated collections from the Chiwawa River, and by comparing genetic diversity prior to the presumed effect of the Chiwawa Hatchery Supplementation Program, with contemporary collections. We report that the genetic diversity present in the Chiwawa River is unchanged (allowing for differences among cohorts) from 1989 – 2006, and the contemporary estimate of the effective population size (N_e) using genetic data is approximately the same as the N_e estimate extrapolated from 1989 – 1992 census data (i.e., pre-hatchery collection years). We observed substantial genetic diversity, with heterozygosities ~80% over thirteen microsatellite markers. Yet, temporal variation in allele frequencies was the norm among temporal collections from the same populations (i.e., location). The genetic differentiation of replicated collections from the same population is likely the result of salmon life history in this area, as four-year-old Chinook comprise a majority of returns each year. The genetic tests are detecting the differences of contributing parents for each cohort. An important point related to the temporal variation, is that the hatchery broodstock is composed in part of the natural origin Chinook from the Chiwawa River. When we compared the genetic data (within a collection year) for Chinook brought into the hatchery as broodstock with the Chinook that remained in the river (years 2001, 2004 – 2006), there was a trend of decreasing statistical differences in allele frequencies from 2001 to 2004, and no differences were detected for 2005 and 2006. While the replicated collections may have detectable differences in allele frequencies, those differences reflect actual differences in cohorts, not the result of hatchery operations, and the hatchery broodstock collection method captures the differences in returning Chiwawa River spring adults each year. We conclude from these results that the genetic diversity of natural spring Chiwawa Chinook has been maintained during the Chiwawa Hatchery Supplementation Program.

We observe slight, but statistically significant population differentiation between Chiwawa River, White River, and Nason Creek collections. Murdoch et al (2006) and Williamson et al. (submitted) also observed population differentiation between Chiwawa River, White River, and Nason Creek collections. Yet, 99.3% of the genetic variation observed was within samples, very little variance could be attributed to population differences (i.e., population structure). The AMOVA analysis and poor individual assignment results suggest the occurrence of gene flow among Wenatchee River locations or a very recent divergence of these groups. While Murdoch et al. 2006 did not perform an AMOVA analysis, their F_{ST} results provide comparable data to our among-population results. Murdoch et al. 2006 report F_{ST} ranging from 2%-3% for pairwise comparisons between of Chiwawa, White, and Nason River collections. Since F_{ST} is an estimate of among-sample variance, these results also imply a majority of the genetic variance (i.e., 97%-98%) resides within collections. To provide further context for the magnitude of these variance estimates, we present the among-group data from Murdoch et al. 2006 comparing summer-run and spring-run Chinook from the Wenatchee River. They report that approximately 91% of observed genetic variance is within-collection for comparisons between collections of summer- and spring-run Chinook. Ultimately, the information provided by this and other reports will be incorporated into the management process for Wenatchee River Chinook. However, we would like to emphasize that the application of these genetic data to management is more about the goals related to the distribution of genetic diversity in the future than specific data values reported. If Chinook are collected at Tumwater Dam instead of within the upper Wenatchee River tributaries, a vast majority of the genetic variation present in the basin would be captured, although any differences among tributaries would be mixed. Alternatively, management policies could be crafted to promote and maintain the among-group genetic diversity that genetic studies consistently observe to be non-zero within the Wenatchee River.

We agree with Murdoch et al. (2006) that it appears hatchery Chinook are not contributing to reproduction in proportion to their abundance. Additionally, if the total census size (i.e., NOS and HOS combined) within the Chiwawa River does not continue to increase, genetic diversity may decline within this system, given the smaller N_e within the hatchery-origin collections compared with the natural-origin collections.

Acknowledgements

We would like to thank Denise Hawkins, Craig Busack, and Cheryl Dean for helpful comments regarding this project. This project was funded by Chelan County PUD and the Washington State General Fund.

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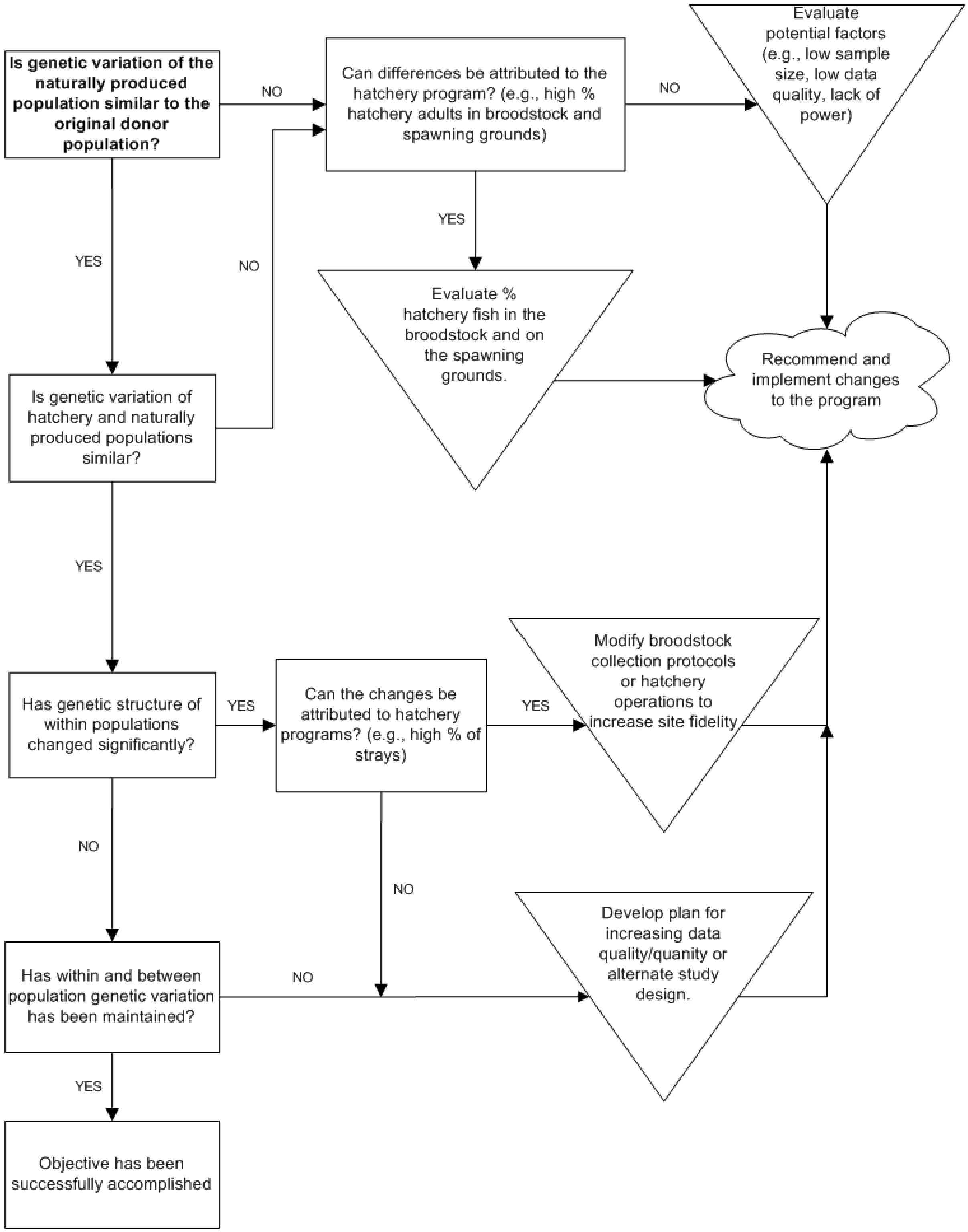

Figure 1. Conceptual process for evaluating potential changes in genetic variation in the Chiwawa naturally produced populations as a result of the supplementation hatchery programs (From Murdoch and Peven 2005).

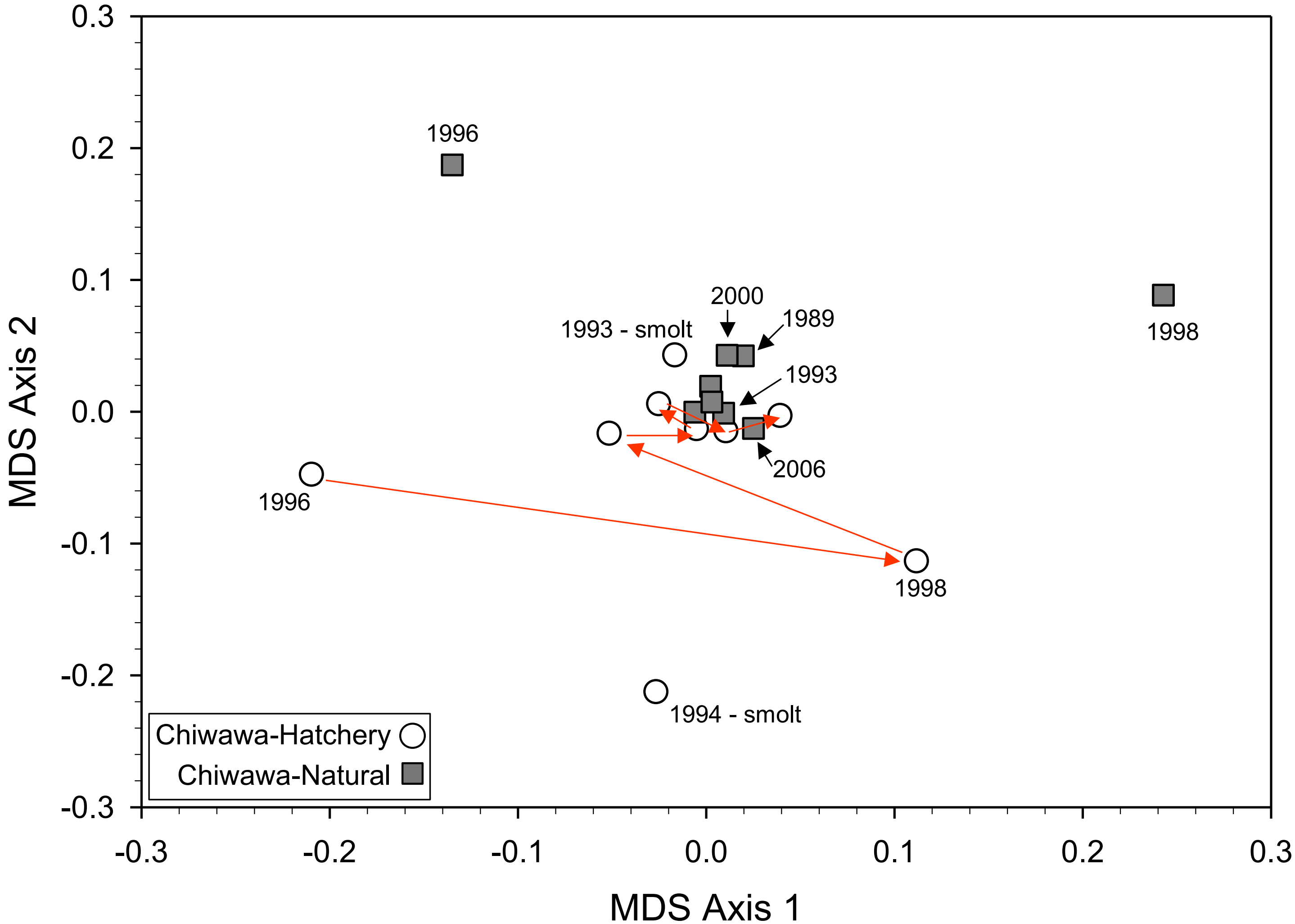

Figure 2. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by fish origin (i.e., hatchery versus natural). The red arrows connect consecutive hatchery-origin collections starting with the first adult collection (1996) and ending with the 2006 collection (see Table 1 for collection years).

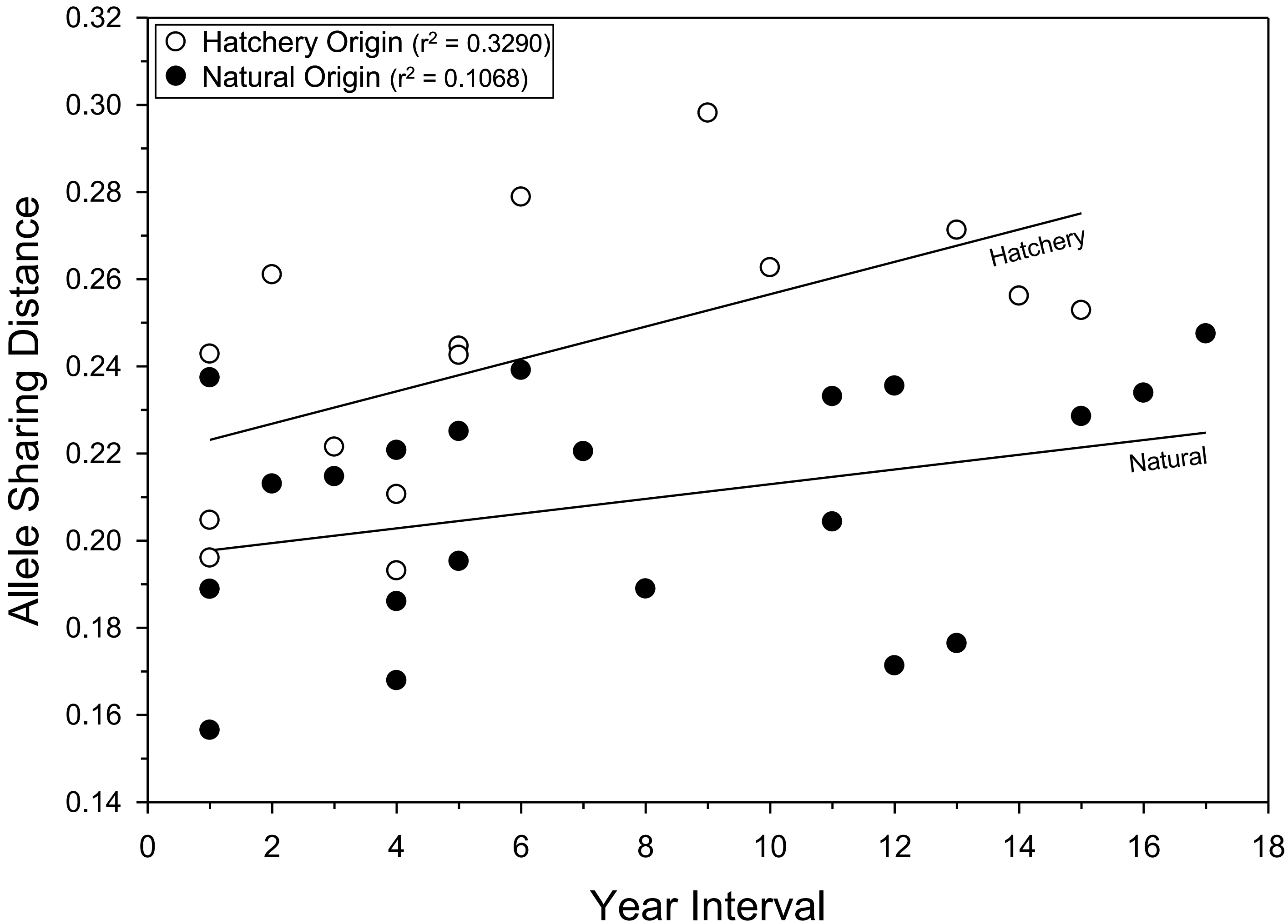

Figure 3. Relationships between the time interval in years and allele sharing distances, with each circle representing the pairwise relationship between two Chiwawa collections. Separate regression lines for the natural- and hatchery-origin collections. The slope for the natural-origin collection is not significantly different from zero (p=0.1483), while the slope for hatchery-origin collection is significantly greater than zero (p=0.0254) indicating a positive relationship between time interval and allele sharing distance.

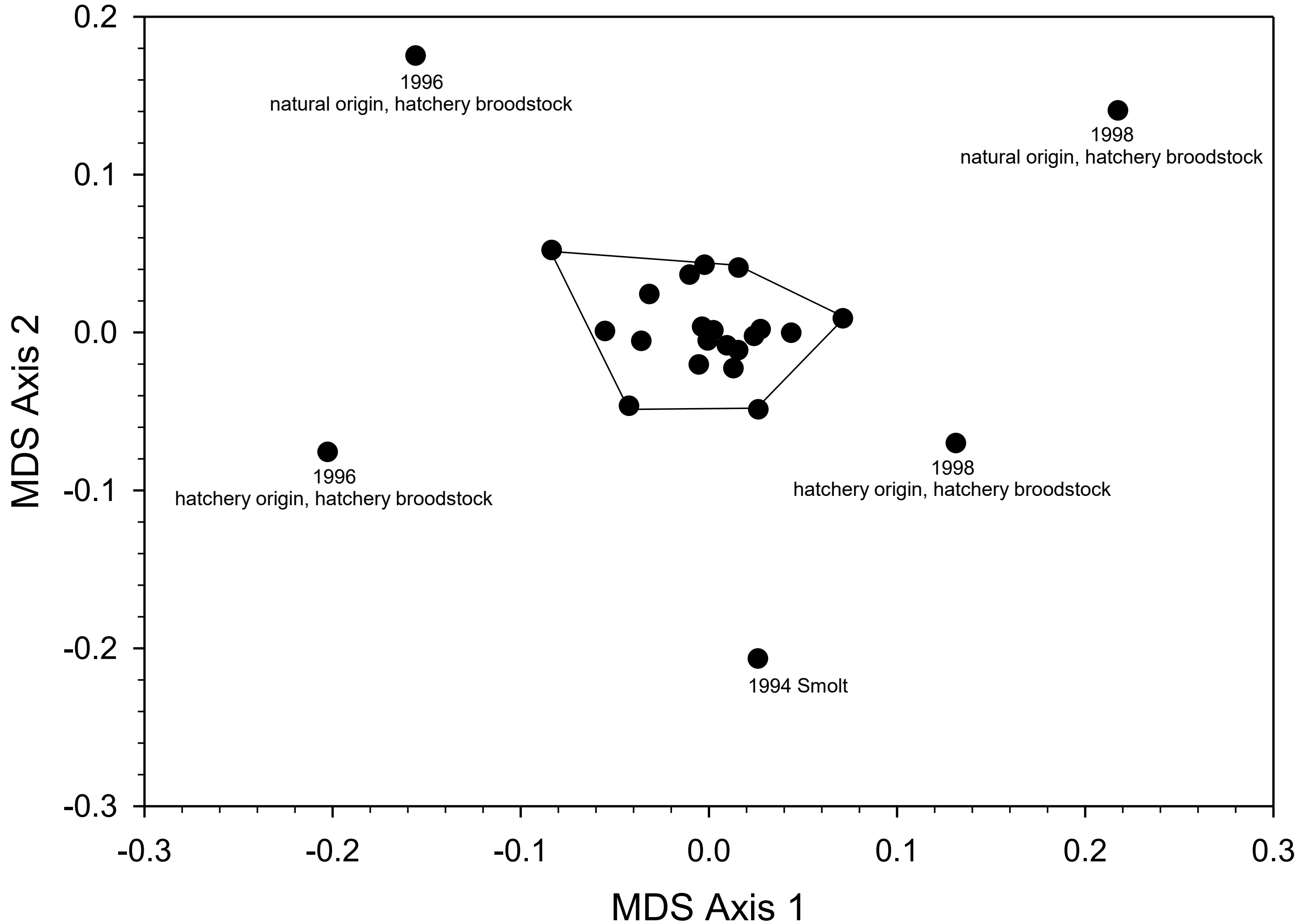

Figure 4. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by four treatment groups, as discussed in the text. Each circle represents a single collection within each of the four treatment groups, and the polygon encloses all groups that are not outliers. Each outlier group is specifically labeled.

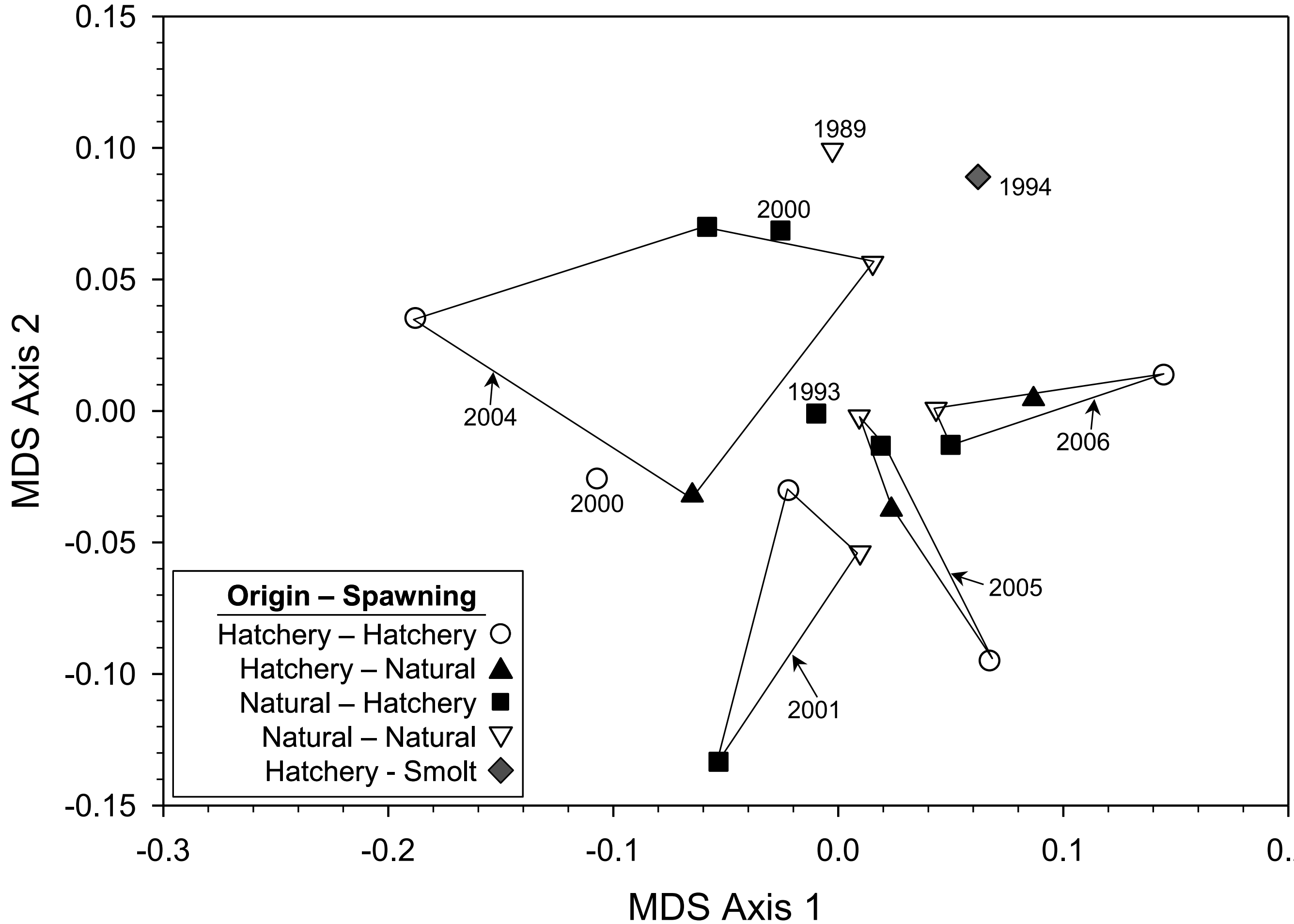

Figure 5. As in Figure 4, but allele-sharing distance matrix recalculated without the five outlier groups shown in Figure 4. Polygons group together treatment groups from the same collection year. Dates associated with symbols also refer to collection year. Collection years 2004-2006 included all four treatment groups, while collection year 2001 did not include a hatchery-origin natural spawner group. Legend is read as follows: Open circles refer to hatchery-origin hatchery spawner group, while filled box refers to natural-origin hatchery spawner group, and so on.

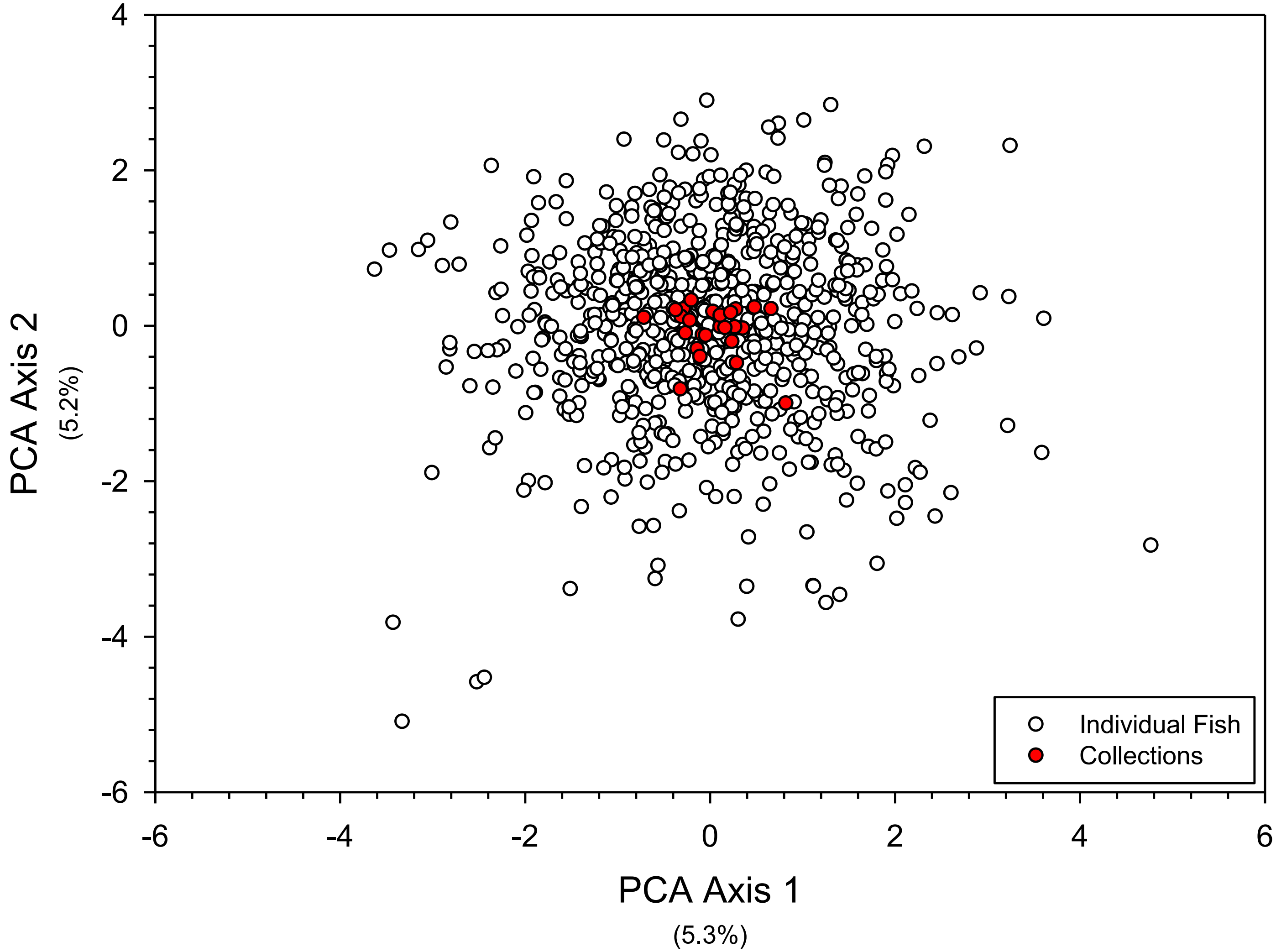

Figure 6. Principal component (PC) analysis of individual fish from the Chiwawa River. Only fish with complete microsatellite genotypes were included in the analysis (n = 757). Open circles are the PC scores for individual fish, and the filled circles are the centroids (bivariate means) for each of the 25 groups discussed in the text. PC axes 1 and 2 account for only 10.5% of the total molecular variance.

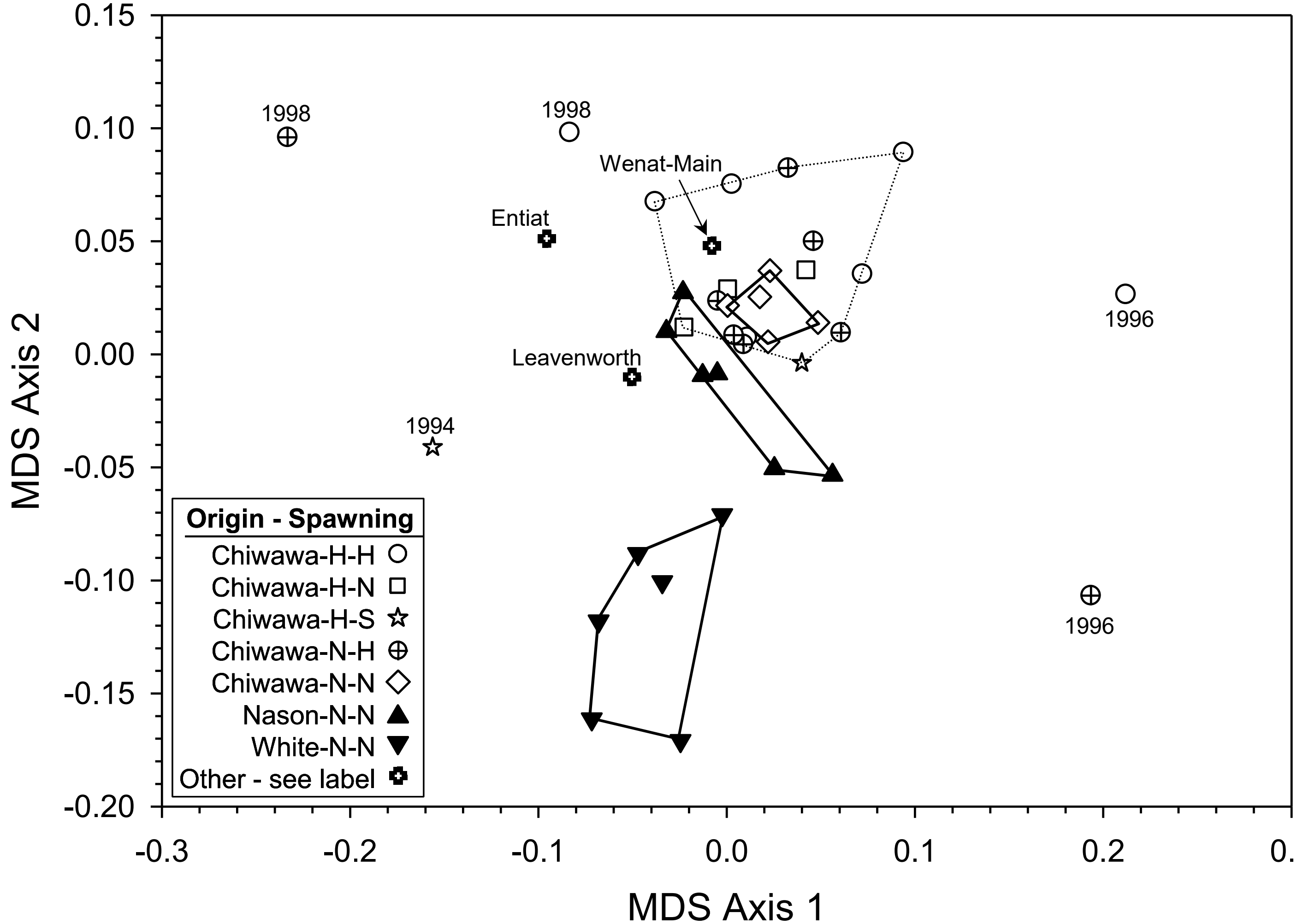

Figure 7. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa origin data set and all other non-Chiwawa collections, except Little Wenatchee River. Legend is read with abbreviations beginning with origin and then spawning location. H=hatchery, N=natural, and S=smolts. Polygons with solid lines enclose the natural-origin natural spawner collections from each population (i.e., river). The polygon with the dotted lines enclose all Chiwawa collections, except for the five outlier collections, as discussed in text.

Table 1 Summary of within population genetic data. Chiwawa collection data are summarized in A) by origin of the sample (i.e., clipped vs. non-clipped). All collection data are summarized in B) by spawning location (i.e., hatchery broodstock or on spawning grounds). Hz is heterozygosity, HWE is the statistical significance of deviations from Hardy-Weinberg expectations (* = 0.05, ** = 0.01, and *** = 0.001), LD is the proportion of pairwise locus tests (across all populations) exhibiting linkage disequilibrium (bolded values are statistically significant), and the last column is mean number of alleles per locus.

Collection	Sample size	Gene Diversity	Observed Hz	HWE	F_{IS}	LD	Mean # Alleles
A) Origin							
1993 Chiwawa Hatchery	95	0.77	0.79	***	-0.02	**0.86**	14.00
1994 Chiwawa Hatchery	95	0.76	0.77	***	-0.01	**0.91**	11.38
1996 Chiwawa Hatchery	8	0.75	0.81	-	-0.01	0.00	8.23
1998 Chiwawa Hatchery	27	0.81	0.82	-	0.00	0.04	12.62
2000 Chiwawa Hatchery	43	0.75	0.78	***	-0.01	**0.19**	12.46
2001 Chiwawa Hatchery	69	0.77	0.80	***	-0.02	**0.14**	15.31
2004 Chiwawa Hatchery	72	0.77	0.77	***	0.01	**0.45**	15.92
2005 Chiwawa Hatchery	91	0.79	0.82	*	-0.03	**0.05**	16.15
2006 Chiwawa Hatchery	95	0.80	0.84	***	-0.05	**0.49**	15.85
1989 Chiwawa Natural	36	0.76	0.78	-	0.01	0.00	12.77
1993 Chiwawa Natural	62	0.78	0.81	-	-0.02	0.04	15.85
1996 Chiwawa Natural	8	0.72	0.78	-	-0.02	0.00	7.54
1998 Chiwawa Natural	10	0.78	0.84	-	0.00	0.00	8.23
2000 Chiwawa Natural	39	0.78	0.79	***	0.00	**0.10**	14.00
2001 Chiwawa Natural	75	0.78	0.80	-	-0.03	0.03	15.31
2004 Chiwawa Natural	85	0.78	0.77	-	0.02	0.01	15.77
2005 Chiwawa Natural	90	0.79	0.79	-	0.01	0.01	16.15
2006 Chiwawa Natural	96	0.80	0.81	-	-0.01	0.01	16.46

Table 1 Within population genetic data analysis summary continued.

Collection	Sample size	Gene Diversity	Observed Hz	HW	F_{IS}	LD	Mean # Alleles
B) Spawning Location							
1993 Chiwawa Broodstock	62	0.78	0.81	-	-0.02	0.00	15.85
1996 Chiwawa Broodstock	16	0.75	0.79	-	-0.02	0.00	10.92
1998 Chiwawa Broodstock	37	0.82	0.83	-	0.00	0.01	14.38
2000 Chiwawa Broodstock	82	0.78	0.78	***	0.00	**0.32**	15.62
2001 Chiwawa Broodstock	89	0.78	0.80	*	-0.02	**0.13**	15.77
2004 Chiwawa Broodstock	61	0.77	0.76	*	0.02	**0.13**	14.92
2005 Chiwawa Broodstock	75	0.79	0.78	*	0.02	0.01	15.85
2006 Chiwawa Broodstock	89	0.80	0.83	-	-0.03	**0.05**	16.46
1989 Chiwawa River	36	0.76	0.78	-	0.01	0.00	12.77
2001 Chiwawa River	55	0.78	0.80	-	-0.02	**0.09**	14.00
2004 Chiwawa River	96	0.78	0.78	*	0.01	**0.18**	17.23
2005 Chiwawa River	106	0.79	0.82	*	-0.02	**0.06**	16.69
2006 Chiwawa River	102	0.80	0.83	***	-0.03	**0.10**	16.77
1989 White River	48	0.75	0.75	-	0.01	0.01	12.85
1991 White River	19	0.76	0.76	-	0.03	0.00	10.92
1992 White River	22	0.75	0.79	-	-0.02	0.01	11.00
1993 White River	21	0.75	0.69	*	0.10	0.00	10.15
2005 White River	29	0.75	0.77	-	-0.01	0.03	12.23
2006 White River	40	0.76	0.76	-	0.01	0.04	13.38

Table 1 Within population genetic data analysis summary continued.

Collection	Sample size	Gene Diversity	Observed Hz	HW	F_{IS}	LD	Mean # Alleles
1993 Little Wenatchee R.	19	0.84	0.85	-	0.02	0.00	11.23
1993 Nason Creek	45	0.78	0.80	-	-0.01	0.01	13.77
2000 Nason Creek	51	0.76	0.78	-	-0.02	**0.13**	13.92
2001 Nason Creek	41	0.79	0.81	-	-0.01	**0.08**	14.23
2004 Nason Creek	38	0.76	0.76	-	0.02	0.03	13.23
2005 Nason Creek	45	0.78	0.82	-	-0.04	0.03	14.92
2006 Nason Creek	48	0.80	0.82	-	-0.01	0.00	15.77
2001 Wenatchee River	32	0.79	0.80	*	0.00	0.04	12.85
2000 Leavenworth NFH	73	0.80	0.82	*	-0.02	**0.15**	16.23
1997 Entiat NFH	37	0.81	0.83	-	-0.01	**0.06**	14.38

Table 2 Demographic data for Chiwawa Hatchery and Chiwawa natural spring Chinook salmon. BS is census size of hatchery broodstock, pNOB is the proportion of hatchery broodstock of natural origin, NOS is the census size of natural-origin spawners present in Chiwawa River, HOS is the census size of hatchery-origin spawners present in Chiwawa River, Total is NOS and HOS combined, and pNOS is the proportion of spawners present in Chiwawa River of natural origin.

	Hatchery		In River			
Brood Year	BS	pNOB	NOS	HOS	Total	pNOS
1989	28	1	1392	0	1392	1.00
1990	18	1	775	0	775	1.00
1991	32	1	585	0	585	1.00
1992	78	1	1099	0	1099	1.00
1993	94	1	677	491	1168	0.58
1994	11	0.64	190	90	280	0.68
1995	0	0	8	50	58	0.14
1996	18	0.44	131	51	182	0.72
1997	111	0.29	210	179	389	0.54
1998	47	0.28	134	45	178	0.75
1999	0	0	119	13	132	0.90
2000	30	0.3	378	310	688	0.55
2001	371	0.3	1280	2850	4130	0.31
2002	71	0.28	694	919	1613	0.43
2003	94	0.44	380	223	603	0.63
2004	215	0.39	820	788	1608	0.51
2005	270	0.33	250	1222	1472	0.17

Table 3 Levels of significance for pairwise tests of genic differentiation among all hatchery- and natural-origin collections used in this analysis. HS = highly significant (P < 0.000095; the Bonferroni corrected p-value for an alpha = 0.05); * = P < 0.05 (nominal critical value for most statistical test); - = P > 0.05 (not significant). A significant result between pairs of populations indicates that the allele frequencies between the pair are significantly different. Results are read by comparing the collections along the rows to collections along columns. The top block for each section is a symmetric matrix, as it compares collections within the same group.

		Chiwawa – Hatchery Origin								
		1993	**1994**	**1996**	**1998**	**2000**	**2001**	**2004**	**2005**	**2006**
Chiwawa – Hat. Origin	**1993**		HS	*	HS	HS	HS	HS	HS	HS
	1994	HS		HS	HS	HS	HS	HS	HS	HS
	1996	*	HS		*	-	*	-	-	*
	1998	HS	HS	*		HS	HS	HS	HS	HS
	2000	HS	HS	-	HS		HS	*	HS	HS
	2001	HS	HS	*	HS	HS		HS	*	HS
	2004	HS	HS	-	HS	*	HS		HS	HS
	2005	HS	HS	-	HS	HS	*	HS		HS
	2006	HS	HS	*	HS	HS	HS	HS	HS	
Chiwawa – Natural Origin	**1989**	HS	HS	-	HS	HS	*	HS	HS	HS
	1993	HS	HS	-	HS	HS	-	HS	*	HS
	1996	*	HS	-	*	-	-	-	-	-
	1998	HS	HS	-	-	HS	*	*	*	-
	2000	HS	HS	-	HS	HS	HS	*	HS	HS
	2001	HS	HS	-	HS	HS	HS	HS	*	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	*	HS	*	HS
	2006	HS	HS	-	*	HS	HS	HS	HS	HS
Nason	**1996**	HS	HS	-	HS	HS	HS	HS	HS	HS
	2000	HS	HS	*	HS	HS	HS	HS	HS	HS
	2001	HS	HS	-	HS	HS	HS	HS	HS	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	HS	HS	HS	HS
	2006	HS	HS	-	*	HS	HS	HS	HS	HS
White	**1989**	HS	HS	HS	HS	HS	HS	HS	HS	HS
	1991	HS	HS	-	HS	HS	HS	HS	HS	HS
	1992	HS	HS	*	HS	HS	HS	HS	HS	HS
	1993	HS	HS	*	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	HS	HS	HS	HS
	2006	HS	HS	HS	HS	HS	HS	HS	HS	HS
Other	**Wen-M**	HS	HS	*	HS	HS	*	*	-	HS
	Leaven	HS	HS	*	HS	HS	HS	HS	HS	HS
	Entiat	HS	HS	*	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		Chiwawa – Natural Origin								
		1989	**1993**	**1996**	**1998**	**2000**	**2001**	**2004**	**2005**	**2006**
Chiwawa – Natural Origin	**1989**		-	-	-	-	*	*	*	*
	1993	-		-	*	*	*	HS	*	HS
	1996	-	-		-	-	-	-	-	-
	1998	-	*	-		*	*	HS	*	*
	2000	-	*	-	*		HS	-	HS	HS
	2001	*	*	-	*	HS		HS	*	HS
	2004	*	HS	-	HS	-	HS		HS	HS
	2005	*	*	-	*	HS	*	HS		*
	2006	*	HS	-	*	HS	HS	HS	*	
Nason	**1996**	*	*	-	*	*	HS	HS	HS	HS
	2000	HS	HS	HS	HS	HS	HS	HS	HS	HS
	2001	HS	*	-	*	HS	HS	HS	HS	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	*	*	-	*	HS	HS	HS	HS	HS
	2006	HS	HS	-	-	HS	HS	HS	HS	HS
White	**1989**	HS	HS	*	HS	HS	HS	HS	HS	HS
	1991	HS	HS	*	-	HS	HS	HS	HS	HS
	1992	HS	HS	-	*	HS	HS	HS	HS	HS
	1993	HS	*	-	*	HS	HS	HS	HS	HS
	2005	HS	*	*	*	HS	HS	HS	*	HS
	2006	HS	HS	*	HS	HS	HS	HS	HS	HS
Other	**Wen-M**	*	-	-	-	*	*	HS	*	*
	Leaven	HS	HS	*	*	HS	HS	HS	HS	HS
	Entiat	HS	HS	*	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		Nason					
		1996	2000	2001	2004	2005	2006
Nason	1996		HS	-	HS	-	*
	2000	HS		HS	HS	HS	HS
	2001	-	HS		*	-	*
	2004	HS	HS	*		*	HS
	2005	-	HS	-	*		-
	2006	*	HS	*	HS	-	
White	1989	HS	HS	HS	HS	HS	HS
	1991	*	HS	HS	HS	*	*
	1992	HS	HS	HS	HS	HS	HS
	1993	*	HS	HS	HS	HS	HS
	2005	*	HS	HS	HS	HS	HS
	2006	HS	HS	HS	HS	HS	HS
Other	Wen-M	HS	HS	HS	HS	*	HS
	Leaven	HS	HS	HS	HS	HS	HS
	Entiat	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		White						Other		
		1989	1991	1992	1993	2005	2006	Wen-M 2001	Leaven 2000	Entiat 1997
White	1989		-	*	-	HS	HS	HS	HS	HS
	1991	-		-	-	*	*	*	HS	HS
	1992	*	-		-	*	*	HS	HS	HS
	1993	-	-	-		*	*	HS	HS	HS
	2005	HS	*	*	*		*	HS	HS	HS
	2006	HS	*	*	*	*		HS	HS	HS
Other	Wen-M	HS	*	HS	HS	HS	HS		HS	HS
	Leaven	HS	HS	HS	HS	HS	HS	HS		HS
	Entiat	HS	HS	HS	HS	HS	HS	HS	HS	

Table 4 Probabilities (above diagonal) and levels of significance (below diagonal) for pairwise tests of genic differentiation among all Chiwawa hatchery broodstock and Chiwawa natural spawner collections used in this analysis. HS = highly significant (P < 0.000476; the Bonferroni corrected p-value for an alpha = 0.05); * = P < 0.05 (nominal critical value for most statistical test); - = P > 0.05 (considered not significant). A significant result between pairs of populations indicates that the allele frequencies between the pair are significantly different. Pairwise comparisons between the hatchery broodstock and natural spawner collections from 2001, 2004, 2005, and 2006, respectively, are highlighted.

		Smolt		Hatchery Broodstock								Natural Spawners				
		1993	1994	1993	1996	1998	2000	2001	2004	2005	2006	1989	2001	2004	2005	2006
Smolt	1993		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1994	HS		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hatchery Broodstock	1993	HS	HS		0.9155	0.0000	0.0073	0.3647	0.0003	0.0694	0.0000	0.2220	0.0039	0.0008	0.0095	0.0000
	1996	HS	HS	-		0.0151	0.8388	0.0452	0.4916	0.3189	0.0716	0.5591	0.0759	0.8101	0.2364	0.0786
	1998	HS	HS	HS	*		0.0000	0.0000	0.0000	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000	0.0005
	2000	HS	HS	*	-	HS		0.0000	0.4720	0.0000	0.0000	0.0036	0.0000	0.0712	0.0000	0.0000
	2001	HS	HS	-	*	HS	HS		0.0000	0.0059	0.0000	0.0003	0.0000	0.0000	0.0126	0.0000
	2004	HS	HS	*	-	HS	-	HS		0.0000	0.0000	0.0001	0.0000	0.0012	0.0000	0.0000
	2005	HS	HS	-	-	HS	HS	*	HS		0.0005	0.0024	0.0137	0.0025	0.7782	0.0018
	2006	HS	HS	HS	-	*	HS	HS	HS	*		0.0000	0.0000	0.0000	0.0000	0.5770
Natural Spawners	1989	HS	HS	-	-	HS	*	*	HS	*	HS		0.0023	0.0317	0.0000	0.0003
	2001	HS	HS	*	-	HS	HS	HS	HS	*	HS	*		0.0000	0.2641	0.0000
	2004	HS	HS	*	-	HS	-	HS	*	*	HS	*	HS		0.0000	0.0000
	2005	HS	HS	*	-	HS	HS	*	HS	-	HS	HS	-	HS		0.0000
	2006	HS	HS	HS	-	*	HS	HS	HS	*	-	*	HS	HS	HS	

Table 5 Analysis of molecular variance (AMOVA) for the Chiwawa collections, showing the partition of molecular variance into (1) within collections, (2) among collections but within group, and (3) among group components. Each column in the table represents a separate analysis testing for differences under a different spatial or temporal hypothesis. The different analyses are grouped together in a single table for comparisons. The values within the table are percentages and the parenthetical values are P-values, or probabilities, associated with that percentage. P-values greater than 0.05 indicate that the percentage is not significantly different from zero. For example, when collections are organized by hatchery- versus natural-origin ("Origin" – fourth column), 0.11% of the molecular variance is attributed to among group (i.e., hatchery- versus natural-origin), which is not significantly different from zero. No collections (first column) indicates no organization or grouping among all collections, and the among-group percentage is equal to the F_{ST} for the entire data set.

	No Structure	Collection Year	Spawning Location	Origin	Origin-Spawning Location
Among Groups	0.26 (0.00)	0.20 (0.43)	0.05 (0.48)	0.11 (0.15)	0.11 (0.06)
Among collections - Within groups	-	0.08 (0.003)	0.24 (0.00)	0.21 (0.00)	0.18 (0.06)
Within collections	99.74 (0.00)	99.72 (0.00)	99.71 (0.00)	99.68 (0.00)	99.71 (0.00)

Table 6 F_{ST} values for all pairwise combinations of populations. Each F_{ST} is the median value for all pairwise combinations of collections within each population (the number of collections within each population is shown parenthetically next to each population name on each row). For example, the F_{ST} for the Chiwawa hatchery versus the White River (0.019) is the median value of 54 pairwise comparisons. The bold values along the center diagonal are the median F_{ST} values within each collection. For those populations with only one collection, the diagonal value was set at 0.000.

	Chiwawa-Hatchery	Chiwawa-Natural	Entiat	Leaven-worth	Nason	Wenatchee-main	White	Little Wenatchee
Chiwawa-Hatchery (9)	**0.013**	0.008	0.016	0.012	0.011	0.005	0.019	0.111
Chiwawa-Natural (9)		**0.003**	0.012	0.011	0.007	0.003	0.014	0.105
Entiat (1)			**0.000**	0.005	0.010	0.008	0.019	0.078
Leavenworth (1)				**0.000**	0.007	0.008	0.014	0.092
Nason (6)					**0.006**	0.008	0.015	0.099
Wenatchee-main (1)						**0.000**	0.012	0.098
White (6)							**0.005**	0.113
Little Wenatchee (1)								**0.000**

Table 7 As in Table 5, except data includes Chiwawa hatchery- and natural-origin, Nason Creek, and White River collections

	All Years	All Years	1989-1996	2005-2006	2005-2006
	No Structure	Origin	Origin	Origin	Collection Year
Among Groups	0.28 (0.00)	0.33 (0.00)	-0.07 (0.67)	0.43 (0.01)	-0.06 (0.57)
Among Collections - Within groups	-	0.04 (0.00)	0.22 (0.00)	0.25 (0.00)	0.64 (0.00)
Within Collections	99.72	99.63	99.85	99.32	99.41

Table 8 Individual assignment results reported are the numbers of individuals assigned to each population using the partial Bayesian criteria of Rannala and Mountain (1997) and a "jack-knife" procedure (see Methods). The population with the highest posterior probability is considered the stock of origin (i.e., no unassigned individuals). Individuals from each population are assigned to specific populations (along rows). Bold values indicate correct assignment back to population of origin. Individuals assigned to a population are read down columns. For example, of the 595 individuals from Chiwawa hatchery origin, 134 individuals were assigned to Chiwawa natural origin (reading across). Of the 511 individuals assigned to Chiwawa natural origin (reading down), 60 were from Nason Creek.

Population	Total	Unassigned	1	2	3	4	5	6	7	8
1) Chiwawa Hatchery	595	0	**371**	134	2	16	0	45	15	12
2) Chiwawa Natural	501	0	156	**269**	4	5	0	42	9	16
3) Entiat	37	0	4	5	**13**	8	0	6	1	0
4) Leavenworth	73	0	9	8	3	**33**	0	17	0	3
5) Little Wenatchee	19	0	0	0	0	0	**19**	0	0	0
6) Nason	268	0	49	60	5	11	0	**131**	1	11
7) Wenatchee Mainstem	32	0	12	9	0	1	0	2	**6**	2
8) White	179	0	22	26	0	2	0	13	1	**115**
TOTAL	1704	0	623	511	27	76	19	256	33	159

Table 9 As in Table 8, except the posterior probability from the partial Bayesian criteria of Rannala and Mountain (1997) must be 0.90 or greater, to be assigned to a population. Those individuals with posterior probabilities less than 0.90 are unassigned.

Aggregate	Total	Unassigned	1	2	3	4	5	6	7	8
1) Chiwawa Hatchery	595	332	**214**	31	1	4	0	10	3	0
2) Chiwawa Natural	501	375	30	**82**	0	1	0	5	2	6
3) Entiat	37	24	1	1	**5**	4	0	2	0	0
4) Leavenworth	73	51	0	1	1	**19**	0	1	0	0
5) Little Wenatchee	19	2	0	0	0	0	**17**	0	0	0
6) Nason	268	188	11	6	2	5	0	**53**	0	3
7) Wenatchee Mainstem	32	23	4	3	0	0	0	0	**2**	0
8) White	179	92	4	3	0	1	0	5	1	**73**
TOTAL	1704	1087	264	127	9	34	17	76	8	82

Table 10 Estimates of N_e based on bias correction method of Waples (2006) implemented in LDNe (Do and Waples unpublished). Collections are categorized by spawning location. Sample size is the harmonic mean of the sample size, 95% CI is the confidence interval calculated using Waples' (2006) equation 12, and Major Cohort assumes that each collection is 100% four-year-olds.

	Sample size	Estimated N_b	95% CI	Major Cohort	Census	N_e/N
1993 Chiwawa Broodstock	58.4	103.1	77.0 - 149.7	1989	1392	0.30
1996 Chiwawa Broodstock	15.5	30.4	19.6 - 58.1	1992	1099	0.11
1998 Chiwawa Broodstock	33.4	37.7	29.8 - 49.7	1994	280	0.54
2000 Chiwawa Broodstock	77.8	48.4	41.4 - 57.2	1996	182	1.06
2001 Chiwawa Broodstock	80.4	49.6	42.2 - 59.2	1997	389	0.51
2004 Chiwawa Broodstock	56.6	48.1	39.0 - 60.9	2000	688	0.28
2005 Chiwawa Broodstock	73	274.3	148.9 - 1131.8	2001	4130	0.27
2006 Chiwawa Broodstock	88.4	198.3	136.1 - 340.5	2002	1613	0.49
1989 Chiwawa River	26.6	5.2	3.9 - 6.3	1985		
2001 Chiwawa River	46.7	38.6	31.0 - 49.3	1997	389	0.40
2004 Chiwawa River	88.5	82.6	67.3 - 104.4	2000	688	0.48
2005 Chiwawa River	104.2	231.5	161.8 - 382.7	2001	4130	0.22
2006 Chiwawa River	101.1	107.3	87.2 - 136	2002	1613	0.27

Table 11 Summary of output from program SALMONNb and data for eight Chiwawa broodstock collections from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):

Year	1993	1996	1998	2000	2001	2004	2005	2006
1993	-	24.5	42.5	66.4	67.2	57.2	64.6	70.3
1996	82	-	21.2	25.8	26.0	24.4	25.6	26.4
1998	80	81	-	46.7	47.2	42.0	45.8	48.4
2000	80	82	84	-	78.6	65.2	75.1	82.7
2001	73	77	81	76	-	66.0	76.2	84.2
2004	77	81	75	76	78	-	63.5	69.0
2005	71	75	82	73	73	69	-	80.0
2006	81	80	84	75	74	75	72	-

Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):

Year	1993	1996	1998	2000	2001	2004	2005	2006
1993	-	-742.7	406.9	1240.8	-5432.0	829.8	808.9	729.0
1996	22491.2	-	110.4	-1786.5	765.9	162.8	824.7	382.7
1998	10910.4	67299.1	-	101.8	237.1	69.6	307.0	140.0
2000	6910.0	742895.8	19122.7	-	490.6	1498.2	706.9	201.6
2001	49318.3	21402.8	9754.2	6126.6	-	307.8	82.0	362.5
2004	8338.4	257267.7	24283.0	145043.4	7095.7	-	269.7	140.1
2005	31511.8	22242.5	10015.8	6596.6	114931.1	8240.4	-	599.6
2006	6223.8	43935.2	73518.7	10152.5	5885.3	12827.0	6370.8	-

$\tilde{N}_b = 269.4$

Table 12 Summary of output from program SALMONNb and data for five Chiwawa in-river spawner collections from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Year	1989	2001	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):					
1989	-	33.3	40.2	41.7	42.2
2001	72	-	60.5	63.9	63.3
2004	72	77	-	95.3	94.0
2005	69	72	75	-	102.5
2006	76	76	77	78	-
Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):					
1989	-	118.4	299.0	143.3	165.3
2001	40378.8	-	181.7	-1537.3	153.5
2004	10455.2	7265.5	-	387.1	329.4
2005	20923.6	68660.6	5040.7	-	356.8
2006	16227.2	8886.9	3802.0	4522.8	-

$\tilde{N}_b = 224.2$

Table 13 Summary of output from program SALMONNb and data for three brood years that combined Chiwawa natural- and hatchery-origin samples from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Year	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):			
2004	-	162	164.3
2005	77	-	188.2
2006	76	75	-
Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):			
2004	-	611.3	210.8
2005	9351.5	-	727.5
2006	14965.5	8673.9	-

$\tilde{N}_b = 386.8$

Appendix N

Fish Trapping at the Nason Creek Smolt Trap 2018

Population Estimates for Juvenile Salmonids in Nason Creek, WA

2018 Annual Report

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Project No. 1996-040-00

ABSTRACT

In 2018, Yakama Nation Fisheries Resource Management (YNFRM) monitored emigration of Endangered Species Act (ESA) - listed Upper Columbia River (UCR) spring Chinook salmon, UCR summer steelhead, and naturally-spawned coho salmon juveniles in Nason Creek. This report summarizes the resulting juvenile abundance and freshwater survival estimates for each of these species. Fish were captured using a 1.5m rotary smolt trap between March 1 and November 30, 2018. Target catch included 1,952 spring Chinook salmon, 699 summer steelhead, and 1 bull trout; all of natural origin and varying age classes. There were no natural-origin coho captured. Daily fish abundances for spring Chinook and steelhead were expanded by stream discharge-to-trap efficiency regressions or pooled estimates. We estimated that 31,867 ± 5,893 brood-year (BY) 2016 wild spring Chinook parr and smolts emigrated from Nason Creek. We subsequently estimated that within Nason Creek, BY2016 spring Chinook had an egg-to-emigrant survival of 8.4%. Additionally, we estimated that 21,471 ± 3,983 BY2015 wild steelhead parr and smolts emigrated from Nason Creek.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This project is part of a basin-wide monitoring program requiring close coordination between multiple agencies and contractors. We greatly appreciate the hard work of the Yakama Nation Fisheries Resource Management (YNFRM) crew members including Matthew Clubb, Jamie Hallman, Bryan Ishida, and Tim Jeffris who maintained and operated the trap during all hours including nights/weekends and through challenging weather conditions. We would like to also thank the Wenatchee River Ranger District (U.S. Forest Service), Mr. Duane Bolser for providing use of the trapping site and accommodating the needs of this project, and Peter Graf and Rolland O'Connar (Grant County PUD) for administering contracting and funding. Finally, thank you to Mike Hughes, Mclain Johnson, Andrew Murdoch, Ben Truscott, and Joshua Williams (Washington Department of Fish and Wildlife), and Tracy Hillman (BioAnalysts, Inc.) for shared data and smolt trap methodologies.

1.0 INTRODUCTION

Beginning in the fall of 2004, Yakama Nation Fisheries Resource Management (YNFRM) began operating a rotary smolt trap in Nason Creek for nine months per year. Prior to 2004, the smolt trap was operated on a limited basis solely for hatchery coho predation studies. This project is a cost share between the YNFRM's Mid-Columbia Coho Reintroduction Program (MCCRP) and Grant County PUD's Hatchery Monitoring Plan. Trap operations were conducted in compliance with ESA consultation specifically to address abundance and productivity of spring Chinook, steelhead trout, and coho salmon in Nason Creek.

Within this document we will report:

1) Juvenile abundance and productivity of spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha*, steelhead trout (shúshaynsh) *Oncorhynchus mykiss* and coho salmon (súnx) *Oncorhynchus kisutch* in Nason Creek.

2) Emigration timing of spring Chinook salmon, steelhead trout and coho salmon emigrating from Nason Creek.

The data presented will be directly used to address Objective 2 in the Monitoring and Evaluation Plan for PUD Hatchery Programs (Hillman et al. 2015) on a 5-year analytic cycle:

> **Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks (Hillman et al. 2013).**

1.1 Watershed Description

The Nason Creek watershed drains 26,547 ha of alpine glaciated landscape where high precipitation and moderate rain on snow recurrence controls the hydrology and aquatic communities. Nason Creek originates near the Cascade crest at Stevens Pass and flows east for approximately 37 river kilometers (rkm) until joining the Wenatchee River at rkm 86.3 just below Lake Wenatchee. There are 26.4 rkm along the mainstem accessible to anadromous fish in Nason Creek. The smolt trap is located downstream from the majority of spring Chinook and steelhead spawning grounds (Figure 1). Private land ownership comprises 21,165 ha (79.7%) of the watershed while 5,180 ha (19.5%) are federal and 194 ha (0.1%) are state owned (USFS et al. 1996).

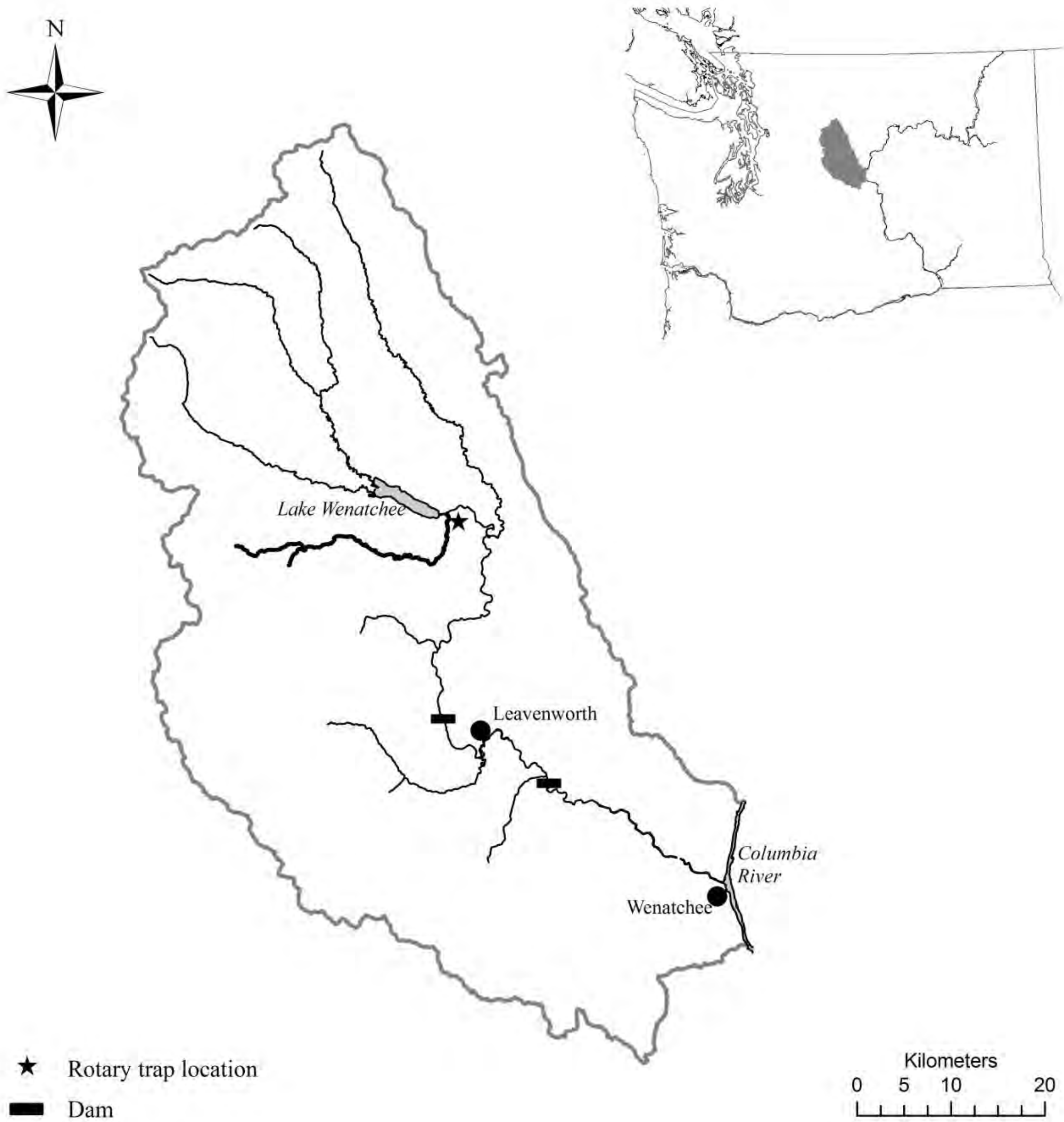


Figure 1. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location.

The channel morphology of the lower 25 rkm of Nason Creek has been impacted by development of highways, railroads, power lines, and residential development resulting in channel confinement and reduced side-channel habitat. The present condition is a low gradient (< 1.1%), low sinuosity (1:2 to 2:0 channel-to-valley length ratio) and depositional channel (USFS et al. 1996). Peak runoff typically occurs in May and June with occasional high water produced by rain on snow events in October and November.

In 2018, mean daily discharge for Nason Creek was 9.5 m^3/s (338 cfs; Figure 2). The timing of spring runoff was typical of the tributary, with the onset ocurring in mid-March, and a peak flow of 72.8 m^3/s on May 9. The seasonal water temperature regime was also typical in 2018 (Figure 3).

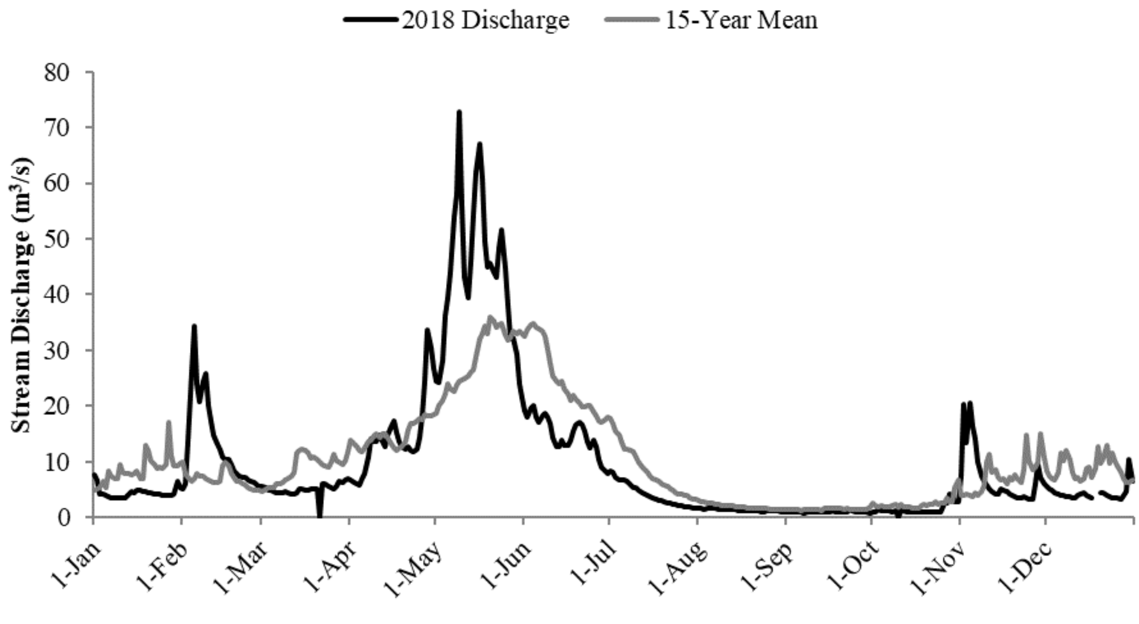


Figure 2. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2018.

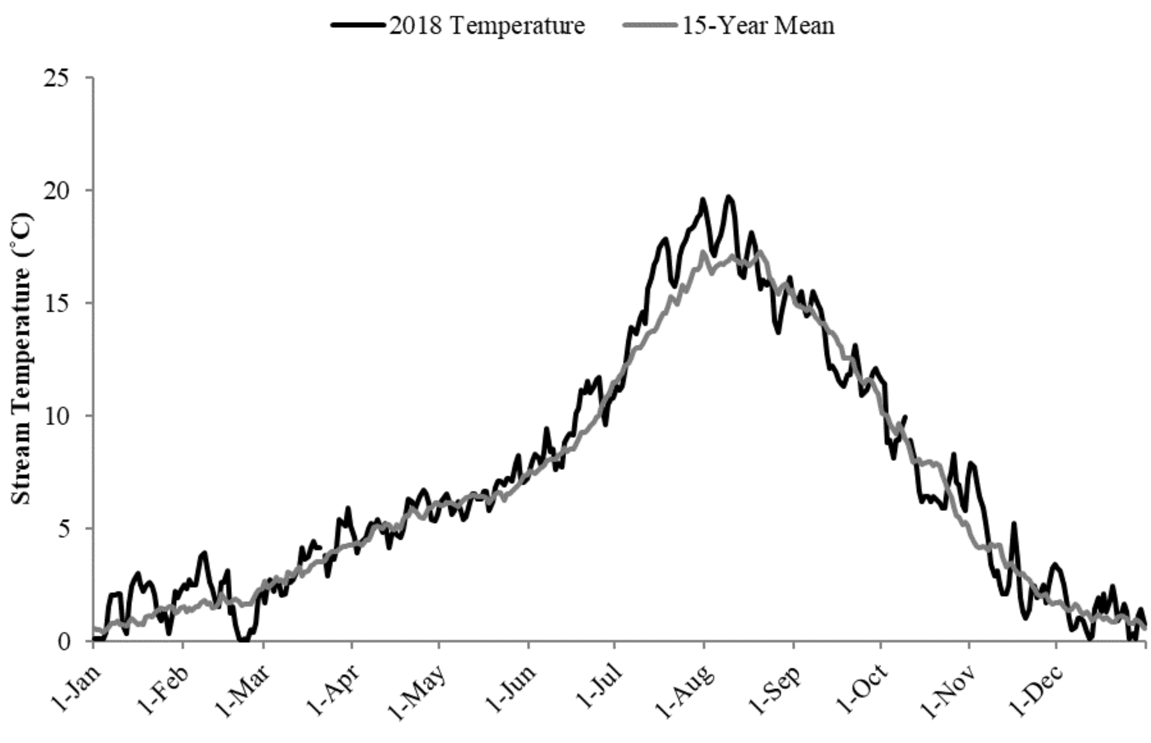


Figure 3. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2018.

2.0 METHODS

2.1 Trapping Equipment and Operation

The smolt trap was operated continually 24 hours per day, 7 days per week when conditions permitted. During spring snowmelt, operations occurred only during hours of darkness in order to minimize trap damage and capture mortality, while retaining the ability to sample during periods of peak fish movement.

On a daily basis, fish were removed from the primary collection box and retained in separate shore-anchored holding boxes until removed for efficiencies trials. A rotating drum-screen constantly removed small debris from the live box to avoid fish injury. All changes/modifications to the trap as well as periods of stoppage were noted.

2.2 Biological Sampling

Trap operating procedures and techniques followed a standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (RTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch and Petersen (2000).

All fish were enumerated by species and size class. Fish to be sampled were anesthetized in a solution of MS-222, weighed with an electronic scale and measured in a wetted trough-type measuring board. Anesthetized fish received air through aquarium bubblers and were allowed to fully recover before being either released downstream of the trap or used in efficiency trials. Fork length (FL) and weight were recorded for all fish except when large numbers of fry or non-target species were collected; a sub-sample of 25 fish were measured and weighed while the remaining fish were tallied. Weight was measured to the nearest 0.1 gram and FL to the nearest millimeter. We used these data to calculate a Fulton-type condition factor (K-factor) using the formula:

$$K = (W/L^3) \times 100{,}000$$

where K = Fulton-type condition metric;
W = weight in grams;
L = fork length in millimeters;
And 100,000 is a scaling constant.

Scale samples were collected from steelhead measuring ≥ 60 mm FL so that age and brood year could be assigned. Samples were collected according to the needs and protocols set by Washington Department of Fish and Wildlife (WDFW), who conducted the analysis and provided YNFRM with results. Tissue samples were collected from spring Chinook and steelhead for DNA analysis. Samples from spring Chinook and steelhead were retained for reproductive success analyses conducted by WDFW and National Marine Fisheries Service (NMFS). All target salmonids were classified as either natural or hatchery origin by physical appearance, presence/absence of coded wire tags (CWTs), or post-orbital elastomer tags. Developmental stages were visually classified as fry, parr, transitional, or smolt. Fry were defined as newly emerged fish with or without a visible yolk sac and a FL measuring < 50 mm.

Age-0 coho and spring Chinook salmon captured before July 1 were considered 'fry' and were excluded from subyearling population estimates because of the uncertainity that these fish were actively migrating (UCRTT, 2001).

2.3 PIT Tagging

All natural origin Chinook, steelhead and coho measuring ≥ 60 mm were PIT tagged. Once anesthetized, each fish was examined for external wounds or descaling, then scanned for the presence of a previously implanted PIT tag. If a tag was not detected, a pre-loaded 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a Biomark MK-25 Rapid Implant Gun. Each unique tag code was electronically recorded along with date of tag implantation, date of fish release, tagging personnel, FL, weight, and anesthetic bath temperature. Data were entered using P4 software and submitted to the PIT Tag Information System (PTAGIS). PIT tagging methods were consistent with methodologies described in the PIT Tag Marking Procedures Manual (CBFWA 1999) as well as in 2008 ISEMP protocols (Tussing 2008).

After marking and sampling, fish were held for a minimum of 24-hours in holding boxes at the trap to; a) ensure complete recovery, b) assess tagging mortality, and c) determine a PIT tag shed rate. Mark groups were released by hand 0.8 rkm above the trap at nautical twilight. At each release, fish were distributed evenly along river-left, and river-right banks in pools and other protected areas. Fish that were not used in mark-recapture trials were released downstream from the trap.

2.4 Mark-Recapture Trials

Groups of marked juveniles were released during a range of stream discharges in order to determine the trapping efficiency. PIT tags were the only method of marking used in 2018. These releases followed the protocols described in Hillman (2004), in which the author suggests a minimum sample size of 100 fish for each mark-recapture trial. Although 100 fish/trial represented the ideal mark group, low abundance of fish often required mark-recapture trials be completed with smaller sample sizes. To achieve the largest marked group possible, we combined catch over a maximum of 72 hours. Fish being held for mark-recapture trials were kept in auxiliary live boxes attached to the end of each pontoon or floating holding boxed anchored to the stream bank. A pre-season, minimum mark group size for each species/life stage was initially determined based on past regression models. During periods of high abundance, minimum trial sizes could be raised to a more robust mark group with the intention of strengthening existing regression models. Current minimum mark group size for inclusion in flow efficiency models is 50 fish.

Each mark-recapture trial was conducted over a three-day (72 hour) period to allow time for passage or capture. Completed trials were only considered invalid if an interruption to trapping occurred or proper pre-release procedures were not followed. Trials resulting in zero recaptures were included in the efficiency regression (if determined valid once vetted through release/recapture protocols) as allowed by the new method of observed trap efficiency calculation. The model used (Bailey) employs use of recaptures +1 in the calculation of efficiency as a mode of bias correction. As a result, even trials yeilding no recaptures can be included in regression modeling (See equation 3 in **2.5.1 Estimate of Abundance**).

In the event that low juvenile abundance could not provide any opportunities for efficiency trials, releases were performed to allow for a pooled estimate. These releases did not have a minimum size and were released at equal intervals across the migratory period. Pooled estimates at the Nason Creek trap were utilized as an alternative method of estimation prior to the development of a viable regression model.

2.5 Data Analysis

2.5.1 Estimate of Abundance During Smolt Trapping

Seasonal juvenile migration, N, was estimated as the sum of daily migrations, N_i, i.e., $N = \sum_i N_i$, and daily migration was calculated from catch and efficiency:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \qquad \textbf{(1)}$$

where C_i = number of fish caught in period *I*;

$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$,

where b_0 is estimated intercept and b_1 is the estimated slope of the regression.

The regression parameters b_0 and b_1 are estimated using linear regression for the model:

$$\arcsin\left(\sqrt{e_k^{obs}}\right) = \beta_0 + \beta_1 flow_k + \varepsilon, \qquad \textbf{(2)}$$

where e_k^{obs} = observed trap efficiency of Eq. 2 for trapping period *k*;

β_0 = intercept of the regression model;

β_1 = slope parameter;

ε = error with mean 0 and variance σ^2.

In Equation 2, the observed trap efficiency, e_k^{obs}, is calculated as follows,

$$e_k^{obs} = \frac{r_k + 1}{m}. \tag{3}$$

The estimated variance of seasonal migration is calculated from daily estimates as:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var(N_i)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov(N_i, N_j)}_{Part\ B}$$

or, **(4)**

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A of equation 4 is the variance of daily estimates. Part B is the between-day covariance. Note that the between-day covariance exists only for days that use the same trap efficiency model. If, for example, day 1 is estimated with one trap efficiency model, and day 2 estimated from a different model, then there is no covariance between day 1 and day 2. The full expression for the estimated variance:

$$\widehat{Var}\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i \hat{N}_i^2 \left(\frac{N_i \hat{e}_i (1 - \hat{e}_i)}{(C^i + 1)^2} + \frac{4(1 - \hat{e}_i)}{\hat{e}_i} \widehat{Var}(b_0 + b_1 flow_i)\right)}_{Part\ A}$$
$$+ \underbrace{\sum_i \sum_j 4\left(\hat{N}_i (1 - \hat{e}_i)\right)\left(\hat{N}_j (1 - \hat{e}_j)\right) \cdot \left[\widehat{Var}(b_0) + flow_i flow_j \widehat{Var}(b_1)\right]}_{Part\ B}$$

where $V\hat{a}r(b_0 + b_1 flow_i) = M\hat{S}E\left(1 + \frac{1}{n} + \frac{\left(flow_i - \overline{flow}\right)^2}{(n-1)s_{flow}^2}\right)$, and $\hat{V}ar(b_0)$ and $\hat{V}ar(b_1)$ are

obtained from regression results. In Excel, the standard error (SE) of the coefficients is provided. The variance is calculated as the square of the standard error, SE^2.

In cases when there was no significant flow-efficiency relationship (i.e., low correlation), then a pooled, or average trap efficiency will suffice for the stratum. The estimator is calculated as follows:

$$\hat{\bar{e}} = \frac{\sum_{j=1}^{k} r_j}{\sum_{j=1}^{k} m_j}$$

where $\hat{\bar{e}}$ = the average or pooled trap efficiency for the stratum;

m_j = the number of smolts marked and released in efficiency trial j for the stratum;

r_j = the number of smolts recaptured out of m_j marked fish in efficiency trial j.

Abundance for a trapping period is estimated as:

$$\hat{N}_i^{pooled} = \frac{C_i}{\hat{\bar{e}}},$$

,and total stratum abundance is:

$$N^{pooled} = \sum_i \hat{N}_i^{pooled}.$$

The variance of seasonal abundance takes into account the variability in catch numbers that are a result of binomial sampling (Part A), the pooled variance of trap efficiency, $\hat{\bar{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right)}_{Part\ A} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i \hat{N}_i^2}_{Part\ B} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i\sum_j \hat{N}_i\hat{N}_j}_{Part\ C}$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right) + \frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i\hat{N}_j\right]$$

The variance of $\hat{\hat{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\hat{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\hat{e}}_k m_k\right)^2}{\overline{m}^2 n(n-1)}$$

where $\overline{m}$ is the average release size across all efficiency trial, $\frac{\sum_{k=1}^{n} m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96 \times \sqrt{\sum \text{var}\left[\hat{N}_i\right]}$

The single M-R estimator of abundance carries a set of well documented assumptions (Everhart and Youngs 1981; Seber 1982),

1. The population is closed to mortality.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked fish were randomly dispersed in the population prior to recapture.
4. Marking does not affect probabilities of capture.
5. Marks were not lost between the time of release and recapture.
6. All marks are reported upon recapture.
7. The number of fish in the trap, C, is fully enumerated and known without error.

2.5.2 Estimate of Abundace During Trap Stoppages and Suspended Operations

Daily catch during stoppages of seven days or less was estimated by averaging catch three days prior to, and after the discreet non-trapping event and then applying that value to the consecutive days without operation. This method was used for all target species.

For periods of suspended trapping longer than seven days, a methodology developed and currently employed by local WDFW smolt trap operators was used (J. Williams, personal communication, March 8, 2017). This method uses historic run-timing to determine the proportion of the entire emigrant estimate missed during the period of suspended trapping. Once determined, the estimated percentage can be used with in-year data to extrapolate how many fish were missed. This method was used exclusively during the fall migratory period, when low summer flows commonly result in extended stoppages. Because steelhead are considered non-migratory during this period, this type of estimate was only applied to spring Chinook subyearlings.

2.5.3 Estimate of Abundance During The Winter Non-Trapping Period

An estimate of spring Chinook emigration during the non-trapping period (December 1 through February 28) was calculated using remote-tagged spring Chinook parr and the lower Nason Creek PIT tag array (NAL). A flow-detection efficiency regression was developed using mark-groups previously released to test the efficiency of the smolt trap. Daily spring Chinook detections at the NAL array and the developed regression were then applied to the Bailey estimator, as was peformed with daily trap abundance data (See equation **2.5.1 Estimate of Abundance**). Tag rate determined at the Nason Creek smolt trap was used to account for unmarked emmigrants passing the NAL array.

Tag rate, t_i, was calculated as:

$$t_i = \frac{t}{p}$$

where t = total smolt trap recaptures subsequent to the tagging effort;
p = total catch at the smolt trap.

Daily abundace during the non-trapping period is calculated as:

$$\hat{N}_i = \left(\frac{C_i}{\hat{e}_i}\right) \Big/ t_i \,,$$

where C_i = number of fish caught in period I;
$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$;
t_i = tag rate.

2.5.4 Production and Survival

Production estimates by age class were summed to produce a total emigration estimate. For spring Chinook and coho, estimates of fall-migrating parr were added to subsequent spring smolt estimates to generate a single brood year estimate. For steelhead, a single brood year was deemed completely emigrated from Nason Creek after three consecutive years of outmigration. Age 4+ steelhead smolts have been previously identified via scale analysis, but are extremely uncommon. Pending eventual scale analysis, steelhead captured in 2018 were aged via an age-length histogram built upon previously analyzed scale samples. For all three species, egg-to-emigrant estimates were calculated by dividing estimated emigrants by approximated egg deposition during a spawning brood (average fecundity used to determine egg deposition derived from WDFW Chiwawa broodstock spawning). The number of emigrants-per-redd for each brood year was calculated by dividing the total emigrant estimate by the number of redds counted during spawning ground surveys.

3.0 RESULTS

3.1 Dates of Operation

The Nason Creek smolt trap was operated between March 1 and November 30 and operated in its fixed position for the entirety of the trapping season. In total, the trap was operated for 176 days (Table 1). The primary cause of un-trapped days was a prolonged period (90 days) of intentional pulling due to base flow conditions (~ ≤50 cfs).

Table 1. Summary of Nason Creek rotary trap operation in 2018.

Date of Trap Operations	Trap Status	Description	Days
March 1 to June 30	Operating	Continuous data collection	117
	Interrupted	Interrupted by debris	3
	Pulled	Intentionally pulled due to high flow, low flow, or heavy debris load	2
July 1 to November 30	Operating	Continuous data collection	59
	Interrupted	Interrupted by debris	2
	Pulled	Intentionally pulled due to high flow, low flow, or heavy debris load	92

3.2 Daily Captures and Biological Sampling

3.2.1 Spring Chinook Yearlings (BY2016)

Between March 1 and June 30, a total of 301 wild Chinook yearlings were captured (Figure 4). The majority of smolts wetre captured in April and May, with a peak catch of 32 yearling smolts occurred on April 8. Mean FL and weight for Chinook yearlings was 95 mm (n = 301; SD = 6.8) and 9.5 g (n = 301; SD = 2.1; Table 2), respectively. A total of 5 yearling Chinook mortalities were incurred in 2018.

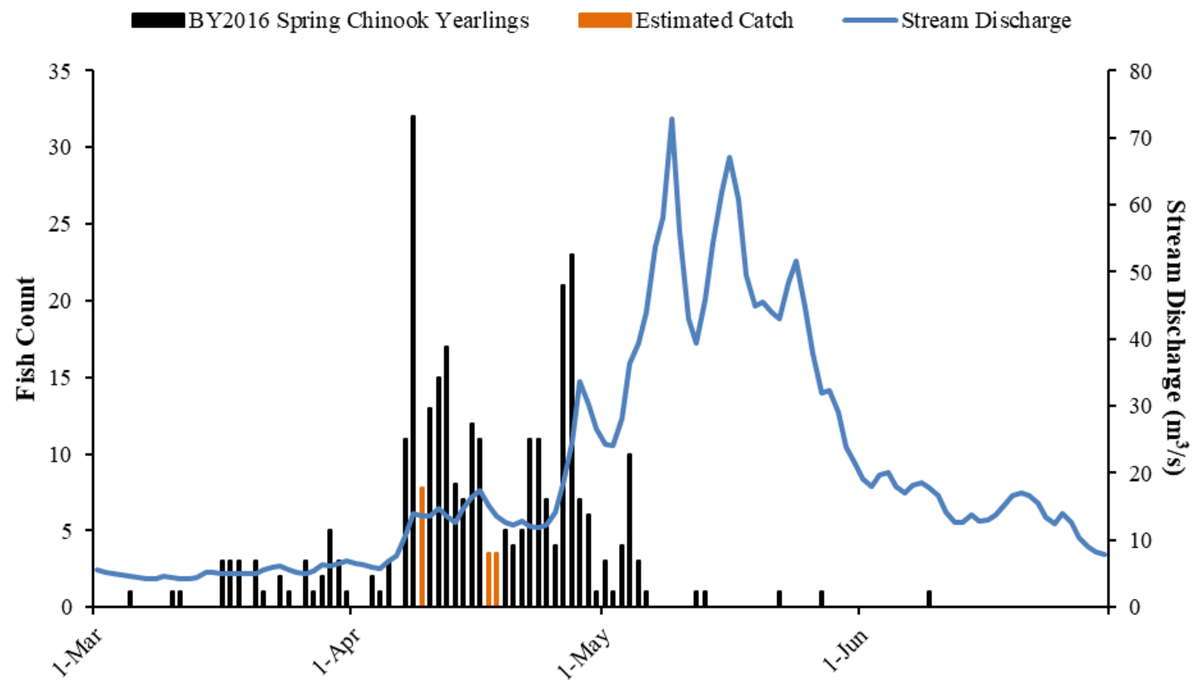


Figure 4. Daily catch of BY2016 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2018.

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap in 2018.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2016	Wild Spring Chinook Yearling Smolt	95	301	6.8	9.5	301	2.1	1.09
2017	Wild Spring Chinook Subyearling Fry	43	834	8.7	0.9	834	0.9	0.89
2017	Wild Spring Chinook Subyearling Parr	83	710	12.1	6.5	710	2.4	1.09
2016	Hatchery Spring Chinook Yearling Smolt	119	87	10.3	19.3	87	5.4	1.12

3.2.2 Spring Chinook Subyearlings (BY2017)

A total of 710 wild spring Chinook subyearling parr (FL ≥ 50 mm) and 951 subyearling fry (FL < 50 mm) were captured in 2018 (Figure 5). The majority of parr movement was documented in November following the first fall freshets. Mean FL and weight among subyearling parr was 83 mm (n = 710; SD = 12.1) and 6.5 g (n = 710; SD = 2.4), respectively. We estimate that an additional 72 Chinook subyearling parr would have been captured during short stoppages (≤7 days) had the trap run without interruption. Daily catch estimates were not made during the period of suspended trapping; total emigrant estimates for this period will be included in section 3.4.2. Tissue samples were collected from 640 fish for an ongoing, parental-based DNA analysis by WDFW. A total of eight subyearling Chinook fry mortalities occurred in 2018. All incidental mortality were attributed to trapping.

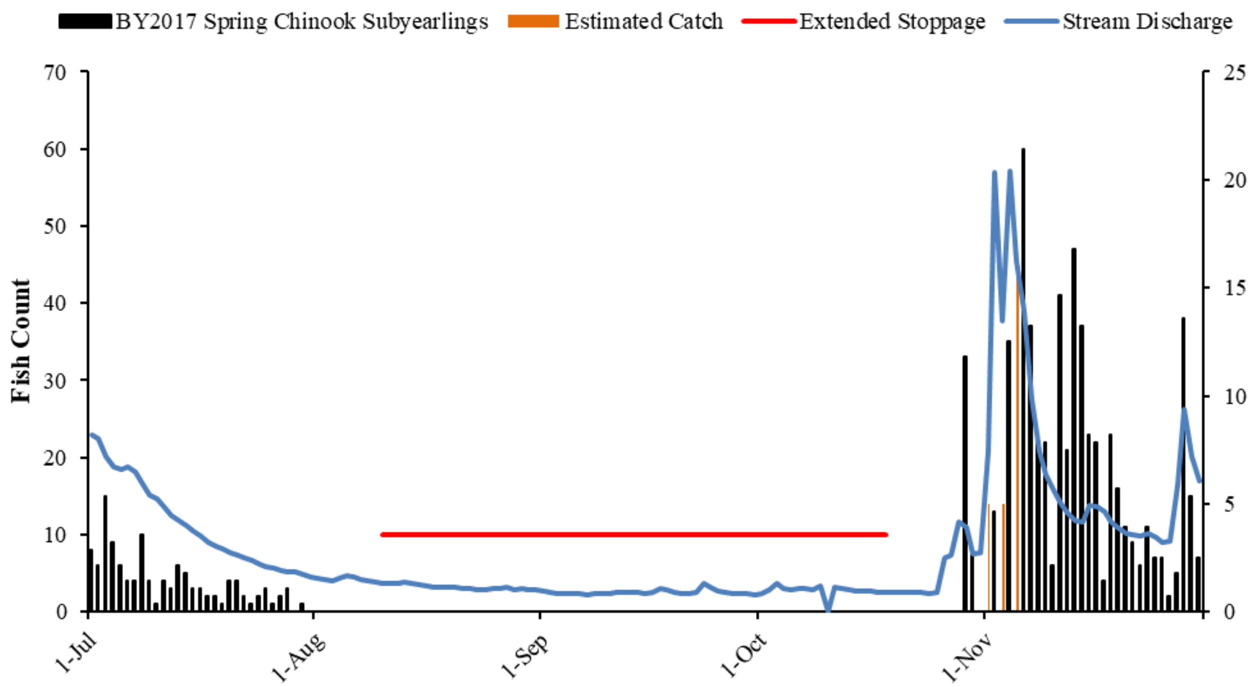


Figure 5. Daily catch of BY2017 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2018. Estimates of fish passage during trap interruptions are not depicted.

3.2.3 Hatchery Spring Chinook Smolts (BY2016)

In April, 233,471 hatchery spring Chinook smolts were released directly from the Grant County Public Utility District (GCPUD) Nason Creek Acclimation Facility located at rkm17.3. Subsequently, a total of 367 smolts were captured with a mean FL and weight of 119 mm (*n* =87; *SD* = 10.3) and 19.3 g (*n* = 87; *SD* = 5.4), respectively (Figure 6). Hatchery spring Chinook were not captured at the smolt trap beyond June 4, with majority of catch occurring immediately after initial release. There were no mortalities incurred.

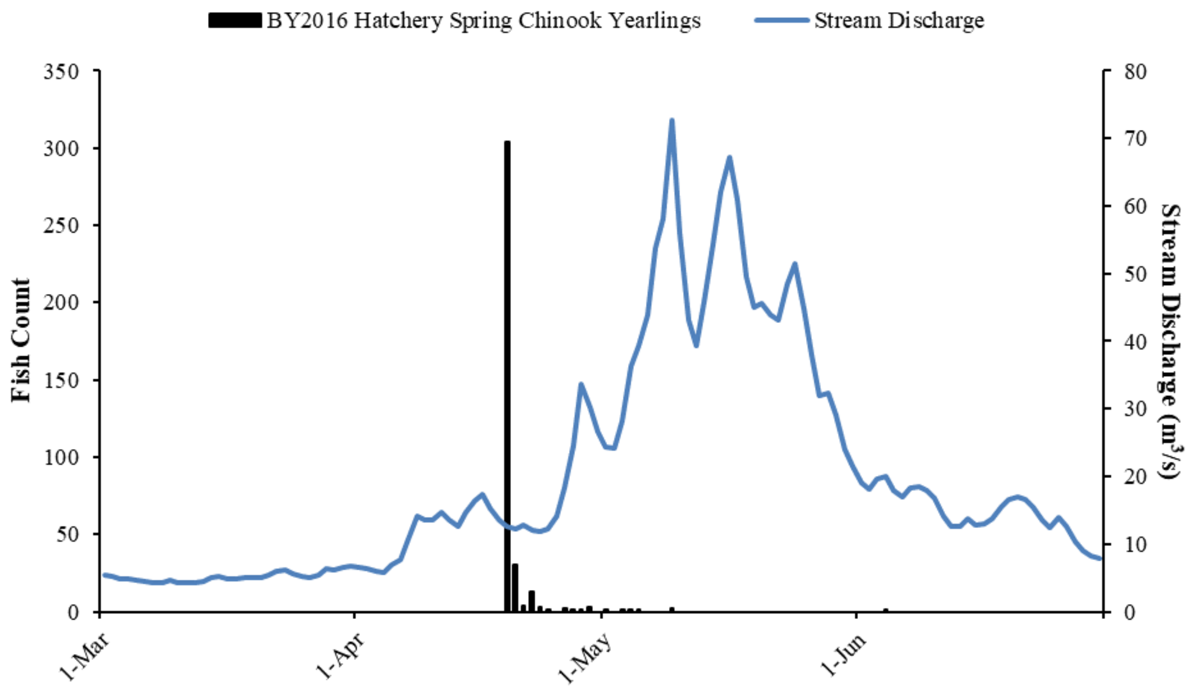


Figure 6. Daily catch of BY2016 hatchery spring Chinook smolts with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2018.

3.2.4 Summer Steelhead

A total of 699 wild summer steelhead juveniles were captured throughout the season from March 1 to November 30, with a peak catch of 30 juveniles on April 27 (Figures 7 & 8). Histogram analysis of known steelhead ages sampled from 2005 to 2016 allowed us to estimate ages of fish captured in 2018 using FL. We estimated that of the total steelhead captured, 221 were young-of-the-year (BY2018), 426 were age-1 (BY2017), 50 were age-2 (BY2016), and 2 were age-3 (BY2015). Subyearling steelhead had a mean FL of 45 mm (n = 221; SD = 21.7), and a mean weight of 1.8 g (n = 214; SD = 2.1). The majority of steelhead juveniles captured during the spring emigration were age-1 parr. Mean FL and weight of age-1 fish was 87 mm (n = 426; SD = 15.1; Table 3) and 7.8 g (n = 426; SD = 4.4), respectively. Age-2 steelhead were caught primarily in the spring, with only two fish being captured after July 31. Mean FL and weight of age-2 fish was 150 mm (n = 50; SD = 16.2) and 34.9 g (n = 50; SD = 11.0), respectively. Mean FL and weight of age-3 fish was 190 mm (n = 2; SD = 0.7) and 56.6 g (n = 2; SD = 6.1), respectively. Additionally, 1 adult resident fish was caught (FL=331 mm, Wt=380 g). Scales were taken from a sub-sample (n = 110) of steelhead with FL ≥ 60 mm to be used for future age analyses. A total of seven mortalities were incurred.

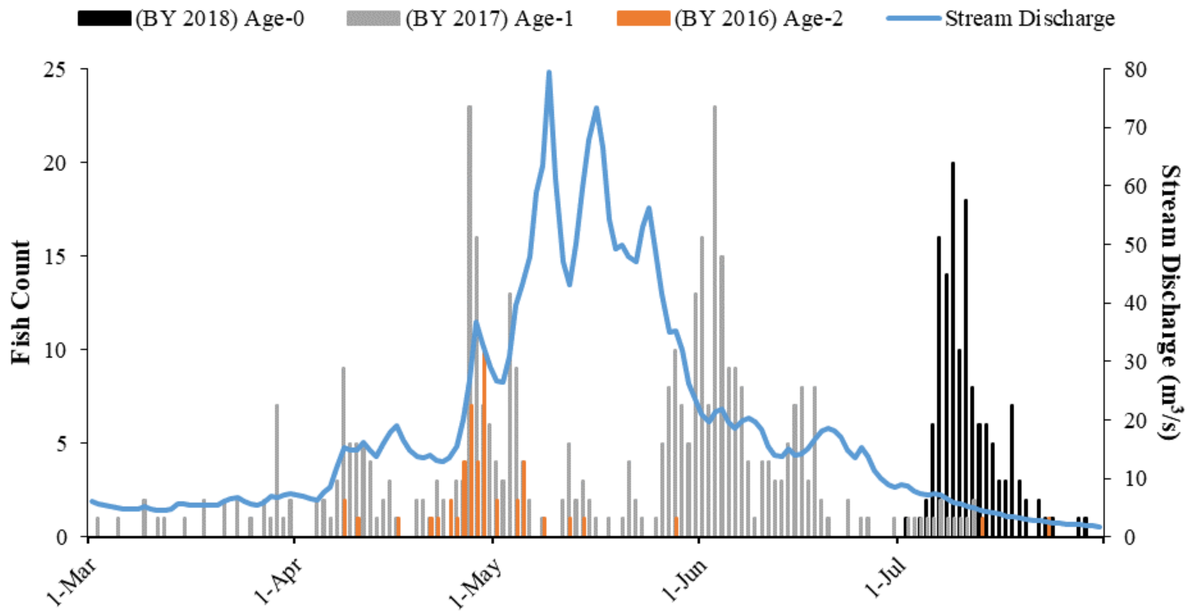


Figure 7. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to July 31, 2018. Estimates of fish passage during trap interruptions are not depicted.

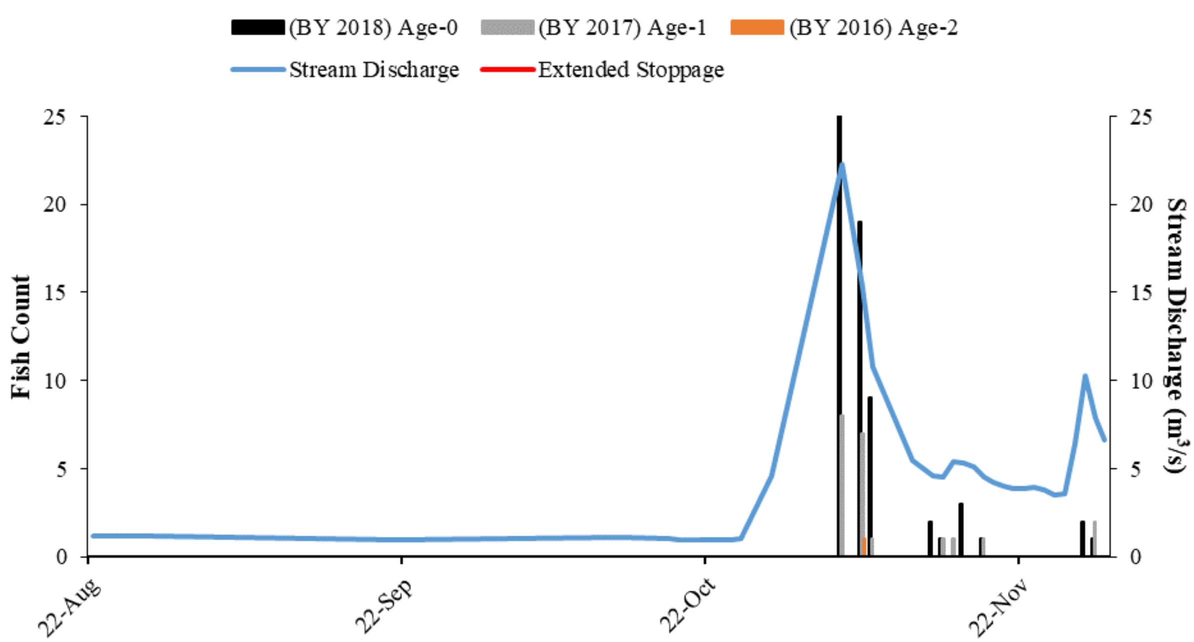


Figure 8. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, August 1 to November 30, 2018. Estimates of fish passage during trap interruptions are not depicted.

Table 3. Summary of length, weight and condition factor by age class of wild summer steelhead emigrants and hatchery steelhead captured at the Nason Creek rotary trap in 2018.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2018	Wild Summer Steelhead (Age-0)	45	221	21.7	1.8	214	2.1	0.93
2017	Wild Summer Steelhead (Age-1)	87	426	15.1	7.8	426	4.4	1.08
2016	Wild Summer Steelhead (Age-2)	150	50	16.2	34.9	50	11.0	1.00
2015	Wild Summer Steelhead (Age-3)	190	2	0.7	56.6	2	6.1	0.83
2017	Hatch. Summer Steelhead Smolt	158	279	17.0	39.8	280	12.9	0.98

3.2.5 Hatchery Steelhead Smolts (BY2016)

During April and May, WDFW directly planted a total of 59,520 hatchery summer steelhead smolts into Nason Creek above the smolt trap (C. Moran, personal communication, April 24, 2019). Subsequently, a total of 733 hatchery steelhead were captured at the smolt trap with a mean FL and weight of 158 mm (n =279; SD = 17.0) and 39.8 g (n = 280; SD = 12.9), respectively (Figure 9). Hatchery origin was determined by the presence of coded wire tags (CWT). There were no hatchery-origin steelhead trapping mortalities (See section 3.7 ESA Compliance).

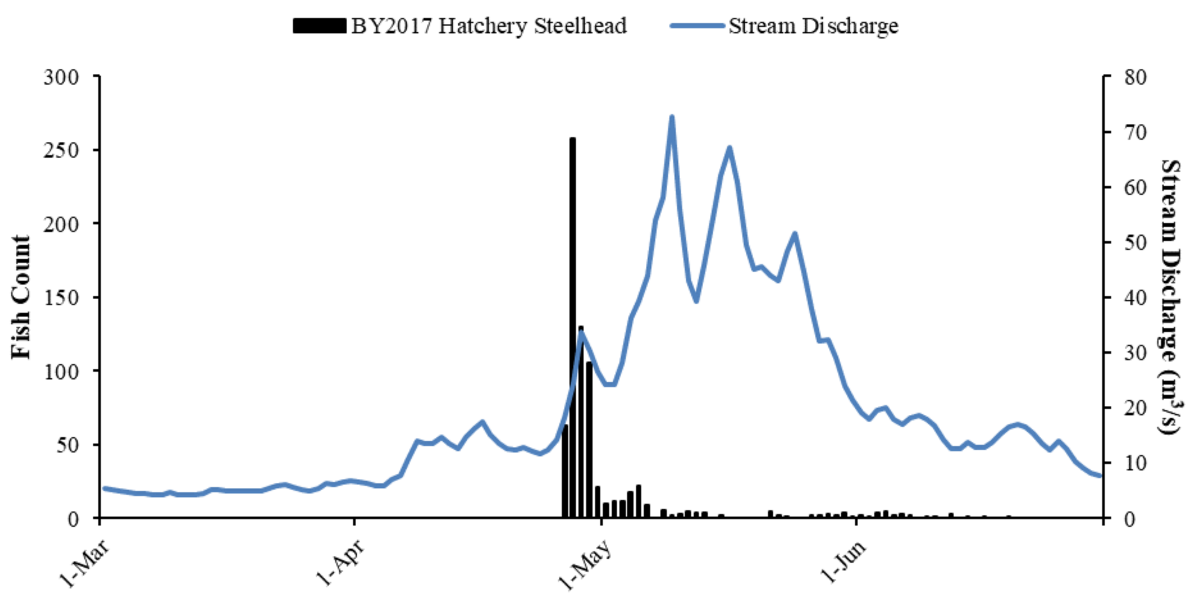


Figure 9. Daily catch of BY2017 hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2018.

3.2.6 Bull Trout

Bull trout presence at the trap in 2018 was limited to a single fish with a FL of 600 mm. The bull trout was released immediately after morphometric measurements were taken. No other sampling/tagging activities were performed.

3.2.7 Coho Yearlings (BY2016)

There were no BY2016 naturally-produced coho smolts captured at the Nason Creek smolt trap in 2018.

3.2.8 Coho Subyearlings (BY2017)

There were no BY2017 naturally-produced coho fry or parr captured at the Nason Creek smolt trap in 2018.

3.2.9 Hatchery Coho Smolts (BY2016)

A total of 364,700 hatchery coho were released into Nason Creek above the trap in spring of 2018. All hatchery coho released were acclimated in natural ponds adjacent to Nason Creek and reared to smolt stage prior to volitional release. Between March 1 and June 30, a total of 1,166 hatchery coho were captured at the trap (Figure 10). Mean FL was 131 mm (n = 258; SD = 8.5) and mean weight was 24.7 g (n = 258; SD = 5.1; Table 2). A peak daily catch of 265 hatchery coho smolts occurred on May 13 following volitional release into Nason Creek. No trapping mortalities were incurred. Hatchery coho emigration data at the Nason Creek trap assists the MCCRP by providing size-at-emigration, emigration timing and duration of residence in Nason Creek.

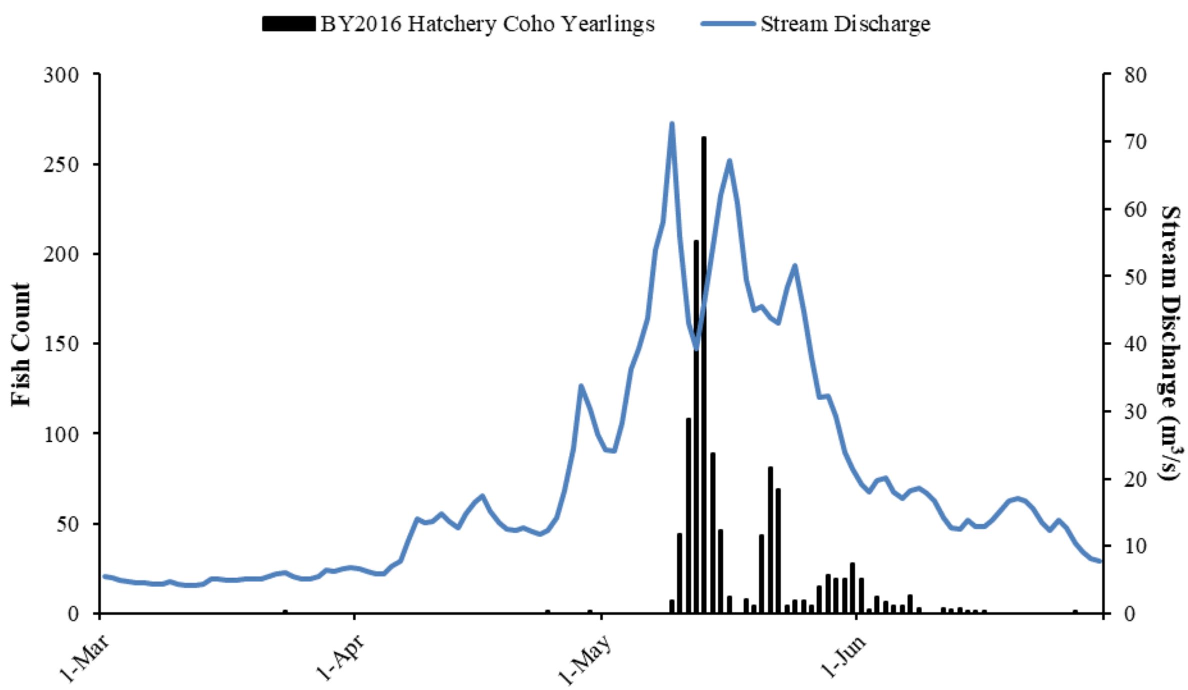


Figure 10. Daily catch of BY2016 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2018.

3.3 Remote Spring Chinook Tagging and Non-Trapping Estimates

3.3.1 BY2016 Parr

YNFRM and WDFW personnel PIT tagged and released a total of 3,242 BY2016 spring Chinook parr between September 4 and November 15, 2017 (Table 4). The total surveyed area included Nason Creek from rkm 0.8 to 26.1. All collections were performed via backpack electrofisher. Equal capture effort (measured in electrofisher seconds used) was applied across all reaches.

Table 4. Remote parr tagging results, BY2013 -2017.

Brood Year	Mark Year	Total Marked	Estimated Tag Rate	Detections at NAL		Non-Trapping Estimate
				Total	Non-Trapping Period	
2013	2014	1,821	3.8%	311	13	6,822
2014	2015	1,214	2.0%	100	2	1,442
2015	2016	802	2.8%	60	26	4,407
2016	2017	3,242	5.3%	245	10	1,401
2017	2018	2,524	—	—	—	—

Between October 1, 2017 and March 31, 2018, a total of 245 re-sights of the remote tagged spring Chinook were documented at the NAL array (Figure 11). Of these detections, 10 were during the winter non-trapping period. Antenna operation during this period was continuous, with no losses in coverage or periods of inactivity. The upstream gauge was inactive during the majority of the non-trapping period, which did not allow concurrent measurement of discharge. Measurement of gauge height was continuous during this period, and acted as a surrogate measurement.

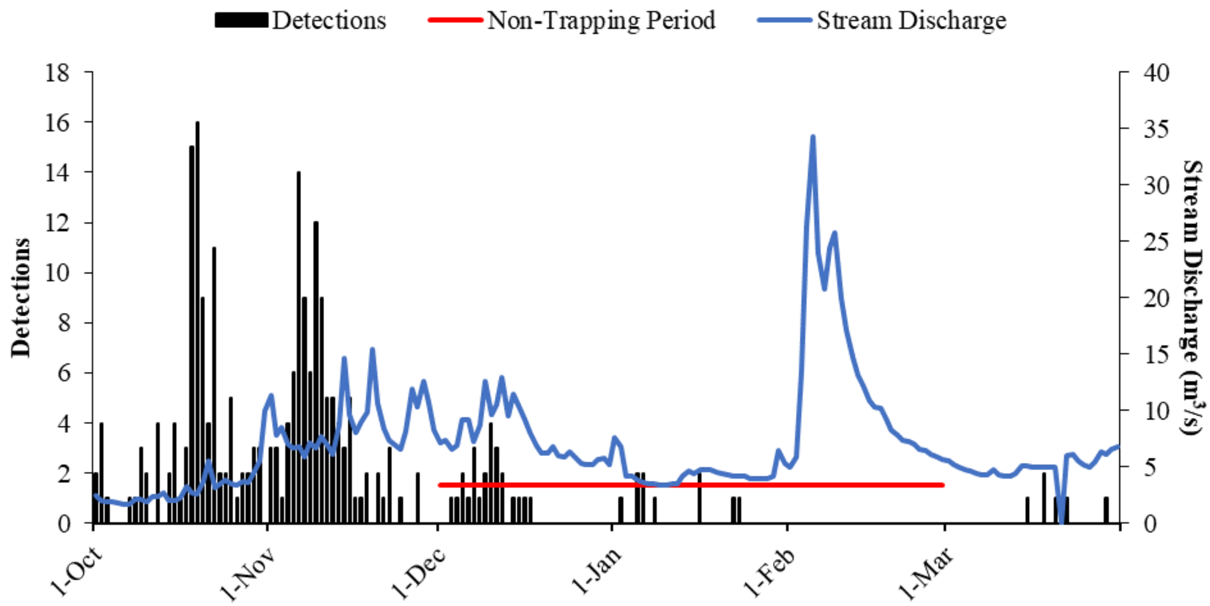


Figure 11. Daily detections of remote-tagged BY2016 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2017 and March 2018.

Subsequent to the remote tagging effort, 26 remote-tagged BY2016 spring Chinook were recaptured at the Nason Creek smolt trap. Total spring Chinook catch at the smolt trap was 1,162 emigrants during the same period. The pooled tag rate for remote-tagged spring Chinook captured at the Nason smolt trap was 5.3%. Parr emmigration during the non-trapping period was estimated using a flow-efficiency regression ($r^2 = 0.61$; $p = 0.0002$) based on detections at the NAL pit tag array. We estimated that 1,401 (± 1,241; 95% CI) BY2016 spring Chinook emigrated out of Nason Creek during the non-trapping period (Table 4).

3.3.2 BY2017 Parr

During remote tagging efforts in the fall of 2018, 2,524 spring Chinook were PIT tagged by YNFRM and WDFW personnel (Table 4). Because tag rate cannot be estimated until the completion of the BY2017 emigrant estimate in the spring/summer of 2019, an estimate of emigration during the non-trapping period will not be reported until the following report.

3.4 Trap Efficiency Calibration and Population Estimates

3.4.1 Spring Chinook Yearlings (BY2016)

Infrequent releases, low abundance, and a lack of recaptures did not allow a flow-efficiency model to be used on BY2016 yearling emigrants. In order to produce an estimate, a pooled efficiency (5.4%) composed of spring Chinook yearling releases in 2018 was used (Table 5). We recognize the sub-optimal nature of this estimation methodology, and will recalculate the estimates using linear regression analysis as soon as feasible. We estimated a total of 5,082 (± 3,580; 95% CI) BY2016 spring Chinook yearlings emigrated in spring of 2018 (Table 6). Combined with the non-trapping estimate of 1,401 (± 1,241; 95% CI) emigrants, and a BY2016 subyearling estimate of 25,384 (± 5,231; 95% CI), we estimated that a total of 31,867 (± 5,794; 95% CI) BY2016 spring Chinook juveniles emigrated from Nason Creek.

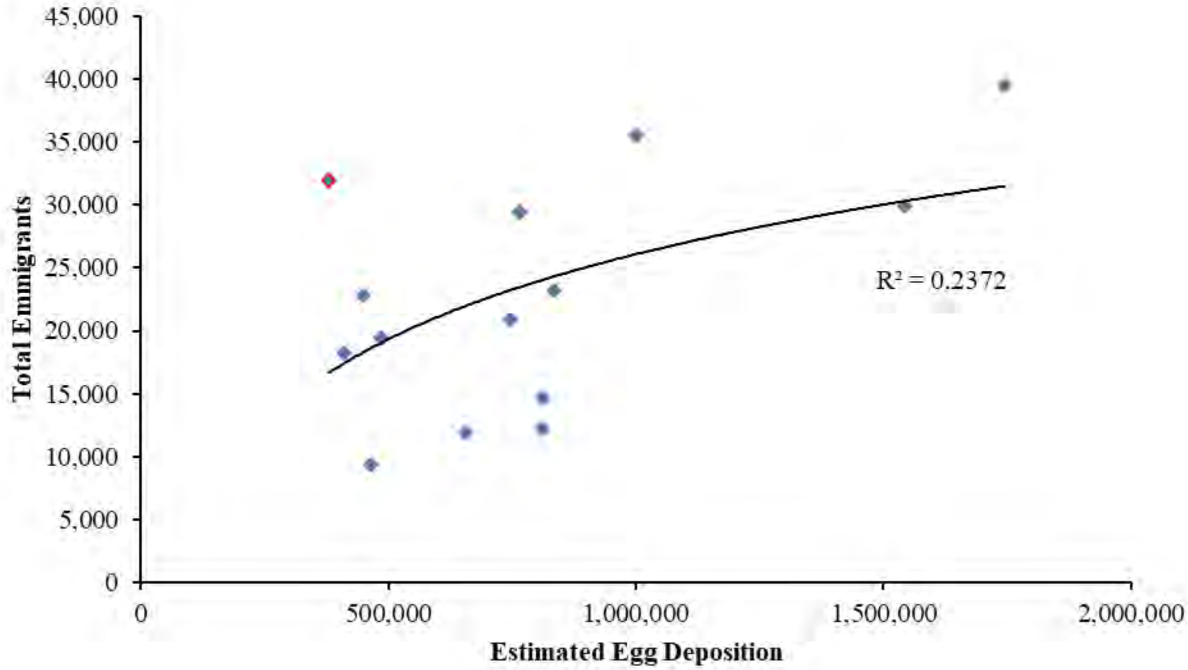
Table 5. Trap efficiency trials conducted with BY2016 wild spring Chinook yearlings.

Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Chinook Yearlings	1+	3/12/2018	1	0	10
Wild Chinook Yearlings	1+	3/18/2018	9	0	N/A
Wild Chinook Yearlings	1+	3/23/2018	5	0	6
Wild Chinook Yearlings	1+	3/27/2018	4	0	6
Wild Chinook Yearlings	1+	3/31/2018	11	1	7
Wild Chinook Yearlings	1+	4/4/2018	3	0	10
Wild Chinook Yearlings	1+	4/8/2018	43	2	14
Wild Chinook Yearlings	1+	4/13/2018	49	6	13
Wild Chinook Yearlings	1+	4/22/2018	22	1	12
Wild Chinook Yearlings	1+	4/26/2018	39	1	18
Wild Chinook Yearlings	1+	4/30/2018	35	2	26
Wild Chinook Yearlings	1+	5/4/2018	16	0	40
Wild Chinook Yearlings	1+	5/15/2018	2	0	71
Wild Chinook Yearlings	1+	5/23/2018	1	0	63
Wild Chinook Yearlings	1+	5/28/2018	1	0	34
Wild Chinook Yearlings	1+	6/9/2018	1	0	17
Total			**242**	**13**	

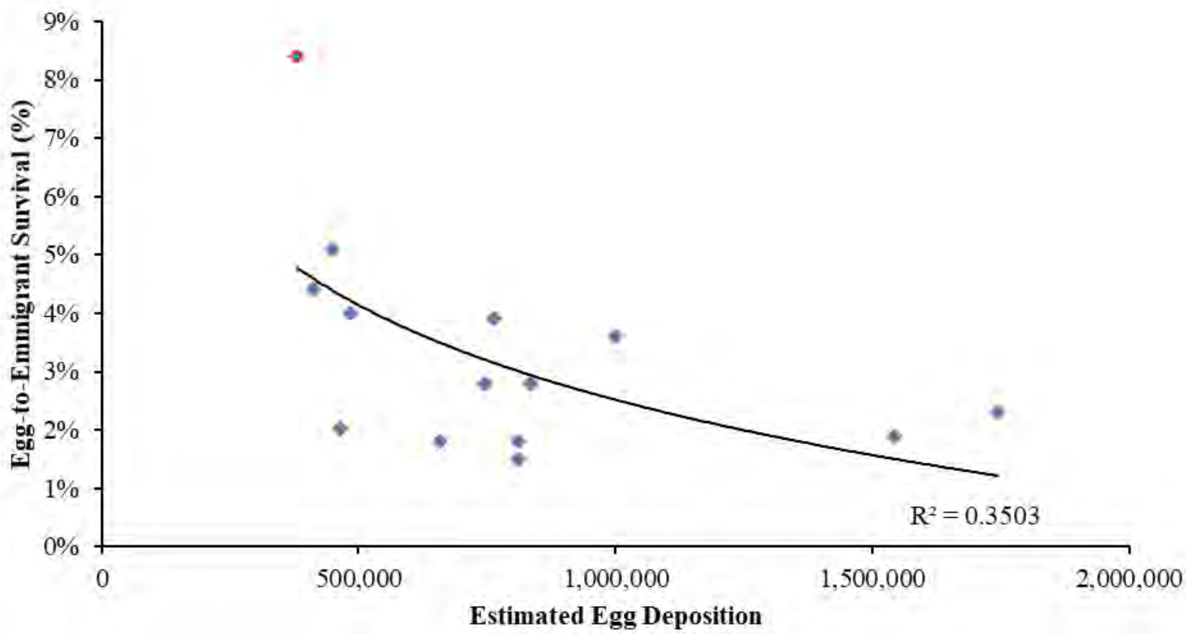
Table 6. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek spring Chinook salmon.

Brood Year	No. Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				Age-0[b]	Non Trap[d]	Age-1	Total ± 95% CI		
2002	294	4,654	1,368,276	—	—	4,683	—	—	—
2003	83	5,844	485,052	13,067	—	6,358	19,425 ± 1,993	4.0%	234
2004	169	4,799	811,031	12,111	—	2,597	14,708 ± 2,938	1.8%	87
2005	193	4,327	835,111	14,565	—	8,696	23,261 ± 5,440	2.8%	121
2006	152	4,324	657,248	4,144	—	7,798	11,942 ± 1,744	1.8%	79
2007	101	4,441	448,541	17,097	—	5,679	22,776 ± 2,983	5.1%	226
2008	336	4,592	1,542,912	26,284	—	3,611	29,895 ± 7,244	1.9%	89
2009	167	4,573	763,691	27,720	—	1,705	29,425 ± 12,777	3.9%	176
2010	188	4,314	811,032	8,685	—	3,535	12,220 ± 1,972	1.5%	65
2011	170	4,385	745,450	18,457	—	2,422	20,879 ± 3,887	2.8%	123
2012	413	4,223	1,744,099	34,961	—	4,561	39,522 ± 6,395	2.3%	96
2013	212	4,716	999,792	21,697	6,822	6,992[e]	35,511 ± 34,195	3.6%	168
2014	115	4,045	465,175	7,020	1,442	930[e]	9,393 ± 5,299	2.0%	82
2015	85	4,847	411,995	6,528	4,407	7,247[e]	18,182 ± 10,379	4.4%	214
2016	85	4,467	379,695	25,384	1,401	5,082[e]	31,867 ± 5,893	8.4%	375
2017	68	4,930	335,240	17,066	—	—	—	—	—
Avg.[c]	177	4,593	800,271	16,986	—	4,801	22,786	3.3%	152

[a] Data provided by Hillman et al. 2018.
[b] Does not include subyearling fry prior to July 1.
[c] 14-year average of complete brood data, BY2003-2016.
[d] Estimated emigration during the winter non-trapping period (December 1 – February 28).
[e] Pooled estimate



Total Emmigrants
Estimated Egg Deposition
R² = 0.2372
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
500,000
1,000,000
1,500,000
2,000,000



Egg-to-Emmigrant Survival (%)
Estimated Egg Deposition
R² = 0.3503
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
0
500,000
1,000,000
1,500,000
2,000,000

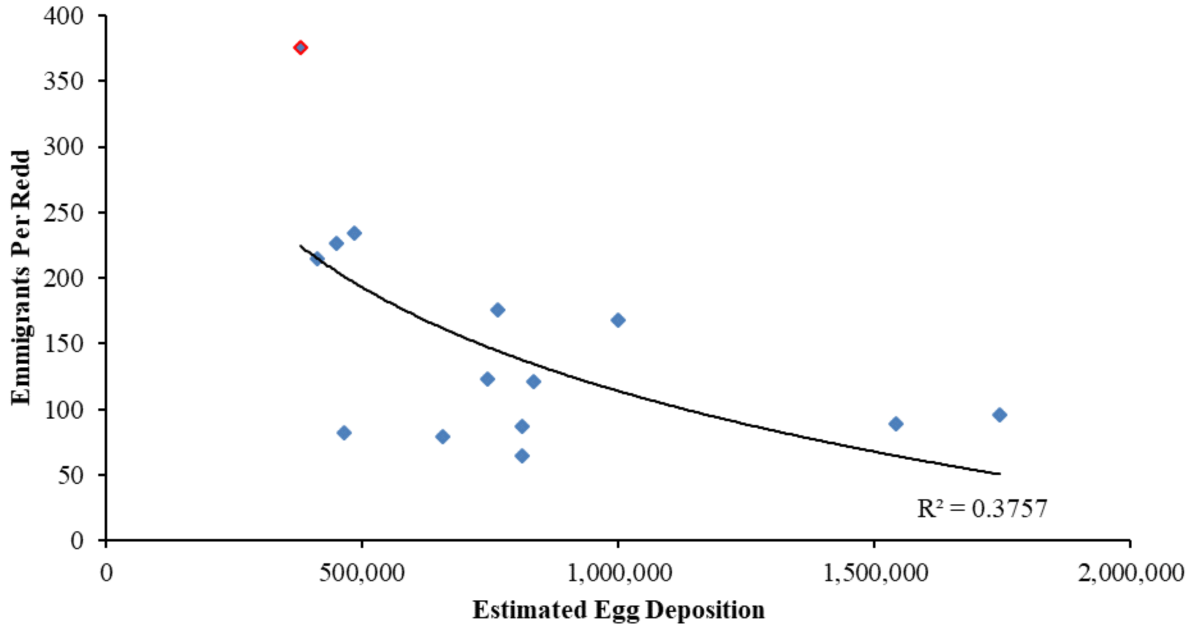


Figure 12. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2016. *BY2016 denoted by red border.

3.4.2 Spring Chinook Subyearlings (BY2017)

A linear regression model was developed using subyearling mark groups released in the fall 2014, 2016, 2017, and 2018. The resulting regression ($r^2 = 0.09$; $p = 0.11$) was below the desired level of statistical significance. However, this was attributed to an outlier value resulting from a single efficiency trial on October 31, 2017 (Appendix C). Without this single outlier, the regression proved significant ($r^2 = 0.37$; $p = 0.003$). We decided to use the regression (including the outlier) due to the small actual effect of the outlier. Using this model, we estimated that a total of 17,066 (± 1,611; 95% CI) BY2016 spring Chinook emigrated past the trap in the fall of 2018.

Table 7. Efficiency trials conducted with BY2017 wild spring Chinook subyearlings.

Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Chinook Subyearlings	0	7/4/2018	10	0	6
Wild Chinook Subyearlings	0	7/8/2018	12	0	6
Wild Chinook Subyearlings	0	7/12/2018	9	0	4
Wild Chinook Subyearlings	0	7/16/2018	1	0	3
Wild Chinook Subyearlings	0	7/20/2018	5	2	3
Wild Chinook Subyearlings	0	7/24/2018	8	1	2
Wild Chinook Subyearlings	0	7/28/2018	5	0	2
Wild Chinook Subyearlings	0	11/7/2018	119	15	10
Wild Chinook Subyearlings	0	11/11/2018	85	10	5
Wild Chinook Subyearlings	0	11/15/2018	121	7	5
Wild Chinook Subyearlings	0	11/19/2018	64	8	4
Wild Chinook Subyearlings	0	11/24/2018	22	4	9
Wild Chinook Subyearlings	0	11/28/2018	48	4	3
Total			**509**	**51**	

3.4.3 Summer Steelhead

Releases of PIT-tagged steelhead were performed every four days at the established release location (Table 8). Because a viable flow-efficiency regression could not be obtained, a pooled estimate was used. In a total of 29 separate trials, 416 wild summer steelhead were released upstream with 6 recaptures (1.4%). Estimates of age-0 fry and parr were not made due to insufficient evidence that active migration is occurring at this young age. Previous attempts at the old location to build a model based on young-of-the-year steelhead parr in the fall have yielded weak flow-efficiency relationships; further suggesting that age-0 parr catch is the result of displacement rather than active migration. We estimated that 28,080 (± 89,542; 95% CI) BY2017 age-1, 3,328 (± 10,648; 95% CI) BY2016 age-2, and 208 (± 702; 95% CI) BY2015 age-3 steelhead emigrated past the trap in 2017 (Table 9). We estimated that total (age 1-3) BY2015 emigration to be 21,471 (± 3,983; 95% CI). All pooled estimates will be recalculated upon development of a species-specific flow-efficiency model.

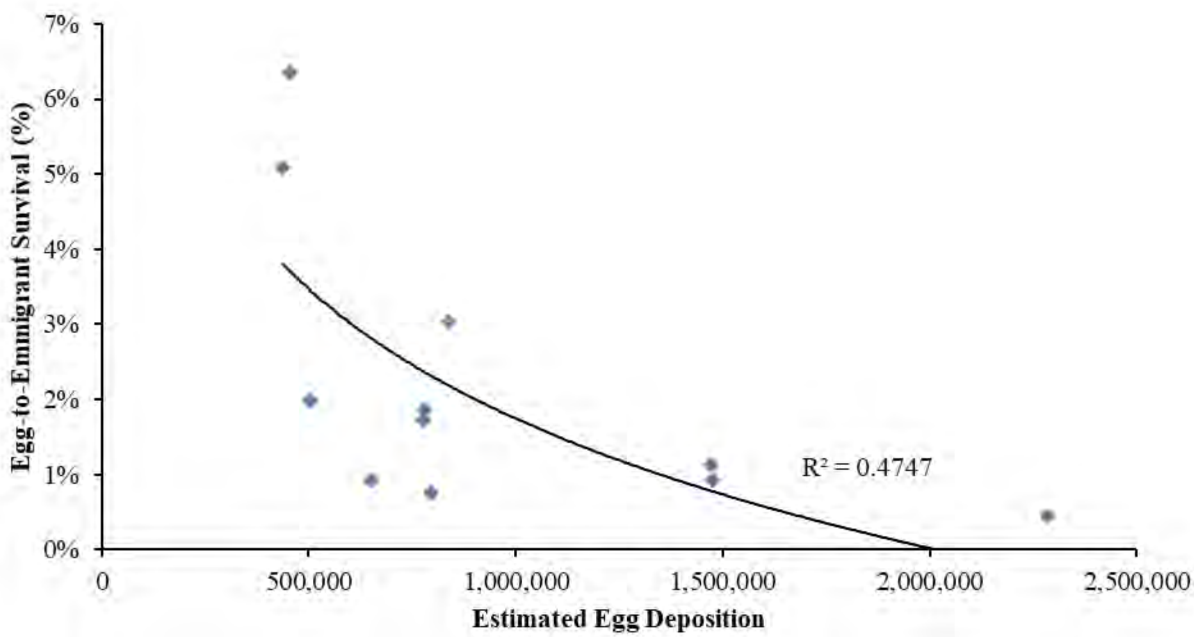
Table 8. Efficiency trials conducted with wild summer steelhead juveniles.

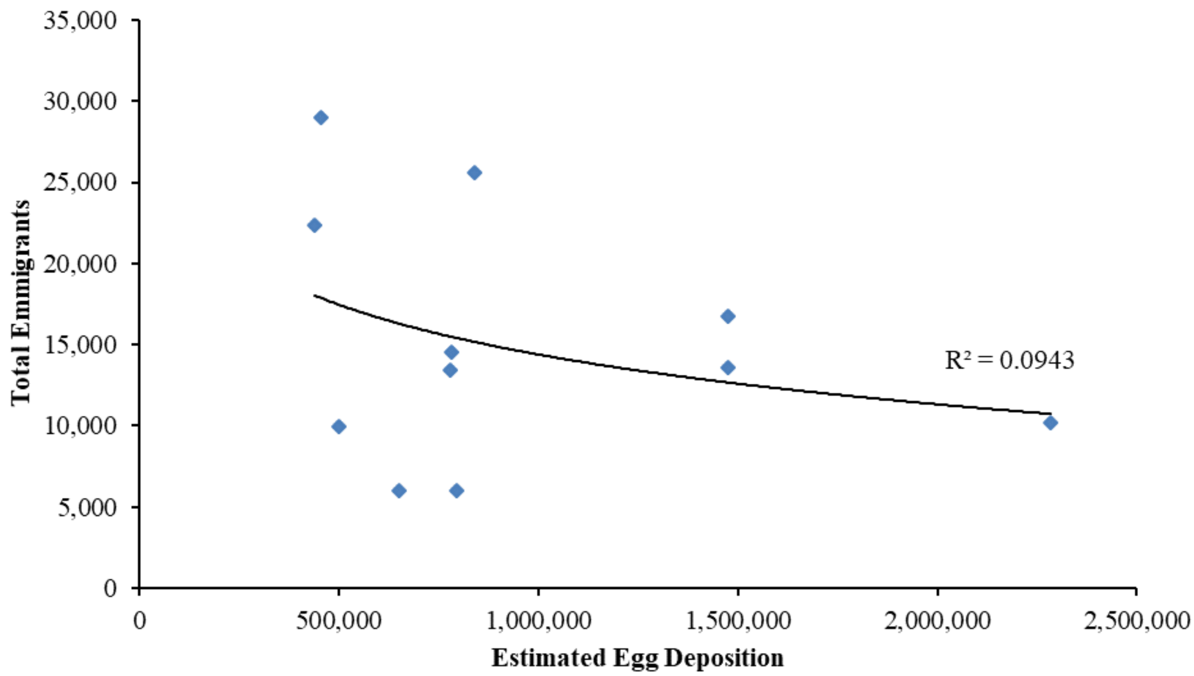
Origin/Species/Stage	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Steelhead Parr/Smolt	3/12/2018	1	0	10
Wild Steelhead Parr/Smolt	3/18/2018	1	1	N/A
Wild Steelhead Parr/Smolt	3/23/2018	4	1	6
Wild Steelhead Parr/Smolt	3/27/2018	3	0	6
Wild Steelhead Parr/Smolt	3/31/2018	11	1	7
Wild Steelhead Parr/Smolt	4/4/2018	3	0	10
Wild Steelhead Parr/Smolt	4/8/2018	17	0	14
Wild Steelhead Parr/Smolt	4/13/2018	15	1	13
Wild Steelhead Parr/Smolt	4/22/2018	10	0	12
Wild Steelhead Parr/Smolt	4/26/2018	15	0	18
Wild Steelhead Parr/Smolt	4/30/2018	74	0	26
Wild Steelhead Parr/Smolt	5/4/2018	33	0	40
Wild Steelhead Parr/Smolt	5/15/2018	13	1	71
Wild Steelhead Parr/Smolt	5/19/2018	2	0	46
Wild Steelhead Parr/Smolt	5/23/2018	6	0	63
Wild Steelhead Parr/Smolt	5/28/2018	24	0	34
Wild Steelhead Parr/Smolt	6/1/2018	41	1	19
Wild Steelhead Parr/Smolt	6/5/2018	49	0	18
Wild Steelhead Parr/Smolt	6/9/2018	19	0	17
Wild Steelhead Parr/Smolt	6/13/2018	14	0	12
Wild Steelhead Parr/Smolt	6/17/2018	22	0	13
Wild Steelhead Parr/Smolt	6/21/2018	11	0	16
Wild Steelhead Parr/Smolt	6/26/2018	4	0	12
Wild Steelhead Parr/Smolt	6/30/2018	1	0	8
Wild Steelhead Parr/Smolt	7/4/2018	3	0	6
Wild Steelhead Parr/Smolt	7/8/2018	5	0	6
Wild Steelhead Parr/Smolt	7/12/2018	5	0	4
Wild Steelhead Parr/Smolt	7/16/2018	9	0	3
Wild Steelhead Parr/Smolt	7/24/2018	1	0	2
Total		**416**	**6**	

Table 9. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead.

Brood Year	No. of Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				1+	2+	3+	Total ± 95%CI		
2001	27	5,951	160,677	DNOT	DNOT	846	—	—	—
2002	80	5,776	462,080	DNOT	2,475	0	—	—	—
2003	121	6,561	793,881	4,906	1,054	27	5,987 ± 1,193	0.80%	49
2004	127	5,118	649,986	5,107	906	22	6,035 ± 885	0.90%	48
2005	412	5,545	2,284,540	7,416	2,502	298	10,216 ± 2,147	0.40%	25
2006	77	5,688	437,976	19,609	2,673	37	22,319 ± 5,722	5.10%	290
2007	78	5,840	455,520	26,518	2,325	117	28,960 ± 7,739	6.40%	371
2008	88	5,693	500,984	8,782	1,164	0	9,946 ± 2,382	2.00%	113
2009	126	6,199	781,074	13,606	608	312	14,526 ± 2,868	1.90%	115
2010	270	5,458	1,473,660	12,767	3,999	0	16,776 ± 3,885	1.10%	62
2011	235	6,276	1,474,860	13,109	482	0	13,591 ± 3,525	0.90%	58
2012	158	5,309	838,822	24,637	813	116[c]	25,566 ± 6,020	3.00%	162
2013	135	5,749	—	11,837	1,508[c]	72[c]	13,417 ± 9,133	1.73%	99
2014	—	5,831	—	22,504[c]	1,224[c]	0	23,728 ± 124,628	—	—
2015	—	6,220	—	19,872[c]	1,391[c]	208[c]	21,471 ± 3,983	—	—
2016	—	5,392	—	20,829[c]	3,328[c]	—	—	—	—
2017	—	6,655	—	28,080[c]	—	—	—	—	—
Avg[b]	166	5,836	951,731	14,667	1,652	137	16,349	2.2%	127

[a] Data provided by Hillman et al. 2018
[b] 13-year average of complete brood estimates, BY2003-2015
[c] Pooled estimate





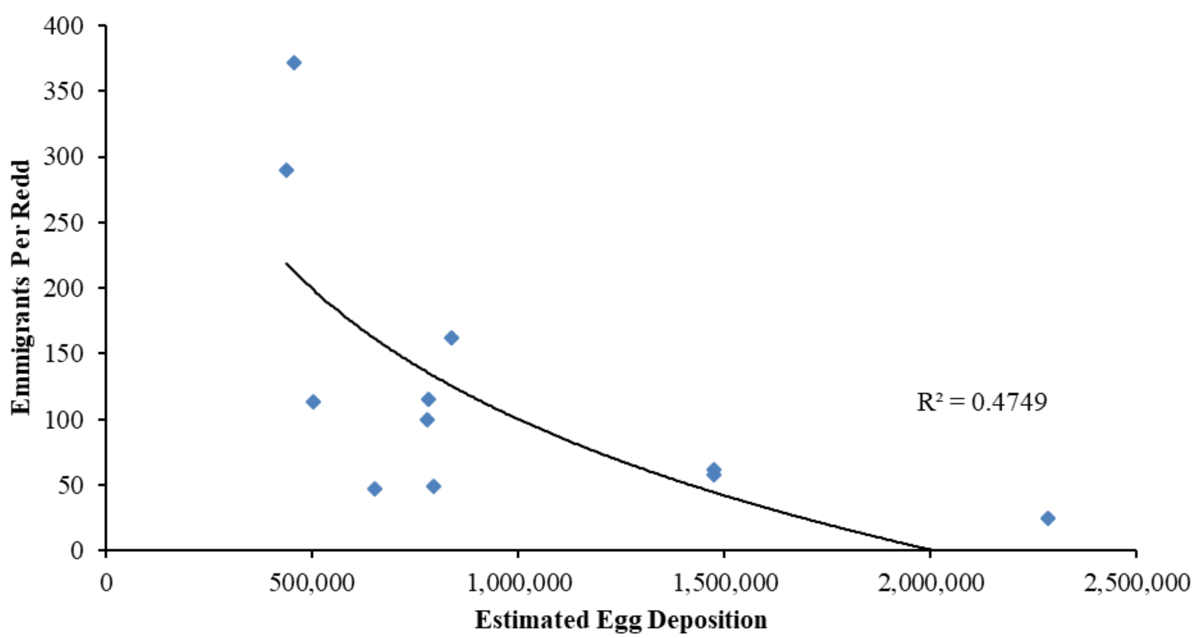


Figure 13. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2015. *2015 brood denoted by red border.

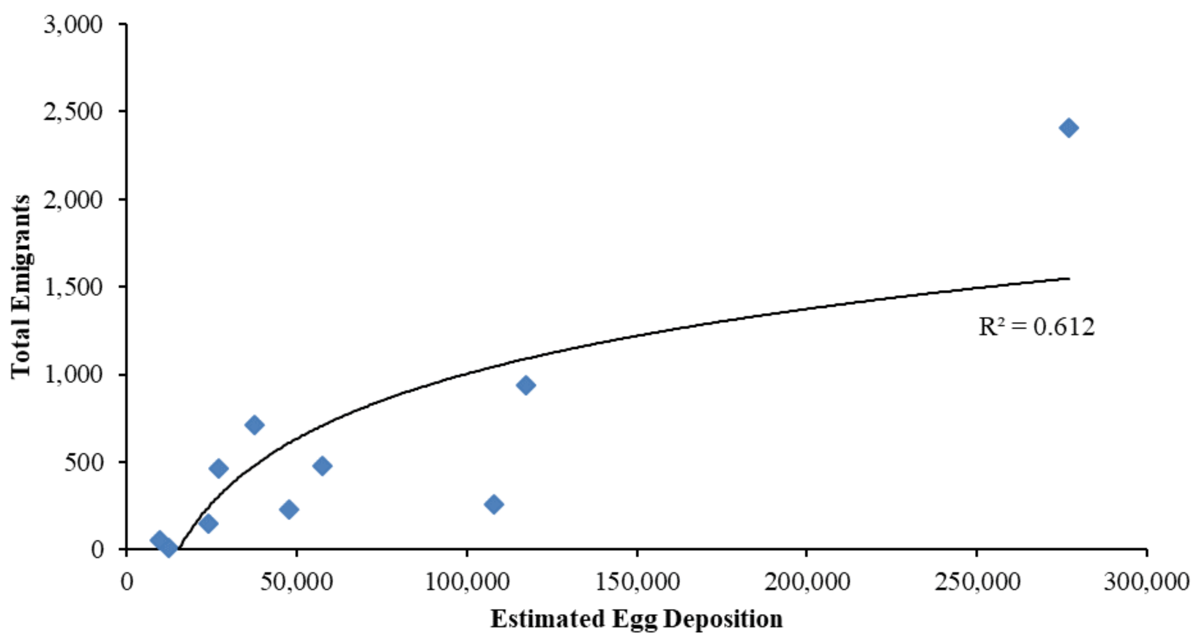
3.4.4 Coho Yearlings (BY2016)

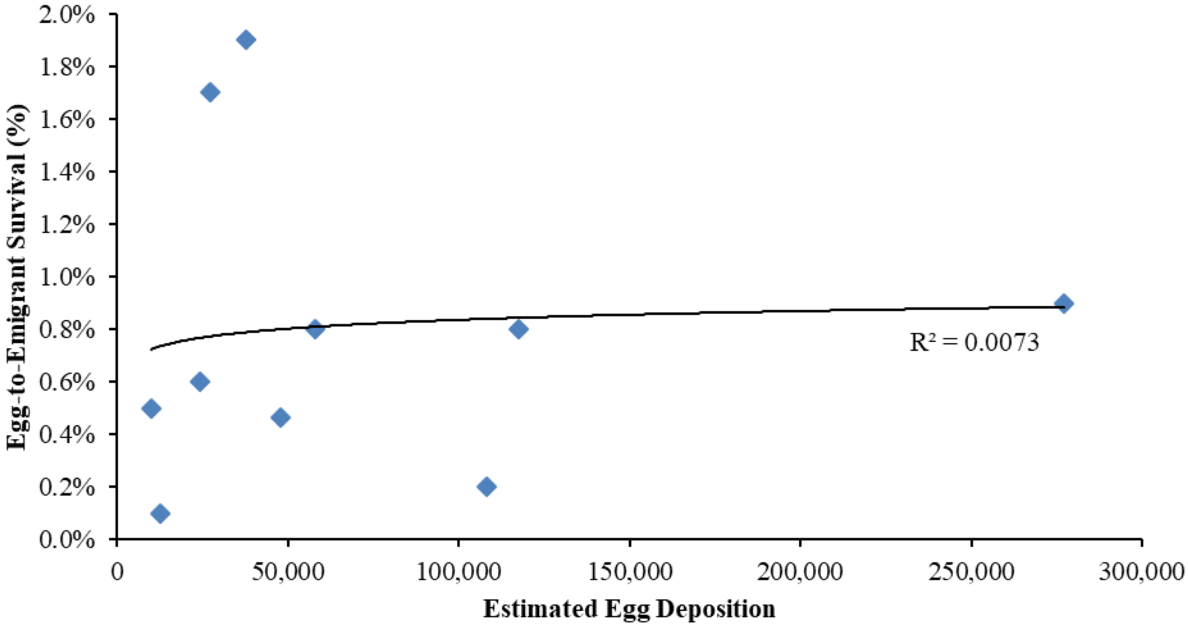
Due to lack of BY2015 naturally-produced coho catch, we concluded that there were no emigrants from Nason in 2018 (Table 10).

Table 10. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek coho salmon.

Brood Year	No. of Redds	Fecundity	Est. Egg Deposition	No. of Emigrants			Egg-to-Emigrant	Emigrants per Redd
				Age-0[a]	Age-1	Total ± 95% CI		
2003	6	2,458	14,748	DNOT	394	—	—	—
2004	35	3,084	107,940	204	56	260 ± 155	0.20%	7
2005	41	2,866	117,506	27	910	937 ± 347	0.80%	23
2006	4	3,126	12,504	7	0	7 ± 10	0.10%	2
2007	10	2,406	24,060	14	136	150 ± 104	0.60%	15
2008	3	3,275	9,825	50	0	50 ± 57	0.50%	17
2009	14	2,691	37,674	471	237	708 ± 478	1.90%	51
2010	8	3,411	27,288	27	437	464 ± 231	1.70%	58
2011	89	3,114	277,146	1,018	1,387	2,405 ± 612	0.90%	27
2012	21	2,752	57,792	46	434	480 ± 237	0.80%	23
2013	0	—	0	91	91[c]	182 ± 714	—	—
2014	16	2,992	47,872	131[c]	92[c]	223 ± 514	0.47%	14
2015	0	—	0	0	0	0	—	—
2016	0	—	0	0	0	0	—	—
2017	1	2,241	2,241	0	—	—	—	—
Avg.[b]	17	2,868	49,106	178	360	489	0.80%	24

[a] Does not include subyearling fry prior to July 1.
[b] 12-year average of complete brood data, BY2004-2017.
[c] Pooled estimate





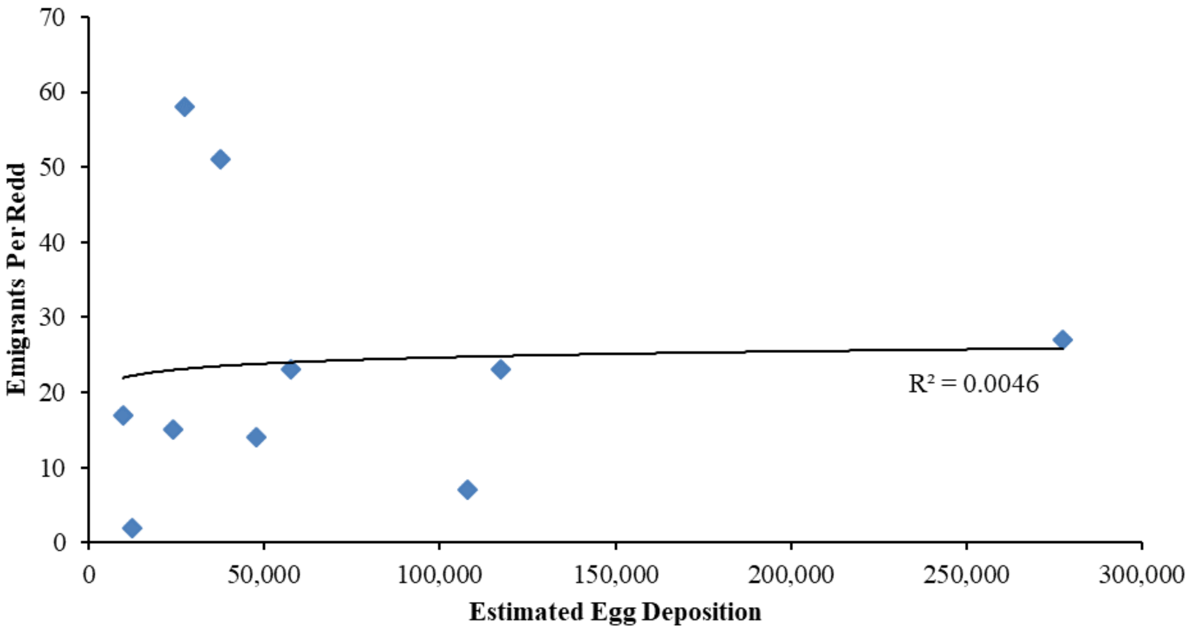


Figure 14. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek natural-produced coho, BY 2003 to 2014.

3.4.5 Coho Subyearlings (BY2017)

Due to lack of BY2017 naturally-produced coho catch, we concluded that there were no emigrants from Nason in 2018.

3.5 PIT Tagging

Total fish PIT tagged included 982 wild spring Chinook and 536 steelhead (Table 11). All tagging files were submitted to the PTAGIS database. There were no shed tags recovered after the 24-72 hr. post-tagging holding period.

Table 11. Number of PIT tagged Chinook and steelhead with shed rates at the Nason Creek rotary trap in 2018.

Species/Stage	Annual Catch	PIT Tagged	No. of Shed Tags	Percent Shed Tags
Chinook Yearling Smolt	301	296	0	0.0%
Chinook Subyearling Parr (Mar 1 to June 30)	181	44	0	0.0%
Chinook Subyearling Parr (July 1 to Nov 30)	710	642	0	0.0%
Steelhead Parr	536	513	0	0.0%
Steelhead Smolt	23	23	0	0.0%

* Counts do not include fish with FL<50mm (fry).

3.6 Incidental Species

Along with wild spring Chinook, wild steelhead/rainbow trout, and naturally produced coho, other resident fish species captured at the Nason Creek rotary trap and included in Table 12 are: bull trout (*Salvelinus confluentus*), cutthroat trout (*Oncorhynchus clarki lewisi*), flathead minnow (*Pimephales promelas*), longnose dace (*Rhinichthys cataractae*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), Pacific lamprey (*Entosphenus tridentatus*), redside shiner (*Richardsonius balteatus*), sculpin (*Cottus sp.*), and sucker (*Catostomus sp.*).

Table 12. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2018.

Species	Total Count	Length (mm)			Weight (g)		
		Mean	N	SD	Mean	N	SD
Bull Trout	1	600	1	—	—	—	—
Cutthroat Trout	2	181	2	3.5	58.2	2	5.3
Fathead Minnow	21	62	21	16.0	4.7	21	6.1
Longnose Dace	72	65	72	29.0	5.9	69	7.1
Mountain Whitefish	86	40	86	26.2	2.5	85	16.9
Northern Pikeminnow	9	130	9	70.5	32.2	9	40.2
Pacific Lamprey	1	—	—	—	—	—	—
Redside Shiner	12	67	12	17.4	5.3	11	3.2
Sculpin	76	77	76	33.8	9.0	76	9.3
Sucker	289	74	289	17.4	5.4	288	3.6

3.7 ESA Compliance

The Nason Creek smolt trap was operated under consultation by NMFS and USFWS. Total numbers of UCR spring Chinook and UCR summer steelhead that were captured or handled (indirect take) at the trap were less than the maximum permitted (20%) for each species. The maximum lethal take threshold of 2% was not exceeded for any species (Table 13).

Table 13. Summary of ESA species and coho salmon mortality at the Nason Creek rotary trap.

Species/Stage/Brood Year	Total Collected	Total Mortality	% Mortality
Spring Chinook Yearling (BY2016)	301	5	1.7%
Spring Chinook Subyearling (BY 2017)	1,651	8	0.5%
Total Wild Spring Chinook	**1,952**	**13**	**0.7%**
Total Hatchery Spring Chinook	**367**	**0**	**0.0%**
Steelhead Age-0 (BY2018)	221	0	0.0%
Steelhead Age-1 (BY2017)	426	7	1.6%
Steelhead Age-2 (BY2016)	50	0	0.0%
Steelhead Age-3 (BY2015)	2	0	0.0%
Total Wild Summer Steelhead	**699**	**7**	**1.0%**
Total Hatchery Summer Steelhead	**733**	**0**	**0.0%**
Total Bull Trout	**1**	**0**	**0.0%**

4.0 DISCUSSION

Trap Operation

Operation in 2018 marked the fourth full year of trapping at the Bolser location. Attempts to characterize a "normal" operational year at the new site are ongoing, and largely inconclusive due to anomalous flow trends during the 2015 through 2018 trapping years. After 2015 and 2016 trap operations were affected by a strong El Niño event, 2017 again saw decreased trap deployment, this time due to precipitation levels markedly below the ten-year mean. The 2018 trapping season again experienced long periods of operation interruption with the trap being pulled for 92 days due to low flows. In these four years, the trap saw a minimum of 62 days at discharges below 1.4 m^3/s (50 cfs); the approximate lowest discharge required to ensure consistent trap rotation. Though we assume that uninterrupted trap operation is unlikely in a tributary that can fall below 0.6 m^3/s (20 cfs), such long periods of trap stoppage were unexpected. In contrast, 2014 was the only summer sampled in the new location in which temperature, flow, and precipitation trends were near average for the tributary. Days below the 1.4 m^3/s minimum operational flow were limited to 20, and were sporadically distributed instead of a single prolonged period of discontinued trapping. Given the anomalous weather patterns and resulting low-flow conditions in the past three years of operation, 2014 is likely the best indicator of what we can expect given average conditions. In the absence of such anomalous weather patterns, we can expect to see improved trap operation in the coming years.

Spring Chinook

The BY2016 spring Chinook emigrant estimate was above average, the third-highest on record, despite the second-lowest egg deposition. It is suspected that the low rearing denisities resulted in above-averarage in-stream survival and the highest estimated egg-to-emigrant ratio (8.4%) on record. Though high survival of BY2016 subyearlings is apparent, we can only speculate as to the cause. We hypothesize that improved survival may be due in-part to natural habitat alterations occurring in the past three years, including a major flood in November 2015 that resulting in significant alterations to channel morphology and LWD throughout the tributary. This pattern of high BY2016 spring Chinook egg-to-emigrant ratio was also observed in the nearby White and Chiwawa Rivers, which both had below-average egg deposition and estimated egg-to-emigrant ratios that were well above-average (Fig. 14).

With the lowest recorded redd counts and egg desposition on record, we might have expected BY2017 subyearling estimates to be similarly high to the BY2016 subyearling estimates, due to low-rearing densities. However, the BY2017 subyearling estimate was relatively average. With that said, BY2017 the egg-to-emigrant ratio is already at 5.1% without including forthcoming yearling estimates, which would be tie for the second highest on record. Conclusions about BY2017 will be made after BY2017 yearling estimates will be made at the conclusion of the 2019 trapping season.

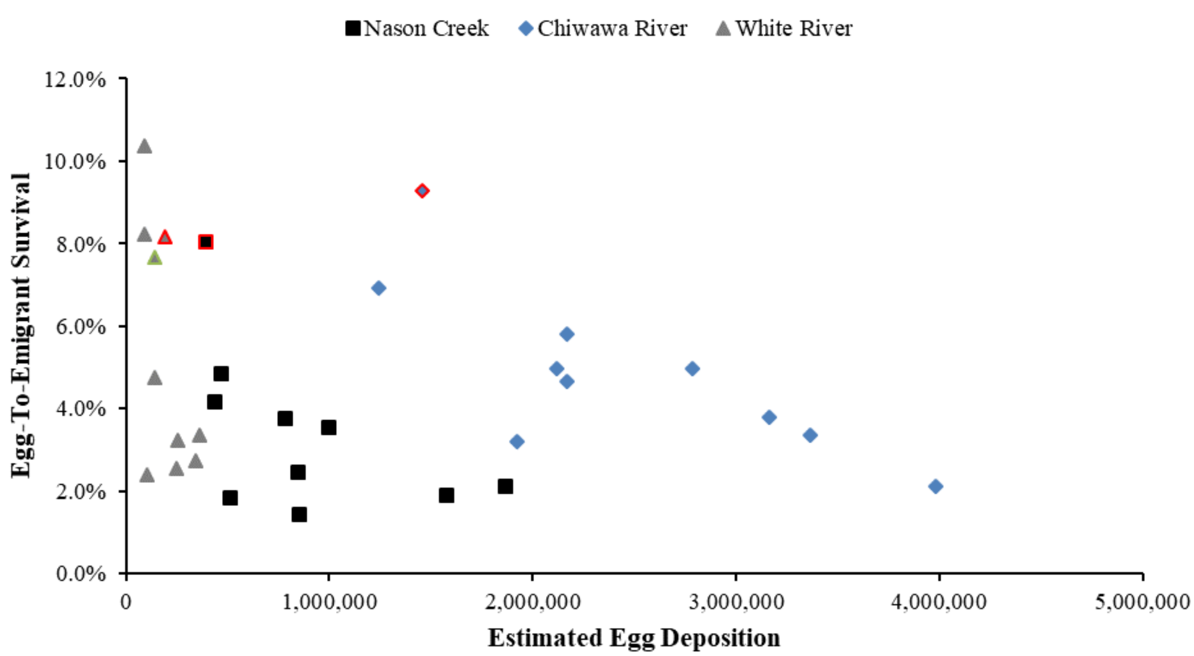


Figure 15 Comparisons of White R., Nason Cr., and Chiwawa River egg-to-emigrant survivals, BY2007-2016. *BY2016 denoted by red border.

Summer Steelhead

The BY2015 steelhead emigrant total was slightly above average. As in previous years, the overwhelming majority (92.6%) of BY2015 juveniles emigrated from Nason Creek at age-1. Pooled estimates were used to produce all steelhead estimates in 2018. As with Chinook subyearlings, we note the caveat that eventual recalculation using a flow efficiency regression may yield different results. Further examination of the success of this completed brood migration should be performed upon recalculation of emigrant estimates.

Initial BY2016 and BY2017 emigrant estimates both suggest above-average juvenile abundances based on the age classes collected so far. Although redd counts were not conducted at Nason Creek beyond 2013, for both brood years, based on age-1 emigrant estimates alone, egg-to-emigrant survival appears likely to be well-above average. High initial survival rates likely achieved in BY2016 and BY2017 summer steelhead may be due to changing habitat conditions resulting from significant high water events in the past three years. A conclusion about BY2016 will be made after the 2019 trapping season.

Coho

The MCCRP is currently in 'Broodstock Develop Phase 2' (BDP2; YNFRM 2018). In an effort to promote the long-range upriver adaptation of the stock, BDPD2 prioritizes adult coho collected at Tumwater Dam. The emphasis placed on Tumwater Dam for adult collections combined with low adult coho returns in both 2015 and 2016 resulted in few coho escaping to spawning habitats upstream of Tumwater Dam (such as Nason Creek). In 2016, adult passage upstream of Tumwater Dam was limited to 2 adults, and 3 adults in 2017. The lack of juveniles captured at the smolt trap in 2018 were a reflection of this low passage. We expect increased escapement to spawning habitats upstream of Tumwater Dam when biological targets for Broodstock Development Phase 2 have been met and the project transitions to the Natural Production Phases (YNFRM 2018).

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APPENDIX A. Daily Stream Discharge

Date	Stream Discharge (m³/s)	Water Temperature (˚C)
1/1/2018	7.6	0.1
1/2/2018	6.8	0.1
1/3/2018	4.2	0.1
1/4/2018	4.2	0.1
1/5/2018	3.9	0.4
1/6/2018	3.6	1.5
1/7/2018	3.5	2.0
1/8/2018	3.5	2.0
1/9/2018	3.4	2.1
1/10/2018	3.4	2.1
1/11/2018	3.5	0.7
1/12/2018	3.5	0.3
1/13/2018	4.2	1.7
1/14/2018	4.6	2.4
1/15/2018	4.4	2.7
1/16/2018	4.8	3.0
1/17/2018	4.7	2.5
1/18/2018	4.7	2.2
1/19/2018	4.6	2.4
1/20/2018	4.4	2.6
1/21/2018	4.3	2.4
1/22/2018	4.2	2.0
1/23/2018	4.2	1.2
1/24/2018	4.2	0.9
1/25/2018	4.0	1.4
1/26/2018	3.9	1.0
1/27/2018	3.9	0.3
1/28/2018	3.9	1.2
1/29/2018	4.2	2.2
1/30/2018	6.5	1.9
1/31/2018	5.3	2.2
2/1/2018	5.0	2.5
2/2/2018	5.9	2.3
2/3/2018	13.5	2.7
2/4/2018	26.3	2.5
2/5/2018	34.3	2.5
2/6/2018	24.0	3.1
2/7/2018	20.7	3.7
2/8/2018	24.4	3.9
2/9/2018	25.7	3.2
2/10/2018	20.0	2.6
2/11/2018	17.2	2.3
2/12/2018	14.8	1.6
2/13/2018	13.2	1.5
2/14/2018	12.2	2.6
2/15/2018	10.9	2.6
2/16/2018	10.3	3.1
2/17/2018	10.3	1.2
2/18/2018	9.3	1.5
2/19/2018	8.3	0.7
2/20/2018	7.8	0.1
2/21/2018	7.4	0.0
2/22/2018	7.2	0.1
2/23/2018	7.0	0.0
2/24/2018	6.6	0.5
2/25/2018	6.5	0.4
2/26/2018	6.1	0.8
2/27/2018	5.8	2.0
2/28/2018	5.6	2.2
3/1/2018	5.5	1.7
3/2/2018	5.2	2.4
3/3/2018	4.9	2.7
3/4/2018	4.8	2.2
3/5/2018	4.6	2.7
3/6/2018	4.4	2.6
3/7/2018	4.3	2.0
3/8/2018	4.3	2.1
3/9/2018	4.7	2.7
3/10/2018	4.3	2.6
3/11/2018	4.2	2.7
3/12/2018	4.2	3.1
3/13/2018	4.4	3.2
3/14/2018	5.1	4.1
3/15/2018	5.1	3.6
3/16/2018	4.9	3.7
3/17/2018	4.9	4.1
3/18/2018	5.0	4.4
3/19/2018	5.0	4.1
3/20/2018	5.0	4.1
3/21/2018	0.0	
3/22/2018	5.9	3.8

3/23/2018	6.1	2.9	5/5/2018	39.4	5.6
3/24/2018	5.6	3.8	5/6/2018	43.9	5.8
3/25/2018	5.2	3.6	5/7/2018	53.8	6.2
3/26/2018	5.0	4.1	5/8/2018	58.0	5.8
3/27/2018	5.4	5.4	5/9/2018	72.8	5.4
3/28/2018	6.4	5.2	5/10/2018	56.1	5.5
3/29/2018	6.2	5.1	5/11/2018	43.0	6.1
3/30/2018	6.6	5.9	5/12/2018	39.4	6.5
3/31/2018	6.8	5.1	5/13/2018	45.9	6.5
4/1/2018	6.6	4.6	5/14/2018	54.4	6.3
4/2/2018	6.3	3.9	5/15/2018	62.0	6.3
4/3/2018	5.9	4.3	5/16/2018	67.1	6.6
4/4/2018	5.8	4.4	5/17/2018	60.9	6.6
4/5/2018	7.0	4.6	5/18/2018	49.6	5.8
4/6/2018	7.7	5.0	5/19/2018	45.0	6.2
4/7/2018	10.8	5.2	5/20/2018	45.6	6.8
4/8/2018	14.1	5.0	5/21/2018	43.9	7.1
4/9/2018	13.5	5.4	5/22/2018	43.0	7.1
4/10/2018	13.6	5.1	5/23/2018	48.4	6.9
4/11/2018	14.7	4.8	5/24/2018	51.5	7.2
4/12/2018	13.6	5.2	5/25/2018	44.7	7.2
4/13/2018	12.7	4.1	5/26/2018	37.9	7.1
4/14/2018	14.8	4.7	5/27/2018	32.0	7.9
4/15/2018	16.4	4.9	5/28/2018	32.3	8.2
4/16/2018	17.4	4.7	5/29/2018	29.2	7.0
4/17/2018	15.2	4.6	5/30/2018	23.9	7.0
4/18/2018	13.5	4.9	5/31/2018	21.5	7.2
4/19/2018	12.6	5.6	6/1/2018	19.1	7.6
4/20/2018	12.3	6.3	6/2/2018	18.0	8.0
4/21/2018	12.7	6.2	6/3/2018	19.7	8.3
4/22/2018	12.1	5.8	6/4/2018	20.1	8.1
4/23/2018	11.8	6.1	6/5/2018	18.0	7.7
4/24/2018	12.3	6.4	6/6/2018	17.0	8.4
4/25/2018	14.2	6.7	6/7/2018	18.2	9.4
4/26/2018	18.3	6.5	6/8/2018	18.5	8.4
4/27/2018	24.5	6.1	6/9/2018	17.9	8.5
4/28/2018	33.7	5.4	6/10/2018	16.7	7.6
4/29/2018	30.3	5.3	6/11/2018	14.2	7.9
4/30/2018	26.6	5.6	6/12/2018	12.7	7.7
5/1/2018	24.3	6.1	6/13/2018	12.6	8.8
5/2/2018	24.1	6.3	6/14/2018	13.8	9.0
5/3/2018	28.2	6.5	6/15/2018	12.8	9.2
5/4/2018	36.2	6.2	6/16/2018	13.0	9.1

6/17/2018	13.8	10.1	7/30/2018	1.7	18.9
6/18/2018	15.4	10.3	7/31/2018	1.6	19.6
6/19/2018	16.7	11.1	8/1/2018	1.6	19.2
6/20/2018	17.0	11.0	8/2/2018	1.5	18.2
6/21/2018	16.6	11.5	8/3/2018	1.4	17.3
6/22/2018	15.5	11.0	8/4/2018	1.6	17.1
6/23/2018	13.5	11.3	8/5/2018	1.7	17.6
6/24/2018	12.4	11.6	8/6/2018	1.6	18.0
6/25/2018	13.9	11.7	8/7/2018	1.5	18.5
6/26/2018	12.7	10.5	8/8/2018	1.4	19.3
6/27/2018	10.4	9.6	8/9/2018	1.4	19.7
6/28/2018	9.1	10.5	8/10/2018	1.3	19.5
6/29/2018	8.2	10.7	8/11/2018	1.3	18.8
6/30/2018	7.8	10.8	8/12/2018	1.3	17.3
7/1/2018	8.2	11.3	8/13/2018	1.4	16.3
7/2/2018	8.0	11.1	8/14/2018	1.3	16.1
7/3/2018	7.2	11.3	8/15/2018	1.3	17.0
7/4/2018	6.7	11.9	8/16/2018	1.2	17.6
7/5/2018	6.6	13.3	8/17/2018	1.2	18.1
7/6/2018	6.7	13.9	8/18/2018	1.1	17.5
7/7/2018	6.5	13.8	8/19/2018	1.1	16.4
7/8/2018	5.9	13.6	8/20/2018	1.2	15.6
7/9/2018	5.4	14.3	8/21/2018	1.1	16.0
7/10/2018	5.2	14.6	8/22/2018	1.1	15.8
7/11/2018	4.8	14.1	8/23/2018	1.0	16.0
7/12/2018	4.5	15.6	8/24/2018	1.0	15.9
7/13/2018	4.2	16.1	8/25/2018	1.1	14.2
7/14/2018	4.0	16.7	8/26/2018	1.1	13.7
7/15/2018	3.7	16.9	8/27/2018	1.2	14.4
7/16/2018	3.5	17.4	8/28/2018	1.0	15.0
7/17/2018	3.2	17.7	8/29/2018	1.1	15.5
7/18/2018	3.1	17.8	8/30/2018	1.0	16.1
7/19/2018	2.9	17.3	8/31/2018	1.0	15.4
7/20/2018	2.8	16.0	9/1/2018	0.9	15.2
7/21/2018	2.6	15.7	9/2/2018	0.9	15.0
7/22/2018	2.5	16.2	9/3/2018	0.9	15.5
7/23/2018	2.4	17.1	9/4/2018	0.8	14.8
7/24/2018	2.2	17.5	9/5/2018	0.8	14.4
7/25/2018	2.1	17.8	9/6/2018	0.8	14.5
7/26/2018	2.0	18.2	9/7/2018	0.8	15.5
7/27/2018	1.9	18.3	9/8/2018	0.8	15.2
7/28/2018	1.9	18.4	9/9/2018	0.8	14.9
7/29/2018	1.8	18.8	9/10/2018	0.8	14.7

9/11/2018	0.9	13.8	10/24/2018	0.9	6.8
9/12/2018	0.9	12.7	10/25/2018	0.9	7.5
9/13/2018	0.9	12.1	10/26/2018	2.5	8.3
9/14/2018	0.9	12.2	10/27/2018	2.6	7.0
9/15/2018	0.9	11.9	10/28/2018	4.2	6.9
9/16/2018	0.9	11.6	10/29/2018	3.9	6.0
9/17/2018	1.1	11.4	10/30/2018	2.7	5.8
9/18/2018	1.0	11.3	10/31/2018	2.7	7.2
9/19/2018	0.9	11.8	11/1/2018	7.4	7.9
9/20/2018	0.8	11.8	11/2/2018	20.4	7.7
9/21/2018	0.8	12.5	11/3/2018	13.5	7.0
9/22/2018	0.9	13.1	11/4/2018	20.4	6.4
9/23/2018	1.3	12.0	11/5/2018	16.3	5.9
9/24/2018	1.1	10.9	11/6/2018	14.0	5.2
9/25/2018	1.0	11.0	11/7/2018	9.8	4.4
9/26/2018	0.9	11.1	11/8/2018	7.4	3.4
9/27/2018	0.9	11.6	11/9/2018	6.4	2.9
9/28/2018	0.8	11.9	11/10/2018	5.7	3.1
9/29/2018	0.8	12.1	11/11/2018	5.0	2.5
9/30/2018	0.8	11.8	11/12/2018	4.6	2.1
10/1/2018	0.8	11.5	11/13/2018	4.2	2.1
10/2/2018	1.0	11.4	11/14/2018	4.2	2.5
10/3/2018	1.3	8.8	11/15/2018	5.0	3.8
10/4/2018	1.1	8.9	11/16/2018	4.9	5.2
10/5/2018	1.0	8.1	11/17/2018	4.6	3.5
10/6/2018	1.1	8.9	11/18/2018	4.1	1.9
10/7/2018	1.1	8.9	11/19/2018	3.9	1.3
10/8/2018	1.0	9.4	11/20/2018	3.7	1.0
10/9/2018	1.2	9.9	11/21/2018	3.5	1.4
10/10/2018	0.0		11/22/2018	3.5	2.5
10/11/2018	1.2	8.9	11/23/2018	3.6	2.4
10/12/2018	1.1	8.4	11/24/2018	3.5	1.9
10/13/2018	1.0	7.7	11/25/2018	3.2	2.2
10/14/2018	1.0	6.6	11/26/2018	3.3	2.5
10/15/2018	0.9	6.2	11/27/2018	5.9	1.7
10/16/2018	0.9	6.4	11/28/2018	9.4	2.4
10/17/2018	0.9	6.4	11/29/2018	7.2	3.2
10/18/2018	0.9	6.2	11/30/2018	6.1	3.4
10/19/2018	0.9	6.4	12/1/2018	5.6	3.2
10/20/2018	0.9	6.3	12/2/2018	5.1	3.1
10/21/2018	0.9	6.1	12/3/2018	4.7	2.5
10/22/2018	0.9	5.9	12/4/2018	4.4	1.8
10/23/2018	0.9	5.9	12/5/2018	4.2	1.0

12/6/2018	3.9	0.5
12/7/2018	3.9	0.6
12/8/2018	3.7	1.0
12/9/2018	3.6	1.0
12/10/2018	3.5	0.9
12/11/2018	3.5	0.4
12/12/2018	3.9	0.1
12/13/2018	4.2	0.2
12/14/2018	4.4	1.4
12/15/2018	3.9	1.9
12/16/2018	3.7	1.3
12/17/2018	3.5	2.1
12/18/2018		1.3
12/19/2018		1.8
12/20/2018	4.3	2.4
12/21/2018	4.4	1.8
12/22/2018	3.9	0.9
12/23/2018	3.8	1.2
12/24/2018	3.5	1.6
12/25/2018	3.4	1.3
12/26/2018	3.3	0.1
12/27/2018	3.2	0.3
12/28/2018	3.8	0.1
12/29/2018	4.6	1.1
12/30/2018	10.3	1.4
12/31/2018	6.5	0.7

APPENDIX B. Daily Trap Operations

Date	Trap Status	Comments
3/1/2018	Opp.	
3/1/2018	Opp.	
3/2/2018	Opp.	
3/3/2018	Opp.	
3/4/2018	Opp.	
3/5/2018	Opp.	
3/6/2018	Opp.	
3/7/2018	Opp.	
3/8/2018	Opp.	
3/9/2018	Opp.	
3/10/2018	Opp.	
3/11/2018	Opp.	
3/12/2018	Opp.	
3/13/2018	Opp.	
3/14/2018	Opp.	
3/15/2018	Opp.	
3/16/2018	Opp.	
3/17/2018	Opp.	
3/18/2018	Opp.	
3/19/2018	Opp.	
3/20/2018	Opp.	
3/21/2018	Opp.	
3/22/2018	Opp.	
3/23/2018	Opp.	
3/24/2018	Opp.	
3/25/2018	Opp.	
3/26/2018	Opp.	
3/27/2018	Opp.	
3/28/2018	Opp.	
3/29/2018	Opp.	
3/30/2018	Opp.	
3/31/2018	Opp.	
4/1/2018	Opp.	
4/2/2018	Opp.	
4/3/2018	Opp.	
4/4/2018	Opp.	
4/5/2018	Opp.	
4/6/2018	Opp.	
4/7/2018	Opp.	
4/8/2018	Opp.	
4/9/2018	Stopped	Debris
4/10/2018	Opp.	
4/11/2018	Opp.	
4/12/2018	Opp.	
4/13/2018	Opp.	
4/14/2018	Opp.	
4/15/2018	Opp.	
4/16/2018	Opp.	
4/17/2018	Pulled	
4/18/2018	Pulled	
4/19/2018	Opp.	
4/20/2018	Opp.	
4/21/2018	Opp.	
4/22/2018	Opp.	
4/23/2018	Opp.	
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5/1/2018	Opp.	
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5/25/2018	Opp.	
5/26/2018	Opp.	
5/27/2018	Opp.	
5/28/2018	Opp.	
5/29/2018	Opp.	
5/30/2018	Opp.	
5/31/2018	Opp.	
6/1/2018	Opp.	
6/2/2018	Stopped	Debris
6/3/2018	Opp.	
6/4/2018	Opp.	
6/5/2018	Opp.	
6/6/2018	Opp.	
6/7/2018	Opp.	
6/8/2018	Stopped	Debris
6/9/2018	Opp.	
6/10/2018	Opp.	
6/11/2018	Opp.	
6/12/2018	Opp.	
6/13/2018	Opp.	
6/14/2018	Opp.	
6/15/2018	Opp.	
6/16/2018	Opp.	
6/17/2018	Opp.	
6/18/2018	Opp.	
6/19/2018	Opp.	
6/20/2018	Opp.	
6/21/2018	Opp.	
6/22/2018	Opp.	
6/23/2018	Opp.	
6/24/2018	Opp.	
6/25/2018	Opp.	
6/26/2018	Opp.	
6/27/2018	Opp.	
6/28/2018	Opp.	
6/29/2018	Opp.	
6/30/2018	Opp.	
7/1/2018	Opp.	
7/2/2018	Opp.	
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7/4/2018	Opp.	
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7/16/2018	Opp.	
7/17/2018	Opp.	
7/18/2018	Opp.	
7/19/2018	Opp.	
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7/24/2018	Opp.	
7/25/2018	Opp.	
7/26/2018	Opp.	
7/27/2018	Opp.	
7/28/2018	Opp.	
7/29/2018	Opp.	
7/30/2018	Opp.	
7/31/2018	Pulled	Low flow
8/1/2018	Pulled	Low flow
8/2/2018	Pulled	Low flow
8/3/2018	Pulled	Low flow
8/4/2018	Pulled	Low flow
8/5/2018	Pulled	Low flow
8/6/2018	Pulled	Low flow
8/7/2018	Pulled	Low flow
8/8/2018	Pulled	Low flow
8/9/2018	Pulled	Low flow
8/10/2018	Pulled	Low flow
8/11/2018	Pulled	Low flow
8/12/2018	Pulled	Low flow

8/13/2018	Pulled	Low flow	9/25/2018	Pulled	Low flow
8/14/2018	Pulled	Low flow	9/26/2018	Pulled	Low flow
8/15/2018	Pulled	Low flow	9/27/2018	Pulled	Low flow
8/16/2018	Pulled	Low flow	9/28/2018	Pulled	Low flow
8/17/2018	Pulled	Low flow	9/29/2018	Pulled	Low flow
8/18/2018	Pulled	Low flow	9/30/2018	Pulled	Low flow
8/19/2018	Pulled	Low flow	10/1/2018	Pulled	Low flow
8/20/2018	Pulled	Low flow	10/2/2018	Pulled	Low flow
8/21/2018	Pulled	Low flow	10/3/2018	Pulled	Low flow
8/22/2018	Pulled	Low flow	10/4/2018	Pulled	Low flow
8/23/2018	Pulled	Low flow	10/5/2018	Pulled	Low flow
8/24/2018	Pulled	Low flow	10/6/2018	Pulled	Low flow
8/25/2018	Pulled	Low flow	10/7/2018	Pulled	Low flow
8/26/2018	Pulled	Low flow	10/8/2018	Pulled	Low flow
8/27/2018	Pulled	Low flow	10/9/2018	Pulled	Low flow
8/28/2018	Pulled	Low flow	10/10/2018	Pulled	Low flow
8/29/2018	Pulled	Low flow	10/11/2018	Pulled	Low flow
8/30/2018	Pulled	Low flow	10/12/2018	Pulled	Low flow
8/31/2018	Pulled	Low flow	10/13/2018	Pulled	Low flow
9/1/2018	Pulled	Low flow	10/14/2018	Pulled	Low flow
9/2/2018	Pulled	Low flow	10/15/2018	Pulled	Low flow
9/3/2018	Pulled	Low flow	10/16/2018	Pulled	Low flow
9/4/2018	Pulled	Low flow	10/17/2018	Pulled	Low flow
9/5/2018	Pulled	Low flow	10/18/2018	Pulled	Low flow
9/6/2018	Pulled	Low flow	10/19/2018	Pulled	Low flow
9/7/2018	Pulled	Low flow	10/20/2018	Pulled	Low flow
9/8/2018	Pulled	Low flow	10/21/2018	Pulled	Low flow
9/9/2018	Pulled	Low flow	10/22/2018	Pulled	Low flow
9/10/2018	Pulled	Low flow	10/23/2018	Pulled	Low flow
9/11/2018	Pulled	Low flow	10/24/2018	Pulled	Low flow
9/12/2018	Pulled	Low flow	10/25/2018	Pulled	Low flow
9/13/2018	Pulled	Low flow	10/26/2018	Pulled	Low flow
9/14/2018	Pulled	Low flow	10/27/2018	Pulled	Low flow
9/15/2018	Pulled	Low flow	10/28/2018	Pulled	Low flow
9/16/2018	Pulled	Low flow	10/29/2018	Opp.	
9/17/2018	Pulled	Low flow	10/30/2018	Opp.	
9/18/2018	Pulled	Low flow	10/31/2018	Opp.	
9/19/2018	Pulled	Low flow	11/1/2018	Pulled	High Flow
9/20/2018	Pulled	Low flow	11/2/2018	Stopped	Debris
9/21/2018	Pulled	Low flow	11/3/2018	Pulled	High Flow
9/22/2018	Pulled	Low flow	11/4/2018	Opp.	
9/23/2018	Pulled	Low flow	11/5/2018	Stopped	Debris
9/24/2018	Pulled	Low flow	11/6/2018	Opp.	

11/7/2018	Opp.
11/8/2018	Opp.
11/9/2018	Opp.
11/10/2018	Opp.
11/11/2018	Opp.
11/12/2018	Opp.
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11/14/2018	Opp.
11/15/2018	Opp.
11/16/2018	Opp.
11/17/2018	Opp.
11/18/2018	Opp.
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11/20/2018	Opp.
11/21/2018	Opp.
11/22/2018	Opp.
11/23/2018	Opp.
11/24/2018	Opp.
11/25/2018	Opp.
11/26/2018	Opp.
11/27/2018	Opp.
11/28/2018	Opp.
11/29/2018	Opp.
11/30/2018	Opp.

APPENDIX C. Regression Models

Model: Chinook Yearlings (Spring '06-'14) Back Position, ($r^2 = 0.15$; $p = 0.03$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	24.6
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	7.5
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	4.9
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	7.1
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	18.6
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	12.3
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	27.4
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	20.7
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	10.1
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	12.5
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.16	0.41	5.9
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.03	0.19	39.1
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.07	0.26	10.4
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.14	0.38	24.8
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.13	0.36	26.5
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.05	0.21	9.3
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.19	0.46	7.8
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.14	0.38	5.3
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.15	0.40	34.8
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.17	0.42	8.9
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.16	0.41	7.7
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.48	9.3
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.08	0.28	27.1
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.15	0.40	16.0

Model: Chinook Subyearling (Fall '06-'13) Back Position, ($r^2 = 0.55$; $p = 0.001$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	10/26/2006	Back	183	50	0.28	0.56	1.4
Wild Chinook Parr	0	10/30/2006	Back	168	52	0.32	0.60	1.8
Wild Chinook Parr	0	11/1/2010	Back	254	42	0.17	0.42	5.6
Wild Chinook Parr	0	11/4/2010	Back	287	49	0.17	0.43	6.1
Wild Chinook Parr	0	11/7/2010	Back	168	32	0.20	0.46	6.8
Wild Chinook Parr	0	11/13/2010	Back	185	35	0.19	0.46	3.7
Wild Chinook Parr	0	11/3/2012	Back	201	25	0.13	0.37	11.4

Wild Chinook Parr	0	11/7/2012	Back	233	27	0.12	0.35	11.2
Wild Chinook Parr	0	11/11/2012	Back	328	87	0.27	0.54	6.1
Wild Chinook Parr	0	11/15/2012	Back	195	34	0.18	0.44	6.0
Wild Chinook Parr	0	9/30/2013	Back	171	12	0.08	0.28	15.3
Wild Chinook Parr	0	10/2/2013	Back	213	43	0.21	0.47	9.3
Wild Chinook Parr	0	10/3/2013	Back	181	41	0.23	0.50	8.4
Wild Chinook Parr	0	10/7/2013	Back	242	31	0.13	0.37	6.6
Wild Chinook Parr	0	10/9/2013	Back	203	40	0.20	0.47	8.6
Wild Chinook Parr	0	11/27/2013	Back	241	55	0.23	0.50	5.2

Model: Chinook Subyearling (Fall ’06-’13) Forward Position, ($r^2 = 0.16$; $p = 0.02$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	7/13/2006	Back	52	8	0.17	0.43	4.8
Wild Chinook Parr	0	7/17/2006	Back	138	15	0.12	0.35	3.7
Wild Chinook Parr	0	7/20/2006	Back	74	5	0.08	0.29	3.2
Wild Chinook Parr	0	7/28/2006	Back	54	5	0.11	0.34	2.6
Wild Chinook Parr	0	7/31/2006	Back	99	7	0.08	0.29	2.2
Wild Chinook Parr	0	9/18/2006	Back	55	10	0.20	0.46	1.3
Wild Chinook Parr	0	7/31/2008	Back	60	15	0.27	0.54	3.4
Wild Chinook Parr	0	8/12/2008	Back	103	2	0.03	0.17	2.4
Wild Chinook Parr	0	8/22/2008	Back	75	11	0.16	0.41	2.7
Wild Chinook Parr	0	8/28/2008	Back	72	7	0.11	0.34	2.3
Wild Chinook Parr	0	10/9/2008	Back	110	22	0.21	0.48	1.8
Wild Chinook Parr	0	10/27/2008	Back	51	12	0.26	0.53	1.6
Wild Chinook Parr	0	10/30/2008	Back	84	15	0.19	0.45	1.5
Wild Chinook Parr	0	11/6/2008	Back	78	8	0.12	0.35	2.2
Wild Chinook Parr	0	11/10/2008	Back	88	0	0.01	0.11	8.7
Wild Chinook Parr	0	7/14/2009	Back	86	2	0.04	0.19	5.5
Wild Chinook Parr	0	7/15/2009	Back	105	4	0.05	0.22	5.1
Wild Chinook Parr	0	7/17/2009	Back	122	8	0.07	0.28	4.4
Wild Chinook Parr	0	7/20/2009	Back	89	2	0.03	0.19	3.8
Wild Chinook Parr	0	8/17/2009	Back	73	1	0.03	0.17	1.6
Wild Chinook Parr	0	9/10/2009	Back	56	7	0.14	0.39	1.7
Wild Chinook Parr	0	8/8/2010	Back	58	1	0.03	0.19	2.4
Wild Chinook Parr	0	8/11/2010	Back	114	8	0.08	0.29	2.2
Wild Chinook Parr	0	9/11/2010	Back	68	9	0.15	0.39	2.1
Wild Chinook Parr	0	10/12/2010	Back	216	42	0.20	0.46	3.6
Wild Chinook Parr	0	10/15/2010	Back	192	37	0.20	0.46	2.7
Wild Chinook Parr	0	10/18/2010	Back	193	36	0.19	0.45	2.3

Wild Chinook Parr	0	10/22/2010	Back	92	18	0.21	0.47	2.0
Wild Chinook Parr	0	10/25/2010	Back	60	7	0.13	0.37	2.2
Wild Chinook Parr	0	10/29/2010	Back	127	0	0.01	0.09	2.7
Wild Chinook Parr	0	8/19/2011	Back	106	5	0.06	0.24	3.5

Model: Chinook Subyearling (Fall '14-'18) Bolser Site ($r^2 = 0.09$; $p = 0.11$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1)/M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	7/14/2014	1	89	7	0.09	0.30	9.3
Wild Chinook Parr	0	7/21/2014	1	74	4	0.07	0.26	5.6
Wild Chinook Parr	0	7/27/2014	1	72	4	0.07	0.27	4.4
Wild Chinook Parr	0	10/24/2014	1	53	4	0.09	0.31	6.3
Wild Chinook Parr	0	10/27/2014	1	71	3	0.06	0.24	6.8
Wild Chinook Parr	0	10/30/2014	1	70	5	0.09	0.30	9.6
Wild Chinook Parr	0	11/1/2014	1	96	6	0.07	0.27	9.6
Wild Chinook Parr	0	10/24/2016	1	59	6	0.12	0.35	8.0
Wild Chinook Parr	0	11/1/2016	1	68	8	0.13	0.37	11.3
Wild Chinook Parr	0	11/15/2016	1	69	11	0.17	0.43	15.1
Wild Chinook Parr	0	7/17/2017	1	71	3	0.05	0.24	3.7
Wild Chinook Parr	0	10/23/2017	1	813	25	0.14	0.39	13.5
Wild Chinook Parr	0	10/27/2017	1	248	24	0.10	0.32	7.5
Wild Chinook Parr	0	10/31/2017	1	114	24	0.22	0.49	4.8
Wild Chinook Parr	0	11/12/2017	1	115	6	0.06	0.25	2.7
Wild Chinook Parr	0	11/27/2017	1	100	11	0.12	0.35	18.4
Wild Chinook Parr	0	11/7/2018	1	119	15	0.13	0.38	9.8
Wild Chinook Parr	0	11/11/2018	1	85	10	0.13	0.37	5.0
Wild Chinook Parr	0	11/15/2018	1	121	7	0.07	0.26	5.0
Wild Chinook Parr	0	11/19/2018	1	64	8	0.14	0.38	3.9

Model: Summer Steelhead Back Position ('07-'14), ($r^2 = 0.35$; $p = 2.90E-05$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Steelhead Parr/Smolt	1+	3/20/2007	Back	55	1	0.04	0.19	34.8
Wild Steelhead Parr/Smolt	1+	3/31/2007	Back	56	4	0.09	0.30	24.6
Wild Steelhead Parr/Smolt	1+	4/10/2007	Back	60	8	0.15	0.40	27.4
Wild Steelhead Parr/Smolt	1+	5/1/2007	Back	52	2	0.06	0.24	22.2
Wild Steelhead Parr/Smolt	1+	6/9/2007	Back	71	9	0.14	0.38	23.8

Wild Steelhead Parr/Smolt	1+	6/12/2007	Back	65	8	0.14	0.38	19.9
Wild Steelhead Parr/Smolt	1+	6/14/2007	Back	61	5	0.10	0.32	19.5
Wild Steelhead Parr/Smolt	1+	6/21/2007	Back	67	4	0.07	0.28	21.3
Wild Steelhead Parr/Smolt	1+	4/14/2008	Back	149	46	0.32	0.60	9.3
Wild Steelhead Parr/Smolt	1+	4/17/2008	Back	75	3	0.05	0.23	7.8
Wild Steelhead Parr/Smolt	1+	4/28/2008	Back	74	11	0.16	0.41	7.7
Wild Steelhead Parr/Smolt	1+	5/1/2008	Back	176	29	0.17	0.43	8.9
Wild Steelhead Parr/Smolt	1+	5/12/2008	Back	55	8	0.16	0.42	18.8
Wild Steelhead Parr/Smolt	1+	5/15/2008	Back	57	1	0.04	0.19	39.4
Wild Steelhead Parr/Smolt	1+	6/9/2008	Back	142	20	0.15	0.39	26.6
Wild Steelhead Parr/Smolt	1+	6/12/2008	Back	83	10	0.13	0.37	23.3
Wild Steelhead Parr/Smolt	1+	6/16/2008	Back	81	8	0.11	0.34	32.3
Wild Steelhead Parr/Smolt	1+	4/20/2010	Back	121	11	0.10	0.32	19.1
Wild Steelhead Parr/Smolt	1+	4/22/2010	Back	121	10	0.09	0.31	20.6
Wild Steelhead Parr/Smolt	1+	6/20/2010	Back	128	11	0.09	0.31	26.2
Wild Steelhead Parr/Smolt	1+	4/5/2011	Back	52	1	0.04	0.20	21.5
Wild Steelhead Parr/Smolt	1+	5/22/2011	Back	84	3	0.05	0.22	43.6
Wild Steelhead Parr/Smolt	1+	6/12/2012	Back	69	5	0.09	0.30	33.1
Wild Steelhead Parr/Smolt	1+	7/26/2012	Back	63	4	0.08	0.29	7.9
Wild Steelhead Parr/Smolt	1+	4/22/2013	Back	66	6	0.11	0.33	14.7
Wild Steelhead Parr/Smolt	1+	4/26/2013	Back	50	2	0.06	0.25	18.2
Wild Steelhead Parr/Smolt	1+	4/30/2013	Back	54	2	0.06	0.24	22.0
Wild Steelhead Parr/Smolt	1+	5/8/2013	Back	62	0	0.02	0.13	61.4
Wild Steelhead Parr/Smolt	1+	5/19/2013	Back	122	15	0.13	0.37	32.0
Wild Steelhead Parr/Smolt	1+	5/22/2013	Back	58	4	0.09	0.30	30.6
Wild Steelhead Parr/Smolt	1+	5/26/2013	Back	79	3	0.05	0.23	20.5
Wild Steelhead Parr/Smolt	1+	5/30/2013	Back	92	7	0.09	0.30	24.0
Wild Steelhead Parr/Smolt	1+	6/3/2013	Back	71	6	0.10	0.32	27.2
Wild Steelhead Parr/Smolt	1+	6/7/2013	Back	94	4	0.05	0.23	40.2
Wild Steelhead Parr/Smolt	1+	6/13/2013	Back	64	2	0.05	0.22	21.1
Wild Steelhead Parr/Smolt	1+	6/17/2013	Back	115	5	0.05	0.23	25.0
Wild Steelhead Parr/Smolt	1+	6/29/2013	Back	60	12	0.22	0.48	20.7
Wild Steelhead Parr/Smolt	1+	7/7/2013	Back	75	9	0.13	0.37	9.2
Wild Steelhead Parr/Smolt	1+	5/5/2014	Back	55	3	0.07	0.27	35.7
Wild Steelhead Parr/Smolt	1+	5/20/2014	Back	57	0	0.02	0.13	42.2
Wild Steelhead Parr/Smolt	1+	6/3/2014	Back	75	1	0.03	0.16	45.6

Model: 2013 Summer Steelhead Back Position (In-yr.), ($r^2 = 0.15$; $p = 0.05$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)

Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	24.6
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	7.5
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	4.9
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	7.1
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	18.6
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	12.3
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	27.4
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	20.7
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	10.1
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	12.5
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.16	0.41	5.9
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.03	0.19	39.1
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.07	0.26	10.4
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.14	0.38	24.8
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.13	0.36	26.5
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.05	0.21	9.3
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.19	0.46	7.8
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.14	0.38	5.3
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.15	0.40	34.8
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.17	0.42	8.9
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.16	0.41	7.7
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.48	9.3
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.08	0.28	27.1
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.15	0.40	16.0

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) – Full Antenna Function, ($r^2 = 0.61$; $p = 0.0002$)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	11/4/2010	254	95	0.38	0.66	6.3
Wild Chinook Parr	0	11/7/2010	287	70	0.25	0.52	7.0
Wild Chinook Parr	0	11/10/2010	168	74	0.45	0.73	4.8
Wild Chinook Parr	0	11/13/2010	74	41	0.57	0.85	4.0
Wild Chinook Parr	0	11/18/2010	185	22	0.12	0.36	7.9
Wild Chinook Parr	0	11/3/2012	201	21	0.11	0.34	10.9
Wild Chinook Parr	0	11/7/2012	233	31	0.14	0.38	10.7
Wild Chinook Parr	0	11/11/2012	328	66	0.20	0.47	6.3
Wild Chinook Parr	0	11/15/2012	195	68	0.35	0.64	6.2
Wild Chinook Parr	0	11/4/2013	130	51	0.40	0.68	3.7
Wild Chinook Parr	0	11/8/2013	106	39	0.38	0.66	4.2

Wild Chinook Parr	0	3/9/2014	65	4	0.08	0.28	24.9
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	15.3
Wild Chinook Parr	0	11/4/2014	114	5	0.05	0.23	10.5
Wild Chinook Parr	0	11/1/2014	96	5	0.06	0.25	16.5
Wild Chinook Parr	0	11/10/2014	78	8	0.12	0.35	11.3

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) – Partial Antenna Function, (r^2 = 0.38; p = 0.007)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1)/M	ASIN Transform	Discharge
Wild Chinook Parr	0	11/4/2010	254	39	0.16	0.41	6.3
Wild Chinook Parr	0	11/7/2010	287	16	0.06	0.25	7.0
Wild Chinook Parr	0	11/10/2010	168	34	0.21	0.47	4.8
Wild Chinook Parr	0	11/13/2010	74	17	0.24	0.52	4.0
Wild Chinook Parr	0	11/18/2010	185	8	0.05	0.22	7.9
Wild Chinook Parr	0	11/3/2012	201	7	0.04	0.20	10.9
Wild Chinook Parr	0	11/7/2012	233	8	0.04	0.20	10.7
Wild Chinook Parr	0	11/11/2012	328	24	0.08	0.28	6.3
Wild Chinook Parr	0	11/15/2012	195	30	0.16	0.41	6.2
Wild Chinook Parr	0	11/4/2013	130	40	0.32	0.60	3.7
Wild Chinook Parr	0	11/8/2013	106	30	0.29	0.57	4.2
Wild Chinook Parr	0	3/9/2014	65	1	0.03	0.18	24.9
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	15.3
Wild Chinook Parr	0	11/1/2014	96	1	0.02	0.15	10.5
Wild Chinook Parr	0	11/4/2014	114	4	0.04	0.21	16.5
Wild Chinook Parr	0	11/10/2014	78	3	0.05	0.23	11.3

APPENDIX D. Historical Morphometric Data

Spring Chinook (2004-2018)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Wild Chinook Yearling Smolt	93.4	336	12.4	9	337	5	1.1
2004	2003	Wild Chinook Subyearling Fry	39.5	82	5.1	0.6	79	0.3	1.0
2004	2003	Wild Chinook Subyearling Parr	82.4	792	7.9	6.1	702	2.7	1.1
2005	2003	Wild Chinook Yearling Smolt	93.6	278	7.9	8.7	276	2.1	1.1
2005	2004	Wild Chinook Subyearling Fry	42.1	107	5.6	0.7	102	0.4	0.9
2005	2004	Wild Chinook Subyearling Parr	75.9	924	9.6	4.9	890	3.8	1.1
2006	2004	Wild Chinook Yearling Smolt	91.2	363	7.1	7.5	362	1.8	1.0
2006	2005	Wild Chinook Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Wild Chinook Subyearling Parr	72.9	1,428	9.6	3.9	1,428	2.3	1.0
2007	2005	Wild Chinook Yearling Smolt	89	676	8.2	8	675	6.1	1.1
2007	2006	Wild Chinook Subyearling Fry	39	24	3.7	0.6	24	0.5	1.0
2007	2006	Wild Chinook Subyearling Parr	79.5	686	13.8	6.1	685	2.6	1.2
2008	2006	Wild Chinook Yearling Smolt	96.1	904	6.6	9.5	904	2.1	1.1
2008	2007	Wild Chinook Subyearling Fry	42.8	127	4.6	0.8	127	0.4	1.0
2008	2007	Wild Chinook Subyearling Parr	75.8	2,049	12.5	5.2	2,049	2.4	1.2
2009	2007	Wild Chinook Yearling Smolt	94.4	198	8.9	9.2	198	2.5	1.1
2009	2008	Wild Chinook Subyearling Fry	44.8	82	4.8	0.9	82	0.6	1.0
2009	2008	Wild Chinook Subyearling Parr	70.1	2,333	12	4.2	2,333	2	1.2
2010	2008	Wild Chinook Yearling Smolt	96.9	366	7.3	10.2	366	2.3	1.1
2010	2009	Wild Chinook Subyearling Fry	41.8	30	5	1.3	8	0.2	1.8
2010	2009	Wild Chinook Subyearling Parr	80.7	3,021	10.7	6.2	3,021	2.3	1.2
2011	2009	Wild Chinook Yearling Smolt	89.1	152	9.9	7.7	152	1.8	1.1
2011	2010	Wild Chinook Subyearling Fry	39.8	217	6.6	0.6	217	0.5	1.0
2011	2010	Wild Chinook Subyearling Parr	73.4	1,046	13.1	4.9	1,046	2.5	1.2
2012	2010	Wild Chinook Yearling Smolt	93.3	368	7	9.2	368	2.2	1.1
2012	2011	Wild Chinook Subyearling Fry	42.7	48	9.1	0.9	48	0.6	1.2
2012	2011	Wild Chinook Subyearling Parr	77.9	2,160	10.7	5.3	2,160	1.9	1.1
2013	2011	Wild Chinook Yearling Smolt	90.6	239	75	7.9	239	2.1	1.1
2013	2012	Wild Chinook Subyearling Fry	45.6	1,824	6.8	1	1,803	0.6	1.1
2013	2012	Wild Chinook Subyearling Parr	70	4,422	11.4	3.8	4,409	1.7	1.1
2014	2012	Wild Chinook Yearling Smolt	89.5	464	6.9	7.5	464	1.8	1.0
2014	2013	Wild Chinook Subyearling Fry	40.1	677	5.2	0.9	221	0.5	1.4
2014	2013	Wild Chinook Subyearling Parr	69.1	1,549	12.3	3.8	1,547	2.3	1.2
2015	2013	Wild Chinook Yearling Smolt	93	152	7	8.4	152	2.2	1.0
2015	2014	Wild Chinook Subyearling Fry	45	338	9.9	1	338	0.9	0.9

2015	2014	Wild Chinook Subyearling Parr	84	210	8	6.5	209	1.7	1.1
2015	2013	Hatchery Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.1
2016	2014	Wild Chinook Yearling Smolt	96	61	5.5	9.0	61	1.7	1.0
2016	2015	Wild Chinook Subyearling Fry	38	285	3.0	0.5	285	0.2	0.8
2016	2015	Wild Chinook Subyearling Parr	85	491	12.7	6.9	490	2.5	1.1
2016	2014	Hatchery Chinook Yearling Smolt	119	87	13.5	19.6	87	7.6	1.1
2017	2015	Wild Chinook Yearling Smolt	96	357	6.6	9.8	357	2.1	1.1
2017	2016	Wild Chinook Subyearling Fry	38	557	3.9	0.5	557	0.3	0.9
2017	2016	Wild Chinook Subyearling Parr	74	1,864	12.3	4.7	1,863	2.1	1.1
2017	2015	Hatchery Chinook Yearling Smolt	115	143	10.3	18.4	143	5.4	1.2
2018	2016	Wild Chinook Yearling Smolt	95	301	6.8	9.5	301	2.1	1.09
2018	2017	Wild Chinook Subyearling Fry	43	834	8.7	0.9	834	0.9	0.89
2018	2017	Wild Chinook Subyearling Parr	83	710	12.1	6.5	710	2.4	1.09
2018	2016	Hatchery Chinook Yearling Smolt	119	87	10.3	19.3	87	5.4	1.12

Summer Steelhead (2004-2018)

Trap Year	Brood Year	Age	Origin/Species	Fork Length (mm)			Weight (g)			K-factor
				Mean	n	SD	Mean	n	SD	
2004	2004	0	Wild Summer Steelhead	67	358	10	3.5	279	1.5	1.2
2004	2003	1	Wild Summer Steelhead	101.7	394	23.2	13.2	366	27.3	1.3
2004	2002	2	Wild Summer Steelhead	161.6	146	19.8	43.4	141	15.5	1.0
2004	2001	3	Wild Summer Steelhead	201.6	43	11.2	76	43	21.2	0.9
2004	2003	1	Hat. Summer Steelhead	182.8	523	22.4	62.1	497	21.2	1.0
2005	2005	0	Wild Summer Steelhead	54.1	649	15.7	2.2	616	3.2	1.4
2005	2004	1	Wild Summer Steelhead	93.6	585	25.6	10.8	575	10.1	1.3
2005	2003	2	Wild Summer Steelhead	153.5	103	21.2	38.1	102	16.4	1.1
2005	2002	3	Wild Summer Steelhead	144	1	—	43.2	1	—	1.4
2005	2004	1	Hat. Summer Steelhead	188.2	343	21.2	66	343	24	1.0
2006	2006	0	Wild Summer Steelhead	66.3	180	5.8	2.5	180	1	0.9
2006	2005	1	Wild Summer Steelhead	85.2	877	18.7	6.7	877	6.6	1.1
2006	2004	2	Wild Summer Steelhead	155.9	106	26.8	36.1	105	13.5	1.0
2006	2003	3	Wild Summer Steelhead	197	2	—	73.5	2	—	1.0
2006	2005	1	Hat. Summer Steelhead	—	—	—	—	—	—	—
2007	2007	0	Wild Summer Steelhead	54.2	329	11.7	2	328	1.4	1.3
2007	2006	1	Wild Summer Steelhead	82.7	1,330	16.8	7.2	1,329	6.3	1.3
2007	2005	2	Wild Summer Steelhead	143.8	102	20.6	31.4	102	11.9	1.1
2007	2004	3	Wild Summer Steelhead	143	1	—	26.8	1	—	0.9
2007	2006	1	Hat. Summer Steelhead	149.3	3	47	33.1	3	29.1	1.0
2008	2008	0	Wild Summer Steelhead	52.9	930	11.1	1.7	930	1.2	1.1

2008	2007	1	Wild Summer Steelhead	84.5	1,876	17.1	7.4	1,874	6.6	1.2
2008	2006	2	Wild Summer Steelhead	149.9	122	22.9	36	122	15.5	1.1
2008	2005	3	Wild Summer Steelhead	180.3	13	18.9	57.4	13	16.4	1.0
2008	2007	1	Hat. Summer Steelhead	179.4	389	16.5	55.9	388	14.8	1.0
2009	2009	0	Wild Summer Steelhead	55.6	843	10.5	2.2	688	1.1	1.3
2009	2008	1	Wild Summer Steelhead	82.6	452	18.6	7.1	447	5.5	1.3
2009	2007	2	Wild Summer Steelhead	156.9	72	22	40.9	72	15.5	1.1
2009	2006	3	Wild Summer Steelhead	195	3	5	73	3	6.7	1.0
2009	2008	1	Hat. Summer Steelhead	183.1	280	16.7	60.8	280	18.2	1.0
2010	2010	0	Wild Summer Steelhead	55	1,287	11.1	2.5	917	1.3	1.5
2010	2009	1	Wild Summer Steelhead	89.8	1,079	19.1	9	1,072	7.1	1.2
2010	2008	2	Wild Summer Steelhead	144.9	87	25.1	35	87	17.4	1.2
2010	2007	3	Wild Summer Steelhead	184	8	12.2	61.9	8	10.2	1.0
2010	2009	1	Hat. Summer Steelhead	183.5	531	19.5	61.3	526	19.6	1.0
2011	2011	0	Wild Summer Steelhead	43.5	1,093	10.1	1.1	783	0.9	1.3
2011	2010	1	Wild Summer Steelhead	75.7	818	18.5	5.5	811	5.7	1.3
2011	2009	2	Wild Summer Steelhead	144.8	27	41.3	42.1	27	62.1	1.4
2011	2008	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2011	2010	1	Hat. Summer Steelhead	180.7	464	17	59.1	464	17.6	1.0
2012	2012	0	Wild Summer Steelhead	55.1	589	14.2	2.6	402	1.2	1.6
2012	2011	1	Wild Summer Steelhead	84.7	747	17.4	7.6	741	5.7	1.3
2012	2010	2	Wild Summer Steelhead	127.1	132	27	23.7	132	14.5	1.2
2012	2009	3	Wild Summer Steelhead	161	4	32	40.5	4	15.6	1.0
2012	2011	1	Hat. Summer Steelhead	154.8	318	20.9	37.7	318	14	1.0
2013	2013	0	Wild Summer Steelhead	56.1	878	11.3	2.1	777	1.1	1.2
2013	2012	1	Wild Summer Steelhead	44.5	1,777	14.7	5.4	1,772	4.2	1.2
2013	2011	2	Wild Summer Steelhead	144.7	21	15.7	36.1	21	10.2	1
2013	2010	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2013	2012	1	Hat. Summer Steelhead	166.2	365	21.4	49.2	363	18.2	1.1
2014	2014	0	Wild Summer Steelhead	49.6	490	12.8	1.7	389	1.1	1.4
2014	2013	1	Wild Summer Steelhead	82.2	745	13.6	6.3	745	3.5	1.1
2014	2012	2	Wild Summer Steelhead	145.1	30	16.5	33	30	13.4	1.1
2014	2011	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2014	2013	1	Hat. Summer Steelhead	173.4	632	18.7	52.6	633	15.9	1.0
2015	2015	0	Wild Summer Steelhead	70	182	15.5	4.3	176	2	1.1
2015	2014	1	Wild Summer Steelhead	88	233	20.2	8.3	233	6.7	1.0
2015	2013	2	Wild Summer Steelhead	149	14	13.5	33.7	14	8.2	1.0
2015	2012	3	Wild Summer Steelhead	191	1	—	73.8	1	—	1.1
2015	2014	1	Hat. Summer Steelhead	175	273	15.2	51.3	273	12.5	0.9
2016	2016	0	Wild Summer Steelhead	56	674	16.4	2.4	617	1.8	1.0
2016	2015	1	Wild Summer Steelhead	87	278	21.5	8.3	278	5.9	1.1

2016	2014	2	Wild Summer Steelhead	143	19	17.4	31.1	19	9.6	1.0
2016	2013	3	Wild Summer Steelhead	202	1	—	90.1	1	—	1.1
2016	2015	1	Hat. Summer Steelhead	175	95	15.5	55.1	95	16.2	1.0
2017	2017	0	Wild Summer Steelhead	54	370	17.6	2.5	306	1.5	1.0
2017	2016	1	Wild Summer Steelhead	88	1,109	14.5	8.1	1,108	4.4	1.0
2017	2015	2	Wild Summer Steelhead	150	74	15.8	35.6	74	11.0	1.0
2017	2014	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2017	2016	1	Hat. Summer Steelhead	167	497	19.2	48.3	497	17.8	1.0
2018	2018	0	Wild Summer Steelhead	45	221	21.7	1.8	214	2.1	0.93
2018	2017	1	Wild Summer Steelhead	87	426	15.1	7.8	426	4.4	1.08
2018	2016	2	Wild Summer Steelhead	150	50	16.2	34.9	50	11.0	1.00
2018	2015	3	Wild Summer Steelhead	190	2	0.7	56.6	2	6.1	0.83
2018	2017	1	Hat. Summer Steelhead	158	279	17.0	39.8	280	12.9	0.98

Coho (2007-2018)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2004	2003	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2004	2003	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2004	2002	Hatchery Coho Yearling Smolt	136.6	847	12.8	27.4	820	7.5	1.1
2005	2003	Nat. Or. Coho Yearling Smolt	114.4	17	8.8	16.2	17	3.6	1.1
2005	2004	Nat. Or. Coho Subyearling Fry	49.1	9	10.4	1.3	9	0.8	1.1
2005	2004	Nat. Or. Coho Subyearling Parr	76.7	9	12.8	4.9	9	2.7	1.1
2005	2003	Hatchery Coho Yearling Smolt	137.3	689	11.3	28.6	690	7.2	1.1
2006	2004	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2006	2005	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Nat. Or. Coho Subyearling Parr	71	4	13.6	3.8	4	2.9	1.1
2006	2004	Hatchery Coho Yearling Smolt	—	—	—	—	—	—	—
2007	2005	Nat. Or. Coho Yearling Smolt	92.9	36	12.5	8.7	36	4	1.1
2007	2006	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2007	2006	Nat. Or. Coho Subyearling Parr	83	1	—	6.2	1	—	1.1
2007	2005	Hatchery Coho Yearling Smolt	116	2	—	16.8	2	—	1.1
2008	2006	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2008	2007	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2008	2007	Nat. Or. Coho Subyearling Parr	87	1	—	6.4	1	—	1
2008	2006	Hatchery Coho Yearling Smolt	130.2	843	10.4	23.6	843	6.2	1.1
2009	2007	Nat. Or. Coho Yearling Smolt	103	4	9.7	11.7	4	3.4	1.1
2009	2008	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—

2009	2008	Nat. Or. Coho Subyearling Parr	79.6	5	20.1	6.6	5	4.8	1.3
2009	2007	Hatchery Coho Yearling Smolt	135.3	625	8.9	26.2	579	5.2	1.1
2010	2008	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2010	2009	Nat. Or. Coho Subyearling Fry	48	2	—	1.3	2	—	1.2
2010	2009	Nat. Or. Coho Subyearling Parr	83.6	27	8.6	6.7	27	2.4	1.1
2010	2008	Hatchery Coho Yearling Smolt	130	1,051	10.1	23.8	1,049	5.3	1.1
2011	2009	Nat. Or. Coho Yearling Smolt	100.2	14	12.7	11.3	14	3.9	1.1
2011	2010	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2011	2010	Nat. Or. Coho Subyearling Parr	64.7	3	10.8	3	3	1.5	1.1
2011	2009	Hatchery Coho Yearling Smolt	124.6	969	8.6	21	969	4.8	1.1
2012	2010	Nat. Or. Coho Yearling Smolt	102.1	17	9.1	11.9	17	3	1.1
2012	2011	Nat. Or. Coho Subyearling Fry	36	1	—	—	—	—	—
2012	2011	Nat. Or. Coho Subyearling Parr	78.4	84	9.3	5	84	2.1	1
2012	2010	Hatchery Coho Yearling Smolt	126.2	1,684	7.6	21.5	1,684	5.5	1.1
2013	2011	Nat. Or. Coho Yearling Smolt	97	81	10	10	81	3.1	1.1
2013	2012	Nat. Or. Coho Subyearling Fry	47.3	3	1	1	3	1	0.9
2013	2012	Nat. Or. Coho Subyearling Parr	87.8	4	3.8	6.6	4	1	1
2013	2011	Hatchery Coho Yearling Smolt	130.1	982	8.5	23.3	977	4.9	1.1
2014	2012	Nat. Or. Coho Yearling Smolt	96.3	20	9.8	9.9	20	3	1.1
2014	2013	Nat. Or. Coho Subyearling Fry	36	1	—	—	—	—	—
2014	2013	Nat. Or. Coho Subyearling Parr	73	3	22.5	5.9	3	4.7	1.5
2014	2012	Hatchery Coho Yearling Smolt	127	1,203	9.7	21.7	1,207	5.0	1.1
2015	2013	Nat. Or. Coho Yearling Smolt	109	2	4.9	12.0	2	0.1	0.9
2015	2014	Nat. Or. Coho Subyearling Fry	47	7	13.7	1.4	7	1.5	0.9
2015	2014	Nat. Or. Coho Subyearling Parr	69	3	7	4.0	3	1.3	1.2
2015	2013	Hatchery Coho Yearling Smolt	131	952	9.9	23.3	952	4.8	1.0
2016	2014	Nat. Or. Coho Yearling Smolt	100	6	15.8	11.1	6	5.5	1.0
2016	2015	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2016	2015	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2016	2014	Hatchery Coho Yearling Smolt	134	302	8.4	24.8	301	5.0	1.0
2017	2015	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2017	2016	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2017	2016	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2017	2015	Hatchery Coho Yearling Smolt	122	548	8.0	20.1	548	4.1	1.1
2018	2016	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2018	2017	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2018	2017	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2018	2016	Hatchery Coho Yearling Smolt	131	258	8.5	24.7	258	5.1	1.1

Appendix O

Fish Trapping at the White River Smolt Trap during 2018

Population Estimates for Juvenile Spring Chinook Salmon in White River, WA

2018 Annual Report

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ABSTRACT

In 2007, Yakama Nation Fisheries Resource Management began monitoring emigration of Endangered Species Act (ESA) - listed Upper Columbia River (UCR) spring Chinook salmon in the White River to provide abundance and freshwater survival estimates. This report summarizes data collected between March 1 and November 30, 2018. We used 1.5 m, and 2.4 m rotary screw traps to collect 365 juvenile spring Chinook; 14 fry, 117 subyearling parr, 225 yearling smolts, and 9 precocial parr. Daily counts at the trap were expanded via regression analysis derived from mark and recapture trials. We estimated that 11,170 (± 13,710; 95% CI) BY2016 wild spring Chinook smolts and 1,679 (± 1,373; 95% CI) BY2017 wild spring Chinook parr emigrated past the White River trap in 2018. Combined with data collected in 2017, this gives us a total estimate of 16,021 (± 13,779; 95% CI) BY2015 emigrants. Using spring Chinook spawning ground data collected by Washington Department of Fish and Wildlife (WDFW) in 2016, we estimated egg-to-emigrant survival of BY2016 spring Chinook to be 8.2% (364 smolts-per-redd).

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This project is part of a basin-wide monitoring program requiring close coordination between multiple agencies and contractors. We greatly appreciate the hard work of the Yakama Nation FRM crew members including Matthew Clubb, Jamie Hallman, Tim Jeffris, Bryan Ishida, and Allyse Thompson who maintained and operated the trap during all hours including nights/weekends and inclement weather conditions. Also, thank you to Peter Graf and Rolland O'Connor (Grant County PUD) for administering contracting and funding as well as Mclain Johnson, Andrew Murdoch, and Josh Williams (WDFW) for data sharing and collaboration on smolt trap methodologies.

1.0 INTRODUCTION

White River spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha* are part of the Upper Columbia River (UCR) spring Chinook salmon Evolutionarily Significant Unit (ESU), which was listed as endangered under the Endangered Species Act (ESA) in 1999. Due to critically low abundance, a captive broodstock program was operated in the White River between 1997 and 2015 as a risk aversion measure. Determining freshwater productivity of spring Chinook salmon in the White River is an essential component of the overall population monitoring, and will help contribute to the body of knowledge needed to evaluate if further supplementation in the White River is warranted.

In the fall of 2005, Washington State Department of Fish and Wildlife (WDFW) began smolt trapping in the lower White River in order to provide an estimate of juvenile spring Chinook salmon production. No trapping was conducted in 2006 as there was a transition between trap operators. In 2007, Public Utility District No. 2 of Grant County (GCPUD) contracted with Yakama Nation Fisheries (YNF) to operate a rotary trap in the White River. This document reports data collected between March 1 and November 30, 2018, and provides emigration estimates for spring Chinook salmon yearlings (BY2016) and subyearlings (BY2017) during that time period. Fish trap operations were conducted in compliance with ESA consultation specifically to address abundance and productivity of spring Chinook salmon in the White River.

Within this document, we will report:

1) Juvenile abundance and productivity of spring Chinook salmon in the White River.

2) Emigration timing of spring Chinook salmon emigrating from the White River.

1.1 Watershed Description

The White River drainage encompasses 40,451 ha originating in alpine glaciers and perennial snow fields (Figure 1; USFS 2004). Elevation within the drainage varies from 569 m at the surface of Lake Wenatchee to 2,614 m at Clark Mountain (Andonaegui 2001). As one of two primary tributaries to Lake Wenatchee, the White River flows in a south-easterly direction for 42.9 rkm before emptying into the lake. Precipitation ranges from 79 cm at the mouth to more than 356 cm in the head waters (Andonaegui 2001). Due to its glacial origins, peak runoff for the White River typically occurs between April and July with occasional high flows caused by rain-on-snow events in the fall and winter months. Water temperatures in this watershed tend to be cooler than other tributaries to the upper Wenatchee River subbasin. As of September 2002, Washington State Department of Ecology (WDOE) began operating a stream monitoring station at rkm 9.9. Operation of this station by WDOE is currently maintained with funding provided by GCPUD. In 2018, daily mean stream discharge ranged from 2.4 m^3/s (85 cfs) to 158.6 m^3/s (5,600 cfs) while mean daily stream temperatures ranged from 0.0°C to 13.7°C (Figs. 2 & 3). Discharge and temperature data provided by WDOE should be considered provisional and are presented in Appendix A.

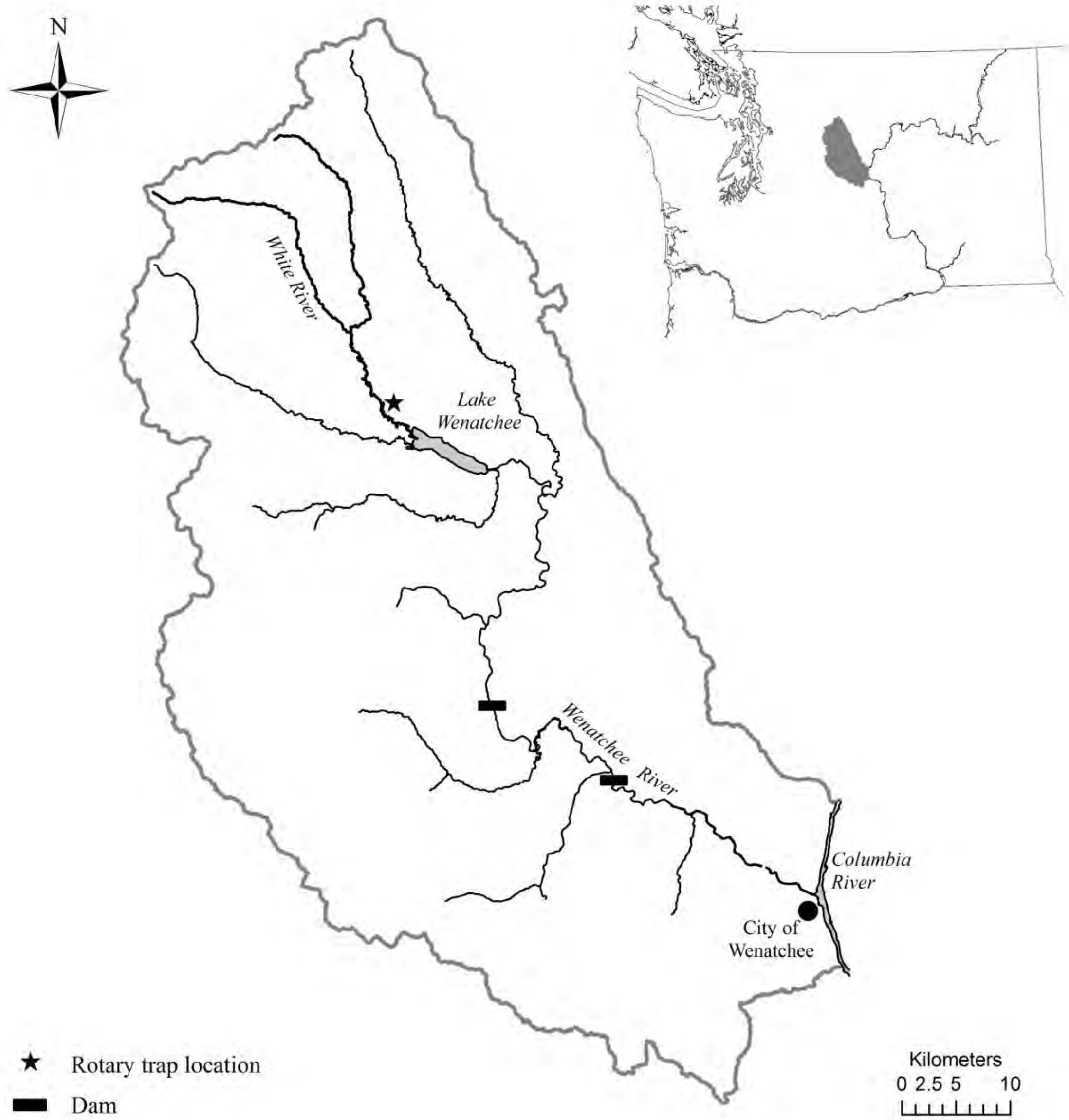


Figure 1. Map of the Wenatchee River subbasin with White River rotary trap location.

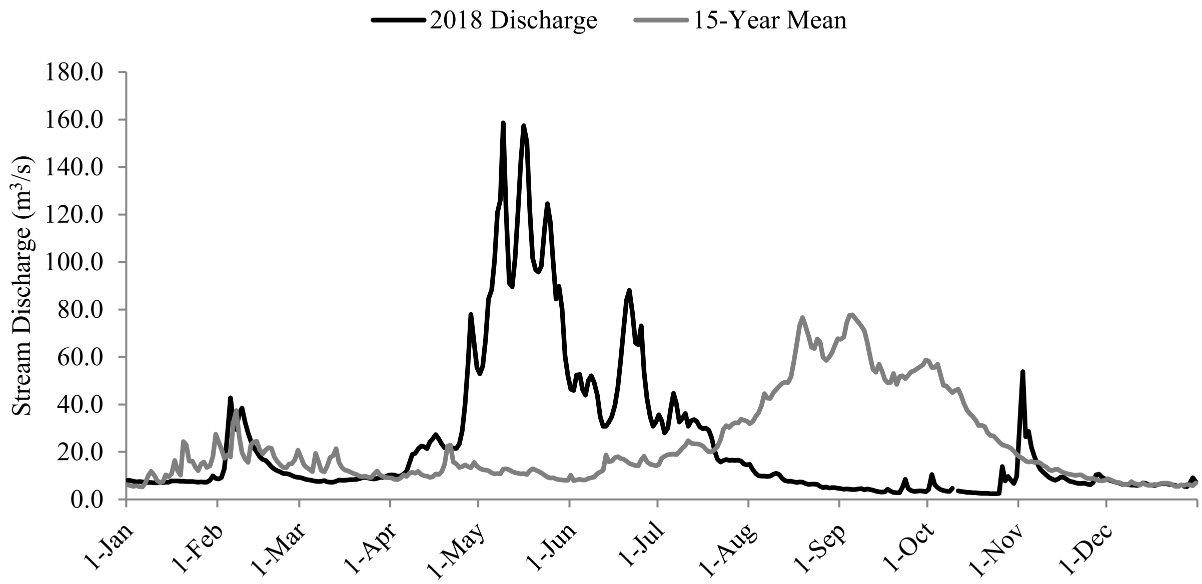


Figure 2. Mean daily stream discharge at the White River DOE stream monitoring station at Sears Creek Bridge, 2018.

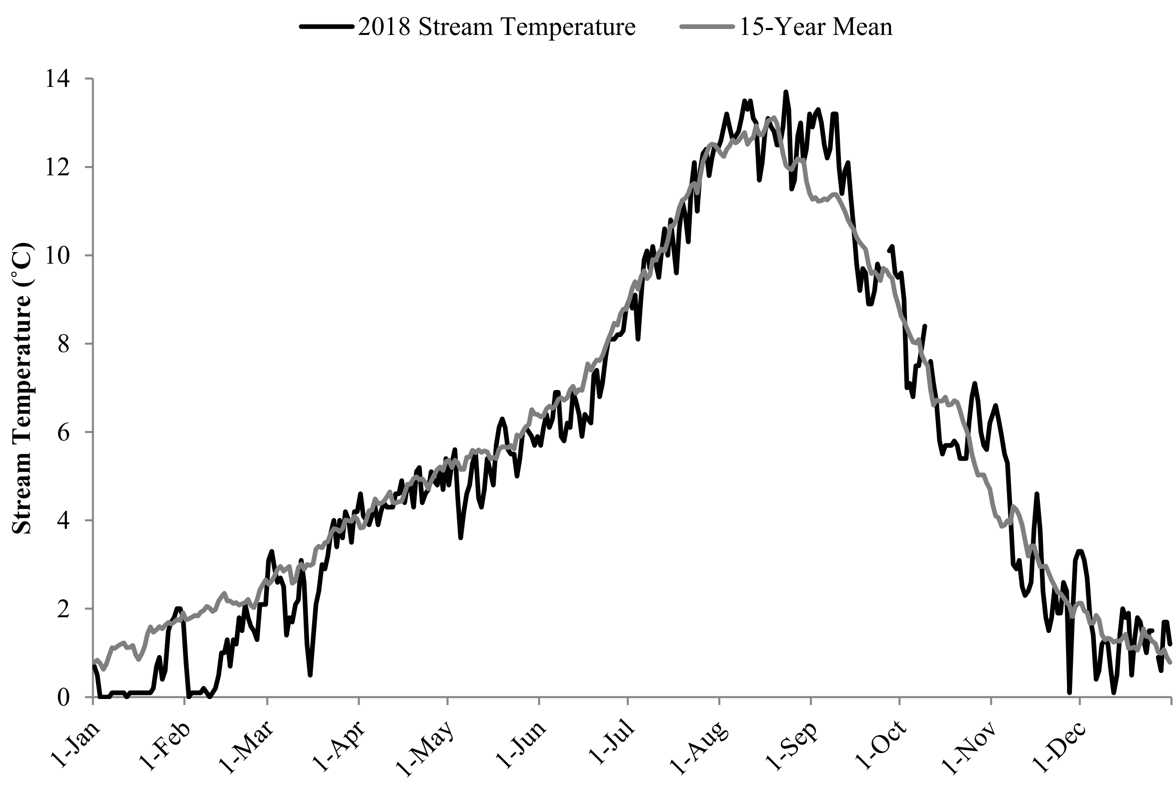


Figure 3. Mean daily water temperatures at the White River DOE stream monitoring station at Sears Creek Bridge, 2018.

The White River drainage has had minimal riparian harvest from the 1950's to the present on federally owned land. Turn of the century settlement and land clearing activities have impacted the riparian reserve network up to the Napeequa confluence, yet, riparian areas in the mainstem below Panther Creek remain in fair condition (USFS 2004). In the remainder of the watershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation appear to be in good condition. Current habitat concerns pertaining to the development of homes and vacation retreats on private lands do exist. Bank armoring (Rip-rap), channel constriction, and stream degradation are considered minor in the watershed. Public ownership comprises 78% of the drainage area; more than half of public land is located within the Glacier Peak Wilderness. The remaining 22% of the drainage is in private ownership (USFS 2004).

Downstream of White River Falls are key spawning grounds for spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha*, sockeye salmon (kálux) *O. nerka*, and bull trout *Salvelinus confluentus*. Two large tributaries to the White River, Napeequa River and Panther Creek, are also known to support populations of anadromous salmonids (Mullen et al. 1992). For a complete list of known fish species encountered in the White River see Section 3.4 (Incidental Species).

2.0 METHODS

2.1 Trapping Equipment and Operation

Throughout the duration of the trapping season, a 1.5m diameter cone rotary trap (Trap-A) was operated at a fixed position along the river-right bank. This trapping regime employed a single trap position across all flows since 2013. Additionally, a 2.4m diameter rotary trap (Trap B) was installed along the river-left bank to be operated concurrently with Trap-A. Trap-B was installed for the sole purpose of catching additional spring Chinook parr and smolts for tagging and efficiency trials used to build the flow-efficiency model of Trap-A. Both traps were suspended from a single 1/2" 6x37 IWRC galvanized (26,500 lb. breaking strength, 5,300 lb. working-load limit) wire-rope highline anchored to two large western red cedar (*Thuja plicata*) trees on opposing banks. Both traps were affixed to the highline with 13/32" nylon-coated wire rope (9,800 lb. breaking-strength/1,960 lb. working-load limit) and a heavy duty pulley. Each pulley could be moved laterally along the highline with a system of 7/32" nylon-coated wire rope (2,000 lb. breaking-strength/400 lb. working-load limit) positioning cables controlled by hand-powered winches on the river-left bank. For a detailed explanation of the use of Trap B, see the original pilot proposal in Appendix E.

Trap-A acted as the primary trap upon which the flow-efficiency relationship was based i.e., daily catch was integral to producing emigrant estimates. Because of this, we attempted to operate Trap-A 24 hours per day, 7 days per week at all flows. During spring runoff, operations only occurred during hours of darkness to minimize trap damage and fish mortality, while enabling collection during hours of peak migration. Trap-B was operated as channel depth and discharge level permitted. A record of daily trap operations is provided in Appendix B.

During all ranges of river discharge, fish were removed daily. Additional trap checks were necessary during periods of high discharge and/or debris accumulation. Debris in the live-box was removed continually by a rotating drum screen driven by the force of the rotating cone.

2.2 Biological Sampling

Trap operating procedures and techniques followed a standardized, basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (UCRTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch & Petersen (2000).

Captured fish were transferred from the rotary trap's live box using covered five-gallon plastic buckets to a stream-side portable sampling station. Fish were anesthetized in a solution of tricaine methanesulfonate (MS-222) to facilitate sampling and reduce handling stress. Fork length (FL) and weight were recorded for all fish, except large numbers of sockeye fry. For these fish, a daily subsample of 25 individuals was measured while the remaining fish were enumerated and released. Weight was measured to the nearest 0.1g with a portable digital scale while FL was recorded to the nearest 1.0 mm using a trough-type measuring board. These data were used to calculate a Fulton-type condition factor (K-factor) for each target species using the formula:

$$K = (W/L^3) \times 100{,}000$$

where K = Fulton-type condition metric;
W = weight in grams;
L = fork length in millimeters;
And 100,000 is a scaling constant.

Portable aerators were used to oxygenate holding water during sampling. All fish were allowed to fully recover from anesthesia before being released. Developmental stages (fry, parr, transitional or smolt) were visually identified and assigned to each individual sampled. Transitional juveniles were identified as having both parr and smolt characteristics; visible parr marks, semi-transparent fin coloration along with silvery coloration throughout body. Smolts were identified by a strong silvery coloration over entire body and faint or absent parr marks. Fry were defined as newly emerged fish with or without a visible yolk sac and a FL measuring < 50 mm. Age-0 spring Chinook salmon captured before July 1 were considered 'fry' and excluded from population estimates due to the inconclusive nature of their movement (i.e. active emigration or local distribution in-stream). Age-0 spring Chinook salmon captured after 1 July were considered subyearling emigrants and included in the population estimate (UCRTT, 2001).

Tissue samples (caudal clip) were taken from spring Chinook salmon and applied to blotter sheets. Samples were provided to WDFW for reproductive success analysis. Scale samples were also collected from all steelhead captured. Scale samples were submitted to WDFW for age analysis. Bull trout tissue or scale samples were not collected in 2018.

During periods when the trap operations were suspended (e.g. - high discharge, high debris and/or mechanical problems), passage estimates were generated to account for emigrants during these time periods. This estimate was calculated using the average number of fish captured three days prior and three days after the break in operation (Hillman et al., 2013; Snow et al., 2013).

2.3 Mark-Recapture Trials

Groups of marked spring Chinook salmon were used for trap efficiency trials. Fish were marked by insertion of a Passive Integrated Transponder (PIT) tag into the abdominal cavity. Ideally, marked groups of fish were released over a broad range of stream discharges in order to determine a trap efficiency-discharge relationship. (See **2.4 Data Analysis**). Mark-recapture (M-R) trials followed the protocol described in Hillman (2004). Although the protocol suggests a minimum sample size of 100 fish for each mark-group, limited abundance of juvenile emigrants from the White River required efficiency trials be completed with smaller sample sizes. YN's continued goal is to increase individual mark-group sizes, when possible, to meet the standard described above. Current minimum mark group size is 50 fish.

Number of wild fish included in a marked group was maximized by combining catches from three days of trapping. Fish were held up to 72 hours prior to release in holding boxes located on the river-left bank. Fish to be used in efficiency trials were then transported in five gallon buckets ~1.0 rkm upstream to the release location at Sears Creek Bridge (rkm 10.3). All mark groups are released by hand at nautical twilight.

Each M-R trial was conducted over a three-day (72 hour) period to allow time for passage or capture. Completed trials were only considered invalid if an interruption to trapping occurred or proper pre-release procedures were not followed. Trials resulting in zero recaptures were included in the efficiency regression as allowed by the new method of observed trap efficiency calculation (See equation 3 in **2.4.1 Estimate of Abundance**).

2.3.1 Marking and PIT tagging

All spring Chinook and summer steelhead juveniles with FL ≥ 60mm were PIT tagged unless the health of a specimen was in question. Once anesthetized, each fish was examined for external wounds or descaling and scanned for the presence of a previously implanted PIT tag. If a tag was not detected, a pre-loaded 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a Biomark MK-25 Rapid Implant Gun. Each unique tag code was electronically recorded with an appropriate tagging date, release date, tagging personnel and biological data. These data were entered into P_3 and submitted to the PIT Tag Information System (PTAGIS) at the end of each month. Tagging methods were consistent with methodology described in the PIT Tag Marking Procedures Manual (CBFWA 1999) as well as with 2008 ISEMP protocols (Tussing 2008).

Tagged fish were held for a minimum of 24-hours to a) ensure complete recovery, b) assess tagging mortality and c) determine tag-shed rate. Fish that were not to be used in an efficiency trial were released downstream of the smolt trap.

2.4 Data Analysis

2.4.1 Estimate of Abundance

Seasonal juvenile migration, N, was estimated as the sum of daily migrations, N_i, i.e., $N = \sum_i N_i$, and daily migration was calculated from catch and efficiency:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \tag{1}$$

where C_i = number of fish caught in period *I*;

$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$,

where b_0 is estimated intercept and b_1 is the estimated slope of the regression.

The regression parameters b_0 and b_1 are estimated using linear regression for the model:

$$\arcsin\left(\sqrt{e_k^{obs}}\right) = \beta_0 + \beta_1 flow_k + \varepsilon, \quad (2)$$

where e_k^{obs} = observed trap efficiency of Eq. 2 for trapping period k;

β_0 = intercept of the regression model;

β_1 = slope parameter;

ε = error with mean 0 and variance σ^2.

In Equation 2, the observed trap efficiency, e_k^{obs}, is calculated as follows,

$$e_k^{obs} = \frac{r_k + 1}{m}. \quad (3)$$

The estimated variance of seasonal migration is calculated from daily estimates as:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var(N_i)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov(N_i, N_j)}_{Part\ B}$$

or, **(4)**

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A of equation 4 is the variance of daily estimates. Part B is the between-day covariance. Note that the between-day covariance exists only for days that use the same trap efficiency model. If, for example, day 1 is estimated with one trap efficiency model, and day 2 estimated from a different model, then there is no covariance between day 1 and day 2. The full expression for the estimated variance:

$$\widehat{Var}\left(\sum_{i=1}^{n}\hat{N}_i\right)=\underbrace{\sum_i \hat{N}_i^2\left(\frac{N_i\hat{e}_i(1-\hat{e}_i)}{(C^i+1)^2}+\frac{4(1-\hat{e}_i)}{\hat{e}_i}\widehat{Var}(b_0+b_1flow_i)\right)}_{Part\ A}$$
$$+\underbrace{\sum_i\sum_j 4\left(\hat{N}_i(1-\hat{e}_i)\right)\left(\hat{N}_j(1-\hat{e}_j)\right)\cdot\left[\widehat{Var}(b_0)+flow_iflow_j\widehat{Var}(b_1)\right]}_{Part\ B}$$

where $V\hat{a}r(b_0+b_1flow_i)=M\hat{S}E\left(1+\frac{1}{n}+\frac{(flow_i-\overline{flow})^2}{(n-1)s^2_{flow}}\right)$, and $\hat{V}ar(b_0)$ and $\hat{V}ar(b_1)$ are

obtained from regression results. In Excel, the standard error (SE) of the coefficients is provided. The variance is calculated as the square of the standard error, SE^2.

In cases when there was no significant flow-efficiency relationship (i.e., low correlation), then a pooled, or average trap efficiency will suffice for the stratum. The estimator is calculated as follows:

$$\hat{\hat{e}}=\frac{\sum_{j=1}^{k}r_j}{\sum_{j=1}^{k}m_j}$$

where $\hat{\hat{e}}$ = the average or pooled trap efficiency for the stratum;

m_j = the number of smolts marked and released in efficiency trial j for the stratum;

r_j = the number of smolts recaptured out of m_j marked fish in efficiency trial j.

Abundance for a trapping period is estimated as:

$$\hat{N}_i^{pooled}=\frac{C_i}{\hat{\hat{e}}},$$

and total stratum abundance is:

$$N^{pooled}=\sum_i\hat{N}_i^{pooled}.$$

The variance of seasonal abundance takes into account the variability in catch numbers that are a result of binomial sampling (Part A), the pooled variance of trap efficiency, $\hat{\bar{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right)}_{Part\ A} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i \hat{N}_i^2}_{Part\ B} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i\sum_j \hat{N}_i\hat{N}_j}_{Part\ C}$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right) + \frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i\hat{N}_j\right]$$

The variance of $\hat{\bar{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\bar{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\bar{e}}_k m_k\right)^2}{\overline{m}^2 n(n-1)}$$

where $\overline{m}$ is the average release size across all efficiency trial, $\frac{\sum_{k=1}^{n} m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96 \times \sqrt{\sum \text{var}\left[\hat{N}_i\right]}$

The single M-R estimator of abundance carries a set of well documented assumptions (Everhart and Youngs 1981; Seber 1982),

1. The population is closed to mortality.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked fish were randomly dispersed in the population prior to recapture.

4. Marking does not affect probabilities of capture.
5. Marks were not lost between the time of release and recapture.
6. All marks are reported upon recapture.
7. The number of fish in the trap, C, is fully enumerated and known without error.

3.0 RESULTS

3.1 Dates of Operation

Trap-A was operated between March 1 and November 30. During this period, it was run 24 hours per day, 7 days per week barring inoperable environmental conditions (i.e. heavy debris loads or high discharge). Trap-A was not operational for a total of 18 days (Table 1).

Table 1. Summary of Trap A operation, 2018.

Trap Status	Description	Days
Operating	Continuous data collection	257
Interrupted	Unexpected interruption by debris, etc.	16
Pulled	Intentionally pulled to protect the trap during high flows	2

Trap-B was operated between March 1 and November 30. During this period, it was operated 24 hours per day, 7 days per week barring inoperable environmental conditions (i.e. insufficient channel depth or high discharge). Trap-B was not operational for a total of 50 days (Table 2).

Table 2. Summary of Trap B operation, 2018.

Trap Status	Description	Days
Operating	Continuous data collection	225
Interrupted	Unexpected interruption by debris, etc.	5
Pulled	Intentionally pulled due to grounding, or to protect the trap during high flows	45

3.2 Daily Captures and Biological Sampling

3.2.1 Wild Spring Chinook Yearlings (BY 2016)

A total of 114 wild yearling Chinook smolts were collected at Trap A between March 1 and June 30 (Figure 4). Mean FL was 98 mm (*n* = 114; *SD* = 7.0) and mean weight was 10.6 g (*n* = 112; *SD* = 2.2; Table 2). All spring Chinook smolts were implanted with PIT tags and had tissue samples taken. An additional 111 yearling Chinook smolts were caught at Trap B (Figure 5) with a mean length of 100 mm (*n*=11; SD=7.5) and a mean weight of 11.2 g (*n* = 106; SD = 2.8). Additionally, 8 wild spring Chinook precocial parr were captured at Trap A following the smolt migration. Mean FL for precocial parr was 147 mm (*n* = 8; *SD* = 22.1) and mean weight was 37.8 g (*n* = 8; *SD* = 14.3). Additionally, 1 precocial parr was caught in Trap B. There were no BY2016 spring Chinook mortalities incurred during the trapping season.

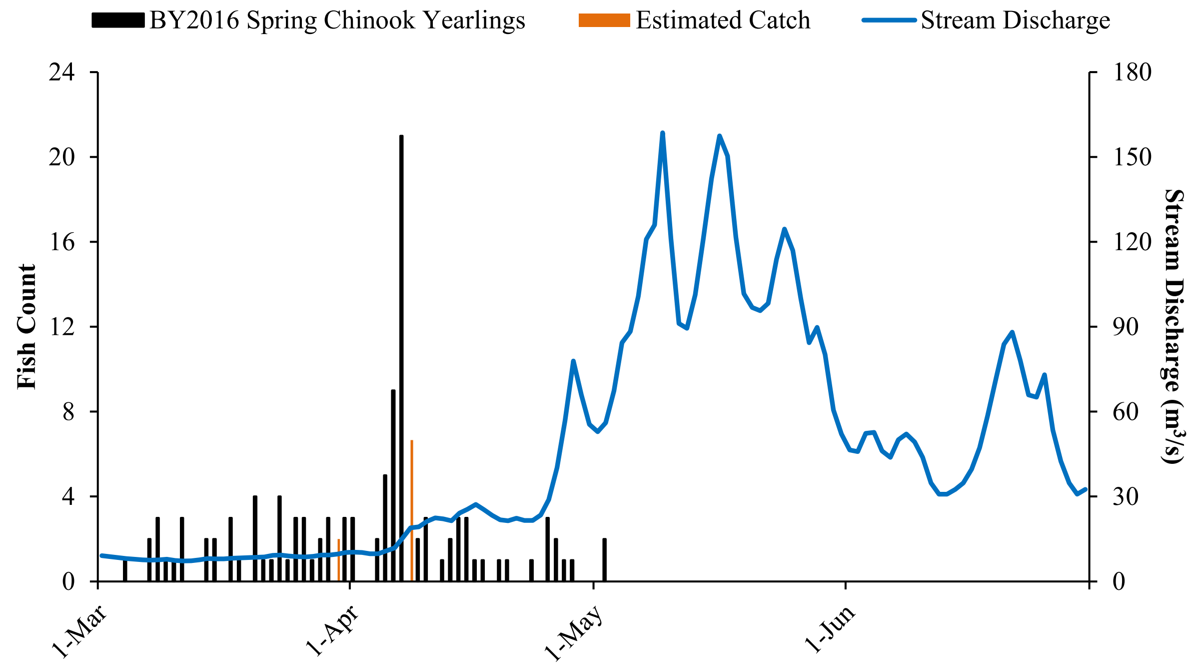


Figure 4. Daily catch of yearling spring Chinook smolt with mean daily stream discharge at the White River rotary Trap A, March 1 to June 30, 2018.

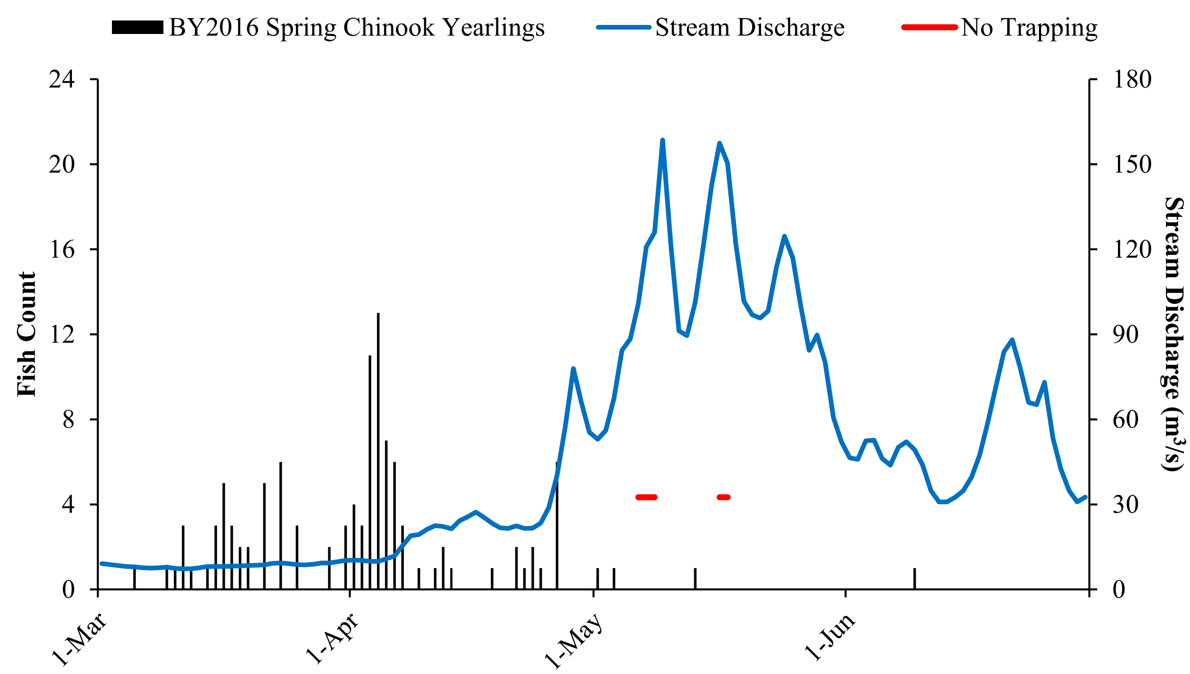


Figure 5. Daily catch of yearling spring Chinook smolt with mean daily stream discharge at the White River rotary Trap B, March 1 to June 30, 2018.

3.2.2 Wild Spring Chinook Subyearlings (BY2017)

Subyearling spring Chinook catch at Trap A included 4 fry (FL<50 mm) and 94 parr (FL≥50 mm) (Figure 6). Chinook fry captured at Trap A had a mean FL of 43 mm (n = 4; SD = 4.4) and a mean weight of 0.7 g (n = 4; SD = 0.2). Parr captured at Trap A had a mean FL of 95 mm (n = 94; SD = 8.4) and a mean weight of 9.3 g (n = 94; SD = 2.3). An additional 10 fry (no measurements taken) and 23 parr with a mean FL of 91 mm (n = 19; SD = 13.6) and a mean weight of 8.7 g (n = 19; SD = 3.1) were captured at Trap B (Figure 7). There were no BY2017 spring Chinook mortalities incurred throughout trap operations.

Table 3. Summary of length and weight sampling of juvenile spring Chinook captured at the White River rotary Trap A, 2018.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
		Mean	n	SD	Mean	n	SD	
2016	Wild Yearling Smolt	98	114	7.0	10.6	112	2.2	1.11
2016	Wild Precocial Parr	147	8	22.1	37.8	8	14.3	1.15
2017	Wild Subyearling Fry	43	4	4.8	0.7	4	0.2	0.89
2017	Wild Subyearling Parr	95	94	8.4	9.3	94	2.3	1.08

Table 4. Summary of length and weight sampling of juvenile spring Chinook captured at the White River rotary Trap B, 2018.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
		Mean	n	SD	Mean	n	SD	
2016	Wild Yearling Smolt	97	111	7.5	11.2	106	2.8	1.11
2016	Wild Precocial Parr	121	1	—	21.2	1	—	1.20
2017	Wild Subyearling Fry	—	—	—	—	—	—	—
2017	Wild Subyearling Parr	91	19	13.6	8.7	19	3.1	1.07

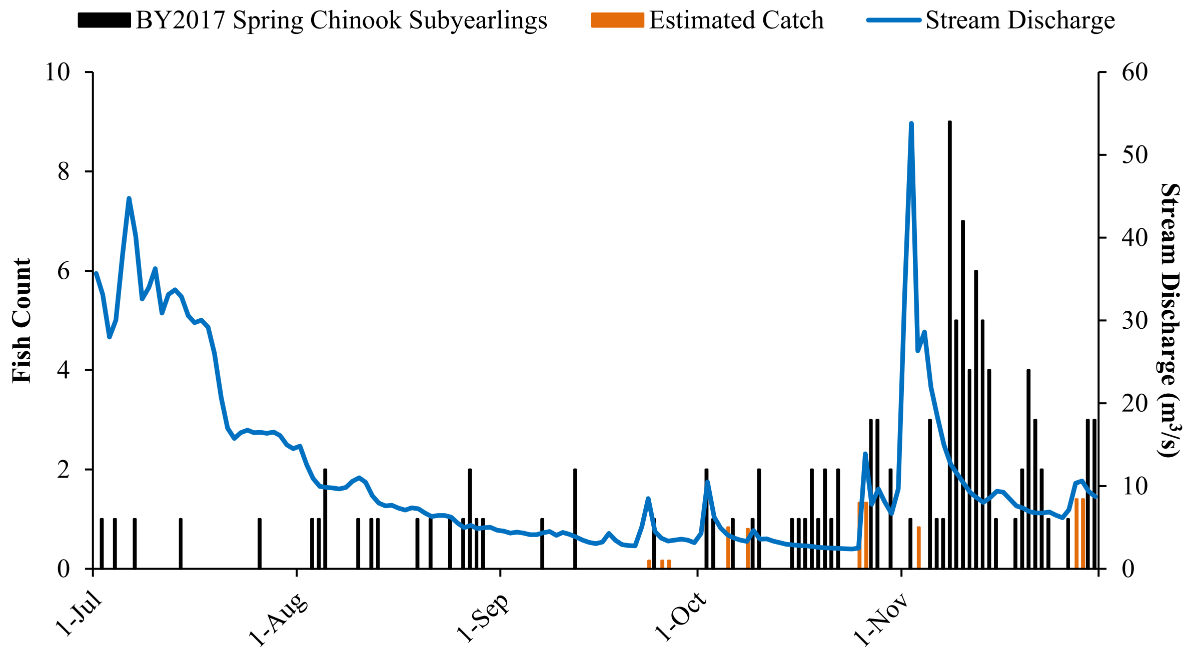


Figure 6. Trap A wild subyearling spring Chinook daily catch with mean daily stream discharge at the White River rotary trap, July 1 to November 30, 2018.

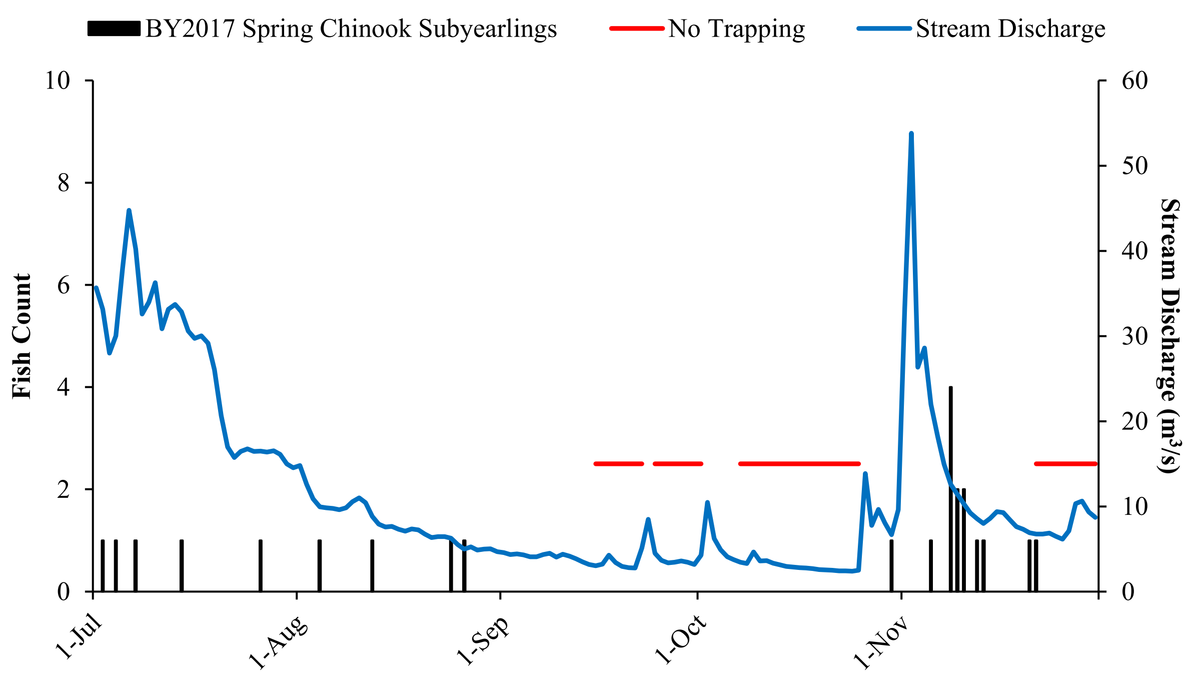


Figure 7. Trap B wild subyearling spring Chinook daily catch with mean daily stream discharge at the White River rotary trap, July 1 to November 30, 2018.

3.3 Trap Efficiency Calibration and Population Estimates

3.3.1 Wild Spring Chinook Yearlings (BY 2016)

A total of two BY2016 efficiency trials were performed in 2018, although only one reached the minimum mark group size of ≥ 50, and was used in the flow-efficiency model. A composite regression model using previous years' (2008-2018) efficiency trials showed a statistically significant ($r^2 = 0.61$; $p = 0.0004$) flow-efficiency relationship, and was used to calculate yearling abundance. Use of a single spring trapping position allowed this regression to be applied to all yearling Chinook captured in 2018. Weighting of this regression via an R script (provided by WDFW) did not affect calculation parameters greatly and yielded the same r-square and *p*-values. In the fall of 2017, we estimated that 4,851 (± 1,371; 95% CI) BY2016 subyearlings emigrated past the trap. In the spring of 2018, we estimated that 11,170 (± 13,710; 95% CI) BY2016 yearlings emigrated past the trap. Combining the two estimates, total BY2016 wild spring Chinook emigrants was 16,021 (± 13,779; 95% CI; Table 5).

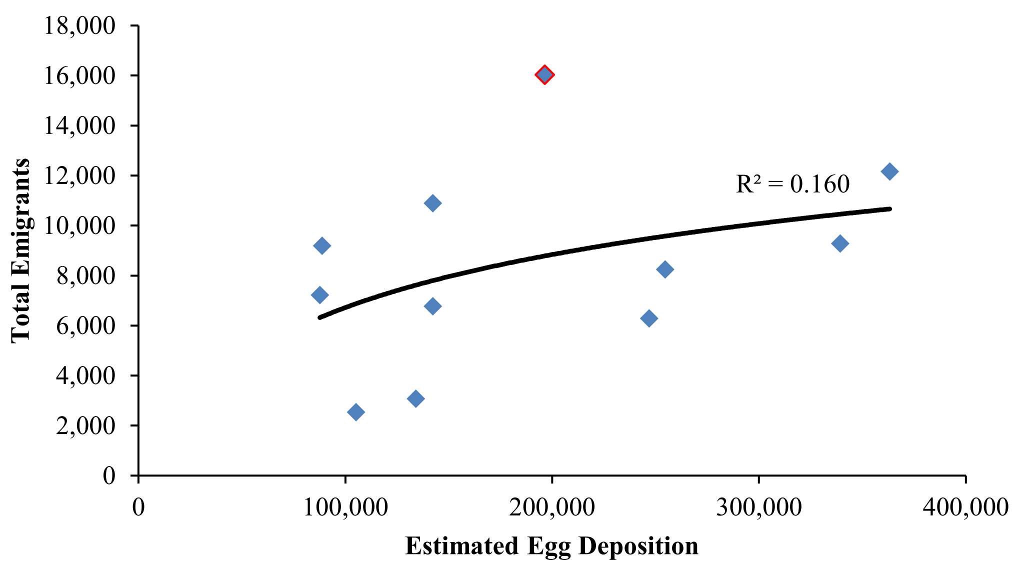
3.3.2 Wild Spring Chinook Subyearling (BY 2017)

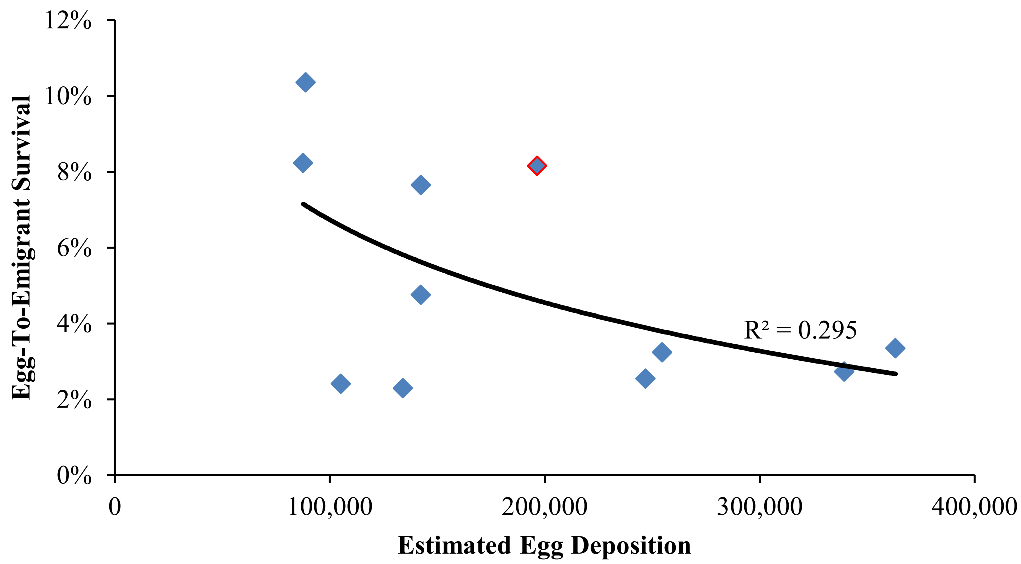
One BY2017 efficiency trial was performed in 2018, although it did not meet the desired minimum mark group size of ≥ 50 subyearling emigrants and, in turn, was not used in the subsequent flow-efficiency model. Test releases used to initially measure the combined efficacy of the two traps in tandem (see section 3.6) did not contribute to the existing flow-efficiency model because of their small sizes and redundancies in flows tested. The existing composite regression model used data from 2009-2015 to build a flow-efficiency relationship. The weighted regression was not significant ($r^2 = 0.14$; $p = 0.074$) at our accepted limit ($\alpha = 0.05$). However, after comparison with a pooled method and considerations of the pooled estimate limitations, we decided to use the regression model despite its slightly higher *p*-value. This single regression was the only model required to estimate total subyearling migration due to the fact only one fall trapping position was used. We estimated that 1,679 (± 1,373; 95% CI) spring Chinook subyearling parr moved past the trap (Table 5).

Table 5. Estimated egg-to-emigrant survival and emigrants per redd for White River spring Chinook.

Brood Year	No. of Redds[a]	Fecundity[b]	No. of Eggs	No. of Emigrants			Egg-to Emigrant	Emigrants per Redd
				Age-0[c]	Age-1	Total ± 95% CI		
2005	86	4,327	372,122	DNOT[d]	4,856	—	—	—
2006	31	4,324	134,044	652	2,004	2,656 ± 1,597	2.0%	86
2007	20	4,441	88,820	2,309	3,395	5,704 ± 2,201	6.4%	285
2008	31	4,592	142,352	5,560	5,193	10,753 ± 3,783	7.6%	347
2009	54	4,573	246,942	2,428	2,939	5,367 ± 2,497	2.2%	99
2010	33	4,314	142,362	1,859	4,103	5,962 ± 3,448	4.2%	181
2011	20	4,385	87,700	3,128	1,659	4,787 ± 2,022	5.5%	239
2012	86	4,223	363,178	3,816	3,995	7,811 ± 3,847	2.2%	91
2013	54	4,716	254,664	2,461	3,023	5,484 ± 2,836	2.2%	102
2014	26	4,045	105,170	1,950	386	2,336 ± 807	2.2%	90
2015	70	4,847	339,290	2,430	2,942	5,372 ± 2,723	1.6%	77
2016	44	4,467	196,548	4,851	11,170	16,021 ± 13,779	8.2%	364
2017	15	4,615	69,225	1,679	—	—	—	—
Avg.	**44**	**4,451**	**195,571**	**2,969**	**5,219**	**8,339**	**5.1%**	**212**

[a] Number of complete redds in White River (Hillman et al. 2017)
[b] Mean annual fecundity of spring Chinook broodstock at Chiwawa River Hatchery
[c] Estimate is based on capture of parr collected during summer/fall and does not include fry captured prior to July1
[d] Did not operate trap; no production estimates were made





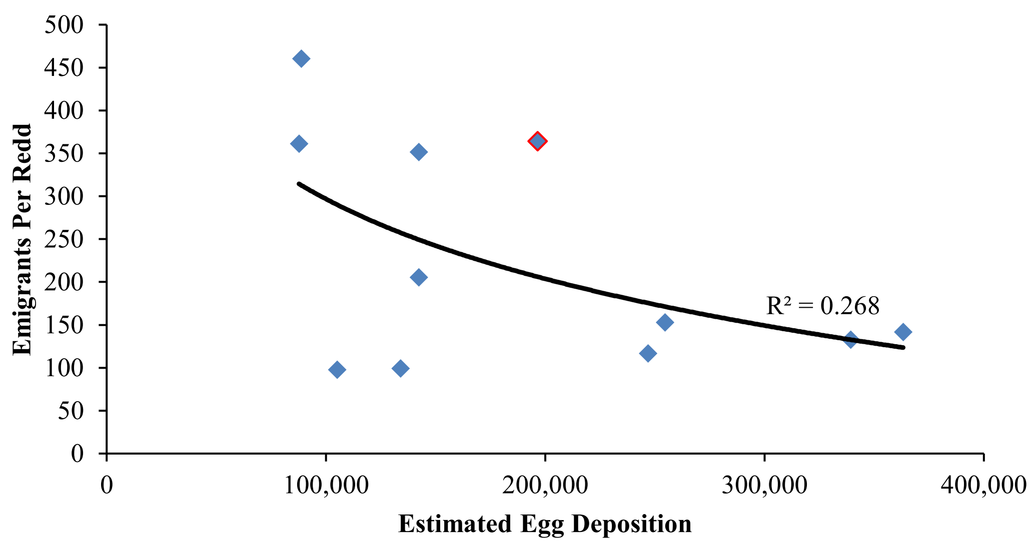


Figure 8. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for White River spring Chinook, BY 2006 to 2016. *BY2016 values denoted by red border.

3.4 PIT Tagging

A total of 216 spring Chinook and 2 steelhead were PIT tagged (Table 5). The post-tagging observational hold time of a minimum of 24 hours yielded no shed tags. There were no tagging mortalities (Table 6).

Table 6. Number of PIT tagged spring Chinook and steelhead (FL ≥ 60 mm) with shed rates at the White River rotary trap, 2018.

Brood Year	Species/Stage	Total Catch	Total PIT Tagged	Percent Tagged	Percent Tags Shed
2016	Spring Chinook Yearlings	225	220	97.8%	0.0%
2017	Spring Chinook Subyearlings	117	106	90.6%	0.0%
*	Summer Steelhead	4	2	50.0%	0.0%

* Brood year unknown

3.5 Incidental Species

Incidental species were enumerated and sampled for length and weight (Table 7). Incidental species included: brook trout *Salvelinus fontinalis*, bull trout, longnose dace *Rhinichthys cataractae*, mountain whitefish *Prosopium williamsoni*, northern pikeminnow *Ptychocheilus oregonensis*, steelhead/rainbow trout (shúshaynsh) *Oncorhynchus mykiss*, redside shiner *Richardsonius balteatus*, sculpin *Cottus sp.*, sockeye salmon, sucker *Catostomus sp.*, and westslope cutthroat *Oncorhynchus clarkii lewisi*.

Table 7. Summary of length and weight sampling of incidental species captured at the White River rotary trap, 2018.

Species	Total Count	Fork Length (mm)			Weight (g)		
		Mean	*n*	SD	Mean	*n*	SD
Brook Trout	1	—	—	—	—	—	—
Bull Trout	25	206	10	124	54.8	8	51.9
Longnose Dace	7	83	6	17	7.1	6	4.2
Mountain Whitefish	223	93	111	56	18.5	110	40.9
Northern Pikeminnow	39	148	18	43	31.2	16	18.5
Rainbow Trout/Steelhead Parr	4	132	2	10	24.0	2	9.8
Redside Shiner	92	81	47	15	7.1	46	3.3
Sculpin	119	67	60	24	5.4	58	6.7
Sockeye Fry	2,432	28	523	2	—	—	—
Sockeye Parr	7	89	1	—	6.1	1	—
Sockeye (Kokanee)	12	—	—	—	—	—	—
Sucker	68	173	19	84	91.3	18	99.7
Westslope Cutthroat	19	226	7	78	93.5	6	62.6

3.6 ESA Compliance

No ESA-listed species mortalities were incurred in 2018 (Table 8). At no point during the trapping season did the lethal take of wild spring Chinook exceed the maximum allowed 2%. All fish handled were inspected prior to tagging or further sampling with any sign of injury or stress warranting immediate release.

Table 8. Summary of White River ESA listed species catch and mortality, 2018.

Species/Stage	Total Catch	Total Mortality	Total % Mortality
Yearling Chinook Smolt	225	0	0.0%
Chinook Precocial Parr	9	0	0.0%
Subyearling Chinook Parr	117	0	0.0%
Subyearling Chinook Fry	14	0	0.0%
Total Wild Spring Chinook	**361**	**0**	**0.0%**
Bull Trout	23	0	0.0%
Steelhead/Rainbow Trout	4	0	0.0%

Maximum allowable incidental (handling) take for wild spring Chinook was 20% annually. To ensure that the addition of Trap B did not push us beyond this limit, multiple test efficiency trails were performed to gauge the combined efficiency of both traps. The April 8 efficiency trial was the only trial to contribute to the existing flow-efficiency models because all others were below the target mark-group size ($n \geq 50$). In total, the test yielded no trials resulting in a combined efficiency of over 20% (Table 9). Mean combined efficiency for the six trials was 4.0% at a mean discharge of 7.6 m^3/s (268 cfs). Though test trials could only be performed at a relatively low range of discharges, based on existing flow-efficiency models we conclude that combined efficiency would also diminish at higher flows.

Table 9. Test combined efficiency trials, 2018.

Release Date	Discharge (m^3/s)	Marked	Recaptured			Combined Efficiency
			Trap A	Trap B	Total	
4/4/2018	8.7	35	0	0	0	0.0%
4/8/2018	7.8	50	0	2	2	4.0%
11/11/2018	6.3	25	2	0	2	8.0%

4.0 DISCUSSION

The continued use of a second trap (Trap B) for catching migrating smolts served to increase catch of juvenile spring Chinook for use in developing flow-efficiency models. While the use of a second trap did not drastically increase the number of subyearling Chinook caught (94 caught in Trap A vs. 23 caught in Trap B), it almost doubled the number of yearling Chinook trapped, with 114 and 111 individuals caught in Trap A and Trap B, respectively. For the first time since 2012, our desired mark group size of ≥ 50 yearlings was reached during a 72-hour period, allowing for the inclusion of this efficiency trial in our flow-efficiency model for use in population estimates. This trial from April 8 (Table 8) was particularly significant, as it occurred at a higher discharge than any other previous efficiency trials currently incorporated into the model, allowing for the expansion of efficiency estimation at higher flows than the previous model.

It should be noted that the expansion of the yearling flow-efficiency model required us to recalculate estimates for yearling Chinook emigrants in previous brood years. In most years, this resulted in an increase in the number of estimated yearling smolts. It should also be noted that small adjustments were made to the subyearling estimates to account for corrected flow values. The resulting effect on existing subyearling emigrant estimates was negligible.

Despite a relatively average White River spawner success rate in 2016, the resulting BY2016 emigrant estimate was above average and egg-to-emigrant survival was well-above average. It is suspected that density-dependent effects cause an inverse relationship between in-stream survival and egg deposition (Figure 9). Moderate juvenile densities, combined with above-average rearing conditions are likely responsible for relatively high egg-to-emigrant survival of BY2016 Chinook. High in-stream survival as seen in the White River's population was mirrored in the nearby Nason Creek, where redd counts in 2016 were below average, but egg-to-emigrant ratios were high. BY2016 egg-to-emigrant estimates for the Chiwawa River were also above average. Age-class composition of BY2016 Chinook was atypical with more than double the number of smolts leaving as yearlings than subyearlings.

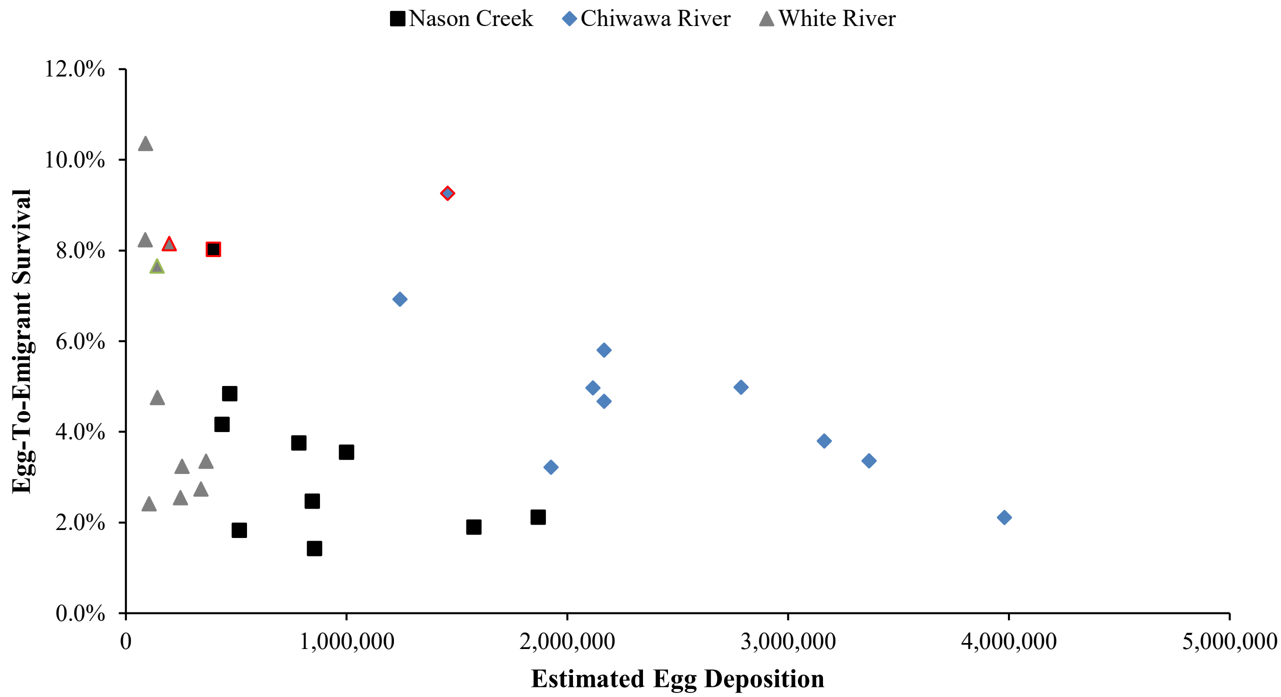


Figure 9. Comparisons of White R., Nason Cr., and Chiwawa River egg-to-emigrant survivals, BY2007-2016. *BY2016 denoted by red border.

BY2016 subyearling emigrant estimates were the second highest on record despite relatively average egg deposition. Unsurprisingly, BY2016 yearling emigrant estimates were the highest on record. Relatively stable fall flows for BY2016 redds likely resulted in the observed high rates of egg-to-emigrant survival. Conversely, BY2017 subyearling emigrant estimates were the lowest since 2006. On November 23, 2017, a discharge of 201 m^3/s (7,090 cfs) was recorded at the White River, making it the highest recorded discharge during smolt trap operations. This high flow event likely caused increased rates of redd scouring, resulting in the low estimates of BY 2017 subyearling emigrants. Potential effects of this high flow event will be evaluated at the conclusion of the 2019 trapping season, when BY2017 yearling emigrant estimates have been calculated.

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APPENDIX A: White River Temperature and Discharge Data

Date	Stream Discharge (m^3/s)	Water Temperature (˚C)
3/1/2018	9.1	3.1
3/2/2018	8.7	3.3
3/3/2018	8.4	2.9
3/4/2018	8.1	2.6
3/5/2018	7.9	2.7
3/6/2018	7.7	2.5
3/7/2018	7.5	1.4
3/8/2018	7.6	1.8
3/9/2018	7.9	1.7
3/10/2018	7.4	2.1
3/11/2018	7.2	2.2
3/12/2018	7.3	3.1
3/13/2018	7.6	2.6
3/14/2018	8.1	1.2
3/15/2018	8.0	0.5
3/16/2018	8.0	1.3
3/17/2018	8.2	2.1
3/18/2018	8.3	2.4
3/19/2018	8.4	3
3/20/2018	8.5	2.9
3/21/2018	8.7	3.2
3/22/2018	9.2	3.7
3/23/2018	9.3	4
3/24/2018	9.0	3.4
3/25/2018	8.7	4
3/26/2018	8.6	3.6
3/27/2018	8.9	4.2
3/28/2018	9.3	4
3/29/2018	9.3	3.5
3/30/2018	9.7	4.2
3/31/2018	10.3	4.2
4/1/2018	10.3	4.6
4/2/2018	10.2	4.1
4/3/2018	9.8	4
4/4/2018	9.8	3.9
4/5/2018	10.8	4.1
4/6/2018	11.8	4.3
4/7/2018	15.4	3.9
4/8/2018	18.9	4.2
4/9/2018	19.3	4.4
4/10/2018	21.2	4.3
4/11/2018	22.5	4.3
4/12/2018	22.2	4.3
4/13/2018	21.4	4.6
4/14/2018	24.2	4.6
4/15/2018	25.5	4.9
4/16/2018	27.3	4.4
4/17/2018	25.4	4.8
4/18/2018	23.3	4.8
4/19/2018	21.8	4.3
4/20/2018	21.5	5.1
4/21/2018	22.4	5.2
4/22/2018	21.5	4.4
4/23/2018	21.6	4.6
4/24/2018	23.4	4.7
4/25/2018	28.9	5.1
4/26/2018	40.2	4.9
4/27/2018	56.9	4.8
4/28/2018	77.9	5.2
4/29/2018	66.0	4.7
4/30/2018	55.5	5.4
5/1/2018	53.0	4.8
5/2/2018	56.1	5.3
5/3/2018	67.4	5.6
5/4/2018	84.4	4.5
5/5/2018	88.3	3.6
5/6/2018	100.8	4.2
5/7/2018	120.9	4.6
5/8/2018	126.0	4.8
5/9/2018	158.6	5.3
5/10/2018	121.2	5.5
5/11/2018	91.2	4.5
5/12/2018	89.5	4.3
5/13/2018	101.4	4.7
5/14/2018	120.9	5.4
5/15/2018	142.4	5.1
5/16/2018	157.4	4.8
5/17/2018	150.4	5.7
5/18/2018	121.8	6.1
5/19/2018	101.7	6.3

5/20/2018	96.8	6.1	7/4/2018	30.0	8.1
5/21/2018	95.7	5.6	7/5/2018	37.9	9
5/22/2018	98.3	5.5	7/6/2018	44.7	9.9
5/23/2018	113.8	5.5	7/7/2018	40.2	10.1
5/24/2018	124.6	5	7/8/2018	32.6	9.7
5/25/2018	116.9	5.4	7/9/2018	34.0	10.2
5/26/2018	100.0	6	7/10/2018	36.2	9.8
5/27/2018	84.4	6.1	7/11/2018	30.9	9.5
5/28/2018	89.8	6	7/12/2018	33.1	10.1
5/29/2018	80.1	5.9	7/13/2018	33.7	10.6
5/30/2018	60.6	5.7	7/14/2018	32.8	10
5/31/2018	52.1	5.9	7/15/2018	30.6	10.8
6/1/2018	46.4	5.7	7/16/2018	29.7	10.2
6/2/2018	45.9	6.1	7/17/2018	30.0	9.6
6/3/2018	52.4	6.4	7/18/2018	29.2	10.6
6/4/2018	52.7	6.1	7/19/2018	26.0	11.2
6/5/2018	46.2	6.3	7/20/2018	20.7	10.9
6/6/2018	43.9	6.9	7/21/2018	17.0	10.3
6/7/2018	50.1	6.9	7/22/2018	15.7	11.5
6/8/2018	52.1	5.9	7/23/2018	16.5	12.1
6/9/2018	49.3	5.8	7/24/2018	16.8	11
6/10/2018	43.9	6.2	7/25/2018	16.5	11.9
6/11/2018	34.8	6.1	7/26/2018	16.5	12.3
6/12/2018	30.9	6.9	7/27/2018	16.4	12.4
6/13/2018	30.9	6.7	7/28/2018	16.5	11.8
6/14/2018	32.6	6.4	7/29/2018	16.1	12.2
6/15/2018	34.8	5.9	7/30/2018	15.0	12.5
6/16/2018	39.6	6.4	7/31/2018	14.5	12.4
6/17/2018	47.3	6.3	8/1/2018	14.8	12.6
6/18/2018	58.6	6.2	8/2/2018	12.6	12.9
6/19/2018	71.6	7.3	8/3/2018	10.9	13.2
6/20/2018	83.8	7.4	8/4/2018	10.0	12.9
6/21/2018	88.1	6.8	8/5/2018	9.9	12.6
6/22/2018	78.2	7.1	8/6/2018	9.8	12.7
6/23/2018	66.0	7.7	8/7/2018	9.6	12.8
6/24/2018	65.1	8.1	8/8/2018	9.8	13.1
6/25/2018	73.1	8.1	8/9/2018	10.6	13.5
6/26/2018	53.5	8.1	8/10/2018	11.0	13.3
6/27/2018	42.5	8.2	8/11/2018	10.4	13.5
6/28/2018	34.8	8.2	8/12/2018	8.8	13.1
6/29/2018	30.9	8.3	8/13/2018	7.9	13
6/30/2018	32.6	8.8	8/14/2018	7.6	11.7
7/1/2018	35.7	9	8/15/2018	7.7	12.1
7/2/2018	33.1	8.8	8/16/2018	7.3	12.8
7/3/2018	28.0	9.1	8/17/2018	7.1	13.1

8/18/2018	7.4	12.9	10/2/2018	10.5	9
8/19/2018	7.2	12.8	10/3/2018	6.2	7
8/20/2018	6.7	12.5	10/4/2018	4.9	7.1
8/21/2018	6.3	12.5	10/5/2018	4.1	6.8
8/22/2018	6.5	12.9	10/6/2018	3.7	7.5
8/23/2018	6.5	13.7	10/7/2018	3.5	7.5
8/24/2018	6.3	13.3	10/8/2018	3.3	7.9
8/25/2018	5.5	11.5	10/9/2018	4.6	8.4
8/26/2018	5.0	11.7	10/10/2018	0.0	-
8/27/2018	5.2	12.7	10/11/2018	3.6	7.6
8/28/2018	4.9	13	10/12/2018	3.3	7.1
8/29/2018	5.0	12.1	10/13/2018	3.1	6.7
8/30/2018	5.0	12.4	10/14/2018	3.0	5.8
8/31/2018	4.7	13.2	10/15/2018	2.9	5.5
9/1/2018	4.6	12.9	10/16/2018	2.8	5.7
9/2/2018	4.3	13.2	10/17/2018	2.8	5.7
9/3/2018	4.4	13.3	10/18/2018	2.7	5.7
9/4/2018	4.3	13	10/19/2018	2.6	5.8
9/5/2018	4.1	12.5	10/20/2018	2.5	5.7
9/6/2018	4.1	12.2	10/21/2018	2.5	5.4
9/7/2018	4.4	12.4	10/22/2018	2.5	5.4
9/8/2018	4.5	13.2	10/23/2018	2.4	5.4
9/9/2018	4.0	13.2	10/24/2018	2.4	6.2
9/10/2018	4.4	12	10/25/2018	2.5	6.8
9/11/2018	4.2	11.4	10/26/2018	13.9	7.1
9/12/2018	3.9	11.9	10/27/2018	7.8	6.7
9/13/2018	3.5	12.1	10/28/2018	9.7	6
9/14/2018	3.2	11.3	10/29/2018	8.1	5.7
9/15/2018	3.0	10.6	10/30/2018	6.7	5.6
9/16/2018	3.2	9.8	10/31/2018	9.6	6.2
9/17/2018	4.3	9.2	11/1/2018	33.1	6.4
9/18/2018	3.4	9.7	11/2/2018	53.8	6.6
9/19/2018	2.9	9.6	11/3/2018	26.3	6.3
9/20/2018	2.8	8.9	11/4/2018	28.6	5.9
9/21/2018	2.8	8.9	11/5/2018	22.0	5.5
9/22/2018	5.1	9.2	11/6/2018	18.2	5.3
9/23/2018	8.5	9.8	11/7/2018	15.0	4.2
9/24/2018	4.5	9.6	11/8/2018	12.6	3.0
9/25/2018	3.7	9.7	11/9/2018	11.5	2.9
9/26/2018	3.4	-	11/10/2018	10.3	3.1
9/27/2018	3.5	10.1	11/11/2018	9.2	2.5
9/28/2018	3.6	10.2	11/12/2018	8.6	2.3
9/29/2018	3.5	9.6	11/13/2018	8.0	2.4
9/30/2018	3.2	9.5	11/14/2018	8.6	2.6
10/1/2018	4.3	9.6	11/15/2018	9.4	3.8

11/16/2018	9.3	4.6	11/24/2018	6.5	1.9
11/17/2018	8.4	3.8	11/25/2018	6.2	2.6
11/18/2018	7.6	2.4	11/26/2018	7.1	2.4
11/19/2018	7.3	1.8	11/27/2018	10.3	0.1
11/20/2018	6.9	1.5	11/28/2018	10.6	1.8
11/21/2018	6.8	1.8	11/29/2018	9.3	3.1
11/22/2018	6.7	2.5	11/30/2018	8.7	3.3
11/23/2018	6.9	1.9			

APPENDIX B: Daily Trap Operation Status

Date	Trap A Status	Trap B Status	Comments
3/1/2018	Op.	Op.	
3/2/2018	Op.	Op.	
3/3/2018	Op.	Op.	
3/4/2018	Op.	Op.	
3/5/2018	Op.	Op.	
3/6/2018	Op.	Op.	
3/7/2018	Op.	Op.	
3/8/2018	Op.	Op.	
3/9/2018	Op.	Op.	
3/10/2018	Op.	Op.	
3/11/2018	Op.	Op.	
3/12/2018	Op.	Op.	
3/13/2018	Op.	Op.	
3/14/2018	Op.	Op.	
3/15/2018	Op.	Op.	
3/16/2018	Op.	Op.	
3/17/2018	Op.	Op.	
3/18/2018	Op.	Op.	
3/19/2018	Op.	Op.	
3/20/2018	Op.	Op.	
3/21/2018	Op.	Op.	
3/22/2018	Op.	Op.	
3/23/2018	Op.	Op.	
3/24/2018	Op.	Op.	
3/25/2018	Op.	Op.	
3/26/2018	Op.	Op.	
3/27/2018	Op.	Op.	
3/28/2018	Op.	Op.	
3/29/2018	Op.	Op.	
3/30/2018	Stopped	Op.	Debris
3/31/2018	Op.	Op.	
4/1/2018	Op.	Op.	
4/2/2018	Op.	Op.	
4/3/2018	Op.	Op.	
4/4/2018	Op.	Op.	
4/5/2018	Op.	Op.	
4/6/2018	Op.	Op.	
4/7/2018	Op.	Op.	
4/8/2018	Stopped	Op.	Debris
4/9/2018	Op.	Op.	
4/10/2018	Op.	Op.	
4/11/2018	Op.	Op.	
4/12/2018	Op.	Op.	
4/13/2018	Op.	Op.	
4/14/2018	Op.	Op.	
4/15/2018	Op.	Op.	
4/16/2018	Op.	Op.	
4/17/2018	Op.	Op.	
4/18/2018	Op.	Op.	
4/19/2018	Op.	Op.	
4/20/2018	Op.	Op.	
4/21/2018	Op.	Op.	
4/22/2018	Op.	Op.	
4/23/2018	Op.	Op.	
4/24/2018	Op.	Op.	
4/25/2018	Op.	Op.	
4/26/2018	Op.	Op.	
4/27/2018	Op.	Op.	
4/28/2018	Op.	Op.	
4/29/2018	Op.	Op.	
4/30/2018	Op.	Op.	
5/1/2018	Op.	Op.	
5/2/2018	Op.	Op.	
5/3/2018	Op.	Op.	
5/4/2018	Op.	Op.	
5/5/2018	Op.	Op.	
5/6/2018	Op.	Stopped	Debris
5/7/2018	Op.	Op.	
5/8/2018	Op.	Pulled	
5/9/2018	Op.	Op.	
5/10/2018	Op.	Op.	
5/11/2018	Op.	Op.	
5/12/2018	Op.	Op.	
5/13/2018	Op.	Op.	
5/14/2018	Op.	Op.	
5/15/2018	Op.	Op.	
5/16/2018	Op.	Pulled	Repair
5/17/2018	Op.	Pulled	Repair
5/18/2018	Op.	Op.	
5/19/2018	Op.	Op.	
5/20/2018	Op.	Op.	
5/21/2018	Op.	Op.	
5/22/2018	Op.	Op.	
5/23/2018	Op.	Op.	

5/24/2018	Op.	Op.		7/8/2018	Op.	Op.
5/25/2018	Op.	Op.		7/9/2018	Op.	Op.
5/26/2018	Op.	Op.		7/10/2018	Op.	Op.
5/27/2018	Op.	Op.		7/11/2018	Op.	Op.
5/28/2018	Op.	Op.		7/12/2018	Op.	Op.
5/29/2018	Op.	Op.		7/13/2018	Op.	Op.
5/30/2018	Op.	Op.		7/14/2018	Op.	Op.
5/31/2018	Op.	Op.		7/15/2018	Op.	Op.
6/1/2018	Op.	Op.		7/16/2018	Op.	Op.
6/2/2018	Op.	Op.		7/17/2018	Op.	Op.
6/3/2018	Op.	Op.		7/18/2018	Op.	Op.
6/4/2018	Op.	Op.		7/19/2018	Op.	Op.
6/5/2018	Op.	Op.		7/20/2018	Op.	Op.
6/6/2018	Op.	Op.		7/21/2018	Op.	Op.
6/7/2018	Op.	Op.		7/22/2018	Op.	Op.
6/8/2018	Op.	Op.		7/23/2018	Op.	Op.
6/9/2018	Op.	Op.		7/24/2018	Op.	Op.
6/10/2018	Op.	Op.		7/25/2018	Op.	Op.
6/11/2018	Op.	Op.		7/26/2018	Op.	Op.
6/12/2018	Op.	Op.		7/27/2018	Op.	Op.
6/13/2018	Op.	Op.		7/28/2018	Op.	Op.
6/14/2018	Op.	Op.		7/29/2018	Op.	Op.
6/15/2018	Op.	Op.		7/30/2018	Op.	Op.
6/16/2018	Op.	Op.		7/31/2018	Op.	Op.
6/17/2018	Op.	Op.		8/1/2018	Op.	Op.
6/18/2018	Op.	Op.		8/2/2018	Op.	Op.
6/19/2018	Op.	Op.		8/3/2018	Op.	Op.
6/20/2018	Stopped	Op.	Debris	8/4/2018	Op.	Op.
6/21/2018	Stopped	Op.	Debris	8/5/2018	Op.	Op.
6/22/2018	Op.	Op.		8/6/2018	Op.	Op.
6/23/2018	Op.	Op.		8/7/2018	Op.	Op.
6/24/2018	Op.	Op.		8/8/2018	Op.	Op.
6/25/2018	Op.	Op.		8/9/2018	Op.	Op.
6/26/2018	Op.	Op.		8/10/2018	Op.	Op.
6/27/2018	Op.	Op.		8/11/2018	Op.	Op.
6/28/2018	Op.	Op.		8/12/2018	Op.	Op.
6/29/2018	Op.	Op.		8/13/2018	Op.	Op.
6/30/2018	Op.	Op.		8/14/2018	Op.	Op.
7/1/2018	Op.	Op.		8/15/2018	Op.	Op.
7/2/2018	Op.	Op.		8/16/2018	Op.	Op.
7/3/2018	Op.	Op.		8/17/2018	Op.	Op.
7/4/2018	Op.	Op.		8/18/2018	Op.	Op.
7/5/2018	Op.	Op.		8/19/2018	Op.	Op.
7/6/2018	Op.	Op.		8/20/2018	Op.	Op.
7/7/2018	Op.	Op.		8/21/2018	Op.	Op.

8/22/2018	Op.	Op.		10/6/2018	Op.	Op.	
8/23/2018	Op.	Op.		10/7/2018	Op.	Stopped	Grounded
8/24/2018	Stopped	Op.	Debris	10/8/2018	Stopped	Pulled	Debris/Grounded
8/25/2018	Op.	Op.		10/9/2018	Op.	Pulled	Grounded
8/26/2018	Op.	Op.		10/10/2018	Op.	Pulled	Grounded
8/27/2018	Op.	Op.		10/11/2018	Op.	Pulled	Grounded
8/28/2018	Op.	Op.		10/12/2018	Op.	Pulled	Grounded
8/29/2018	Op.	Op.		10/13/2018	Op.	Pulled	Grounded
8/30/2018	Op.	Op.		10/14/2018	Op.	Pulled	Grounded
8/31/2018	Op.	Op.		10/15/2018	Op.	Pulled	Grounded
9/1/2018	Op.	Op.		10/16/2018	Op.	Pulled	Grounded
9/2/2018	Op.	Op.		10/17/2018	Op.	Pulled	Grounded
9/3/2018	Stopped	Op.	Debris	10/18/2018	Op.	Pulled	Grounded
9/4/2018	Op.	Op.		10/19/2018	Op.	Pulled	Grounded
9/5/2018	Op.	Op.		10/20/2018	Op.	Pulled	Grounded
9/6/2018	Op.	Op.		10/21/2018	Op.	Pulled	Grounded
9/7/2018	Op.	Op.		10/22/2018	Op.	Pulled	Grounded
9/8/2018	Op.	Op.		10/23/2018	Op.	Pulled	Grounded
9/9/2018	Op.	Op.		10/24/2018	Op.	Pulled	Grounded/Grounded
9/10/2018	Op.	Op.		10/25/2018	Stopped	Pulled	Grounded/Grounded
9/11/2018	Op.	Op.		10/26/2018	Stopped	Op.	Grounded
9/12/2018	Op.	Op.		10/27/2018	Op.	Op.	
9/13/2018	Op.	Op.		10/28/2018	Op.	Op.	
9/14/2018	Op.	Op.		10/29/2018	Op.	Op.	
9/15/2018	Op.	Stopped	Grounded	10/30/2018	Op.	Op.	
9/16/2018	Op.	Pulled	Grounded	10/31/2018	Op.	Op.	
9/17/2018	Op.	Pulled	Grounded	11/1/2018	Op.	Op.	
9/18/2018	Op.	Pulled	Grounded	11/2/2018	Stopped	Stopped	Grounded/Grounded
9/19/2018	Op.	Pulled	Grounded	11/3/2018	Pulled	Op.	
9/20/2018	Op.	Pulled	Grounded	11/4/2018	Op.	Op.	
9/21/2018	Op.	Pulled	Grounded	11/5/2018	Op.	Op.	
9/22/2018	Op.	Pulled	Grounded	11/6/2018	Op.	Op.	
9/23/2018	Stopped	Op.	Debris	11/7/2018	Op.	Op.	
9/24/2018	Op.	Pulled	Grounded	11/8/2018	Op.	Op.	
9/25/2018	Stopped	Pulled	Debris/Grounded	11/9/2018	Op.	Op.	
9/26/2018	Stopped	Pulled	Debris/Grounded	11/10/2018	Op.	Op.	
9/27/2018	Op.	Pulled	Grounded	11/11/2018	Op.	Op.	
9/28/2018	Op.	Pulled	Grounded	11/12/2018	Op.	Op.	
9/29/2018	Op.	Pulled	Grounded	11/13/2018	Op.	Op.	
9/30/2018	Op.	Pulled	Grounded	11/14/2018	Op.	Op.	
10/1/2018	Op.	Pulled	Grounded	11/15/2018	Op.	Op.	
10/2/2018	Stopped	Op.	Debris	11/16/2018	Op.	Op.	
10/3/2018	Op.	Op.		11/17/2018	Op.	Op.	
10/4/2018	Op.	Op.		11/18/2018	Op.	Op.	
10/5/2018	Stopped	Op.	Debris	11/19/2018	Op.	Op.	

11/20/2017	Op.	Op.	
11/21/2017	Op.	Op.	
11/22/2017	Stopped	Stopped	Debris
11/23/2017	Pulled	Pulled	Flood
11/24/2017	Pulled	Pulled	Flood
11/25/2017	Op.	Op.	
11/26/2017	Stopped	Op.	Debris
11/27/2017	Op.	Op.	
11/28/2017	Op.	Op.	
11/29/2017	Op.	Op.	
11/30/2017	Op.	Op.	

APPENDIX C: Regression Models

Model: Chinook Yearlings (Spring ’08-’15) Back Position, (r^2=0.609; p = 0.0004)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (m^3/s)
Wild Chinook Yearlings	4/10/2008	25	2	0.120	0.354	6
Wild Chinook Yearlings	3/26/2009	24	5	0.250	0.524	5
Wild Chinook Yearlings	3/30/2009	34	4	0.147	0.394	5
Wild Chinook Yearlings	4/2/2009	37	10	0.297	0.577	6
Wild Chinook Yearlings	4/5/2009	59	15	0.271	0.548	6
Wild Chinook Yearlings	4/10/2009	36	3	0.111	0.34	11
Wild Chinook Yearlings	3/12/2010	25	1	0.080	0.287	8
Wild Chinook Yearlings	3/16/2010	30	5	0.200	0.464	8
Wild Chinook Yearlings	3/20/2010	21	1	0.095	0.314	8
Wild Chinook Yearlings	4/5/2010	37	1	0.054	0.235	10
Wild Chinook Yearlings	4/9/2010	31	4	0.161	0.413	9
Wild Chinook Yearlings	4/12/2010	58	4	0.086	0.298	8
Wild Chinook Yearlings	4/16/2010	73	2	0.041	0.204	11
Wild Chinook Yearlings	4/14/2012	48	1	0.042	0.206	15
Wild Chinook Yearlings	4/9/2018	50	0	0.020	0.142	20

Model: Chinook Subyearlings (Fall ’09-’15) Back Position, (r^2=0.143; p = 0.074)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (m^3/s)
Wild Chinook Subyearlings	8/20/2009	20	2	15.00%	0.398	9
Wild Chinook Subyearlings	8/29/2009	34	4	14.71%	0.394	7
Wild Chinook Subyearlings	10/7/2009	22	2	13.64%	0.378	3
Wild Chinook Subyearlings	10/16/2009	34	6	20.59%	0.471	4
Wild Chinook Subyearlings	11/17/2009	35	3	11.43%	0.345	11
Wild Chinook Subyearlings	11/23/2009	21	0	4.76%	0.22	9
Wild Chinook Subyearlings	11/21/2011	39	2	7.69%	0.281	5
Wild Chinook Subyearlings	10/4/2012	33	5	18.18%	0.441	4
Wild Chinook Subyearlings	10/24/2012	87	6	8.05%	0.288	8
Wild Chinook Subyearlings	10/28/2012	36	1	5.56%	0.238	21
Wild Chinook Subyearlings	10/31/2013	46	7	17.39%	0.43	8
Wild Chinook Subyearlings	11/6/2013	38	9	26.32%	0.539	7
Wild Chinook Subyearlings	11/9/2013	40	6	17.50%	0.432	7
Wild Chinook Subyearlings	11/13/2013	29	2	10.34%	0.327	12
Wild Chinook Subyearlings	11/23/2013	25	3	16.00%	0.412	12
Wild Chinook Subyearlings	11/27/2013	24	0	4.17%	0.206	10
Wild Chinook Subyearlings	9/17/2015	39	4	12.82%	0.366	3

Appendix D. Historical Morphometric Data

Spring Chinook (Trap A 2007-2018)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2007	2005	Wild Yearling Smolt	93	173	8.5	8.6	173	2.2	1.1
2007	2005	Wild Yearling Precocial Parr	123	4	7.2	22.2	4	5.8	1.2
2007	2005	Hatchery Yearling Smolt*	76	208	17.9	5.4	203	4.2	1.2
2007	2005	Hatchery Yearling Precocial Parr	98	20	8.7	11.1	19	2.2	1.2
2007	2006	Wild Subyearling Fry	35	7	1.6	—	—	—	—
2007	2006	Wild Subyearling Parr	95	33	12.4	9.8	33	4.1	1.1
2008	2006	Wild Yearling Smolt	100	105	12.3	12.5	105	13.5	1.2
2008	2006	Wild Yearling Precocial Parr	126	9	8.4	22.8	9	4.1	1.1
2008	2006	Hatchery Yearling Smolt	117	229	12.7	18.7	228	9.8	1.2
2008	2006	Hatchery Yearling Precocial Parr	155	2	15.6	47.6	2	12.6	1.3
2008	2007	Wild Subyearling Fry	41	10	4.4	—	—	—	—
2008	2007	Wild Subyearling Parr	95	202	9.1	9.4	202	2.5	1.1
2009	2007	Wild Yearling Smolt	104	275	6.4	12.5	274	2.6	1.1
2009	2007	Wild Yearling Precocial Parr	134	5	7.0	28.5	2	2.7	1.2
2009	2007	Hatchery Yearling Precocial Parr	188	2	17.7	81.9	2	27.1	1.2
2009	2008	Wild Subyearling Fry	38	13	2.1	—	—	—	—
2009	2008	Wild Subyearling Parr	85	507	11.8	7.2	499	2.7	1.2
2010	2008	Wild Yearling Smolt	96	345	7.1	11.2	345	2.4	1.3
2010	2008	Wild Yearling Precocial Parr	130	15	10.3	26.4	15	6.6	1.2
2010	2009	Wild Subyearling Fry	40	31	3.6	—	—	—	—
2010	2009	Wild Subyearling Parr	87	166	12.6	7.7	166	3.0	1.2
2011	2009	Wild Yearling Smolt	99	64	7.7	11.3	64	2.8	1.2
2011	2009	Wild Yearling Precocial Parr	137	1	—	32.3	1	—	1.3
2011	2009	Hatchery Yearling Smolt	127	46	10.6	24.3	46	6.5	1.2
2011	2010	Wild Subyearling Fry	37	26	2.5	—	—	—	—
2011	2010	Wild Subyearling Parr	91	159	13.0	9.2	159	7.1	1.2
2012	2010	Wild Yearling Smolt	98	182	7.9	10.9	179	2.8	1.2
2012	2010	Wild Yearling Precocial Parr	123	13	12.7	22.4	13	6.5	1.2
2012	2011	Hatchery Subyearling Fry	84	29	4.4	6.5	2	2.3	1.1
2012	2011	Hatchery Subyearling Parr	110	25	7.4	14.6	25	3.3	1.1
2012	2011	Wild Subyearling Fry	35	18	2.7	—	—	—	—
2012	2011	Wild Subyearling Parr	91	315	10.1	8.8	288	2.8	1.2
2013	2011	Wild Yearling Smolt	103	20	7.0	12.3	20	3.0	1.1
2013	2011	Wild Yearling Precocial Parr	111	2	0.7	13.5	2	3.0	1.0
2013	2011	Hatchery Yearling Precocial Parr	155	4	17.4	43.4	4	17.8	1.2
2013	2012	Wild Subyearling Fry	40	77	8.1	—	—	—	—
2013	2012	Wild Subyearling Parr	84	445	12.3	6.7	444	4.7	1.1

2014	2012	Wild Yearling Smolt	94	43	7.0	9.4	43	2.2	1.1
2014	2012	Wild Yearling Precocial Parr	127	7	13.0	23.2	7	7.4	1.1
2014	2013	Wild Subyearling Fry	40	22	3.8	—	—	—	—
2014	2013	Wild Subyearling Parr	86	185	14.1	7.5	185	3.3	1.2
2015	2013	Wild Yearling Smolt	103	32	6.8	13.0	31	2.8	1.1
2015	2013	Wild Yearling Precocial Parr	145	2	13.4	35.2	2	11.4	1.1
2015	2014	Wild Subyearling Fry	38	11	3.3	0.5	10	0.2	0.9
2015	2014	Wild Subyearling Parr	96	151	7.5	10.4	148	6.3	1.2
2016	2014	Wild Yearling Smolt	106	3	1.5	12.4	3	0.3	1.1
2016	2015	Wild Subyearling Fry	38	50	3.0	0.46	49	0.3	0.8
2016	2015	Wild Subyearling Parr	89	147	10.7	8.29	147	2.8	1.1
2017	2015	Wild Yearling Smolt	98	41	6.6	10.7	35	2.3	1.1
2017	2015	Wild Yearling Precocial Parr	140	20	11.7	30.1	20	7.2	1.1
2017	2016	Wild Subyearling Fry	38	47	3.4	0.4	47	0.2	0.8
2017	2016	Wild Subyearling Parr	86	530	10.1	7.1	516	7.1	1.1
2018	2016	Wild Yearling Smolt	98	114	7.0	10.6	112	2.2	1.11
2018	2016	Wild Yearling Precocial Parr	147	8	22.1	37.8	8	14.3	1.15
2018	2017	Wild Subyearling Fry	43	4	4.8	0.7	4	0.2	0.89
2018	2017	Wild Subyearling Parr	95	94	8.4	9.3	94	2.3	1.08

[a] Includes residualized non-precocial smolts caught after June 30
[b] "Fry" classification based on age despite FL ≥ 50mm

White River Smolt Trap

Proposal for Pilot 2.4-Meter Trap Addition

July 2017

Prepared by:

Bryan R. Ishida

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Established in 2005 to target juvenile Upper Columbia River (UCR) spring Chinook (*Oncorhynchus tshawytscha*), operation of the White River smolt trap has undergone several changes to facilitate development of a flow-efficiency model capable of producing accurate abundance estimates. Early trapping strategies included switching operations between a high-water position at an upstream highline cable, and a low-flow position at a lower highline cable. In the upstream high-water position, 1.5 m (5 ft.) and 2.4 m (8 ft.) traps were separately operated to accommodate a range of flows. However, operation of two trap sizes and two trap positions created the need for multiple flow-efficiency models to produce a single population estimate. Low catch in some trap positions did not allow marked group releases to develop needed flow-efficiency models, making catch expansion impossible. By 2013, the decision was made to abandon the use of multiple trap positions and instead run the smaller 1.5 m trap continuously in a fixed position off of the downstream highline. The use of a single, fixed position provided the ability to simplify abundance estimates to two models (yearling and subyearling) which could be applied across years. Though the single trap and single positon provided a much simpler, and more effective means of producing population estimates, the smaller trap has low efficiency at higher flows. Low catch at the current trap limits our ability to further develop the models needed to produce accurate population estimates. Recently, annual yearling and subyearling abundances have dropped markedly (Table 1). Given the low return of natural-origin adults in 2017 and the discontinuation of GCPUD's hatchery supplementation program in 2015, further development of the flow-efficiency models will be challenging unless catch at the current position can be increased or supplemented.

Table 10. Summary of natural-origin spring Chinook captured at the White River Smolt Trap, 2007-2016.

Capture Year	Yearlings	Sub-Yearlings
2007	172	47
2008	102	229
2009	286	543
2010	372	249
2011	65	251
2012	204	335
2013	22	522
2014	50	212
2015	35	162
2016	3	198
Average	**131**	**275**

Regarding potential changes to trap operation for the purpose of increasing catch, GCPUD has specified the following goals (R. O'Connor, personal communication, June 14, 2017):

1) Preservation of the long term dataset that has been established with the 5' trap

2) Collection of more fish for PIT tagging

3) Preservation of the current budget

The following proposal describes a pilot study in which the feasibility and effectiveness of a tandem-trap configuration at the current location is assessed. Data and results will be reviewed by YN and GCPUD at a later point to determine if the goals can effectively be met and further use of a second trap is warranted.

2.0 PROPOSED ACTION

To supplement the catch of the current 1.5 m trap (Trap-A), we propose the simultaneous operation of a 2.4 m diameter trap (Trap-B). Trap-B will operate with the sole purpose of catching additional spring Chinook parr and smolts for tagging and efficiency trials used to build the flow-efficiency model of Trap-A. Not limited to a single trapping position, Trap-B will be free to be moved in order to optimize channel depth and velocity. Operation of Trap-B can be discontinued during low flow, high flow, and/or heavy debris load conditions without loss of daily emigrant estimates given continued operation of Trap-A.

2.1 Rigging/location

The location of Trap-B will not affect the ability of Trap-A to collect fish in its current position i.e., fish captured in Trap-B will be those which would have otherwise passed Trap-A during outmigration. To ensure this, Trap-B will be suspended off of the same river-spanning cable as Trap-A, with the opening of its cone in line with, or slightly downstream of that of Trap-A (Figure 1). Initial changes to the positioning of Trap-A as a result of the installation of Trap-B will be compensated for via the adjustment of positioning and lead cables.

Figure 10. Current location of Trap-A, and proposed location of Trap-B at rkm 9 of the White River.

Trap-B will be positioned along the river-left bank as shown in Figure 1. The river-left location will provide easy access to the trap for personnel, and an adjacent eddy that can be used as a haven during periods of high flow. The river-left side of the channel is also the deepest section of the river transect, aside from the location of Trap-A and the river-right bank eddy (Figure 2). Because Trap-B will be situated in a shallower location and using a larger cone, we anticipate that it will not be able to operate at the base flows in which Trap-A can run. Based on the latest low-flow transect (2016), it does appear that Trap-B will maintain cone clearance to discharges as low as 154 cfs, although it is unclear if water velocity will be sufficient to turn the cone. However, base, or near-base flow operation is not of major concern given that supplemented catch is needed particularly at mid, to high-water discharges when Trap-A is least efficient.

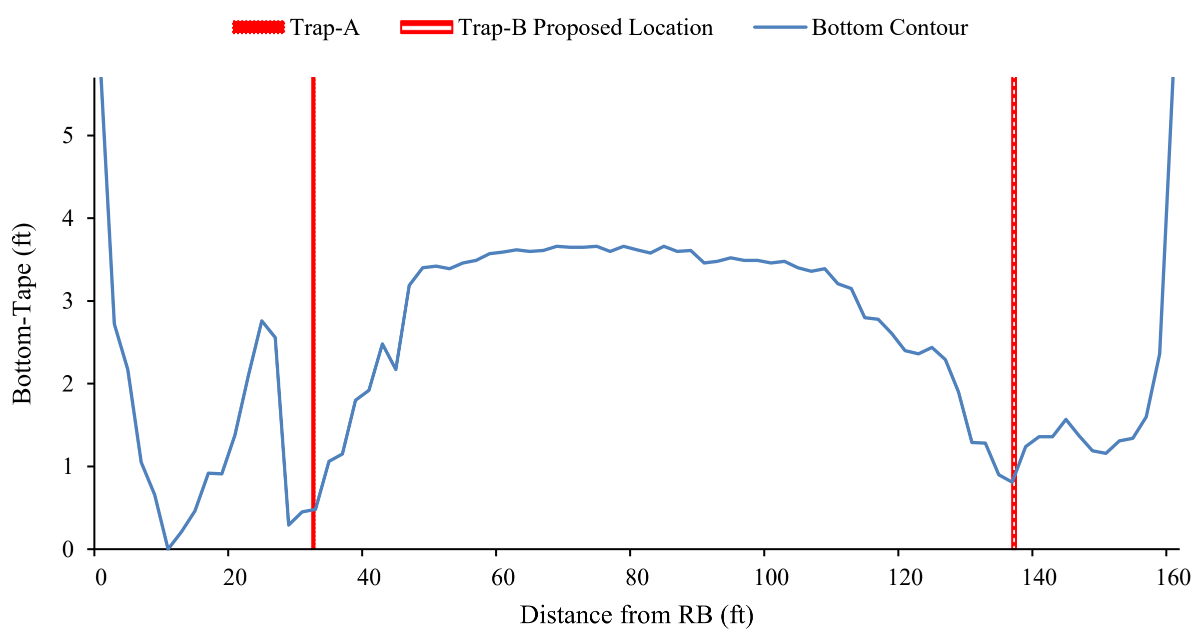

Figure 11. White River transect showing the current position of Trap-A, and the proposed position of Trap-B. Measurement taken on 9/8/2016 at 154 cfs.

Trap-B will be held in place by a rigging configuration similar to that of the Nason Creek smolt trap (Figure 3). This system of rigging will include two side anchors attaching the fore and aft of the starboard pontoon to the river-left bank in addition to the main lead cables attached to the highline. Lateral anchoring points will allow the inclusion of a break-away point located in between the main pulley and the leads. In the unlikely event that the force of debris on Trap-B begins to threaten the integrity of the highline and its anchors, the breakaway point will give way, transferring the load of the trap onto the lateral anchors. With the shift in anchor point(s), the trap will be drawn into an eddy on the river-left bank, alleviating pressure on the trap. A safety cable attached to the aft of the port pontoon will provide a secondary failsafe. In the event that both the highline connection and lateral anchors are pulled, the secondary safety will assume the load, swinging the trap around to a downstream-facing position, clearing the debris blockage and again drawing the trap back to the river-left bank. Lateral movement of the trap within the channel will be made using two positioning cables attached to separate hand winches located below the highline anchor point.

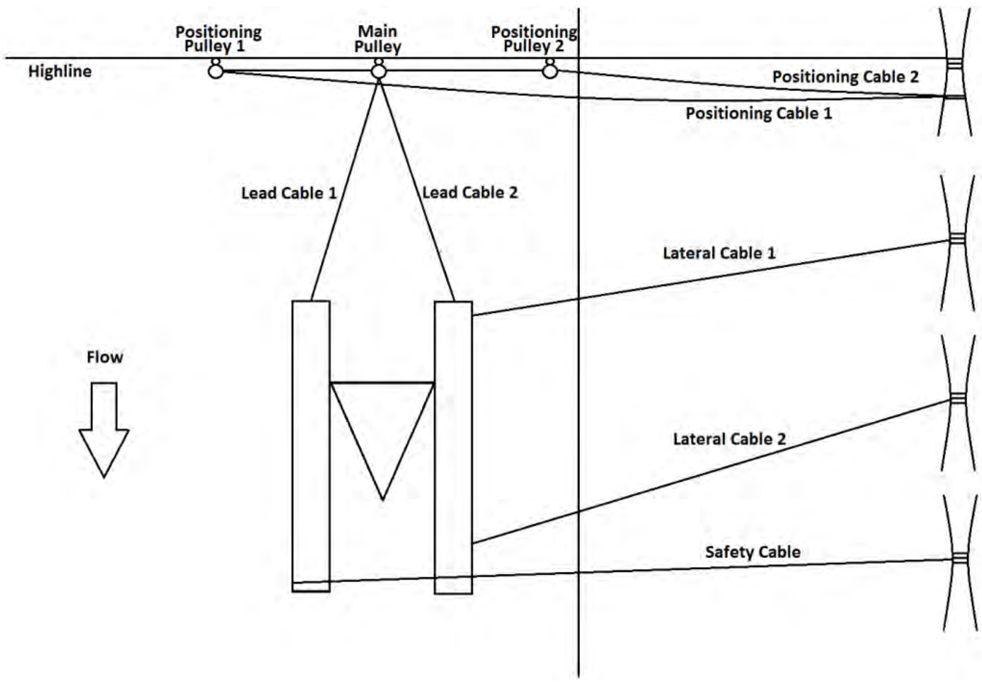

Figure 12. Rigging system to be used to secure Trap-B on the White River.

The current highline cable is made of 1/2” 6x37 IWRC galvanized wire rope (26,500 lb. breaking strength, 5,300 lb. working-load limit). The lateral, safety, and lead cables will all be 13/32” nylon-coated wire rope (9,800 lb. breaking-strength/1,960 lb. working-load limit). Both positioning cables will be made of 7/32” nylon-coated wire rope (2,000 lb. breaking-strength/400 lb. working-load limit). The break-away point will be a single locking shackle (maximum capacity 1,500 – 2,000 lbs.). All live trees used as anchor points will be protected by a layer of untreated 2”x4” wood “tree savers”, preventing direct contact between cables and the tree and distributing pressure across a greater surface area. With the exception of the highline cable, all rigging will be removed at the end of the season.

2.2 Target Operational Periods

The secondary trap will be most useful during periods in which active emigrant movement is elevated, yet coinciding with diminishing trap efficiency as a result of increasing discharge (Figure 4). Namely, this includes the initial-onset periods of spring (mid-March to mid-May) and fall freshets (mid-October to late-November). High-flow operations will be limited to avoid undue risk to the trap and fish captured. Trap-B will not be operated if any risk of damage is foreseen, including periods of rapid increase in discharge and/or sustained debris load. When trapping is suspended due to high flow, Trap-B will be pulled into the river-left eddy and secured to the bank with all tension off of the lead cables. We will attempt to run Trap-B at the lowest discharge possible.

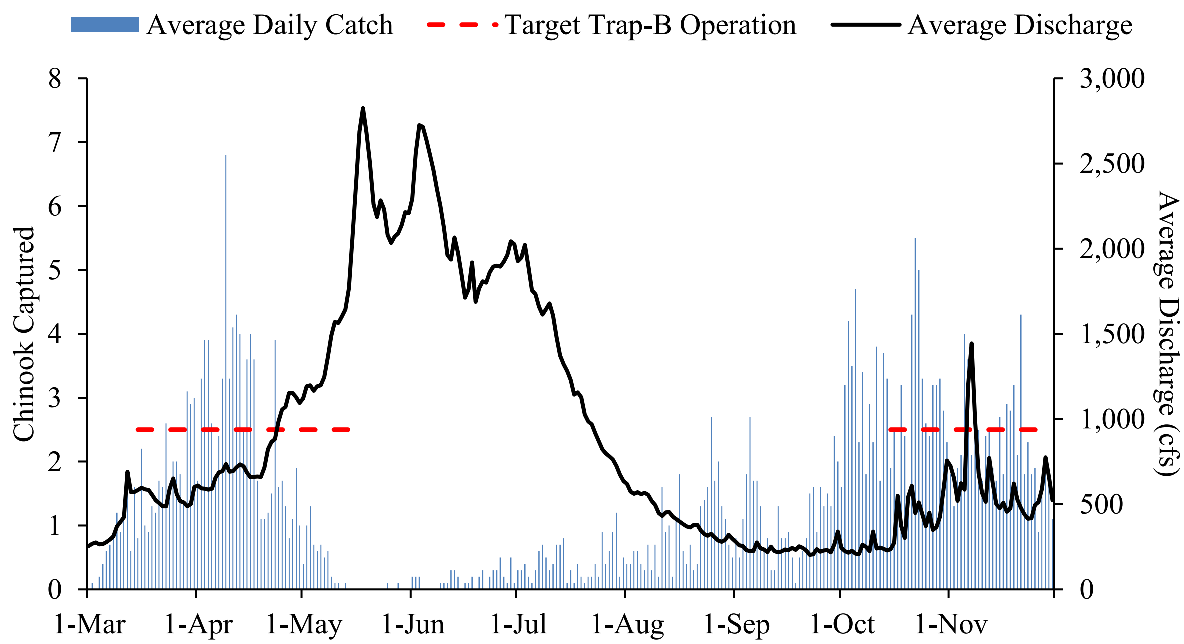

Figure 13. Average daily catch and discharge (2007-2016) with target periods of Trap-B operation.

2.3 Daily Operation and Sampling

YN personnel will sample Trap-B daily when it is running. All non ESA-listed species will be released immediately off of the trap. Non-target ESA-listed species will be quantified, scanned for PIT tags, and released off of the trap without further handling or anesthetization. Spring Chinook juveniles will be the only specimens retained for sampling in aerated five-gallon buckets. Spring Chinook will be sampled using the same protocol as Trap-A, though kept separate in a different P4 tagging file. All spring Chinook with fork lengths ≥ 60mm will be tagged. Tagged fish will be held in holding boxes along the river-left bank until the next mark group release, or release on-site if the minimum mark-group size is not achieved. Efficiency trials will continue to be performed at the Sears Creek Bridge located approximately 2 rkm upstream of the trap location. Trap-B will be operated during the three-day recapture period following each release to determine the combined efficiencies of both traps so that we can ensure we do not exceed the annual handling take for ESA listed spring Chinook (see section 3.3). All trapping, and tagging-caused mortalities of ESA-listed species will be quantified and applied to the take.

3.0 PERMITTING/TAKE LIMITS

3.1 WDFW Land Use Permit #140152A

The current WDFW-issued Land Use Permit (LUP; expiration date February 15, 2020), limits and manages the use of WDFW-owned land adjacent to the smolt trap including impacts on the river bank and trees used as anchor points. It does not regulate how the traps are operated or how many fish are handled. Because both traps will share the same existing access point, no additional impact to the bank and surrounding riparian vegetation will occur. No additional highline or other river-spanning cables/ropes will be needed. The aforementioned break-away system will minimize excessive stress on the highline and its existing tree anchors. Two or three additional tree anchors will be established along the river left bank to secure the lateral and safety cables. The additional anchor points established will not be load-bearing unless a break-away occurs; daily stress on the side anchor points will be minimal. In total, the addition of Trap-B will have a less of an impact than the previously-approved use of two alternating trapping sites, which included two highline cables.

3.2 WDFW Hydraulic Project Approval #2015-2-25+01

The current WDFW Hydraulic Project Approval (HPA; expiration date March 3, 2020) also regards the use of the area around the trap, and does not refer to take limits. Trap-B will not cause any additional disturbance of the bank, riparian vegetation, streambed, or large woody debris within the channel. With the exception of establishing two, to three non-load bearing anchors on the river left bank, impacts on the surrounding environment will remain unchanged after the introduction of Trap-B. All HPA requirements as related to the prohibition of petroleum-based chemicals, motorized tools and equipment, and other substances/practices that may be harmful to the environment will be strictly adhered to in the operation of Trap-B. The operation of a second trap as proposed will be less impactful to the riparian area than the operation of two traps in different positions.

3.3 NMFS Section 7 Biological Opinion #NMFS-WCR-2015-3778

The NMFS Section 7 Biological Opinion (BO) currently specifies the maximum annual total (non-lethal) and lethal take for wild and UCR hatchery-origin spring Chinook and UCR summer steelhead (*Oncorhynchus mykiss*) at the White River Trap. Section 2.8.1.3 of the BO sets an annual total take of "20% of spring-run Chinook salmon and steelhead out-Migrants." Lethal take is specified as: "2% of fish handled," for both species. Because the limitations set on the White River in the BO are based on take percentages and not effort, the operation of the second smolt trap will not violate its terms given continued adherence to the established limits. All take associated by Trap-B will be counted against the single permit, with no extra allowances provided by the change in trapping regime. Non-lethal take will continue to be assessed as a function of mean trap efficiency, with the combined efficiency of both traps representing the total percentage of the out-migrants sampled during tandem-operation.

Because the primary use of Trap-B is to supplement catch during periods in which efficiency of Trap-A is low (>5%), the chance that the 20% threshold is exceeded with the addition of the second trap above approximately 500 cfs is unlikely. Though combined trap efficiency at low flows may approach 20%, annual take will likely be much lower given the bulk of emigration is at higher flows. We have no reason to believe that Trap-B will increase the total lethal take beyond the permitted limit. If anything, lethal take incurred by Trap-B will be less than that of Trap-A considering that it will not be run during periods in which mortalities often occur: extreme low and extreme high flows.

3.4 USFWS Section 10 Permit # TE-022743-6

The White River currently operates under Grant County's USFWS Section 10 permit (expiration date October 27, 2021), which establishes the guidelines associated with the handling of bull trout (*Salvelinus confluentus*). The lethal take maximum as described in the terms and conditions is set as "five individuals, of all life stage, per calendar year." As with the NMFS BO, we do not perceive this as precluding the use of the secondary smolt trap as long as the maximum take is not exceeded in the total catch of both traps. Bull trout captured in Trap-B will be released off the trap with minimal handling and no exposure to anesthetic.

Annual bull trout catch on the white river is relatively low, especially in recent years (Table 2). In the past ten years of operation, we have not had a single bull trout mortality of any kind (trapping or handling). Though possible that Trap-B may capture bull trout, mortalities will be unlikely; especially given the policy of minimal handling.

Table 11. Bull trout catch at the White River smolt trap, 2007-2016.

Capture Year	FL < 50 mm	FL ≥ 50 mm
2007	1	6
2008	24	21
2009	19	27
2010	68	11
2011	46	8
2012	49	16
2013	19	9
2014	11	2
2015	1	8
2016	0	5
Average	**24**	**11**

4.0 BUDGET

We intend to operate Trap-B within the general confines of the current budget (Table 3). All major equipment and rigging are currently on-hand from previous operation at the upper cable. Because the two traps will be in the same vicinity, increase to the daily workload will only be associated with the actual removal, and work-up of fish collected (which would be the same if we were catching target numbers of fish in one trap). Travel times, daily set-up/break-down, data processing, report preparation, and mark-group release procedures will remain virtually the same. We expect that any future increases in the budget will be due to operating costs which are subject to inflation (i.e. wage rates, indirect, GSA vehicle rates, changes in costs of supplies). Such increases would still occur in the absence of Trap-B.

Appendix P

Genetic Diversity of Upper Columbia River Summer Chinook Salmon

Genetic Structure of upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs

by

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February 2011

Abstract

We investigated genetic relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin. Samples from the Eastbank Hatchery – Wenatchee stock, Eastbank Hatchery – MEOK stock, and Wells Hatchery were also included in the analysis. Samples of natural- and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation program has had any impacts to the genetic structure of these populations. We also calculated the effective number of breeders for collection locations of natural- and hatchery-origin summer Chinook from 1993 and 2008. In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings, but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been

spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

Introduction

The National Marine Fisheries Service (NMFS) recognizes 15 Evolutionary Significant Units (ESU) for Chinook salmon (*Oncorhynchus tshawytscha*) (Myers et al. 1998). The summer Chinook from the upper Columbia River are included in the Upper Columbia River Summer- and Fall-Run ESU, which encompasses all late-run (summer and fall), ocean-type Chinook salmon from the mainstem Columbia River and its tributaries (excluding the Snake River) between Chief Joseph and McNary Dams (Waknitz et al. 1995). Waknitz et al. (1995) concluded that due to high total abundance this ESU was not likely to become at risk from extinction. Yet, a majority of natural spawning activity was in the vicinity of Hanford Reach, and it was unclear whether natural production was self-sustaining given the vast summer Chinook artificial propagation efforts (Waknitz et al. 1995). Additionally, the Biological Review Team expressed concern about potential consequences to genetic and life-history traits from an increasing contribution of hatchery fish to total spawning escapement (Waknitz et al. 1995).

Artificial propagation of ocean-type Chinook from the middle/upper Columbia has been continuous since the implementation of the Grand Coulee Fish Maintenance Project (GCFMP) in 1939 (Myers et al. 1998). The US Fish and Wildlife Service established three hatchery programs for summer/fall Chinook during the GCFMP, Leavenworth NFH, Entiat NFH, and Winthrop NFH. The Washington Department of Fisheries (now Washington Department of Fish and Wildlife) followed with hatchery programs at Rocky Reach (1964), Wells Dam (1967), Priest Rapids (1974), and Eastbank (1990) facilities. Currently, only Leavenworth NFH and Winthrop NFH are not producing summer/fall Chinook. Entiat NFH has resumed production of summer/fall Chinook (Wells FH Stock) in 2009 and released their first yearling summer Chinook smolts in 2010. Since

1941, over 200 million ocean-type Chinook salmon have been released into the middle Columbia River Basin (Myers et al. 1998). Initially, the hatchery programs differentiated between early returning fish (i.e., stream-type) and later returning fish (i.e., ocean-type), but no distinction was made regarding the "summer" and "fall" components of the ocean-type stocks (Waknitz et al. 1995). Therefore, all Chinook salmon now migrating above Rock Island Dam descend from not only a mixture between different stocks from the basin, but also a mixture between the endemic summer and fall life histories. While hatchery protocols have been modified of late to maintain discreet summer and fall Chinook hatchery stocks (Utter et al. 1995; see also HGMP), physical evidence and genetic data suggests that summer and fall Chinook may have become homogenized. During the 1970's and 80's, given coded-wire tag recoveries, summer-run Chinook originating from above Rock Island Dam were believed to have spawned extensively with Hanford Reach and Priest Rapids Hatchery fish (Chapman 1994). Stuehrenberg et al. (1995) reported that 10% of their radio tagged summer Chinook were occupying typical fall-run spawning habitat on the mainstem Columbia river, and 25% of fall fish released from Priest Rapids were recovered as summers at (or above) Wells Hatchery. Genetic data reported by Marshall et al. (1995) and Waknitz et al. (1995) corroborate these observations, as genetic distances observed between summer and fall Chinook within the Upper Columbia River Summer- and Fall-Run ESU were essentially zero.

In response to the need for evaluation of the supplementation hatchery programs, both a monitoring and evaluation plan (DCPUD 2005; Murdoch and Peven 2005) and the associated analytical framework (Hays et al. 2006) were developed for the Habitat Conservation Plan's Hatchery Committee through the joint effort of the fishery co-managers (CCT, NMFS, USFWS, WDFW, and YN) and Chelan County and Douglas County PUDs. These reports outline 10 objectives to be applied to various species assessing the impacts of hatchery operations mitigating the operation of Wells, Rocky Reach, and Rock Island hydroelectric projects. The present monitoring and evaluation study plan differs in scope from previous monitoring and evaluation projects proposed by WDFW Molecular Genetics Lab, in that it does not investigate a single watershed, but instead will encompass all summer Chinook stocks from the upper Columbia River including the three supplementation (Wenatchee, Methow, and Okanogan) and the harvest augmentation program (Wells summer Chinook). The objectives of this study were to determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery programs.

Materials and Methods

Collections

A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin and were analyzed (Table 1). Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River Basin and were compared to collections of hatchery and natural-origin from 2006 and 2008 that were post-supplementation. Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to post-supplementation collections from 2006 and 2008. Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with post-supplementation collections from 2006 and 2008. A collection of natural-origin summer Chinook from the Chelan River was also analyzed. Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and MEOK stock) and Wells Hatchery were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River was also used for comparison. Lastly, data from eight collections of fall Chinook was compared to the collections of summer Chinook.

Laboratory Analyses

All laboratory analyses were conducted at the WDFW Genetics Laboratory in Olympia, Washington. Genomic DNA was extracted by digesting a small piece of fin tissue using the nucleospin tissue kits obtained from Macherey-Nagel following the recommended conditions in the user manual. Extracted DNA was eluted with a final volume of 100 µL.

Genotype information was generated using thirteen microsatellite markers following standard laboratory protocols and analysis methods. Descriptions of the loci assessed in this study and polymerase chain reaction (PCR) conditions are given in Table 2. PCR reactions were run with a thermal profile consisting of: denaturation at 95°C for 3 min, denaturation at 95°C for 15 sec, anneal for 30 sec at the appropriate temperature for each locus (Table 2), extension at 72°C for 1 min, repeat cycle (steps 2-4), final extension at 72°C for 30 minutes. PCR products were then processed with an ABI-3730 DNA Analyzer. Genotypes were visualized with a known size standard (GS500LIZ 3730) using GENEMAPPER 3.7 software. Alleles were binned in GENEMAPPER using the standardized allele sizes established for the Chinook GAPS dataset (Seeb et al. 2007).

Within-collection Statistical Analyses

Allele frequencies were calculated with CONVERT (version 1.3, Glaubitz 2003). Hardy-Weinberg proportions for all loci within each collection were calculated using GENEPOP (version 3.4, Raymond and Rousset 1995). Heterozygosity (observed and expected) was computed for each collection group using GDA (Lewis and Zaykin 2001).

Allelic richness and F_{IS} (Weir and Cockerham 1984) inbreeding coefficient were calculated using FSTAT (version 2.9.3.2, Goudet 2001). Linkage disequilibrium for each pair of loci in each collection was calculated using GENEPOP v 3.4 (10,000 dememorizations, 100 batches, and 5,000 iterations per batch). Pairwise estimates of genetic differentiation between collection groups were calculated using GENEPOP (version 3.4, Raymond and Rousset 1995). Statistical significance for the tests of Hardy-Weinberg proportions, linkage disequilibrium, and genotypic differentiation was evaluated using a Bonferroni correction of p-values to account for multiple, simultaneous tests (Rice 1989).

Between-collection Statistical Analyses

Pairwise F_{ST} estimates were computed to examine population structure among collections using GENETIX (version 4.03, Belkhir et al. 2001). This estimate uses allelic frequency data and departures from expected heterozygosity to assess differences between pairs of populations.

We used PHYLIP (version 3.5c, Felsenstein 1993) to calculate Cavalli-Sforza and Edwards (1967) pairwise chord distances between collections. Bootstrap calculations were performed using SEQBOOT followed by calculations of genetic distance using GENDIST. The NEIGHBOR-JOINING method of Saitou and Nei (1987) was used to generate the dendrograms and CONSENSE to generate a final consensus tree from the 1,000 replicates. The dendrogram generated in PHYLIP was plotted as an unrooted radial tree using TREEVIEW (version 1.6.6, Page 1996).

Effective Number of Breeders

The effective number of breeders (N_b) was estimated for pre- and post-supplementation program collections (where possible) to investigate whether hatchery programs had affected that genetic metric over the operational period. Wang (2009) derived an equation for effective size (N_e) as a function of the frequency of nested full-sib and half-sib families in a random collection of individuals.

$$\frac{1}{N_e} = \frac{1+3\alpha}{4}\left(Q_1 + Q_2 + 2Q_3\right) - \frac{\alpha}{2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right) \qquad \text{(equation 10)}$$

Where α is a measure of the deviation of genotype frequencies from Hardy-Weinberg expectation (equivalent to Wright's (1969) F_{IS}), Q_i are the probabilities that a pair of offspring are paternal half sibs, maternal half sibs, or full sibs, respectively, and N_1 and N_2 are the number of male and female parents that generation, respectively. Genetic parameters (i.e., sibship distributions) were estimated for summer Chinook collections using algorithms implemented in COLONY (Jones and Wang 2009). To be clear, Wang's (2009) method as implemented here will estimate N_b, given multi-locus genotypes from each collection were partitioned by brood year for this analysis. To obtain an estimate of N_e each N_b value must be multiplied by the mean generation time of that population.

Results

Collections

A total of 2,350 individuals from 32 collections of temporally replicated samples (six locations) were analyzed (Table 1). Temporally replicated collections of hatchery and natural-origin samples were from the Wenatchee, Methow, and Okanogan Rivers. Temporally replicated hatchery-origin summer Chinook were from Wells Hatchery, Eastbank Hatchery - Wenatchee stock, and Eastbank Hatchery - Methow/Okanogan (MEOK) stock. A total of 232 of those individuals were excluded from any analyses because they failed to amplify at nine or more loci. Data for remaining 2,118 individuals were analyzed to assess differences between temporally replicated natural- and hatchery-origin summer Chinook for each location and to compare the differences among the different collection locations. Summer Chinook data from the temporally replicated collection locations were then combined and compared to fall Chinook data from the GAPS v.3.0 dataset.

Statistical Analyses

The population statistics (Hardy-Weinberg equilibrium and F_{IS}) calculated for each of the 32 temporally replicated collection locations were consistent with neutral expectations (i.e., no associations among alleles). Three collections did have a single locus that did not meet expectations (Wenatchee hatchery-origin 2006, Wells hatchery 2006, and Okanogan hatchery-origin 2009). Based on these results we suggest the collections represented randomly breeding groups and were not comprised of mixtures of individuals from different genetic source populations.

Population differentiation was assessed for each of the temporally replicated collections from within each location (Table 3). This analysis revealed the only significant difference observed within a collection location pertained to the collection from 1993 Okanogan River natural-origin samples. Because of the significant difference of this collection to the other temporal replicates it was not included in further analyses.

Given the absence of genetic differentiation observed among the temporally replicated collections, the 32 collections from the Wenatchee, Methow, and Okanogan River were combined to form three location-specific collections for analysis. Population differentiation metrics were compared among the composite Wenatchee, Methow, and Okanogan collections and eight other location-specific collections (11 locations total). Comparing all collections, there were a total of 39 significant genic test comparisons out of a total 496 (Table 4). Thirty-eight of the 39 statistically significant pairwise differences pertained to the Okanogan River and 2006 Wells Hatchery collections (Table 4). F_{ST} results are described further below.

Within-collection genetic metrics were estimated for the 11 location-specific collections of summer Chinook from the upper Columbia River, in addition to eight collections of fall Chinook (Table 1). The population statistics (Hardy-Weinberg equilibrium and F_{IS}) calculated for these collections of summer and fall

Chinook were also consistent with neutral expectations. The collection from Lyons Ferry Hatchery had one locus that did not meet expectations and the collections from Crab Creek and Marion Drain both had three loci that did not meet expectations.

The hatchery collections in general had a higher percentage of significantly linked loci; however the observed genetic diversity were similar for the natural and hatchery-origin collections. Analysis of allelic richness was based on 11 individuals per collection, the minimum number of individuals across all collections with complete multilocus genotypes. The largest number of linked loci occurred in the Crab Creek, Entiat River, and Okanogan natural-origin collections. Allelic richness was on average lower in the collections of summer Chinook (10.7) collections in comparison to the collections of fall Chinook (11.0).

Pairwise F_{ST} (Table 4) estimates revealed low levels of differentiation, where all observed F_{ST} values between the collections of summer Chinook were lower than 0.0096. There were 15 out of 28 comparisons between collections of summer Chinook that were significantly different from zero and occurred primarily from comparisons of the Okanogan River (hatchery and natural-origin) and Wells Hatchery to all other collections. The collection of Eastbank Hatchery – MEOK stock was differentiated from the Wenatchee River natural-origin and Entiat River collections. The collection from the Chelan River had a small sample size of 23 individuals and only differentiated from the Eastbank Hatchery – MEOK stock. F_{ST} estimates regarding pairwise comparisons between each of four fall Chinook collection locations (Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River) to all other collections were significantly different from zero (Table 5). Pairwise comparisons for three other fall Chinook collections (Hanford Reach, lower Yakima River, and Umatilla River) to the collections of summer Chinook were significantly different from zero (Table 6). The only fall Chinook collection that was not significantly differentiated from all of the summer Chinook was Priest Rapids.

The relative genetic relationships among the test groups were assessed using the consensus clustering analysis (Figure 1). Statistical support for the dendrogram topology (i.e., tree shape) was low regarding the branching that separated the collections of summer Chinook from the upper Columbia River. The collections of fall Chinook; however were supported with bootstrap support over 76% with the exception of three collections (lower Yakima River, Crab Creek, and Umatilla River). In other words, 760 of the 1000 bootstrap replicates supported the placement of the node separating summer and fall collections. The collection from the Chelan River had bootstrap support of 68%; however the sample size for that collections was small (N = 23). Even though the bootstrap support was low among the collections of summer Chinook there was concordance between geography and genetic distance.

Where comparisons were possible between pre- and post-supplementation program collections, the effective number of breeders (N_b) estimated to have comprised those collections were slightly lower for contemporary (2008) collections; however in all cases the 95% confidence intervals overlapped between historical and contemporary collections, suggesting statistical equivalency. Regarding Wenatchee River collections, the point estimates of N_b ranged from 134 (08FU) to 190 (93DD), where all collections had overlapping confidence intervals (Table 7). The upper bound of the 1989 brood year for collection 93DD was very large, suggesting the sample size was insufficient for properly inferring the sibship distribution within the collection. Comparing the Okanogan natural collections 93ED and 08GA, the estimated N_b were 142 (CI 102 – 203) and 127 (CI 92 – 180), respectively. For the Eastbank Hatchery MEOK stock comparisons, the N_b estimated for the 93DF collection was 171 (CI 129 – 229), as compared to the 166 (CI 126 – 226) estimated for collection 08MO. In all cases, the estimated N_b can be converted to effective population size (N_e) by multiplying the estimate by the mean generation time.

Discussion

The collections of summer Chinook populations from the upper Columbia River are of interest because census sizes are reduced below historic levels and are the subject of mitigation and supplementation hatchery programs. Concern over the impacts of hatchery supplementation programs on the genetic integrity of natural-origin populations led to our primary objective, which was to evaluate genetic metrics for temporally replicated collections of summer Chinook in the upper Columbia River pre and post hatchery supplementation. A similar analysis by Kassler and Dean (2010) was conducted on spring Chinook in the Tucannon River to evaluate the effects of a supplementation and captive brood program on natural-origin stocks. Additionally, upper Columbia River spring Chinook supplementation programs (Blankenship et al. 2007; Small et al. 2007), spring and fall Chinook populations in the Yakima Basin (Kassler et al. 2008), and a potentially unique population of fall Chinook in Crab Creek (Small et al. 2010) have been evaluated. In the present analysis of summer Chinook populations, collections of pre- and post- supplementation summer Chinook were collected from the Wenatchee River, Methow River, and Okanogan River Basins and analyzed to determine if the genetic profile has changed as a result of the supplementation program. Analysis was then conducted on the collections of summer run to compare the fall run Chinook collections in the upper Columbia River basin.

Allozyme analyses of these three summer run Chinook stocks in the upper Columbia River have identified that each stock was distinct, with a closer relationship detected between the Wenatchee and Methow Rivers (WDF and WDW 1993, Marshall 2002). Wenatchee summer Chinook are thought to be a mixture of native summer Chinook and Chinook from the Grand Coulee Fish Maintenance Project (GCFMP). The goal of the GCFMP project between 1939 and 1943 was to trap migrating Chinook salmon at Rock Island dam (75 miles below Grand Coulee) and homogenize the populations, which reduced the genetic uniqueness of the distinct tributary populations present in the upper Columbia River.

We found allele frequencies for individual temporally replicated hatchery- and natural-origin collection locations of adult summer Chinook were not significantly different from that expected of a single underlying population, except for one collection (1993 Okanogan natural-origin; Table 3). This collection was differentiated to the Okanogan collections in 2006 and 2008; however it was not differentiated from the collection in 1992. The Okanogan collection from 1992 was also not differentiated to any other collection; therefore the difference in the collection from Okanogan 1993 was likely not an indication of genetic change from pre supplementation to post supplementation. The collection was however dropped from further analyses so as to not confuse interpretation of results. The lack of allelic differentiation observed among the temporally replicated collections was interpreted as the genetic metrics from each location in the early 1990's did not differ from the samples collected in 2008. Spanning a few generations, allele frequencies are not expected to change for large populations at genetic equilibrium. In contrast, changes in allele frequencies of small populations may occur due to the stochastic sampling of genes from one generation to the next (i.e., genetic drift).

A second round of analyses was conducted to evaluate the genetic relationships of the summer run collections (temporal collections were combined) with data from the Entiat River, Chelan River, and eight collections of fall Chinook. Assessment of the relationship between the summer run collections in comparison to each other provided very little evidence of genetic differentiation between these collections. While population differentiation did show some significant differences between the Okanogan River and Wells Hatchery collections, all of the pairwise F_{ST} values were below 0.003. Meaning that a very small proportion of the observed genetic variation could be attributed to restrictions in gene flow (i.e., population structure)

The comparison of the hatchery-origin collections revealed a lack of differentiation between the Eastbank Hatchery – Wenatchee stock, Eastbank Hatchery – MEOK stock, and the Wells Hatchery (with exception of the 2006 collection). The genetic similarity or low level of genetic differentiation among these stocks suggests that there has been an integration of natural- and hatchery-origin summer Chinook in the upper Columbia River or a lack of ancestral genetic difference. The difference of the 2006 Wells Hatchery collection to the other collections is most likely a result of sampling effect because of the lack of differentiation among the stocks in the basin. If the 2006 collection had been mixed from different sources of summer Chinook there would not be a detectable level of differentiation as was seen with the 2006 sample.

The analyses to compare summer and fall Chinook collections provided some understanding on the genetic relationships of Chinook with different run timings in the upper Columbia River basin. Historically, the hatchery programs in the upper Columbia River were separated into groups of the early returning fish (i.e., stream-type) and later returning fish (i.e., ocean-type), but the programs did not sort individuals identified as "summer" or "fall" stocks (Waknitz et al. 1995). Now all Chinook salmon that are migrating above Rock Island Dam descend from a mixture of different stocks from the upper Columbia River basin, but also a mixture between the endemic summer and fall life histories.

Small et al. (2010) conducted an analysis on summer run and fall run Chinook in the upper Columbia River and concluded that Crab Creek Chinook in the upper Columbia River were genetically distinct to all other fall and summer run Chinook stocks that were analyzed. They did note a departure from Hardy Weinberg expectation as a result of a null allele at the microsatellite locus *Ogo-4* and a higher linkage disequilibrium value due to the inclusion of family groups in one of their samples. Kassler et al. (2008) found differentiation among spring and fall Chinook populations in the Yakima River.

The tests of pairwise F_{ST} indicated a very low level of genetic differentiation (less than one percent difference) between collections of summer-run Chinook and fall-run Chinook. The range of pairwise F_{ST} values for comparisons between the summer run and fall run collections was 0.0016 – 0.0248. The larger values from the range were associated to the collections from Crab Creek, Lyons Ferry Hatchery, and Marion Drain. Studies by Kassler et al. (2008) and Small et al. (2010) have documented differences among the populations of these collections to others within the upper Columbia River basin. The low pairwise F_{ST} values between Priest Rapids and Hanford Reach collections and the summer run collections were not surprising because summer-run Chinook originating from above Rock Island Dam were believed to have spawned extensively with Hanford Reach and Priest Rapids Hatchery fish during the 1970's and 80's (Chapman 1994). The lack of differentiation among the summer and fall stocks in the Columbia River was also identified by Utter et al. (1995) and the HGMP where they state physical evidence and genetic data suggests that summer and fall Chinook may have become homogenized.

Despite low levels of statistical bootstrap support for dendrogram topology (i.e., tree shape), there was concordance observed between geographic location and the genetic relationships among the summer and fall Chinook populations. The collections from the Okanogan (hatchery and natural-origin) did separate out with collections from Wells Dam Hatchery, Entiat River, and Eastbank Hatchery – MEOK stock, and were next to a group of the Methow and Wenatchee collections. The fall Chinook populations are also separated to the summer collections and the position of all but three of these collections (lower Yakima River, Crab Creek, and Umatilla River) were statistically supported. The geographic proximity of the fall collections seemed to follow the observed pattern in this dendrogram. The relationship of the Snake River and Lyons Ferry Hatchery in proximity to the collection from Marion Drain was not surprising while the relationship between Priest Rapids and Hanford Reach was easily a result of the stocking practices of fall Chinook in the 1970 and 1980’s.

A secondary objective of this study was to determine if the effective population size of upper Columbia River summer Chinook populations had changed over time due to supplementation efforts. We observed that the number of effective breeders in the collections from 1993 and 2008 has not changed thus providing reason to believe that the genetic diversity of summer Chinook in the upper Columbia River has not been altered through the supplementation program.

Acknowledgements

Chelan County PUD, Grant County PUD, and Washington State General Funds provided funding for this project. Cherril Bowman (WDFW – Molecular Genetics Laboratory) processed samples in the laboratory. Maureen (Mo) Small provided data for some collections and discussion of the analyses. USFWS provided data from the Entiat River.

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Table 1. Samples of adult hatchery- and natural-origin summer and fall Chinook that were analyzed from the upper Columbia River. Total number of individuals that were analyzed / individuals with data for 9 or more loci that were included in the analysis. Collection statistics (allelic richness, linkage disequilibrium (before and after Bonferroni correction), F_{IS}, heterozygosity (H_O and H_E)) and p-values for deviations from Hardy-Weinberg equilibrium (HWE). P-values were defined as significant after implementation of Bonferroni correction for multiple tests (Rice 1989).

WDFW GSI code[a]	Collection location	N =	Allelic Richness[b]	Linkage Disequilibrium[c]	F_{IS} (p-value)[d]	H_O	H_E
93DD	Wenatchee River upstream of Tumwater Dam - natural origin	51 / 45					
93DE	Wenatchee River downstream of Tumwater Dam - natural origin	88 / 88					
06CQ	Wenatchee River upstream of Tumwater Dam - natural origin	95 / 86					
06CR	Wenatchee River downstream of Tumwater Dam - natural origin	95 / 82					
08FV	Wenatchee River upstream of Tumwater Dam - natural origin	95 / 82					
08FW	Wenatchee River downstream of Tumwater Dam - natural origin	95 / 87					
	Wenatchee River - Natural origin combined	**519 / 470**	**10.7**	**17 / 4**	**0.001 (0.403)**	**0.8504**	**0.8513**
06CP	Wenatchee River - hatchery origin	95 / 70					
08FU	Wenatchee River - hatchery origin	95 / 83					
	Wenatchee River - Hatchery origin combined	**190 / 153**	**10.6**	**18 / 6**	**0.018 (0.013)**	**0.8409**	**0.8561**
93EC	Methow River - natural origin	27 / 27					
06CT	Methow River - natural origin	95 / 90					
08FY	Methow River - natural origin	95 / 88					
09CO	Methow River - natural origin	91 / 80					
	Methow River - Natural origin combined	**308 / 285**	**10.7**	**4 / 1**	**0.006 (0.160)**	**0.8506**	**0.8554**
06CS	Methow River - hatchery origin	14 / 8					
08FX	Methow River - hatchery origin	21 / 18					
09CP	Methow River - hatchery origin	19 / 18					
	Methow River - Hatchery origin combined	**54 / 44**	**10.8**	**11 / 2**	**-0.003 (0.593)**	**0.8553**	**0.8523**

Table 1 continued.							
92FM	Okanogan River - natural origin	49 / 46					
93ED*	Okanogan River - natural origin	103 / 87					
06CV	Okanogan River - natural origin	95 / 88					
08GA	Okanogan River - natural origin	95 / 92					
09CN	Okanogan River - natural origin	133 / 126					
	Okanogan River - Natural origin combined	**475 / 439**	**10.8**	**9 / 4**	**0.003 (0.304)**	**0.8563**	**0.8596**
* - not included in the combined dataset							
06CU	Okanogan River - hatchery origin	58 / 49					
08FZ	Okanogan River - hatchery origin	19 / 18					
09CM	Okanogan River - hatchery origin	117 / 107					
	Okanogan River - hatchery origin combined	**194 / 174**	**10.8**	**31 / 10**	**-0.011 (0.920)**	**0.8678**	**0.8586**
91FL	Wells Hatchery	68 / 42					
92FK	Wells Hatchery	25 / 23					
93DG	Wells Hatchery	11 / 9					
06DM	Wells Hatchery	95 / 91					
08HY	Wells Hatchery	95 / 91					
	Wells Hatchery combined	**294 / 256**	**10.7**	**8 / 3**	**-0.001 (0.529)**	**0.8670**	**0.8665**
08MN	**Eastbank Hatchery - Wenatchee River stock**	**95 / 90**	**10.7**	**6 / 1**	**0.020 (0.024)**	**0.8326**	**0.8498**
92FO	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	36 / 33					
93DF	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	90 / 86					
08MO	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	95 / 88					
	Eastbank Hatchery - MEOK stock combined	**221 / 207**	**10.7**	**2 / 0**	**-0.005 (0.782)**	**0.8647**	**0.8604**
		2,350 / 2,118					

Table 1 continued.							
06KN	**Chelan River**	**70 / 23**	**10.3**	**11 / 0**	**0.027 (0.118)**	**0.8334**	**0.8556**
Data provided by USFWS							
	Entiat River - summer Chinook	**190**	**10.9**	**33 / 10**	**0.008 (0.119)**	**0.8553**	**0.8625**
Data from Small et al. (2010)							
08EH	Crab Creek	108					
09AZ	Crab Creek	291					
	Crab Creek	**399**	**10.5**	**35 / 14**	**0.018 (0.000)**	**0.8519**	**0.8676**
GAPS v.3.0 data							
	Priest Rapids Hatchery - fall Chinook	**81**	**11.1**	**3 / 2**	**0.015 (0.079)**	**0.8591**	**0.8723**
	Hanford Reach - fall Chinook	**220**	**11.3**	**4 / 0**	**0.010 (0.068)**	**0.8661**	**0.8746**
	Umatilla - fall Chinook	**96**	**11.2**	**17 / 6**	**-0.003 (0.623)**	**0.8719**	**0.8693**
	lower Yakima River - fall Chinook	**103**	**11.0**	**3 / 1**	**0.000 (0.511)**	**0.8724**	**0.8721**
	Marion Drain - fall Chinook	**190**	**10.8**	**9 / 4**	**0.022 (0.001)**	**0.8586**	**0.8782**
	Lyons Ferry Hatchery - fall Chinook	**186**	**10.6**	**7 / 4**	**0.013 (0.033)**	**0.8527**	**0.8641**
	Snake River - fall Chinook	**521**	**11.1**	**0 / 0**	**-0.001 (0.634)**	**0.8720**	**0.8708**
		NA / 2,009					

[a] - Year that samples were collected is identifed by the two numbers in the WDFW GSI code

[b] - based on a minimum of 11 diploid individuals

[c] - adjusted alpha p-value = 0.0006

[d] - adjusted alpha p-value = 0.0002

Table 2. PCR conditions and microsatellite locus information (number alleles/locus and allele size range) for multiplexed loci used for the analysis of Chinook. Also included are the observed and expected heterozygosity (H_o and H_e) for each locus.

PCR Conditions			Locus statistics		Heterozygosity		
Poolplex	Locus	Dye Label	# Alleles/ Locus	Allele Size Range (bp)	H_o	H_e	References
Ots-M	*Ots-201b*	blue	49	137 - 334	0.9474	0.9544	Unpublished
	Ots-208b	yellow	56	154 - 378	0.9523	0.9672	Greig et al. 2003
	Ssa-408	red	32	184 - 308	0.9177	0.9214	Cairney et al. 2000
Ots-N	*Ogo-2*	red	22	206 - 260	0.8526	0.8673	Olsen et al. 1998
Ots-O	*Ogo-4*	blue	20	128 - 170	0.6694	0.7028	Olsen et al. 1998
	Ots-213	yellow	45	178 - 370	0.9430	0.9525	Greig et al. 2003
	Ots-G474	red	16	152 - 212	0.6816	0.6838	Williamson et al. 2002
Ots-R	*Ots-3M*	blue	15	128 - 158	0.7854	0.7938	Banks et al. 1999
	Omm-1080	green	54	162 - 374	0.9517	0.9670	Rexroad et al. 2001
Ots-S	*Ots-9*	red	9	99 - 115	0.6531	0.6543	Banks et al. 1999
	Ots-212	blue	33	123 - 251	0.9205	0.9360	Greig et al. 2003
Ots-T	*Oki-100*	blue	50	164 - 361	0.9500	0.9567	Unpublished
	Ots-211	red	34	188 - 327	0.9325	0.9414	Greig et al. 2003

Table 3. Tests of population differentiation for temporal collections of summer Chinook from natural and hatchery-origin populations in the upper Columbia River. P-values that are highlighted grey are significantly different after Bonferroni correction (Rice 1989). Adjusted alpha p-value was 0.0001 . The H and W in the collection identifier is for wild or hatchery-origin and the two digit number identifes the year samples were collected.

Wenatchee River

	WenW93U	WenW93D	WenH06	WenW06U	WenW06D	WenH08	WenW08U	WenW08D
WenW93U	****							
WenW93D	0.0162	****						
WenH06	0.0033	0.0102	****					
WenW06U	0.3039	0.1642	0.4795	****				
WenW06D	0.0261	0.0160	0.0678	0.5300	****			
WenH08	0.1126	0.0708	0.0073	0.4359	0.0893	****		
WenW08U	0.2115	0.1148	0.4191	0.7243	0.3830	0.8856	****	
WenW08D	0.1915	0.0014	0.7047	0.4928	0.1671	0.7755	0.7665	****

D - collection was downstream of Tumwater Dam; U - collection was upstream of Tumwater Dam

Methow River

	MetW93	MetH06	MetW06	MetH08	MetW08	MetW09	MetH09
MetW93	****						
MetH06	0.3962	****					
MetW06	0.5481	0.4688	****				
MetH08	0.1408	0.1192	0.2052	****			
MetW08	0.8219	0.8937	0.6156	0.3779	****		
MetW09	0.2564	0.4282	0.2502	0.0328	0.7309	****	
MetH09	0.1543	0.5678	0.0547	0.0017	0.0098	0.0073	****

Okanogan River

	OkanW92	OkanW93	OkanH06	OkanW06	OkanH08	OkanW08	OkanH09	OkanW09
OkanW92	****							
OkanW93	0.0066	****						
OkanH06	0.0193	0.0000	****					
OkanW06	0.2843	0.0082	0.0031	****				
OkanH08	0.1290	0.1106	0.0652	0.7329	****			
OkanW08	0.0106	0.0029	0.0082	0.4075	0.7396	****		
OkanH09	0.0187	0.0001	0.0094	0.0551	0.2214	0.0281	****	
OkanW09	0.0527	0.0000	0.0024	0.7130	0.0262	0.0065	0.0002	****

Table 3 continued.

Wells Dam Hatchery

	Wells91	Wells92	Wells93	Wells06	Wells08
Wells91	****				
Wells92	0.5863	****			
Wells93	0.0490	0.0784	****		
Wells06	0.0089	0.0100	0.0542	****	
Wells08	0.0819	0.1088	0.2552	0.0256	****

Eastbank Hatchery - Wenatchee and MEOK stocks

	EBHWen08	EBHME92	EBHME93	EBHME08
EBHWen08	****			
EBHME92	0.8681	****		
EBHME93	0.0251	0.8661	****	
EBHME08	0.0086	0.9563	0.1895	****

Table 4. F_{ST} pairwise comparisons and genotypic tests of differentiation for hatchery- and natural-origin summer Chinook from the upper Columbia River. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

	Wenatchee Hatchery	Wenatchee Natural	Methow Hatchery	Methow Natural	Okanogan Hatchery	Okanogan Natural	Wells Hatchery	Eastbank Wenatchee stock	Eastbank MEOK stock	Entiat River	Chelan River
Wenatchee Hatchery	****	**0.0000**	**0.0011**	**0.0000**	**0.0013**	**0.0010**	0.0015	**0.0004**	**0.0007**	**0.0004**	**0.0072**
Wenatchee Natural	**0.4351**	****	**0.0016**	**0.0000**	0.0014	0.0016	0.0024	**0.0006**	0.0012	0.0009	**0.0068**
Methow Hatchery	**0.3800**	**0.0205**	****	**0.0012**	0.0029	**0.0008**	**0.0027**	**0.0014**	**0.0022**	**0.0019**	**0.0078**
Methow Natural	**0.2237**	**0.6566**	**0.1502**	****	**0.0011**	0.0011	0.0013	**0.0007**	**0.0007**	**0.0008**	**0.0053**
Okanogan Hatchery	0.0001	0.0000	**0.0364**	**0.0008**	****	**0.0010**	**0.0014**	0.0029	**0.0000**	**0.0007**	**0.0055**
Okanogan Natural	0.0000	0.0000	**0.1755**	0.0000	**0.0003**	****	0.0016	0.0023	**0.0005**	**0.0008**	**0.0049**
Wells Hatchery	0.0000	0.0000	**0.0129**	0.0000	0.0000	0.0000	****	0.0036	**0.0006**	**0.0008**	**0.0041**
Eastbank Wenatchee	**0.5261**	**0.4102**	**0.1215**	**0.8404**	**0.0015**	0.0000	0.0000	****	**0.0018**	0.0030	0.0096
Eastbank MEOK stock	**0.0485**	0.0000	**0.4246**	**0.0009**	**0.5786**	**0.0051**	0.0000	**0.0065**	****	**0.0005**	**0.0039**
Entiat River	**0.0565**	0.0000	**0.1795**	**0.0044**	**0.0005**	0.0000	**0.0032**	**0.0039**	**0.0042**	****	**0.0052**
Chelan River	**0.0091**	**0.0026**	**0.0182**	**0.0156**	**0.0048**	**0.0030**	**0.0066**	**0.0059**	**0.0493**	**0.0617**	****

Table 5. F_{ST} pairwise comparisons and genotypic tests of differentiation for fall Chinook. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

	Crab Creek	Hanford Reach Fall	Lyons Ferry Hatchery Fall	lower Yakima River Fall	Marion Drain Fall	Priest Rapids Fall	Umatilla River Fall	Snake River Fall
Crab Creek	****	0.0087	0.0134	0.0079	0.0143	0.0107	0.0073	0.0097
Hanford Reach Fall	0.0000	****	0.0077	**0.0000**	0.0064	**0.0000**	**0.0000**	0.0022
Lyons Ferry Hatchery Fall	0.0000	0.0000	****	0.0063	0.0074	0.0092	0.0062	0.0029
lower Yakima River Fall	0.0000	**0.4140**	0.0000	****	0.0054	**0.0000**	**0.0000**	0.0018
Marion Drain Fall	0.0000	0.0000	0.0000	0.0000	****	0.0067	0.0061	0.0060
Priest Rapids Fall	0.0000	**0.0695**	0.0000	**0.0083**	0.0000	****	**0.0000**	0.0027
Umatilla River Fall	0.0000	**0.4879**	0.0000	**0.4896**	0.0000	**0.2539**	****	0.0011
Snake River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	****

Table 6. F_{ST} pairwise comparisons and genotypic tests of differentiation for hatchery- and natural-origin summer Chinook from the upper Columbia River and fall Chinook. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

Population Differentiation

	Wenatchee Hatchery	Wenatchee Natural	Methow Hatchery	Methow Natural	Okanogan Hatchery	Okanogan Natural	Wells Hatchery	Eastbank Wenatchee stock	Eastbank MEOK stock	Entiat River	Chelan River
Crab Creek	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hanford Reach Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0349**
Lyons Ferry Hatchery Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
lower Yakima River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0074**
Marion Drain Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Priest Rapids Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0642**
Umatilla River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0579**
Snake River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 6 continued.

Pairwise F_{ST}

	Crab Creek	Hanford Reach Fall	Ferry Hatchery	Yakima River	Marion Drain Fall	Priest Rapids Fall	Umatilla River Fall	Snake River Fall
Wenatchee Hatchery	0.0158	0.0054	0.0180	0.0056	0.0153	**0.0025**	0.0053	0.0103
Wenatchee Natural	0.0162	0.0059	0.0185	0.0063	0.0157	0.0030	0.0059	0.0102
Methow Hatchery	0.0191	0.0104	0.0248	0.0095	0.0220	0.0069	0.0107	0.0165
Methow Natural	0.0148	0.0057	0.0182	0.0051	0.0148	0.0033	0.0055	0.0101
Okanogan Hatchery	0.0146	0.0041	0.0166	0.0042	0.0151	**0.0016**	0.0041	0.0082
Okanogan Natural	0.0163	0.0064	0.0187	0.0062	0.0170	0.0035	0.0068	0.0113
Wells Hatchery	0.0120	0.0051	0.0135	0.0044	0.0120	0.0028	0.0046	0.0077
Wenatchee stock	0.0184	0.0073	0.0203	0.0074	0.0167	0.0047	0.0084	0.0128
Eastbank MEOK stock	0.0128	0.0036	0.0143	0.0038	0.0135	**0.0019**	0.0038	0.0079
Entiat River	0.0147	0.0059	0.0176	0.0057	0.0156	0.0028	0.0056	0.0100
Chelan River	0.0074	**0.0046**	0.0110	**0.0040**	0.0160	**0.0047**	**0.0035**	0.0072

Table 7. Effective number of breeders per brood year with the largest number of samples of summer Chinook in the upper Columbia River. Brood years with sample size less than 19 individuals (shown in bold type) were not analyzed with exception of the 2008 Wells Hatchery collection. A comparison could not be made between an early and late collection from Wells Hatchery.

WDFW Code	Collection Location	Sample Size	Nb =	CI95(L) =	CI95(U) =
93DD[A]	Wenatchee Natural - upstream	23 / 19	152 / 190	77 / 87	616 / 2,147,483,647
08FV	Wenatchee Natural - upstream	56	162	112	249
93DE[A]	Wenatchee Natural - downstream	39 / 34	145 / 152	94 / 95	256 / 302
08FW	Wenatchee Natural - downstream	67	140	105	199
08FU	Wenatchee Hatchery	60	134	90	213
93EC[A]	Methow Natural	**10 / 15**	---	---	---
08FY	Methow Natural	62	150	106	218
08FX	Methow Hatchery	**9**	---	---	---
93ED	Okanogan Natural	69	142	102	203
08GA	Okanogan Natural	59	127	92	180
08FZ	Okanogan Hatchery	**16**	---	---	---
93DG	Wells Hatchery	**6**	---	---	---
08HY[B]	Wells Hatchery	24 / 39	---	---	---
08MN	Eastbank Hatchery - Wenatchee	88	190	144	263
93DF	Eastbank Hatchery - MEOK	84	171	129	229
08MO	Eastbank Hatchery - MEOK	88	166	126	226

[A] - calculations were made for samples from brood year 1988 / brood year 1989

[B] - samples were collected from brood year 2003 / brood year 2004

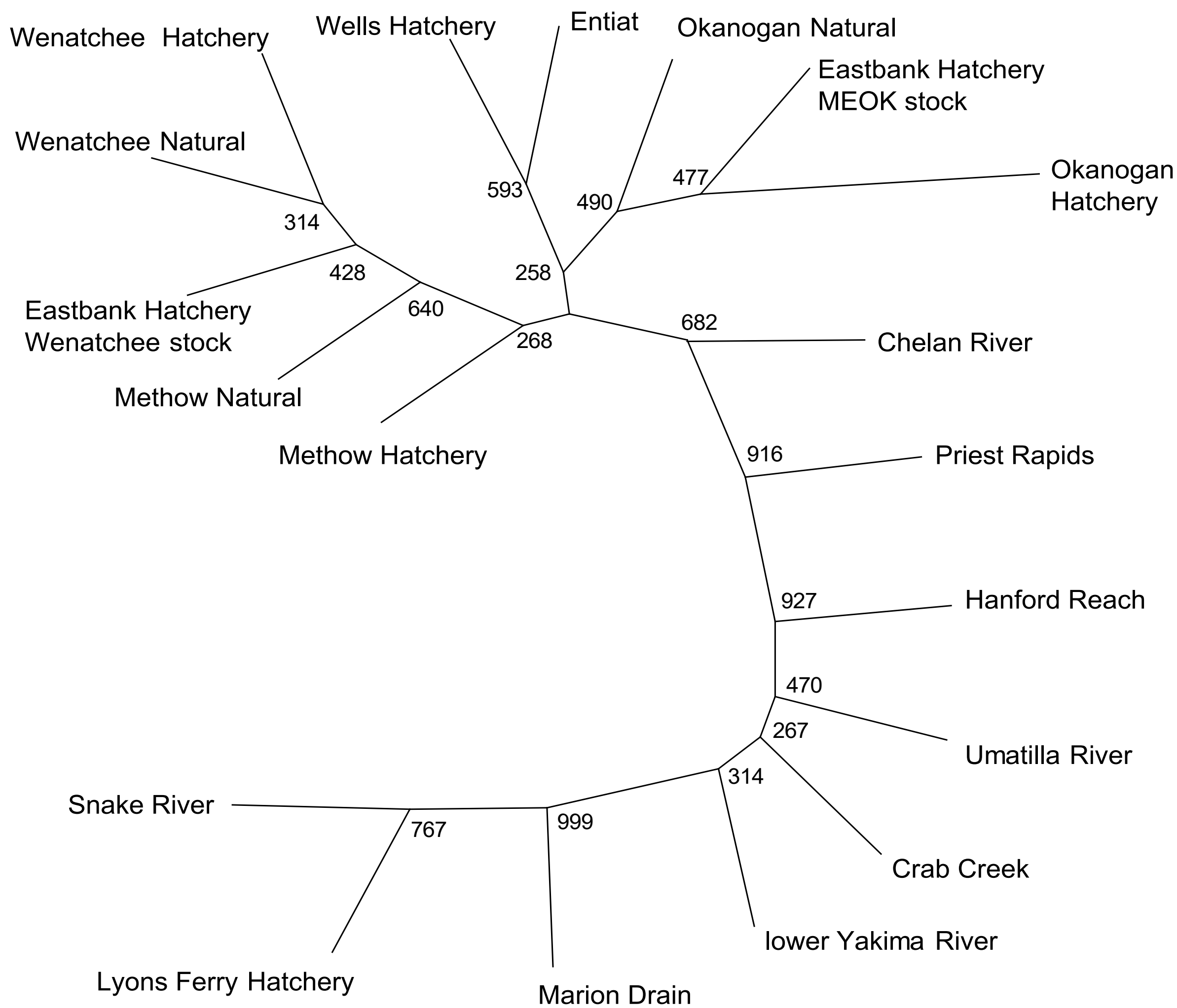

Figure 1. Relationship of natural- and hatchery-origin Chinook collections from the upper Columbia River basin using Cavalli-Sforza and Edwards (1967) chord distance. Bootstrap values are shown at each node.

Appendix Q

Summer Chinook Salmon Spawning Ground Surveys in the Methow River Basin and Chelan River, 2018

BioAnalysts, Inc.℠
4725 North Cloverdale Road, Ste. 102
Boise ID 83713

March 10, 2019

To: Chelan and Grant Public Utility Districts

From: Denny Snyder, Mark Miller, and John Stevenson

Re: 2018 Summer Chinook Spawning Ground Surveys in the Methow Basin and Chelan River.

The purpose of this memo is to provide information on the supplemented natural spawning population of summer Chinook salmon in the Methow and Chelan River basins. This work is part of a larger effort focused on monitoring and evaluating Grant and Chelan PUDs' hatchery supplementation programs. The tasks and objectives associated with implementing Grant and Chelan PUDs' Hatchery M&E Plan for 2018 are outlined in Hillman et al. (2013). In 2018, The Okanogan Basin was surveyed by the Colville Confederated Tribes (CCT).

METHODS

Spawning ground surveys were conducted by foot and raft beginning the third week of September and ending late-November. Observers floated or walked through sampling reaches and recorded the location and numbers of redds each week (see Figures 1 and 2). Observers recorded redd and carcass locations using an GIS application on an electronic notepad.

To maintain consistency, at least one observer surveyed the same stream reach on successive dates. In areas where numerous summer Chinook salmon spawned, we created polygons within the I-pads to help identify the number of redds in these areas. Polygons were bound by noticeable landmarks along the banks (e.g., bridges or trees) or at stream habitat boundaries (e.g., transitions between pools and riffles). The number of redds were then recorded in the corresponding polygon in the map. When possible, observers estimated the number of redds in a large disturbed area by counting females that defended redds. We assumed that the area or territory defended by a female was one redd.

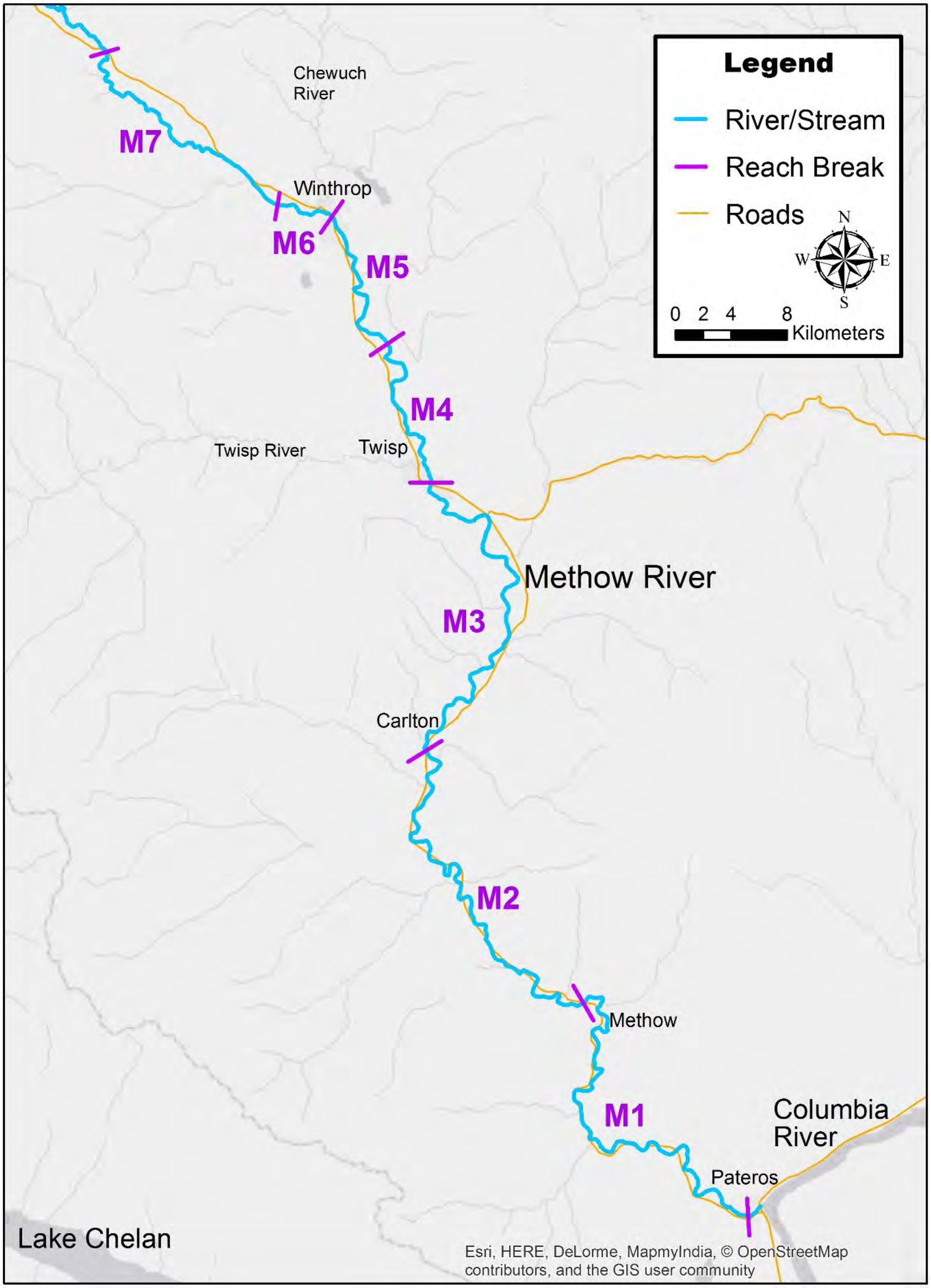

Figure 1. Summer Chinook salmon survey reaches on the Methow River, 2018.

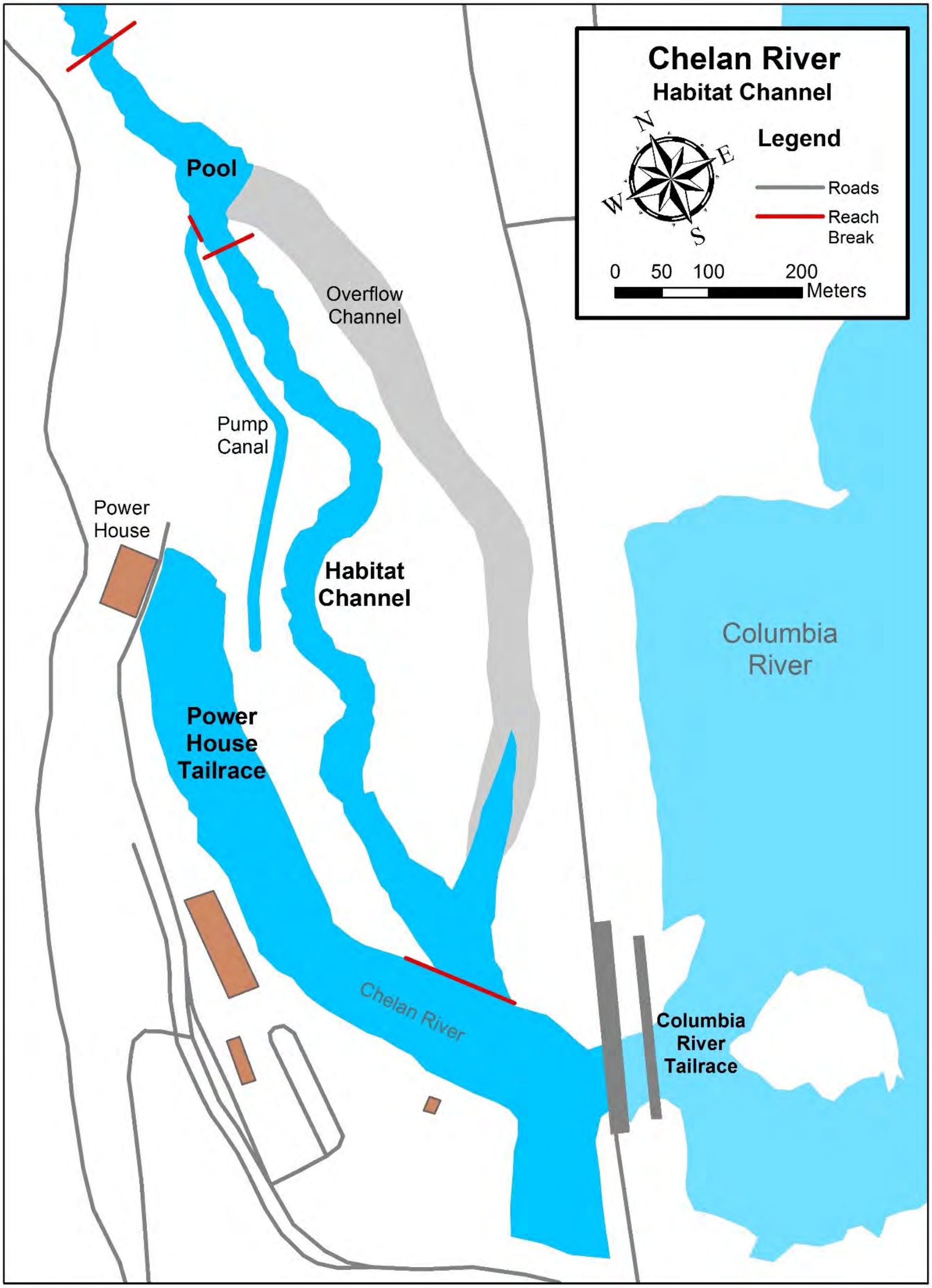

Figure 2. Summer Chinook salmon survey areas on the Chelan River, 2018.

Spawning escapement was estimated as the number of redds times the sex ratio observed at Wells Dam during broodstock collection. Carcasses of summer Chinook salmon were sampled to describe the spawning population. Biological data collection included: scale samples for age analysis, length measurements (POH and FKL), sex, egg voidance, marks, and presence of PIT tags. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), and stray rates. No DNA samples were collected on summer Chinook salmon this year. In this report, we only report the number of redds counted in the Okanogan Basin.

RESULTS

Methow

There were 594 summer Chinook salmon redds counted within seven reaches on the Methow River (Table 1). Most redds (84%) were located in reaches from the mouth to the town of Twisp (M1-M3). Estimated escapement based on expansion of redd counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 1,367 summer Chinook salmon (594 redds x 2.301 fish/redd) spawned in the Methow River.

Table 1. Number of summer Chinook salmon redds observed each week within the Methow River, 2018. Dashes (--) indicate that no survey occurred.

Reach	Location (Rkm)	Sep	Oct				Nov				Total	Percent
		23-29	30-6	7-14	14-20	21-27	28-3	4-10	11-17	18-24		
		39	40	41	42	43	44	45	46	47		
Methow River												
M1	0.0-23.8	---	7	48	39	18	3	5	---	---	120	20.2
M2	23.8-43.8	10	68	56	49	15	5	1	---	---	204	34.3
M3	43.8-63.7	10	57	62	34	9	0	---	---	---	172	29.0
M4	63.7-72.3	1	9	6	5	1	0	---	---	---	22	3.7
M5	72.3-80.1	4	16	28	8	3	0	---	---	---	59	9.9
M6	80.1-83.0	1	1	1	0	0	0	---	---	---	3	0.5
M7	83.0-96.1	1	5	6	2	0	---	---	---	---	14	2.4
Total:		**27**	**163**	**207**	**137**	**46**	**8**	**6**	**0**	**0**	**594**	**100.0**

Time of spawning was assessed as the number of new redds counted each week in the Methow River. Spawning began the last week of September, peaked in early October, and ended the first week of November (Figure 3). Stream temperatures in the Methow River varied from 10.5-11.0°C in September when spawning began. Spawning peaked the second week of October in Reaches M1, M3 and M5-M7, while peak spawning occurred in reach M2 and M4 the first week of October. Spawning continued in reach M1 and M2 into the first week of November (Table 1). This was the seventeenth highest redd count observed in the last 28 years for the Methow River (Appendix A).

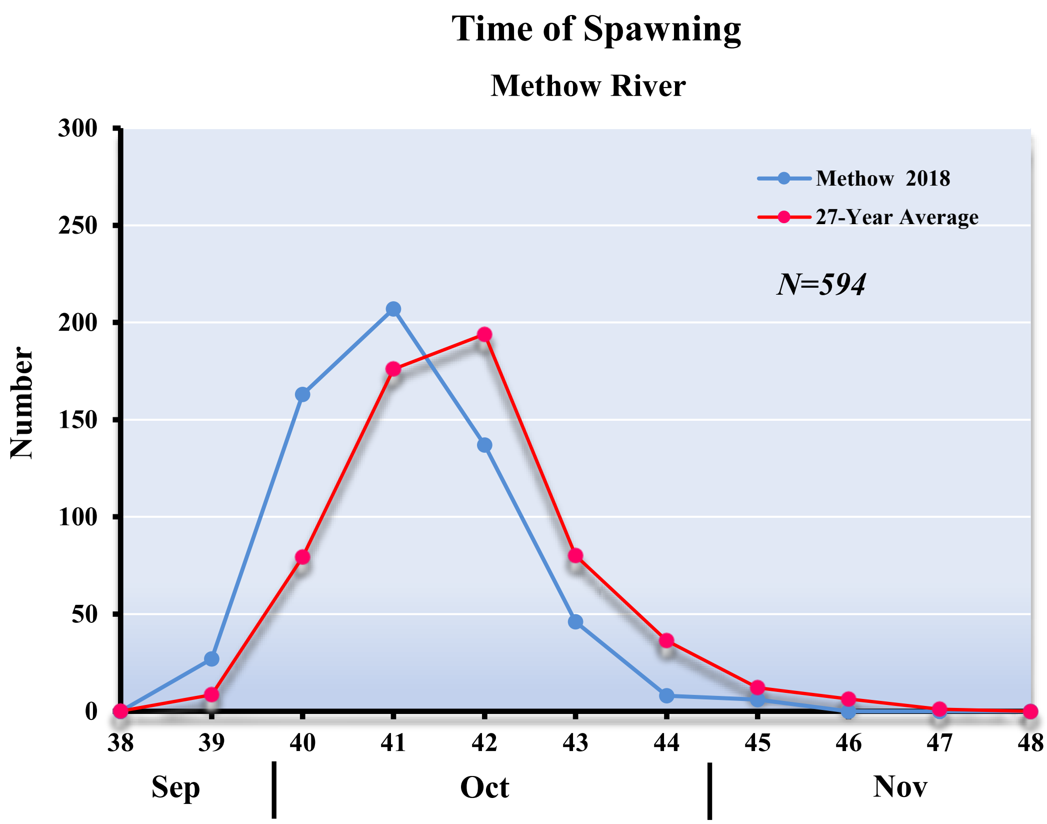

Figure 3. Number of new redds counted each week from late September to mid-November in the Methow River, 2018. The figure compares the beginning, peak, and end of spawning in 2018 for summer Chinook salmon compared to a 27-year average (1991-2017).

There were 333 summer Chinook salmon carcasses sampled within six reaches on the Methow River, in reach M-7 no carcasses were sampled (Table 2). Twenty-four percent of the fish returning to the Methow River were sampled based on the estimated escapement of 1,367 summer Chinook salmon. Ad-clipped hatchery fish made up 50% and naturally produced fish (adipose fin present) made up 50% of the fish sampled (Table 2).

Table 2. Number and percent of hatchery (ad-clipped) and naturally produced (ad-present) summer Chinook salmon sampled in the Methow River, 2018.

Reach	Location (Rkm)	Ad-Clipped Hatchery				Naturally Produced				Reach Total
		Male	Female	Total	Percent	Male	Female	Total	Percent	
M1	0.0-23.8	23	23	46	64.8	13	12	25	35.2	71
M2	23.8-43.8	35	29	64	54.2	29	25	54	45.8	118
M3	43.8-63.7	18	21	39	39.8	21	38	59	60.2	98
M4	63.7-72.3	4	1	5	41.7	3	4	7	58.3	12
M5	72.3-80.1	3	8	11	33.3	8	14	22	66.7	33
M6	80.1-83.0	0	0	0	0.0	0	1	1	100.0	1
M7	83.0-96.1	0	0	0	0.0	0	0	0	0.0	0
Total		83	82	165	49.5	74	94	168	50.5	333

Most (90%) of the ad-clipped hatchery fish were located in reaches M1-M3, while naturally produced fish were sampled within M1-M6 survey reaches (Figure 4). Naturally produced fish made up 100% of the fish sampled in reach M6. Female summer Chinook salmon accounted for 53% of the fish sampled in 2018 (Table 2). Twelve Coho salmon were sampled while conducting Chinook salmon surveys, all Coho salmon data was given to YIN, Winthrop office.

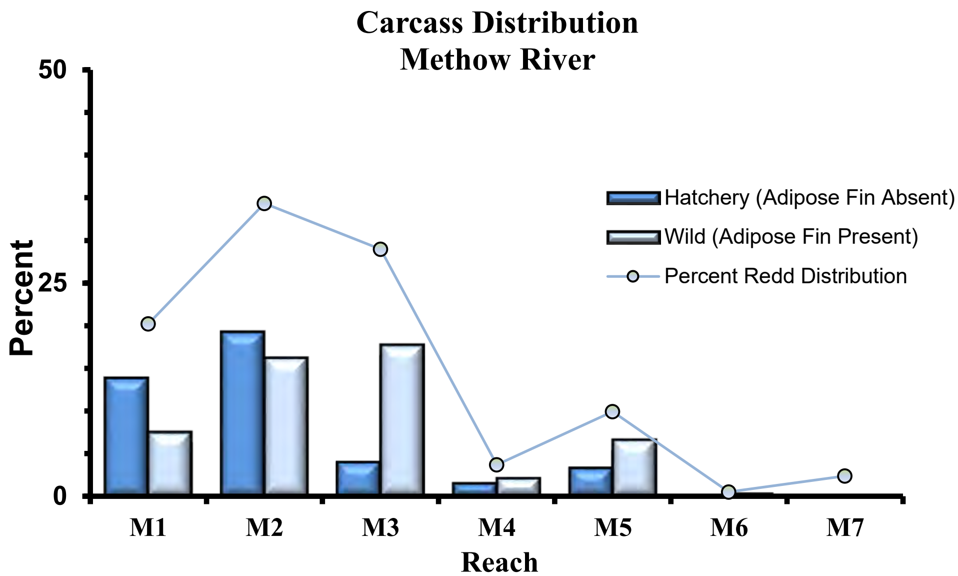

Figure 4. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Methow River, 2018.

Egg voidance was assessed by sampling female carcasses. Based on 174 sampled female carcasses, average egg voidance was 95%. A total of 176 females were sampled however 2 carcasses had been scavenged and were not able to be assessed. Seven females (4%) died before spawning (i.e., they retained all their eggs).

Chelan River

There were 420 redds counted in the Chelan River. This is the sixth highest redd count observed for summer Chinook salmon in the Chelan River since 2000. The majority of spawning occurred in the powerhouse tailrace (37%) and habitat channel (30%) (Table 3). Estimated escapement based on expansion of counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 966 summer Chinook salmon (420 redds x 2.301 fish/redd) spawned in the Chelan River.

Table 3. Number of summer Chinook salmon redds observed each week within the Chelan and Columbia rivers, 2018. Dashes (--) indicate that no survey occurred.

Reach	Sep	Oct					Nov				Dec	Total	Percent
	23-29	30-6	7-13	14-20	21-27	28-3	4-10	11-17	18-24	25-1	2-8		
	39	40	41	42	43	44	45	46	47	48	49		
Powerhouse Tailrace	0	0	0	79	39	25	6	4	4	0	--	157	37.4
Columbia R. Tailrace	0	0	0	21	20	10	0	4	0	0	--	55	13.1
Pool	0	2	28	23	22	5	3	0	0	0	--	83	19.8
Habitat Channel	0	4	32	27	27	6	1	0	1	0	--	125	29.8
Total:	**0**	**6**	**60**	**177**	**108**	**46**	**10**	**8**	**5**	**0**	**--**	**420**	**100.0**

Time of spawning was assessed as the number of new redds counted each week in the Chelan River. Spawning activity began the first week of October and peaked two weeks later (Figure 5). Spawning ended the third week of November. An exceptionally high redd count in 2013 (792 redds) and late spawning in 2014 currently influence the average time of spawning.

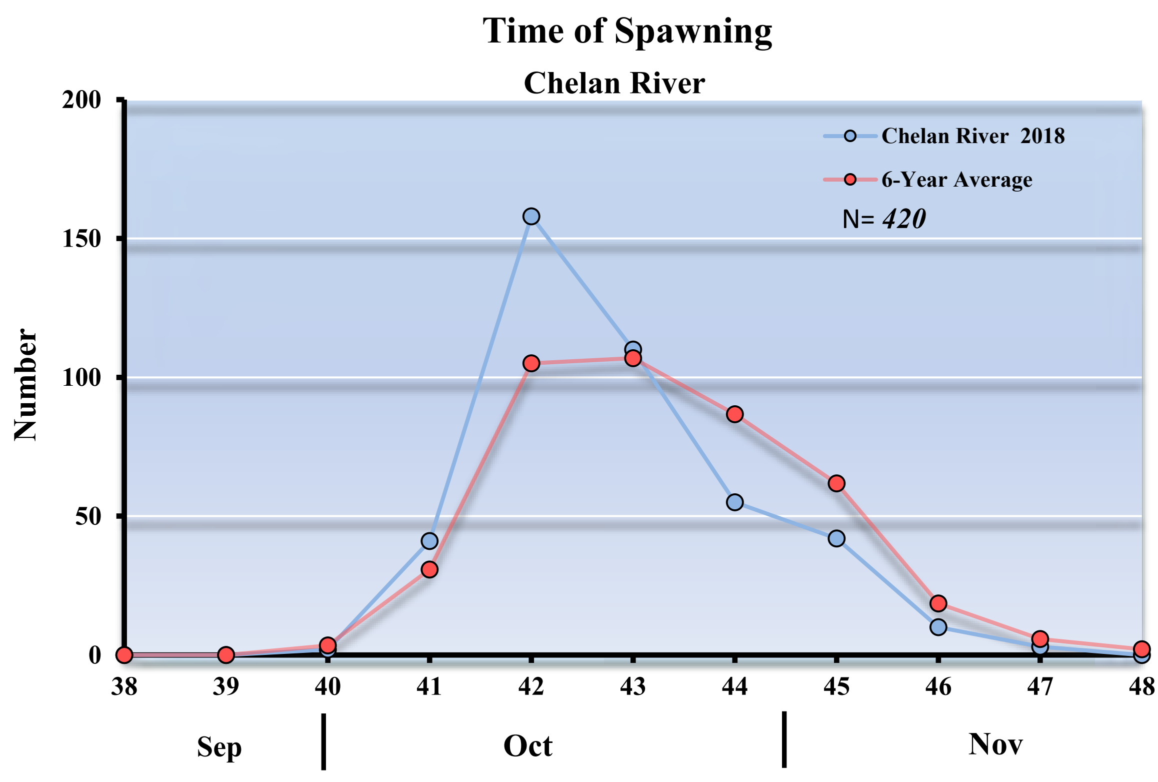

Figure 5. Number of new summer Chinook redds counted each week in the Chelan River from late September to mid-November. The figure compares the beginning, peak, and end of spawning for summer Chinook salmon in 2018 compared to a 6-year average (2012-2017).

There were 213 summer Chinook salmon carcasses sampled in the Chelan River (Table 4). Twenty-two percent of the summer Chinook salmon returning to the Chelan River were sampled based on the estimated spawning escapement of 966 fish. Based on the absence of their adipose fin, hatchery fish made up 53% and naturally produced (ad-present) fish made up 47% of the fish examined. Females made up 83% of the carcasses examined (Table 4).

Table 4. Number and percent of hatchery (ad-clipped) and naturally produced (ad-present) summer Chinook collected in the Chelan River, 2018. The origin of one fish sampled could not be determined in the Chelan River.

Reach	Location (Rkm)	Ad-Clipped Hatchery				Naturally Produced				Reach Total
		Male	Female	Total	Percent	Male	Female	Total	Percent	
Powerhouse Tailrace		3	20	23	48.9	1	23	24	51.5	**47**
Columbia R. Tailrace		9	33	42	44.7	8	44	52	55.3	**94**
Pool		8	16	24	72.7	2	7	9	27.3	**33**
Habitat Channel		3	21	24	61.5	2	13	15	38.5	**39**
Total		**23**	**90**	**113**	**53.1**	**13**	**87**	**100**	**46.9**	**213**

The distribution of ad-clipped hatchery fish and naturally produced fish varied within the Chelan River (Figure 6). A disproportionate number of fish (compared to redd counts) were sampled in the Columbia River tailrace. This likely occurs because carcasses drifted from upstream spawning areas and settle in the Columbia River tailrace. A higher percentage of hatchery fish were sampled in the habitat channel (61%) and pool (73%). Conversely, more wild fish were sampled in the Powerhouse (51%) and Columbia R. tailraces (55%) than hatchery summer Chinook.

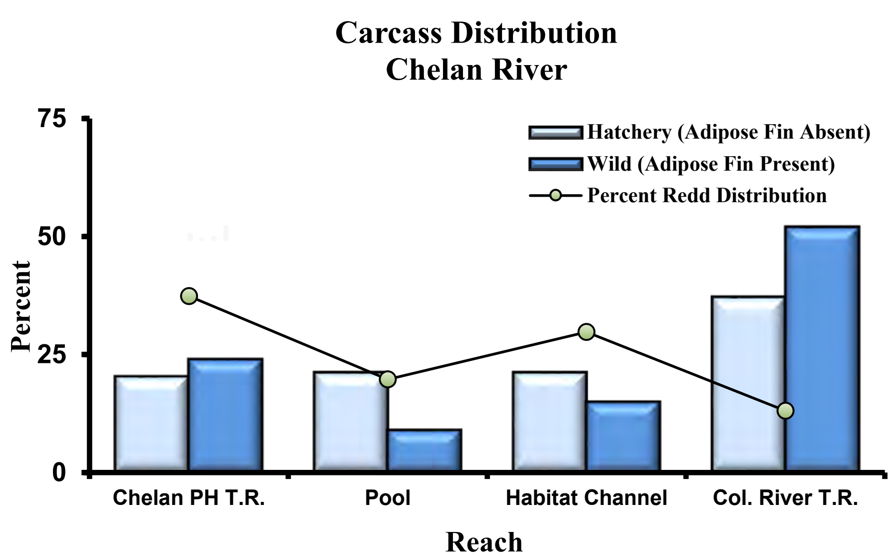

Figure 6. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Chelan River, 2018.

In 2018, summer Chinook were once again collected for broodstock from the pool area upstream from the habitat channel the number collected is not known.

Mean egg voidance assessed from 165 female carcasses was 95%. Egg voidance from twelve females could not be determined and 2 females (1%) died before spawning. One female Coho salmon was sampled (Columbia River tailrace) and two Coho salmon redds were counted in the pool and one in the Powerhouse tailrace in 2018. Carcass data was given to the YIN in Winthrop, WA.

Okanogan Basin

In 2018, CCT conducted summer Chinook salmon surveys in the Okanogan River basin. A total of 2,112 redds were counted in the Okanogan Basin (1,554 in Okanogan R. and 558 in Similkameen R) (Personal Communication, Andrea Pearl, CCT).

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Appendix A. Historical aerial and ground redd counts of summer Chinook in the Methow, Chelan, Okanogan, and Similkameen rivers, 1956-2016.

Year	Methow		Okanogan		Similkameen		Chelan	
	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground
1956	109	--	37	--	30	--	--	--
1957	451	--	53	--	30	--	--	--
1958	335	--	94	--	31	--	--	--
1959	130	--	50	--	23	--	--	--
1960	194	--	29	--	--	--	--	--
1961	120	--	--	--	--	--	--	--
1962	678	--	--	--	17	--	--	--
1963	298	--	9	--	51	--	--	--
1964	795	--	112	--	67	--	--	--
1965	562	--	109	--	154	--	--	--
1966	1,275	--	389	--	77	--	--	--
1967	733	--	149	--	107	--	--	--
1968	659	--	232	--	83	--	--	--
1969	329	--	103	--	357	--	--	--
1970	705	--	656	--	210	--	--	--
1971	562	--	310	--	55	--	--	--
1972	325	--	182	--	64	--	--	--
1973	366	--	138	--	130	--	--	--
1974	223	--	112	--	201	--	--	--
1975	432	--	273	--	184	--	--	--
1976	191	--	107	--	139	--	--	--
1977	365	--	276	--	268	--	--	--
1978	507	--	195	--	268	--	--	--
1979	622	--	173	--	138	--	--	--
1980	345	--	118	--	172	--	--	--
1981	195	--	55	--	121	--	--	--
1982	142	--	23	--	56	--	--	--
1983	65	--	36	--	57	--	--	--
1984	162	--	235	--	301	--	--	--
1985	164	--	138	--	309	--	--	--
1986	169	--	197	--	300	--	--	--
1987	211	--	201	--	164	--	--	--
1988	123	--	113	--	191	--	--	--
1989	126	--	134	--	221	370	--	--
1990	229	--	88	47	94	147	--	--
1991	--	153	55	64	68	91	--	--
1992	--	107	35	53	48	57	--	--
1993	--	154	144	162	152	288	--	--
1994	--	310	372	375	463	777	--	--
1995	--	357	260	267	337	616	--	--

Year	Methow		Okanogan		Similkameen		Chelan	
	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground
1996	--	181	100	116	252	419	--	--
1997	--	205	149	158	297	486	--	--
1998	--	225	75	88	238	276	--	--
1999	--	448	222	369	903	1,275	--	--
2000	--	500	384	549	549	993	--	196
2001	--	675	883	1,108	865	1,540	--	240
2002	--	2,013	1,958	2,667	2,000	3,358	--	253
2003	--	1,624	1,099	1,035	103	378	--	173
2004	--	973	1,310	1,327	2,127	1,660	--	185
2005	--	874	1,084	1,611	1,111	1,423	--	179
2006	--	1,353	1,857	2,592	1,337	1,666	--	208
2007	--	620	1,265	1,301	523	707	--	86
2008	--	599	1,019	1,146	673	1,000	--	153
2009	--	692	1,109	1,672	907	1,298	--	246
2010	--	887	688	1,011	642	1,107	--	398
2011	--	941	1,203	1,714	1,047	1,409	--	413
2012	--	960	1,170	1,613	762	1,066	--	426
2013	--	1,551	NA	2,267	NA	1,280	--	729
2014	--	591	NA	2,231	NA	2,022	--	400
2015	--	1,231	NA	4,276[1]	NA	--	--	448
2016	--	1,115	729	2,757	141	1,649	--	448
2017	--	690	--	--	--	--	--	421
2018	--	594	--	1,554	--	558	--	420

1. The redd count is for the entire Okanogan Basin (Similkameen + Okanogan rivers).

Appendix T
Revisions to Section 5 of the HCP Tributary Committees Policies and Procedures Document

Appendix T. Revisions to Section 5 of the HCP Tributary Committees Policies and Procedures Document.

5 Review Procedures

The Committees will make funding decisions based on eligibility criteria (see Section 4), fund availability, and if necessary, the recommendations from technical advisors. During review of project proposals, the Committees will act in good faith and within the spirit of the collaborative nature of the HCPs to make project funding decisions and having a direct nexus to plan species, plan species habitat, or plan species management. Furthermore, consistent with Section 9 of the HCPs, voting members shall use their best efforts to exercise their rights and authority under statutes, regulations, and treaties, in a manner that allows the goals and objectives of the HCP Agreement to be fulfilled. Importantly, as agreed to during HCP negotiations, funding decisions require unanimous approval of the Committees (as described in HCPs Section 7), affording each member discretionary rights when reviewing and voting on project proposals.

Project proposals will be evaluated based on general and specific criteria. Below we identify the general criteria, which are from the HCPs, and specific criteria, which are based on biological and technical merit, feasibility, durability, and cost-effectiveness. The Committees may also solicit reviews of project proposals from technical experts outside the Committees.

5.1 General Criteria

Project proposals will first be evaluated based on the following general criteria.

Target Species

Does the proposed project address HCP Plan Species (spring Chinook, summer/fall Chinook, coho, sockeye, and/or steelhead)?

Target Area

Is the proposed project located within the geographic scope of the HCPs (projects must be in the Columbia River watershed from Rock Island Dam tailrace to Chief Joseph Dam tailrace)?

5.2 Specific Criteria

Project proposals that address target species within the target area will be evaluated based on biological and technical merit, feasibility, durability, and cost-effectiveness. Separate criteria were established for restoration, protection, design, and assessment projects.

5.2.1 RESTORATION PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration?[2]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Does the proposed project reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Does the proposed project address limiting life stages of Plan Species within the watershed or AU?

Is the proposed project sited within an important spawning/rearing area, or provides access to habitat that would function as important spawning/rearing habitat for Plan Species?

Does the proposed project increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Does the proposed project promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

How long will it take for the proposed project to achieve its intended response?

How long will the proposed project and its benefits persist?

Will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the proposed project from being implemented?

Are there funding constraints that will prevent the project from being implemented?

---

[2] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

5.2.2 PROTECTION PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for protection?[3]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

To what extent does the proposed project protect high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?

What would be the anticipated loss in freshwater survival, capacity, spatial structure, and/or diversity of Plan Species at the project or reach scale if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of Plan Species at the project/reach scale)?

Technical Merit

How imminent is the threat of habitat degradation to the proposed land if the project is not implemented?

Will the landowner allow public access?

Will the landowner allow restoration actions?

Durability[4]

Does the proposed project protect watershed processes or important high-quality habitat in perpetuity?

Are there any conditions regarding the protection of the property that could limit the existing high-quality habitat?

Will the proposed project help ameliorate the effects of climate change?

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[3] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

[4] In Section 7 under Ownership of Assets, the HCPs state that "[a]ll real property purchased shall include permanent deed restrictions to assure protection and conservation of habitat."

Feasibility

Is there a signed landowner agreement form?

Are there funding constraints that will prevent the project from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to implement the project successfully?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Would other approaches achieve similar or increased biological benefit at lower cost?

Does the proposed project need a cost share? If so, how much?

5.2.3 DESIGN PROJECTS

Biological Benefit

Is the proposed project located within a priority assessment unit or area for restoration?[5]

Is the proposed project sited within an important spawning/rearing area for Plan Species?

Will the proposed design lead to development of projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed design lead to development of projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed design sited within an important spawning/rearing area, or will provide access to habitat that would function as important spawning/rearing habitat for Plan Species?

If the design is implemented, will it increase freshwater survival, capacity/abundance, spatial structure, and/or diversity for Plan Species at the project or reach scale?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

Is the proposed project sequenced properly?

Durability

Will the proposed design lead to development of projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

---

[5] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

If the design is implemented, how long will it take for the proposed project to achieve its intended response?

If the design is implemented, how long will the proposed project and its benefits persist?

If the design is implemented, will the proposed project ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the design from being implemented?

Are there funding constraints that will prevent the design from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the designs?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

5.2.4 ASSESSMENT PROJECTS

Biological Benefit

Is the proposed assessment located within a priority assessment unit or area?[6]

Is the proposed assessment sited within an important spawning/rearing area for Plan Species?

Will the proposed assessment lead to projects that reduce the effects of primary ecological concerns (limiting factors) at the project and reach scale?

Will the proposed assessment lead to projects that address limiting life stages of Plan Species within the watershed or AU?

Is the proposed assessment sited within an important spawning/rearing area, or in an area that could function as important spawning/rearing habitat for Plan Species?

Technical Merit

Are the methods outlined within the proposal adequate to achieve the stated objectives?

Is the proposed project appropriately scaled and scoped?

---

[6] Refer to the UCRTT Biological Strategy for a listing of priority areas for spring Chinook salmon and steelhead. The HCP Hatchery Committees have identified important spawning and rearing areas for summer Chinook. High priority areas for sockeye salmon include spawning habitat in tributaries upstream from Lake Wenatchee and Lake Osoyoos.

Durability

Will the proposed assessment lead to projects that promote natural stream/watershed processes that are consistent with the geomorphology of the stream?

Will the proposed assessment lead to projects that ameliorate the effects of climate change?

Feasibility

Is there a signed landowner agreement form?

Are there permitting or regulatory constraints that will prevent the assessment from being implemented?

Are there funding constraints that will prevent the assessment from being implemented?

Does the project sponsor have the experience, resources, and infrastructure to complete the assessment?

Cost Effectiveness

Is the proposed project cost effective (based on the assumed benefit)?

Does the proposed project need a cost share? If so, how much?

All decisions on funding will be held in a closed executive session. The Committees reserve the right to hold closed sessions on other issues, when necessary. Project proposal presentations may be open to the public. All other meetings will be open by invitation only. The Committees may use the Mid-Columbia Forum[7] to inform stakeholders of the status of the Plan Species Account(s). Decisions by the Committees are final and not subject to review by any entity.

The Committees may sponsor workshops for all stakeholders to present the annual Plan activities and project selection policies and procedures. Successful project applicants may be asked to present the status of their projects during these workshops.

[7] The Mid-Columbia Forum is a meeting of the HCP Coordinating, Hatchery, and Tributary Committees with stakeholders, including the Confederated Tribes of the Umatilla Indian Reservation and American Rivers, who were involved in negotiating the HCPs but elected to not sign the HCPs. The purpose of the meeting is to provide stakeholders with a progress report on implementation, as well as give them an opportunity to ask questions of the Committee members.

Appendix U
2019 Annual Financial Report for this Plan Species Account

  

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

MEMORANDUM

DATE: **January 14, 2020**

TO: **Becky Gallaher**
Alene Underwood

FROM: **Debbie Litchfield**
Treasurer/Director – Treasury

RE: **Rocky Reach Hydro Project Habitat Conservation Plan**
2019 Annual Financial Report, Plan Species Account

In accordance with Section 7.4.3 of the Rocky Reach Habitat Conservation Plan, attached is the 2019 year end annual financial report of the Plan Species Account activity completed by Chelan County Public Utility District No. 1.

Chelan County PUD
Rocky Reach Hydroelectric Project
Habitat Conservation Plan
Plan Species Cash Account Activity
Annual Financial Report Per Section 7.4.3
Reporting Year: 2019

Beginning Balance:	**1/1/2019**		**$ 2,888,124.61**
Transfers In:			
Rocky Reach Funding		371,474.00	
Interest Earnings		39,645.00	
Total Transfers In			411,119.00
Transfers Out:			
Payments		(36,104.01)	
Bank Service Fees		(67.00)	
Total Transfers Out			(36,171.01)
Ending Balance:	**12/31/2019**		**$ 3,263,072.60**

The Plan Species Account was established per the Rocky Reach Habitat Conservation Plan, Section 7.4. Interest earnings shall remain in the Account in accordance with Appendix E, Section 7.4.1.

Appendix V
Draft SOA from the Yakama Nation to the HCP Tributary Committees

Appendix V. Draft SOA from the Yakama Nation to the HCP Tributary Committees.

Rocky Reach, Rock Island, and Wells HCP Tributary Committees
DRAFT Statement of Agreement

Basis for Decision Making in HCP Tributary Committees
February 25, 2019

Statement

The Rocky Reach, Rock Island, and Wells Habitat Conservation Plans (HCP) Tributary Committees (TCs) agree that mitigation funding decisions will be based exclusively on the merit of proposed projects (biological benefit, technical merit, feasibility, durability, and cost effectiveness) having a direct nexus to plan species, plan species habitat, or plan species management. Signatories agree not to base funding decisions on criteria other than project merit.

Background

The Wells, Rocky Reach, and Rock Island HCP Tributary Committees' Policies and Procedures for Funding Projects (January 10, 2019) describes the eligibility and review criteria for evaluating project funding decisions. Section 5 of that document specifies that project funding decisions are made on the basis of biological benefit, technical merit, feasibility, durability, and cost effectiveness. However, Section 5 does not explicitly disallow criteria unrelated to resource benefits to be introduced into decision-making. The purpose of this SOA is to clarify that the Tributary Committees intend that all funding or other decisions regarding how PUD mitigation is implemented will have a direct nexus to the expected benefits to a plan species or plan species habitat. Decision making by a signatory for reasons unrelated to mitigation benefits are not within the spirit or intent of the HCPs and will impede the operation of the Committees. Any signatory attempting to vote on the basis of criteria other than those directly related to resource impacts may abstain from 'voting'.

Appendix W
Relative Reproductive Success Study Extension Memorandum

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM -SCIENCE DIVISION
HATCHERY/WILD INTERACTIONS UNIT

3515 Chelan Hwy, Wenatchee, WA 98801
Voice (509) 664-3148 FAX (509) 662-6606

September 19, 2019

To: Rock Island HCP Hatchery Committee
Priest Rapids Hatchery Subcommittee

From: Andrew Murdoch, Research Scientist, Science Division, WDFW
Mike Ford, Director, Conservation Biology Division, NW Fisheries Science Center
NOAA Fisheries

Subject: Clarification of Extension of the Wenatchee spring Chinook RRS Study

Adult management activities at Tumwater Dam began in 2014. As a result, the abundance and proportion of hatchery spawners has and is expected to differ from what has been included in the study thus far (Table 1). For example, the abundance of naturally produced fish has never exceeded that of hatchery fish. In addition, the parental origin of hatchery spawners will also be changing such that only hatchery fish produced by natural origin parents could be allowed upstream to spawn. Furthermore, the sex and age of hatchery fish allowed to spawn naturally may also differ annually if jacks and adult male hatchery fish are disproportionately removed at Tumwater Dam. These significant hatchery reform actions are the reasons we (WDFW and NOAA) proposed extending the duration of study to BPA. These reform actions will be empirically evaluated as these additional brood years are included in the study. WDFW and NOAA is asking for approval from the Rock Island HCP Hatchery Committee for the clarification in change in scope/duration.

Table 1. Summary of the number and percentage of hatchery and naturally produced fish allowed to spawn upstream of Tumwater Dam, 2004 – 2013. Asterisk denotes preliminary numbers that may change after scales are read.

Year	Hatchery		Naturally produced	
	Number	%	Number	%
2004	1,327	0.60	898	0.40
2005	3,217	0.84	594	0.16
2006	1,600	0.74	573	0.26
2007	3,259	0.91	324	0.09
2008	5,338	0.89	631	0.11
2009	4,270	0.85	777	0.15
2010	4,453	0.83	880	0.17
2011	4,792	0.80	1,224	0.20
2012	4,010	0.75	1,370	0.25
2013*	3,274	0.75	1,144	0.25
Mean	3,554	0.79	842	0.21
CV	36	12	39	45

Proposed Action (as clarified)

Extend the scope/duration of the study to include brood years 2014 through 2018. However, comparisons of relative reproductive success will only be made at the smolt stage via DNA sampling of natural origin smolts collected at smolt traps through 2020 and DNA sampling of natural origin adults at Tumwater Dam through 2023 (i.e., 2018 brood). The goal is to sample 100% of the natural origin smolts encountered at smolt traps and as many natural origin adults as possible up to 100% of the return during this period. A comparison of the original proposal and proposed extension is provided in Table 2.

Table 2. A summary of additional impacts directly attributable to the study as a result of the proposal.

Question	Original Project	Proposal
Last brood year in study?	2013	2018
Last year of DNA sampling potential hatchery spawners?[1]	2013	2018
Last year of DNA sampling wild returning adults?[1]	2018	2023
Last year of juvenile DNA sampling?	2015	2020
Last year of intensive spawning ground surveys?	2013	2013

[1] Denotes last year of adult trapping specific to the RRS Study but does change trapping activities that may be associated with adult management, broodstocking, and/or other M&E related activities.

ESA Take and Permitting

Section 10 permit #18121 provides all of the necessary take associated with the extension. Furthermore, because the removal of excess hatchery fish at Tumwater Dam and the collection of DNA from naturally produced fish (i.e., original RRS study) will also require trapping effort (and scheduling) similar to past years efforts under the RRS, the trapping effort for adult management and DNA collection under the original RRS scope of work will be sufficient to conduct the study. The change in scope will result in the additional sampling (i.e., biological data, PIT tag, and DNA) of natural origin adults through 2023 and the DNA sampling of naturally produced juveniles collected at smolt traps that otherwise would already be sampled and PIT tagged through 2020.

Other Logistical Considerations

Results of the study thus far have suggested that spawning location accounts for a significant proportion of variation in reproductive success. Chelan County PUD currently conducts spring Chinook spawning ground surveys in the Wenatchee Basin. As such, WDFW will work closely with PUD staff and supply the equipment and supplies necessary to ensure the any additional data critical to the study (i.e., spawning location of all carcasses not just females and DNA from untagged fish) is collected consistent with past protocols.

Approval of this extension has already been approved by BPA. At this time we are formally seeking approval from the Rock Island HCP Hatchery Committee for the clarification in scope to include natural origin adult DNA sampling at Tumwater Dam through 2023 (2018 brood). If there are any potential questions or issues with the clarification of the study extension/duration please feel free to contact me at your convenience.