ANNUAL REPORT
CALENDAR YEAR 2016
ACTIVITIES UNDER THE ANADROMOUS FISH AGREEMENT AND HABITAT CONSERVATION PLAN
ROCKY REACH HYDROELECTRIC PROJECT
FERC LICENSE NO. 2145

Prepared for

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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 also 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 2016 monthly meetings are compiled in Appendix A (HCP Coordinating Committees), Appendix B (HCP Hatchery Committees), and Appendix C (HCP Tributary Committees). The HCP Policy Committees provide a forum for resolution of disputes that are either elevated to or arise in the HCP Coordinating Committees and remain unresolved. The HCP Policy Committees did not meet in 2016, because no issues were discussed requiring dispute resolution. Therefore, there are no HCP Policy Committees meeting minutes to append to this annual report. Appendix D lists members of the Rocky Reach HCP Committees. The Rocky Reach HCP Coordinating Committee oversaw the preparation of this 13th Annual Report, which covers the period

[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.

from January 1 to December 31, 2016. (The 1st through 12th Annual Reports covered the periods January 1 to December 31, 2004, through 2015, respectively.)

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 2016, 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*], and sockeye salmon [*O. nerka*]). Project survival standards have been exceeded for steelhead, yearling Chinook salmon, and sockeye salmon. Yearling Chinook salmon, sockeye salmon, and steelhead are currently designated Phase III (Standards Achieved). For subyearling summer/fall Chinook salmon (a summer migrant and a 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. Coho salmon are currently classified as Phase III (Standards Achieved – Interim Value[4]) and are compensated at levels established in the HCP to achieve NNI through Tributary Conservation and Hatchery Compensation Plans as the species is being reintroduced to the Upper Columbia River (UCR).

Recalculated NNI production levels 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). Chelan PUD funded the Tributary

[3] The current phase designation will be re-evaluated in 2019.
[4] The current phase designation will be re-evaluated in 2017.

Conservation Plan at the level established in the HCP ($229,800 in 1998 dollars (see Section 2.2; Table 1 [below]).

Table 1
Rocky Reach HCP NNI Progress for Plan Species (2016)

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
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 – Interim Value)	Yes	Yes	Yes

Notes:
ESA = Endangered Species Act
HCP = Habitat Conservation Plan
NNI = No Net Impact

Throughout 2016, 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). These agreements, along with approvals for funding of habitat projects by the Rock Island HCP Tributary Committee, are summarized in Table 2 and discussed in the remainder of this report.

Table 2

Summary of 2016 Decisions for Rocky Reach Habitat Conservation Plan

Date	Agreement	HCP Committee	Reference
January 7, 2016	Approved a time extension request from CDLT on the Entiat Stillwaters Gray Reach Acquisition Project	Tributary	Appendix C
January 20, 2016	Agreed to revise the method (now, 40th percentile, including harvest) for calculating HRR targets	Hatchery	Appendix B
January 20, 2016	Agreed to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly	Hatchery	Appendix B
January 26, 2016	Approved the 2015 Rocky Reach and Rock Island Spill Report, as revised	Coordinating	Appendix A and Appendix G
January 26, 2016	Agreed to provide Deanne Pavlik-Kunkel (Grant PUD) member access to the HCP Hatchery Committees Extranet site, and add Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists	Coordinating	Appendix A
February 17, 2016	Approved the hatchery portion of Chelan PUD's 2016 Action Plan	Hatchery	Appendix B
February 17, 2016	Approved Chelan PUD's Wenatchee Summer Chinook SOA, Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook	Hatchery	Appendix B and Appendix E
February 17, 2016	Agreed to use the methods for calculating and assessing HRR targets described in Grant PUD's Target HRR Proposal, as revised during the HCP Hatchery Committees February 17, 2016, meeting	Hatchery	Appendix B and Appendix H
February 23, 2016	Approved the 2016 Rocky Reach and Rock Island HCP Action Plans, as revised	Coordinating	Appendix A and Appendix I
March 3, 2016	Approved Chelan PUD's 2016 Steelhead Release Plan	Hatchery	Appendix B and Appendix J
March 10, 2016	Approved the tributary portion of the 2016 Rocky Reach and Rock Island HCP Action Plan	Tributary	Appendix C
March 7, 2016	Approved the 2015 Wells HCP Annual Report after no disapprovals were received prior to the 30-day review deadline	Coordinating	Appendix A
March 14, 2016	Approved the 2015 Rocky Reach and Rock Island HCP Annual Reports after no disapprovals were received prior to the 30-day review deadlines	Coordinating	Appendix A

Date	Agreement	HCP Committee	Reference
March 16, 2016	Approved the "USFWS proposal" in the revised Gene Flow Management Standards, and the revised Methow spring Chinook Gene Flow analysis spreadsheet distributed on March 16, 2016 *(Note: final versions were distributed on March 20, 2016)*	Hatchery	Appendix B and Appendix K and Appendix L
March 22, 2016	Approved the 2016 Rocky Reach Juvenile Fish Bypass Operations Plan	Coordinating	Appendix A and Appendix M
March 22, 2016	Approved the 2016 Rocky Reach and Rock Island Fish Spill Plan	Coordinating	Appendix A and Appendix N
March 30, 2016	Approved the WDFW Request for Juvenile Hatchery Steelhead for Conduction Efficiency Trials at Lower Wenatchee River Smolt Trap	Hatchery	Appendix B
May 12, 2016	Approved a time extension request from CDLT on the Entiat Stillwaters Gray Reach Acquisition Project	Tributary	Appendix C
May 18, 2016	Agreed to a 2-day review period for the revised (version 2) April 20, 2016, meeting minutes	Hatchery	Appendix B
June 15, 2016	Approved Hatchery M&E Plan Appendices 2, 4, and 6	Hatchery	Appendix B and Appendix O
June 22, 2016	Agreed to convene quarterly, joint HCP/PRCC sessions to continue discussions regarding subyearling Chinook salmon passage studies	Coordinating	Appendix A
June 22, 2016	Agreed to move the monthly HCP Coordinating Committees meetings from the Radisson Hotel in SeaTac, Washington, to Wenatchee, Washington, starting with the HCP Coordinating Committees meeting on October 25, 2016	Coordinating	Appendix A
July 14, 2016	Approved a habitat restoration design from the Okanogan Conservation District for the Similkameen RM 3.8 Project	Tributary	Appendix C
July 14, 2016	Approved a request for funding from CCFEG for the Burns-Garrity Restoration Design Project	Tributary	Appendix C
July 19, 2016	Agreed, via email, that Chelan PUD can use surplus summer Chinook salmon from Entiat National Fish Hatchery as a back-up source of broodstock for the Chelan Falls program in 2016	Hatchery	Appendix B
July 26, 2016	Approved the Closure of Rocky Reach Adult Fishway Orifice Gates SOA	Coordinating	Appendix A and Appendix F

Date	Agreement	HCP Committee	Reference
July 26, 2016	Agreed that per the Wells Project HCP, 2000 Wells Project Interim BiOp, 2003 BiOp, and Hatchery Permits 1196, 1347, and 1395, trap operators at Wells Dam have the flexibility to trap spring Chinook salmon outside the protocols used to date (16 hours per day, 3 days per week), in order to achieve broodstock collection targets as prescribed and in consultation with the annual Wells HCP Coordinating Committee-approved Broodstock Collection Protocols	Coordinating	Appendix A
August 15, 2016	Approved, via email, on August 15, 2016, ending spill at Rocky Reach Dam at midnight that night	Coordinating	Appendix A
August 17, 2016	Approved Chelan PUD's 2017 Hatchery M&E Implementation Plan	Hatchery	Appendix B and Appendix P
August 17, 2016	Approved Hatchery M&E Plan Appendices 3 and 6, as revised during the meeting (*note: Appendix 6 was previously approved during the June 15 meeting, so this approval is for a revised final version*)	Hatchery	Appendix B and Appendix O
August 17, 2016	Agreed to change their meeting start time from 9:30 to 9:00 a.m. for all future meetings, starting at the next meeting	Hatchery	Appendix B
August 17, 2016	Agreed to hold back-to-back meetings with the PRCC Hatchery Sub-Committee at Grant PUD's Wenatchee, Washington, office when the HCP Hatchery Committees and PRCC Hatchery Sub-Committee facilitators think the agendas are short enough to hold both meetings in 1 day.	Hatchery	Appendix B
September 29, 2016	Approved the Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, as revised, via email, on September 29, 2016	Coordinating	Appendix A and Appendix F
October 19, 2016	Agreed to Douglas PUD's proposed 30-day review period for the Draft 2017 Methow M&E Implementation Plan	Hatchery	Appendix B
October 19, 2016	Agreed to delete draft Appendix 5 from the Hatchery M&E Plan because its contents are included in the plan itself	Hatchery	Appendix B

Date	Agreement	HCP Committee	Reference
October 25, 2016	Approved the 2016 Rocky Reach and Rock Island Spill Report, as revised (note: Jeff Korth provided WDFW's approval of the report via email on November 3, 2016, which Kristi Geris distributed to the HCP Coordinating Committees that same day)	Coordinating	Appendix A and Appendix Q
October 25, 2016	Agreed to Chelan PUD beginning the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early. Rather than beginning January 2, 2017, the new start would be December 12, 2016, to allow more time to complete an overhaul of one or two (of three) AWS pumps (*note: Jeff Korth provided WDFW's approval of the early outage via email on November 3, 2016, which Kristi Geris distributed to the HCP Coordinating Committees that same day*)	Coordinating	Appendix A
October 25, 2016	Agreed that HCP Coordinating Committees approval will be required to add non-HCP representatives and alternates to HCP email distribution lists, similar to approving Extranet access (the latter discussed February 25, 2014)	Coordinating	Appendix A
October 25, 2016	Agreed to add Michael Humling (USFWS) to the HCP Hatchery Committees email distribution list	Coordinating	Appendix A
October 25, 2016	Agreed to move the start time of the monthly HCP Coordinating Committees from 9:30 to 10:00 a.m., to accommodate travel arrangements for attendees	Coordinating	Appendix A
November 11, 2016	Approved a budget amendment request from Trout Unlimited for the Clear Creek Fish Passage and Instream Flow Enhancement Project	Tributary	Appendix C
November 11, 2016	Approved a time extension request from Trout Unlimited for the MVID Instream Flow Improvement Project	Tributary	Appendix C

Notes:
AWS = auxiliary water supply
BiOp = Biological Opinion
CCFEG = Cascade Columbia Fisheries Enhancement Group
CDLT = Chelan-Douglas Land Trust
HCP = Habitat Conservation Plan(s)
HRR = hatchery replacement rate
MVID = Methow Valley Irrigation District
M&E = monitoring and evaluation
PRCC = Priest Rapids Coordinating Committee
RM = river mile

SOA = statement of agreement
USFWS = U.S. Fish and Wildlife Service
WDFW = Washington Department of Fish and Wildlife

The following sections summarize the achievements, actions, and activities taken in 2016 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 of measures to achieve the survival standards." Briefly, Phase I consists of a 3-year period in which studies are conducted to determine annual survival rates for each of the Plan Species. Following the completion of 3 years of valid studies, the Rocky Reach HCP Coordinating Committee will determine whether the survival standard has been achieved. Depending on the results of this determination, Chelan PUD will proceed to either Phase II or Phase III. Under Phase II, the Rocky Reach HCP Coordinating Committee may determine the standards are not met, and Chelan PUD is responsible for evaluating additional tools to improve survival. Under Phase III, the Rocky Reach HCP Coordinating Committee may determine the survival standards are achieved, and Chelan PUD is required to re-evaluate survival every 10 years, or Phase III and NNI compensation is in place, but additional juvenile studies remain.

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	95.79[1]	Phase III (Standards Achieved)	October 24, 2006
UCR Yearling Chinook Salmon	92.28[2]	Phase III (Standards Achieved)	August 30, 2011

Plan Species	Project Survival (%)	Phase Designation	SOA Date
UCR Subyearling Summer/Fall Chinook Salmon	TBD	Phase III (Additional Juvenile Studies)	September 29, 2016
Okanogan River Sockeye Salmon	93.59[1]	Phase III (Standards Achieved)	December 17, 2010
Coho Salmon	NA	Phase III (Standards Achieved – Interim Value)	June 20, 2007

Notes:
1 Juvenile project survival achieved (HCP standard is 93%)
2 Combined adult and juvenile survival achieved (HCP standard is 91%)
NA = Not applicable
SOA = statement of agreement
TBD = to be determined
UCR = Upper Columbia River

In 2010, the HCP Coordinating Committees approved a Chelan PUD request to restart passage survival testing of UCR yearling Chinook salmon at the Rocky Reach Project, starting with the year 2011. In 2011, the estimated juvenile yearling Chinook salmon project survival was 92.94%. In 2011, Chelan PUD also presented the HCP Coordinating Committees with passive integrated transponder (PIT)-tag data in support of an empirically based estimate of adult spring Chinook salmon project passage survival for the Rocky Reach Project (dam and reservoir). As described in Section 2.1.2 of this report, Section 5.2 of the Rocky Reach HCP states that a combined adult and juvenile project survival of 91% shall be achieved and maintained. Due to an inability to differentiate hydro-related mortality from natural adult losses and straying rates when the HCP was developed, 93% juvenile project survival and 95% juvenile dam passage survival standards were used as alternative measures of initial compliance. Using PIT-tag data, the 3-year (2009 to 2011) average adult spring Chinook salmon passage survival rate at Rocky Reach was estimated to be 99.90%. Combined with a 4-year average (2004, 2005, 2010, and 2011) Rocky Reach Project yearling spring Chinook salmon passage survival estimate of 92.37%, the combined adult and juvenile survival was estimated to be 92.28%, which exceeds the HCP combined survival standard of 91%. On August 30, 2011, a Phase III (Standards Achieved) designation for UCR spring Chinook salmon for the Rocky Reach Project was approved by the Rocky Reach HCP Coordinating Committee.

In 2013, information was reviewed on the status of tag technology and life-history attributes of subyearling summer Chinook salmon in the Mid-Columbia. Based on this information and review, the Rocky Reach HCP Coordinating Committee agreed that empirical estimates of juvenile project survival were not feasible. As a result, on June 25, 2013, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for 3 years (through June 2016). In June 2016, the Rocky Reach HCP Coordinating Committee re-evaluated the ability to conduct survival studies on subyearling Chinook salmon (see Section 2.1.2.3.2). Once again, available data indicated conducting survival studies on subyearling Chinook salmon is not feasible at this time. On September 29, 2016, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years (through September 2019) and stipulating that it will continue to evaluate or monitor study design, tag technology, and life-history information to better understand future survival study feasibility by 2019 (Appendix F).

Coho salmon are currently classified as Phase III (Standards Achieved – Interim Value), and are due to be re-evaluated in 2017. In September 2016, Chelan PUD began discussing estimates of juvenile coho salmon survival through the Rock Island and Rocky Reach projects within the Rocky Reach HCP Coordinating Committee. Once agreement is reached on survival estimates within the Rocky Reach HCP Coordinating Committee in 2017, hatchery compensation needed to meet Chelan PUD's NNI mitigation requirement will be discussed within the HCP Hatchery Committees.

2.1.2 Assessment of Project Survival

The 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 Sections 2.1.2.1 through 2.1.2.4.

2.1.2.1 Adult Passage Monitoring

2.1.2.1.1 Rocky Reach Project

When the 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 HCP states that given the inability to differentiate between the sources of adult mortality, initial compliance with the combined adult and juvenile survival standard would be based on the measurement of 93% juvenile project survival or 95% juvenile 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. 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[5].

[5] 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.

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%).

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).

2.1.2.2 Valid Study Flow Duration Curve Update

The Rocky Reach HCP, Section 13.24, 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 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. The final updated Flow Duration Curves is projected to be completed in 2017.

2.1.2.3 2016 Survival Studies

2.1.2.3.1 Yearling Chinook Salmon

No yearling Chinook salmon survival studies were conducted in 2016 at the Rocky Reach Project.

2.1.2.3.2 Subyearling Chinook Salmon

Since 2010, Chelan PUD has been compiling information on PIT-tag detections of subyearling Chinook salmon at Rocky Reach Dam to increase the understanding of subyearling life histories in the mainstem Columbia River upstream of Rocky Reach Dam. As discussed in Section 2.1.1, in 2013, data were reviewed regarding the status of tag technology and life-history attributes for subyearling summer Chinook salmon in the Mid-Columbia Basin. The Rocky Reach HCP Coordinating Committee agreed that, based on this information, an empirical estimate of subyearling project passage survival was not feasible. In June 2013, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for up to 3 years (June 2016).

On June 21, 2016, the Rocky Reach HCP Coordinating Committee participated in a Subyearling Chinook Salmon Passage Survival Workshop, which convened members of the HCP Coordinating Committees and Priest Rapids Coordinating Committee (PRCC), as well as regional expert guest presenters. The goal of the workshop was to communicate the most recent information on the life-history diversity of summer and fall Chinook salmon in the Mid-Columbia Basin and update the Committees on any improvements in fish tagging technologies. Topics discussed included, fish passage survival model updates, Snake River Chinook salmon life-history patterns, subyearling Chinook salmon life-history diversities observed in the Mid-Columbia Basin, availability of study fish, tagging effects, and available tags and detection equipment (Appendix R). Based on the information presented, the Committees concluded that conducting survival studies on subyearling Chinook salmon was not feasible at this time. Obstacles to the assessment of subyearling Chinook salmon project survival at the Rocky Reach Project include tag technology limitations, difficulty in defining active versus non-active migrants and understanding differences between summer and fall subyearling salmon, variability in the data due to the plasticity of the species, deficiencies in juvenile monitoring at facilities during winter months, and comprehension of what is compliant with regard to HCP requirements. Therefore, in September 2016, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years (September 2019; Appendix F). The SOA stipulates that the Rocky Reach and Rock Island HCP Coordinating Committees will continue to evaluate or monitor study design, tag technology, and life-history information to better understand future survival study feasibility by 2019. In addition, the HCP Coordinating Committees agreed to convene quarterly joint sessions with the PRCC to continue discussions regarding subyearling Chinook salmon passage studies.

2.1.2.4 2017 Planned Survival Studies

There are no planned Rocky Reach juvenile salmonid project survival studies for 2017.

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 2016. Actions in 2016 were guided by the 2016 Rocky Reach and Rock Island HCP Action Plans (Appendix I), as approved by the Rocky Reach and Rock Island HCP Coordinating Committees on February 23, 2016 (Appendix A).

2.1.3.1 Operations

2.1.3.1.1 Juvenile Bypass and Fish Spill Operations[6]

On March 22, 2016, the Rocky Reach and Rock Island HCP Coordinating Committees approved the 2016 Rocky Reach Juvenile Fish Bypass System Operations Plan (Appendix M) and the *2016 Rocky Reach and Rock Island Fish Spill Plan* (Appendix N). The Rocky Reach juvenile bypass system operated continuously from April 1 through August 31, 2016, which covered the normal bypass operating period for the outmigration of juvenile salmon and steelhead at Rocky Reach Dam. The target level for summer spill was 9% of the daily average river flow. Spill for summer-migrating subyearling Chinook salmon at Rocky Reach Dam began on May 29, 2016, at 0001 hours, and continued through midnight on August 15, 2016. Following completion of the bypass operations on August 31, 2016, it was estimated that spill was provided for 91.4% of the subyearling Chinook salmon outmigration. Following review of the data, it was determined that the 95% passage target was missed by 1 day, due to the initial Data Access in Real Time passage estimate increasing by 5.71% from May 27 to May 28, 2016, based on a hindsight analysis conducted after the 2016 index season. Once Chelan PUD became aware of the downward revision in the estimated proportion of the outmigration for which spill was provided, Chelan PUD conducted additional analyses of PIT-tag data to determine whether river flow and river temperature were related to subyearling Chinook salmon travel time to Rocky Reach Dam. The purpose of the analysis was to improve the understanding of how to avoid not achieving the 95% passage target in the future. However, no definitive relationships between these factors and subyearling Chinook salmon travel time was found. In the future, Chelan PUD will use extra caution in meeting the 95% passage target given what occurred in 2016.

Spill volume for the 79-day summer period averaged 9.49% of the total river flow, and comprised 9.00% fish spill and an additional 0.49% unavoidable hydraulic spill. The Columbia River flow rate past Rocky Reach Dam during the spill period averaged 115,590 cubic feet per second (cfs), and the daily average spill rate was 10,971 cfs. Complete Rocky Reach Dam 2016 fish spill operations results are summarized in the 2016 Rocky Reach and Rock Island Fish Spill Report (Appendix Q).

[6] 129 FERC ¶ 62,183 (issued December 8, 2009). Order Modifying and Approving Operations Plan Pursuant to License Article 402.

2.1.3.1.2 Pikeminnow Predator Control

In 2016, northern pikeminnow (*Ptychocheilus oregonensis*) predator-control work continued 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 contract was extended to overlap with the 2016 U.S. Department of Agriculture (USDA) effort. The USDA hook-and-line angling program commenced during the peak of juvenile salmonid migration. The total combined harvest of pikeminnow in 2016 from Rocky Reach and Rock Island reservoirs was 91,522 fish. Harvest numbers from the various control efforts in 2016 were as follows: USDA hook-and-line angling – 60,327 fish; Columbia Research long-line angling – 27,472 fish; East Wenatchee Rotary Club pikeminnow derby – 2,347 fish; and removal by Chelan PUD Fish and Wildlife personnel – 1,376 fish. As in 2015, Chelan PUD once again provided contract funding for the annual East Wenatchee Rotary Club Pikeminnow Derby in 2016. A report summarizing results of the 2016 removal effort is expected sometime in early 2017.

2.1.3.1.3 Rocky Reach Juvenile Fish Bypass Pre-season Marked Fish Releases

Each year, Chelan PUD conducts pre-season marked fish releases at the Rocky Reach Juvenile Fish Bypass to test the system for possible descaling injury or mortalities prior to the start of the bypass season, which begins on April 1 at midnight. 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 24, 2016, a total of 200 fish were released into the north and south entrance channels located upstream of the trash rack surface collector system. The majority of fish released in the north entrance (98 of 100) were recovered and free of descaling (97 of 98) and injury (98 of 98). In addition, the majority of fish released in the south entrance (98 of 100) were recovered and were all free of descaling and injury (98 of 98).

On March 24, 2016, a total of 196 fish were released into vertical barrier screens (VBSs) that were deployed in Turbine Units C1 and C2. A total of 92 of 98 fish released in the VBS in C1 were recovered and were free of descaling and injury. In addition, 96 of 98 fish released in the VBS in C2 were recovered, of which one fish showed signs of descaling.

2.1.3.1.4 Pacific Lamprey Passage at Tumwater Dam

In March 2016, the U.S. Fish and Wildlife Service (USFWS) raised a question regarding how to properly address Pacific lamprey (*Entosphenus tridentatus*) passage at Tumwater Dam as it relates to HCP Plan Species broodstock collection. Per the Rock Island, Rocky Reach, and Wells HCPs, the HCP Hatchery Committees have oversight regarding trapping for broodstock, and the HCP Coordinating Committees have oversight regarding fish passage. After internal discussion, Chelan PUD agreed these same principles apply to Pacific lamprey at Tumwater Dam when either collection of broodstock or adult passage of HCP Plan Species is of concern. Therefore, any future discussions of Pacific lamprey passage at Tumwater Dam will likely be presented to the HCP Coordinating and Hatchery Committees because the issue involves activities overseen by both committees. The Rocky Reach Fish Forum has purview over Pacific lamprey, and topics are discussed at monthly meetings.

2.1.3.1.5 Rocky Reach Dam Orifice Gate Closure

In April 2016, Chelan PUD presented a proposal to the Rocky Reach HCP Coordinating Committee to close 6 of 22 orifice gates in the Rocky Reach Dam fishway to improve hydraulic conditions throughout the powerhouse collection channel at Rocky Reach Dam. The purpose of the request is to resolve the difficulty in maintaining the required 1-foot differential at the fishway entrances during low river flow conditions, after flow required to operate the orifice gates leaves the fishway (see Appendix A; April 26, 2016, meeting minutes). The initial proposal also included a review of options to compensate for this lack of water while keeping the orifice gates open; however, closing the gates was ultimately the preferred option. In May 2016, Chelan PUD provided a summary of historical radio telemetry data demonstrating use of the orifice gates by adult salmonids. In June 2016, Chelan PUD also provided a description of the logistics and mechanics associated with the proposal to close the orifice gates. On July 26, 2016, the Rocky Reach HCP Coordinating Committee approved the Closure of Rocky Reach Adult Fishway Orifice Gates SOA (Appendix F), and on August 11, 2016, Chelan PUD closed orifice gates 20, 18, 16, 1, 2, and 3, at Rocky Reach Dam (see Section 2.1.3.2.4). As requested, Chelan PUD also monitored

PIT-tag data from Rock Island Dam and Rocky Reach Dam through the remainder of the 2016 fish-counting season, and compared those data to past years as a means to assess passage delays associated to the orifice gates. These data were provided to the Rocky Reach HCP Coordinating Committee each month, starting in August 2016 and continuing through the end of the fish counting season of the Rocky Reach Adult Fishway on November 15, 2016.

2.1.3.1.6 Canceled Installation of Microturbines at Rocky Reach and Rock Island Dams

In May 2016, Chelan PUD notified the Rocky Reach and Rock Island HCP Coordinating Committees about plans to submit a letter to FERC canceling installation of microturbines in the fishways of Rocky Reach and Rock Island dams. In March 2001, in response to the *2000-2001 Western U.S. Energy Crisis*, FERC issued a FERC Order requesting that licensees increase generation at their respective projects. Chelan PUD developed a conceptual plan to deploy microturbines in the fishways to increase generation capacity, which was approved by FERC on March 14, 2002. However, subsequent analyses showed that upgrading the existing turbines to increase their efficiency would provide a greater increase in generation than installing the new microturbines; therefore, the new microturbines were never installed. In August 2016, the draft letters were provided to the Rocky Reach and Rock Island HCP Coordinating Committees for a 30-day review. No comments were received on the letters from the Rocky Reach and Rock Island HCP Coordinating Committees, which were then submitted to FERC on September 27, 2016.

2.1.3.1.7 Rocky Reach Dam Auxiliary Water Supply System

During the 2016/2017 winter maintenance outage at Rocky Reach Dam, extensive maintenance is planned, including an overhaul of one of three auxiliary water supply system pumps (see Section 2.1.3.2). Considering the unanticipated delays experienced with the Rock Island Dam right fish ladder sluice gate, RO4, in early 2016, as a cautionary measure, Chelan PUD requested an earlier winter maintenance outage than normal to allow more time to complete the needed work. The Rocky Reach HCP Coordinating Committee agreed to Chelan PUD beginning the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early. Rather than beginning January 2, 2017, the new start was December 12, 2016.

2.1.3.2 Improvements and Maintenance

Facility improvements and maintenance at the Rocky Reach Project in 2016 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 C10, mechanic crews discovered a deep hairline crack in a stainless-steel rod that delivers oil to the servo motor. 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 C8, C9, C10, and C11. The interim fix involved fixing the blades at selected steep angles that were determined to be the most efficient at full river flow (23,000 cfs) on the unit curve; these steep angles also represent the safest position, minimizing cavitation and the risk of turbine runaway. In 2015, permanent fixes were underway. 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. These unexpected issues postponed the projected completion date to December 2020.

2.1.3.2.2 2015/2016 Rocky Reach Adult Fish Ladder Winter Maintenance

On January 4, 2016, the fish ladder at Rocky Reach Dam was taken offline for annual winter maintenance. All annual preventative maintenance and inspections were completed, and the ladder was returned to service on February 25, 2016.

2.1.3.2.3 Rocky Reach Dam Adult Fish Ladder Weir Grating

On January 4, 2016, while monitoring for fish stranding during the 2015/2016 winter maintenance outage at Rocky Reach Dam, 22 adult Pacific lamprey were discovered beneath the diffuser grating in Weir A13. The grating was removed and all 22 fish were rescued and released into the Rocky Reach forebay. By February 12, 2016, the 1-inch diffuser grating floors in Weirs A10 to A13 were replaced with 3/4-inch grating. Chelan PUD engineers determined this change in grating width should not affect hydraulic conditions through the area.

2.1.3.2.4 Rocky Reach Dam Orifice Gate Closure

On August 11, 2016, Chelan PUD closed 6 of 22 orifice gates in the Rocky Reach Dam fishway, as approved by the Rocky Reach HCP Coordinating Committee on July 26, 2016 (see Section 2.1.3.1.5). Orifice gates 1, 2, and 3, operated on the north end of the powerhouse near the left powerhouse entrance, and orifice gates 16, 18, and 20, operated on the south end of the powerhouse near the right powerhouse entrance, were closed to help improve hydraulic conditions throughout the powerhouse collection channel at Rocky Reach Dam.

2.1.3.2.5 Rocky Reach Dam Auxiliary Water Supply System

During the 2016/2017 winter maintenance outage at Rocky Reach Dam, Chelan PUD will begin an overhaul on the auxiliary water supply system pumps (one of three pumps total; see Section 2.1.3.1.7). These pumps transfer water from the tailrace into the collection system to maintain proper head differentials on the ladder entrances. If time allows, Chelan PUD plans to repair two pumps during the 2017/2018 outage, which would avoid an early outage for a third year in a row.

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 2016, 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 2016 included the release of 1,363,710 juvenile salmonids (combined Rocky Reach and Rock Island hatchery compensation; Table 5).

To improve coordination, a representative from Grant PUD is invited to the monthly HCP Hatchery Committees meetings. The Grant PUD representative and the

PRCC Hatchery Sub-Committee facilitator also receive meeting announcements, final agendas, and meeting minutes. Furthermore, 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 (see Section 2.2.2.17). This practice benefits the HCP Hatchery Committees through increased coordination and sharing of expertise. The Grant PUD representative has 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.

2.2.1 Hatchery Production Summary

Table 5 summarizes and compares HCP hatchery production objectives and actual 2016 smolt releases.

Table 5
2016 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 2016 (Number of fish)
Spring Chinook Salmon	Methow	Methow Hatchery	60,516	72,019 smolts
Summer Chinook Salmon	Chelan Falls	Chelan Falls	576,000	464,450 smolts
Steelhead	Wenatchee	Chiwawa Hatchery[c]	247,300[d]	198,913 smolts
Sockeye Salmon	Okanogan	Kl cp'elk' stim Hatchery	591,050[e]	367,572 fry
Spring Chinook Salmon	Okanogan	CJH	115,000 (12.81% of CJH production)	93,445 smolts
Summer Chinook Salmon	Okanogan	CJH/ Omak Pond	94,570 (13.51% of CJH production	53,320ʼ subyearlings
Summer Chinook Salmon	Okanogan	Similkameen	166,569 (12.81% of CJH production)	113,991 yearlings

Notes:
a Coho salmon mitigation met by the funding agreement with the Yakama Nation.

b As specified in the Rocky Reach and Rock Island HCP Hatchery Committees Statement of Agreement Chelan PUD Hatchery Compensation, Release Years 2014 to 2023, approved December 14, 2011.
c Includes releases from Blackbird Island Pond and truck planting to other locations in the Wenatchee subbasin.
d Steelhead production at Chiwawa includes Rock Island and Rocky Reach obligations.
e 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 Okanogan Skaha Lake sockeye salmon reintroduction program until otherwise determined by the HCP Hatchery Committees.

CJH = Chief Joseph Hatchery
HCP = Habitat Conservation Plan

2.2.2 Hatchery Planning and Implementation

Sections 2.2.2.1 through 2.2.2.17 detail 2016 actions that are relevant to planning for hatchery operations that support the HCP.

2.2.2.1 2016 Broodstock Collection Protocols

In February 2016, the HCP Hatchery Committees began their review of the draft 2015 Broodstock Collection Protocols (for Chinook salmon and steelhead). The revised draft protocols were approved via email as follows: Washington Department of Wildlife (WDFW) and National Marine Fisheries Service (NMFS) approved April 8, 2016; Douglas PUD approved April 11 2016; and Chelan PUD, Colville Confederated Tribes (CCT), Yakama Nation (YN), and USFWS approved April 13, 2016. The 2016 Broodstock Collection Protocols (Appendix S) were distributed to the HCP Hatchery Committees on April 14, 2016, and implemented at program hatcheries throughout 2016. In-season revisions were made as needed in coordination with the HCP Hatchery Committees. As in previous years, the 2016 Broodstock Collection Protocols were intended to guide the collection of salmon and steelhead broodstock in the Methow River, Wenatchee River, and Columbia River basins. 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 Chelan Falls Summer Chinook Salmon Broodstock Collection

In May 2016, Chelan PUD, Grant PUD, and Douglas PUD discussed methods for collecting summer Chinook salmon broodstock at Wells Dam for the Chelan Falls program; however, Wells Dam was determined not to be an option for broodstock collection for the Chelan Falls

Program. The Rocky Reach and Rock Island HCP Hatchery Committees agreed that collection in 2016 for the Chelan Falls summer Chinook salmon program will be prioritized at the Eastbank Outfall, with summer Chinook salmon surpluses at the Entiat National Fish Hatchery serving as a back-up if a shortfall in the broodstock target is realized. To ensure a more reliable brood collection location in 2017 and beyond, Chelan PUD proposed a pilot study to trap a limited number of broodstock at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station. Chelan PUD indicated in August 2016 that they were successful in collecting broodstock at the outlet structure (the proposal included collection of 50 females and 50 males for testing purposes). Results on gamete viability and egg-to-fry survival rates will be available in 2017. Results from the pilot study will determine if broodstock will be collected at the outlet structure of the water conveyance canal in the future.

2.2.2.1.2 Methow Spring Chinook Salmon Broodstock Collection

In June 2016, WDFW indicated they had collected 90 adult natural-origin spring Chinook salmon, of which approximately 60 could be used as broodstock for the Methow Program. The run timing at Wells Dam was compressed in 2016, and due to trapping constraints, WDFW staff had not been able to collect the target number. The target for 2016 was 122 natural-origin fish. Douglas PUD indicated staff at Wells Dam were 2 weeks delayed in genetic identification, because the genetic sequencer was in need of repair. The Twisp River trap was also operating during the night, and staff were optimizing trapping operations (for Douglas PUD's Twisp Program) based on the time-of-day fish move. Tangle-netting for broodstock in the Chewuch River was proposed to acquire natural-origin recruits for the Methow program. The HCP Hatchery Committees discussed the effectiveness of past years' tangle-netting efforts in the Chewuch River, potential bull trout (*Salvelinus confluentus*) encounters, potential issues with USFWS permitting, and the existing back-up plan to broodstock shortages (using hatchery-origin fish). The HCP Hatchery Committees agreed the HCP Coordinating Committees should discuss trapping constraints at Wells Dam. Following email discussions, the HCP Hatchery Committees supported WDFW using tangle-netting to capture Methow spring Chinook salmon in the Chewuch River in 2016 under the condition that trapping constraints at Wells Dam are addressed, and under the conditions that tangle-netting in 2016 is limited to no more than 8 days during a 2-week period, and trapping complies with all temperature, fish harassment, and fish-handling procedures implemented in 2014. The HCP Coordinating Committees agreed, after discussing various modifications to trapping at Wells Dam, that per the Wells Project HCP; 2000 Wells Project Interim Biological Opinion (BiOp); 2003 BiOp; and Hatchery Permits 1196, 1347, and 1395, trap operators at Wells Dam have the flexibility to trap spring Chinook salmon outside the protocols used to date (16 hours per day, 3 days per week), in order to achieve broodstock collection targets as prescribed and in consultation with the annual Wells HCP Coordinating Committee-approved Broodstock Collection Protocols.

2.2.2.1.3 Chiwawa Spring Chinook Salmon Broodstock Collection

In August 2016, Chelan PUD indicated they stopped trapping for Chiwawa spring Chinook salmon at the Chiwawa Weir on July 25, 2016, because they had reached the maximum allowable number of bull trout encounters (110 fish). At this point, they had collected 30 males and 31 females from the Chiwawa Weir. They collected a few additional natural-origin previously PIT-tagged spring Chinook salmon at Tumwater Dam, and indicated the remainder of the program would comprise hatchery-origin fish.

2.2.2.2 Brood Year 2016 Wenatchee Steelhead Release Plan

In 2016, Chelan PUD's hatchery compensation level was 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. In February 2016, Chelan PUD and WDFW presented to the HCP Hatchery Committees a Draft 2016 Wenatchee Steelhead Release Plan and also presented preliminary results from the 2015 Wenatchee steelhead release. Release strategy objectives for 2016 were the same as in 2015 and included evaluating best management practices for hatchery releases to optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions. The plan implemented a paired release design by vessel type, brood origin, and release sites, and also a detailed monitoring and evaluation (M&E) plan. The 2016 Wenatchee Steelhead Release Plan (Appendix J) was approved by the Rock Island and Rocky Reach HCP Hatchery Committees on March 3, 2016, and was implemented in April and May 2016. During discussions of the 2016 Wenatchee Steelhead Release Plan, Chelan PUD indicated that the program was short by approximately 50,000 hatchery-by-hatchery steelhead because warmer than average in-river water temperatures in 2015 adversely affected egg quality of the broodstock.

2.2.2.3 Hatchery Monitoring and Evaluation Plan Implementation

2.2.2.3.1 Hatchery Monitoring and Evaluation Plan

Since 2013, Chelan PUD hatchery programs have been operated in accordance with the *Monitoring and Evaluation Plan for PUD Programs 2013 Update* and the Chelan PUD Hatchery M&E Implementation Plan, titled *Chelan County PUD Hatchery M&E Work Plan*, prepared annually to describe the M&E activities for the next calendar year. In September 2015, the Chelan PUD 2016 Hatchery M&E Implementation Plan was finalized following a 30-day HCP Hatchery Committees review period, and was appended to the *2015 Rocky Reach HCP Annual Report.*

On June 17, 2015, the Rocky Reach and Rock Island HCP Hatchery Committees agreed to change the deadline for Chelan PUD to provide their draft Hatchery M&E Annual Implementation Plan to the HCP Hatchery Committees for review from July 1 to August 1 of the year preceding the proposed M&E activities, so long as there are no significant changes requiring HCP Hatchery Committees discussion. The Rocky Reach and Rock Island HCP Hatchery Committees approved the Chelan PUD 2017 Hatchery M&E Implementation Plan (Appendix P) on August 28, 2015, following a less than 30-day HCP Hatchery Committees review period. The review period was set at 30 days; however, the Rocky Reach and Rock Island HCP Hatchery Committees completed their review of the document and elected to approve it early during the HCP Hatchery Committees meeting.

2.2.2.3.2 Hatchery Monitoring and Evaluation Plan Report

On June 17, 2015, the Rocky Reach and Rock Island HCP Hatchery Committees approved Chelan PUD's proposed Hatchery M&E Annual Report schedule to provide the HCP Hatchery Committees with a draft Hatchery M&E Annual Report for a 30-day review by June 15, with the final report due to NMFS by September 1. In August 2016, the Chelan PUD 2015 Hatchery M&E Plan Report, titled *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2015 Annual Report,* which documented M&E activities in 2015 (Appendix T) and was finalized following a 30-day

HCP Hatchery Committees review period. In addition, Chelan PUD is working with the HCP Hatchery Committees to develop a long-term scheduling plan to logically orchestrate HCP requirements and M&E reporting, including annual and 5-year interval reports, and the 10-year Program Review (Rocky Reach HCP: Section 8.7). The HCP Hatchery Committees expect to finalize the schedule in early 2017.

2.2.2.4 Hatchery Monitoring and Evaluation Plan Appendices

In January 2015, while discussing where to append the memorandum clarifying standardized methods for Hatchery M&E Plan Objective 8.3, Fecundity at Size, the HCP Hatchery Committees recognized that the Hatchery M&E Plan Appendices had not yet been finalized. In March 2015, the HCP Hatchery Committees agreed to reconvene the Hatchery Evaluation Technical Team (HETT) to finalize the appendices. The HETT first reconvened in April 2015, and discussed a plan for completing the appendices, which are living documents, subject to change as more data become available. Appendices were split up among HETT members to complete by varying dates, and work continued in 2016 to finalize the Hatchery M&E Plan Appendices. HETT members distributed drafts of Appendices 2, 4, 5, and 6 in February and March, 2016. In March 2016, the HCP Hatchery Committees discussed how carrying capacity estimates should be calculated for Appendix 1 and provided feedback to Tracy Hillman on material that should be included in Appendix 1. Hillman presented carrying capacity estimates for Chiwawa River spring Chinook salmon to the HCP Hatchery Committees in April 2016, and the HCP Hatchery Committees suggested Hillman focus on methodology for calculating carry capacity estimates when drafting Appendix 1, with some populations included as examples. In May 2016, Appendix 3 was distributed for review. In June 2016, the HCP Hatchery Committees discussed and revised draft appendices 2 through 6. The HCP Hatchery Committees approved Appendices 2 (Hatchery Replacement Rate [HRR] Targets), 4 (Spatial Distribution of Spawners), and 6 (Rearing Targets) in June 2016. Appendix 6 was later revised, and a final revised version was approved in August 2016. Appendix 3, Proportionate Natural Influence (PNI) and Percent Hatchery-origin Spawners (pHOS) Targets and Sliding Scales, was revised and later approved in August 2016. Appendix 5, Stray Rate Objectives, was further revised and discussed in August, September, and October 2016. The HCP Hatchery Committees discussed in October 2016 that material in Appendix 5 is redundant with the Hatchery M&E Plan, and decided to delete Appendix 5.

Appendices 2, 3, 4, and 6 will be renumbered and appended to the Hatchery M&E Plan in 2017. Appendix 1, which addresses carrying capacity, is not finished and will have a placeholder in the Hatchery M&E Plan until it is complete.

2.2.2.5 Review of the Five-Year Hatchery Monitoring and Evaluation Report

In March 2015, while working toward approving an Interlocal Agreement between Chelan PUD and Douglas PUD to rear Chelan PUD's Methow spring Chinook salmon production at the Methow Fish Hatchery, the HCP Hatchery Committees unanimously agreed on the need to revisit the results of M&E in the Methow Basin to date, and develop an adaptive management plan to improve the performance of the Methow Hatchery Programs. The HCP Hatchery Committees also approved an SOA titled, *Regarding Timeline for Review of 'Evaluation of Hatchery Programs Funded by Douglas County PUD 5-Year Report 2006-2010,'* which outlined specific actions to accomplish within 1 year of approval of the SOA. In April 2015, the HCP Hatchery Committees agreed to review the Five-Year Hatchery M&E Report by species and basin, starting with spring Chinook salmon in the Methow Basin, and moving forward program-by-program (e.g., Methow, Twisp, and Chewuch).

In May 2015, a Methow Spring Chinook Salmon Review of Five-Year Annual Report Plan Outline was distributed, which divided Hatchery M&E Plan objectives into groups to be reviewed during subsequent HCP Hatchery Committees meetings. The HCP Hatchery Committees began reviewing Hatchery M&E Plan objectives for Methow Spring Chinook Salmon, as described in the outline, documenting which objectives are not meeting targets, flagging items to revisit, and, where applicable, developing recommendations or documenting reasons for not revisiting objectives. During this review, Objectives 2, 4, 5, 6, and 7 were flagged for further discussion. Review of all objectives for Methow spring Chinook salmon was complete by August 2015, and in September 2015, the HCP Hatchery Committees reviewed and prioritized the flagged objectives. In October 2015, the HCP Hatchery Committees began a process of addressing flagged objectives, including convening the HETT to further discuss certain flagged objectives and make recommendations to the HCP Hatchery Committees. Review of Hatchery M&E Plan objectives for Methow spring Chinook salmon were continued into 2016, along with the complete review of the Five-Year Hatchery M&E Report.

In January 2016, the HCP Hatchery Committees addressed flagged objectives 2 (Spawner Distribution), 4 (HRRs and Targets), and 6 (Size-at-release Targets). Regarding Objective 2, the HCP Hatchery Committees previously approved a study design to determine if spawner distribution in the Methow Basin can be improved with short-term acclimation (the Upper Methow Acclimation Study Proposal and Goat Wall SOA, approved in March 2015), so no further discussion was needed at that time. Regarding Objective 4, the HCP Hatchery Committees agreed to revise the method for calculating HRR targets (now, as the 40th percentile, including harvest). Regarding Objective 6, the HCP Hatchery Committees agreed to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly. In February 2016, the HCP Hatchery Committees addressed flagged Objectives 1 (Abundance of Natural-origin Spawners), 5 (Homing Fidelity), and 7 (Freshwater Productivity), and also continued to address Objective 4. Objective 1 was not initially flagged, but was discussed in order to ensure hatchery programs have a positive effect on the population, as measured by the abundance of natural-origin spawners. Regarding Objective 4, the HCP Hatchery Committees agreed to revise the methods used for calculating HRR targets (agreed to in January 2016), to those described in Grant PUD's Target HRR Proposal (Appendix H). Regarding Objective 7, more data are being collected to better assess the effects of pHOS on juvenile productivity, so no further discussion occurred at that time. Addressing Objective 5 continued to be a topic of discussion throughout 2016. The HCP Hatchery Committees transitioned in April 2016 from discussing Objective 5 to designing and implementing a study plan to address Objective 5. At that point, the review of the Five-Year Hatchery M&E Report was complete, and the HCP Hatchery Committees began drafting a summary of their review, which is expected to be finalized in January 2017.

Regarding Objective 5 and homing fidelity, in February 2016, the HCP Hatchery Committees invited Andrew Dittman (National Oceanic and Atmospheric Administration [NOAA]) to discuss the effects of hatchery rearing and release practices on olfactory imprinting and homing for salmon. The goal of Objective 5 is to increase spring Chinook salmon homing to the Twisp and Chewuch rivers and decrease straying to the Methow Fish Hatchery and lower Methow River. Potential solutions and experiments in the Methow subbasin were identified, including rearing fish in a hatchery much farther away from their natal sites, and then acclimating and releasing the fish in order to prevent familiar olfactory inputs from the hatchery confusing them as they migrate upstream. Wells and Eastbank fish hatcheries are downstream of natal acclimation sites and perhaps far enough away from natal sites to increase natal homing. A paired release at both Twisp and Chewuch Acclimation Facilities was identified as one potential sequential imprinting study. The HCP Hatchery Committees discussed the logistics and effects of potential studies identified in the Twisp and Chewuch Homing Fidelity Study Options draft provided by YN (Appendix B; February 17, 2016, meeting minutes). While a study plan is being developed, and during the years of the study, straying issues are likely to continue. The HCP Hatchery Committees discussed truck-planting fish into the Chewuch River.

In May 2016, a sub-group of HCP Hatchery Committees members visited the Issaquah Salmon Hatchery to learn more about embryonic imprinting, and after further discussions about embryonic and sequential imprinting, a second sub-group will prepare a plan in 2017 to instead outplant adult spring Chinook salmon in the Chewuch River. The HCP Hatchery Committees determined that evaluating embryonic imprinting to improve homing would be difficult to implement and to statistically evaluate. In an effort to achieve the goal of a higher rate of homing (i.e., increased spawner abundance in a specific location), the HCP Hatchery Committees agreed to pilot adult outplanting of surplus Methow spring Chinook salmon. The HCP Hatchery Committees also agreed to evaluate adult outplanting as a method to increase spawner abundance and natural production in the Chewuch River. Pending the results of the outplanting study, the HCP Hatchery Committees may consider an embryonic or sequential imprinting study.

2.2.2.6 Okanogan Sockeye Salmon Mitigation

In 2016, Chelan PUD provided an eleventh year of funding for a portion of the Okanagan Nation Alliance's 12-year 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 also contributed to the construction of the new Kl cp'elk' stim Sockeye Salmon Hatchery in Penticton, British Columbia, which was completed in September 2014. 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 Okanagan Nation Alliance release. In June 2016, the hatchery released roughly 367,000 fry. Fry release numbers were down in

2016 due to low adult returns and warm water temperatures resulting in poor egg quality in 2015. The hatchery was designed to support up to an 8-million-egg program; however, initial plumbing accommodates 5 million eggs. The egg-take goal of 5 million eggs was achieved for the first time in 2016.

2.2.2.7 Hatchery and Genetic Management Plans

In May 2015, NMFS announced that permits could no longer be issued without first obtaining completed consultations by USFWS. NMFS also indicated that consultations and permitting were further delayed due to the ongoing Puget Sound litigation and NMFS' growing concern with litigation risk.

2.2.2.7.1 Wenatchee Steelhead

On June 30, 2014, after more than 4 years of consultation, the initial draft Wenatchee Steelhead BiOp was completed by NMFS. The BiOp was revised several times in 2014 and 2015, and a final BiOp was issued on July 20, 2016. The Section 10(a)(1)(A) permit is expected to be issued in 2017, pending the completion of Section 7(a)(2) consultation with USFWS.

On November 28, 2012, NMFS requested formal consultation with USFWS under Section 7(a)(2) of the ESA on the proposed permitting of the Chiwawa Spring Chinook Salmon, Wenatchee Steelhead, and Wenatchee summer Chinook Salmon Programs. A partial draft BiOp was distributed by USFWS on December 23, 2014. Another draft was submitted for review on September 8, 2016, and is currently under review.

2.2.2.7.2 Methow Spring Chinook Salmon

In June 2013, NMFS requested that Chelan PUD prepare a full Methow Spring Chinook Hatchery and Genetic Management Plan (HGMP), despite formerly indicating that the HCP Hatchery Committees-approved addendum would be acceptable for the program. After multiple revisions to the draft HGMP, in March 2014, the Rocky Reach HCP Hatchery Committee approved the Chelan PUD Methow Spring Chinook HGMP, as revised. In October 2014, NMFS decided that the Chelan PUD Methow spring Chinook salmon consultation would be combined with the Methow Fish Hatchery and Winthrop National Fish Hatchery consultations with a target completion date of March 31, 2015.

In February 2015, NMFS indicated the March 31, 2015 deadline would not be met due to the urgency of completing permitting for other programs prior to the Winthrop Safety-Net and Methow Conservation Spring Chinook Salmon consultation. NMFS also requested that Chelan and Douglas PUDs coordinate with USFWS to develop: 1) a PNI approach for applying a PNI standard to reduce the contribution of the Winthrop Program to pHOS, for incorporation into the permit; and 2) language outlining shared research, monitoring, and evaluation (RME) responsibilities. In March 2015, the PUDs drafted RME language and developed a draft PNI sliding scale, as requested, and provided these items to USFWS for review. In October 2015, NMFS indicated the RME details have been elevated to the federal level with the U.S. Bureau of Reclamation (USBR) and USFWS, and the PUDs planned to meet with USBR and USFWS to discuss this matter. NMFS also indicated issues with the proposed draft PNI sliding scale. The HCP Hatchery Committees coordinated with WDFW and NMFS to further discuss gene flow standards, and on November 18, 2015, the HCP Hatchery Committees agreed to adopt the three-population gene flow model for calculating PNI. Also, in November 2015, after a meeting between executives of Chelan, Douglas, and Grant PUDs and NMFS, NMFS indicated an estimated Methow Spring Chinook Permit completion date of May 2016, pending completion of USFWS consultation. USFWS indicated in March 2016 that they will move forward with a strategy that relies on the 2012 Wells FERC license BiOp for coverage.

In February and March 2016, the HCP Hatchery Committees further discussed the Methow spring Chinook salmon gene flow sliding scale proposed by NMFS. The Gene Flow Management Standards approved in March 2016 (Appendix K) used a sliding scale for PUD targets and a reduced pHOS target for Winthrop National Fish Hatchery as natural runs increase. NMFS indicated the standards are aggressive and may be challenging to meet; therefore, permits will recognize the challenges of adult management in the Methow Basin and will be written to allow flexibility in meeting targets during the first few years of implementation. In April 2016, NMFS indicated new draft Methow Hatchery permits (Chelan PUD has their own permit with WDFW, whereas Douglas and Grant PUDs have a combined permit) had been distributed to applicants for review. In June 2016, NMFS indicated the Methow spring Chinook salmon BiOp was undergoing internal review and the Environmental Assessment was being drafted. As of August 2016, NMFS had distributed the draft Terms and Conditions for the Methow spring Chinook salmon consultation. In September 2016, USFWS indicated the memorandum documenting coverage for the Methow Hatchery programs from the 2012 Wells FERC license BiOp was undergoing internal review. It is anticipated that the permit process will be completed in 2017.

2.2.2.7.3 Wenatchee 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 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.

2.2.2.8 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 brood year (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 (Appendix B; September 16, 2015, meeting minutes). 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. HxH broodstock male and female fish had the lowest RRS. Hatchery-by-wild (HxW broodstock) male and female fish had a RRS between those of HxH broodstock and wild-by-wild (WxW) broodstock. WxW 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. A final report documenting the study results will be distributed in 2017.

2.2.2.9 Dryden Overwintering Feasibility Study/Wenatchee River Total Maximum Daily Load

In 2011, Chelan PUD agreed to assess the feasibility of modifying the Dryden Acclimation Facility to accommodate overwinter rearing, as memorialized in the SOA titled *Chelan PUD Hatchery Compensation, Release Years 2014-2023*, approved by the Rocky Reach and Rock Island HCP Hatchery Committees on December 14, 2011. Concurrent with this effort, Chelan PUD is evaluating ways to meet Washington State Department of Ecology's addendum to the Wenatchee Total Maximum Daily Load (TMDL) establishing modified phosphorus targets for discharge into the Wenatchee River, effective in 2019.

In July 2012, Chelan PUD committed to conduct specific actions toward assessing the feasibility of converting the Dryden Acclimation Facility to an overwinter facility in conjunction with determining how best to meet TMDL requirements for phosphorous discharge by 2018. Based on the proposed schedule for implementing these actions, Chelan PUD expected to have all the information needed to make a decision by 2015.

In March 2015, the HCP Hatchery Committees agreed for Chelan PUD to continue their Wenatchee and Chelan Falls Summer Chinook Size Target Study for 1 additional year in order to obtain additional data to better inform a long-term decision. This study is intended to contribute information about the performance of hatchery fish released at a smaller size, which may help Chelan PUD meet the phosphorus TMDL targets at the facility (see Section 2.2.2.9.1). Adding an additional year of testing, however, postponed making a final decision for another year.

In January 2016, Chelan PUD presented the results of their feasibility analysis to the HCP Hatchery Committees and concluded that the most effective and risk-minimizing approach to meeting phosphorous discharge limits is to rear Wenatchee summer Chinook salmon to a smaller size (anticipated to be 18 fish per pound). This would be accomplished by constructing a new, chilled, partial water reuse system at Eastbank Fish Hatchery utilizing circular ponds as a successfully demonstrated rearing practice, prior to transfer to the Dryden Acclimation Pond for final spring acclimation. Chelan PUD proposed to proceed with a feasibility study for design of a chilled, partial water reuse aquaculture system at Eastbank Fish Hatchery for Wenatchee summer Chinook salmon, to enable Chelan PUD to meet phosphorus discharge limits under the Wenatchee River TMDL for dissolved oxygen and pH levels. On February 17, 2016, the Rock Island and Rocky Reach HCP Hatchery Committees approved the Improvement Feasibility at Eastbank Fish Hatchery for Wenatchee summer Chinook SOA (Appendix E). The next steps in the feasibility study may include a complete design in 2017, construction in 2018, and first fish ponded in summer 2019.

2.2.2.9.1 Summer Chinook Salmon Size Target Study

In 2015, Chelan PUD conducted the second and final year of the Wenatchee and Chelan Falls Summer Chinook Size Targets Study with NOAA's Northwest Fisheries Science Center to help inform the feasibility of converting the Dryden Acclimation Facility to an overwinter facility in conjunction with determining how best to meet TMDL requirements (see Section 2.2.2.9). During the first year of this study (BY 2012), there were challenges reaching the specific size targets. During the second year of this study (BY 2013), size targets were generally met, and preliminary results showed differences as a result of rearing vessel and/or release size in juvenile performance for Wenatchee summer Chinook salmon and no difference in juvenile performance between the four size-at-release targets. In 2015, the HCP Hatchery Committees agreed for Chelan PUD to conduct a third year of the study (BY 2014) to attempt to replicate success from the BY 2013 study. Results from the BY 2014 study will be available in 2017.

2.2.2.10 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 (JFP) 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. 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 significantly upstream of the site used in the past (the Mid-Valley Pond site). 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 [BPA] Project# 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 JFP), 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; however, they 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. The YN still intends to conduct 5 years of spring Chinook salmon releases from the Goat Wall Acclimation Site.

2.2.2.11 Supplemental Radio-tagging of Summer Steelhead

In November 2015, the HCP Hatchery Committees received a proposal from WDFW and the University of Idaho to PIT-tag and radio-tag summer steelhead collected at Tumwater Dam and the Twisp Weir. WDFW and University of Idaho were trying to tag up to 500 summer steelhead at Priest Rapids Dam; however, due to lower than expected return rates in 2015, only 400 summer steelhead were tagged. There were 100 tags left, and WDFW and University of Idaho suggested tagging at Tumwater Dam and the Twisp Weir could provide additional information on parameters such as estimating stray rates and estimating overwinter survival, among other things. The HCP Hatchery Committees approved the proposal, which was also conducted during the spring 2016.

2.2.2.12 BY 2014 Methow Spring Chinook Salmon Acclimation

In January 2016, the HCP Hatchery Committees discussed logistical constraints for acclimating Chelan PUD's BY 2014 Methow spring Chinook salmon at the Chewuch Acclimation Facility. The fish were being held at Methow Fish Hatchery at the time. Chelan PUD identified their preferred option to have YN operate the facility. Other options included releasing the fish directly from Methow Fish Hatchery, truck-planting the Chewuch River-progeny fish as far upstream in the Chewuch River as possible, or performing final acclimation at Carlton Pond. The HCP Hatchery Committees discussed the pros and cons of each option, contracting issues and permission constraints, concerns about the infrastructure at Chewuch Acclimation Facility, and identified WDFW as another potential operator of the acclimation facility. After further discussion via email, CCT indicated that if contracting, budget and staff-hiring constraints jeopardize the acclimation and release of Chelan PUD's spring Chinook salmon from the Chewuch Acclimation Facility in 2016, they are agreeable to the operation of the Chewuch Acclimation Facility in 2016 consistent with the Rocky Reach and Rock Island HCP HC 2013 Chewuch Acclimation SOA (approved November 20, 2013). WDFW indicated they would not be able to staff the facility in time to release the fish, so Chelan PUD indicated in February 2016 that YN would operate the Chewuch Acclimation Facility in 2016.

2.2.2.13 Population Structure of Upper Columbia River Summer and Fall Chinook Salmon

In August 2016, the HCP Hatchery Committees reviewed the best-available information on genetics and population structure of UCR summer and fall Chinook salmon and concluded the UCR summer and fall Chinook salmon are one genetic population. Therefore, straying among subbasins (e.g., Wenatchee and Methow basins) will be considered a "within population genetic stray," and a 10% genetic stray rate applies. For example, Wenatchee summer Chinook salmon cannot comprise more than 10% of the Methow summer Chinook salmon spawning escapement. Previously, a 5% genetic stray rate was applied because the UCR summer and fall Chinook salmon populations were assumed to be independent populations. For management purposes, straying among subbasins will be considered a "management stray" and should not exceed 5%.

2.2.2.14 Methow Spring Chinook Salmon Gene Flow Standards

In February and March 2016, the HCP Hatchery Committees discussed the Methow spring Chinook salmon gene flow sliding scale proposed by NMFS. The Gene Flow Management Standards approved in March 2016 (Appendix K) included using a sliding scale for PUD targets and a reduced pHOS target for Winthrop National Fish Hatchery as natural runs increase. NMFS indicated the standards are aggressive and may be challenging to meet; therefore, permits will recognize the challenges of adult management in the Methow basin and will be written to allow flexibility in meeting targets during the first few years of implementation. In April 2016, NMFS indicated a draft Methow Hatchery 1196 permit covering all three PUD programs had been distributed to applicants for review. In June 2016, NMFS indicated the Methow spring Chinook salmon BiOp was undergoing internal review and the Environmental Assessment was being drafted. As of August 2016, NMFS had distributed the draft Terms and Conditions for the Methow spring Chinook salmon consultation. In September 2016, the USFWS indicated the memorandum documenting coverage for the Methow Hatchery programs from the 2012 Wells FERC license BiOp was undergoing internal review.

2.2.2.15 Releasing PIT-tagged Pacific Lamprey in the Tumwater Dam Fishway

In April 2016, YN presented a SOW to the HCP Hatchery Committees titled *SOW for Releasing Adult Pacific Lamprey within Tumwater Dam Fish Ladder* (Appendix B; April 20, 2016, meeting minutes). The HCP Coordinating Committees also discussed this topic, as it pertains to potential effects to passage of HCP Plan Species. The HCP Hatchery Committees specifically discussed actions that may affect broodstock collection and adult management. Additionally, many parties expressed concern for lamprey sticking to a PIT-tag array, potentially affecting PIT-tag detection efficiency and monitoring for HCP Plan Species. The YN agreed to monitor the lamprey throughout broodstock collection and report back to the Hatchery Committees should any effects be identified. PIT-tagged lamprey were released in the Tumwater fishway in 2016.

2.2.2.16 Blackbird Pond Steelhead Acclimation

In April 2016, Chelan PUD presented the results of rearing steelhead at Blackbird Pond from 2010 to 2015, in a presentation titled, *Blackbird Pond Acclimation PIT-tag Data Results* (Appendix B; April 20, 2016, meeting minutes). Historically, steelhead were reared at Eastbank Hatchery, then at Turtle Rock Fish Rearing Facility, and then truck-planted in the release locations. Chelan PUD has been working with Trout Unlimited and WDFW to acclimate steelhead at Blackbird Pond to provide a Wenatchee subbasin acclimation site prior to the Chiwawa Acclimation Facility being built. Juvenile steelhead had significantly higher survival when transferred to the facility at a later date. Smolt-to-adult returns to Blackbird Pond compared to combined truck-plant releases varied between 2010, 2011, and 2012. The future of Blackbird Pond Acclimation Facility is uncertain due to needed repairs of the shoreline where the intake structure is located and the cost and required permitting for those repairs.

2.2.2.17 Meeting Logistics

In August 2016, the HCP Hatchery Committees discussed the logistics of holding back-to-back meetings with the PRCC Hatchery Sub-Committee. To save time for many members who are on the PRCC Hatchery Sub-Committee and the HCP Hatchery Committees, the meetings could be held back-to-back in a single day at one location, if both committees have suitably short agendas. Grant PUD's Wenatchee, Washington, office was proposed as the location for back-to-back meetings because it is easily accessible by all attendees. Changing the start time of the HCP Hatchery Committees meetings from 9:30 a.m. to 9:00 a.m. was also proposed. The HCP Hatchery Committees agreed to hold back-to-back meetings with the PRCC Hatchery Sub-Committee at Grant PUD's Wenatchee, Washington, office when the HCP Hatchery Committees Chairperson and PRCC Hatchery Sub-Committee facilitator think the agendas are short enough to hold both meetings in 1 day. The HCP Hatchery Committees also agreed to change the start time of HCP Hatchery Committees meetings to 9:00 a.m. for all future meetings.

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 2017.

2.3 Tributary Committees and Plan Species Accounts

As outlined in the Rocky Reach HCP, the signatory parties each designated one member to serve on the 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 2016, the Rocky Reach HCP Tributary Committee met on nine occasions and held one conference call.

An initial task of the HCP Tributary Committees in 2016 was to review and update their operating procedures that provide a mechanism for decision making. These were initially developed in 2005 and included in that year's annual report (Anchor 2005)[7]. The

[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.

HCP Tributary Committees also developed Policies and Procedures for soliciting, reviewing, and approving project proposals (Anchor 2005). This document was last reviewed and updated in March 2016. 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 2016, the HCP Tributary Committees modified language in Section 3.4 (The General Salmon Habitat Program) and in Section 5.0 (Review Procedures) in the Policies and Procedures document. The Committees revised the language in these sections by indicating that draft GSHP proposals outside the Salmon Recovery Funding Board (SRFB) process are not necessary. The Committees will continue to use the SRFB draft application process when sponsors include the Plan Species Account funds as a cost share on SRFB applications.

Dr. Tracy Hillman continued as the Chairperson for the Rocky Reach HCP Tributary Committee. In 2016, the Committees conducted a formal evaluation of the Chairperson and agreed unanimously to retain Dr. Hillman as the Chairperson for the next 3-year period (2017 through 2019). Dr. Hillman is an Ecological Society of America board-certified senior ecologist and Chief Executive Officer of BioAnalysts, Inc. He has 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, they received meeting announcements, draft agendas, and meeting minutes. This benefits the HCP Tributary Committees through increased coordination and sharing of expertise. The Grant PUD representative and PRCC Habitat Sub-Committee facilitator have no voting authority. The HCP Tributary Committees, through the HCP Coordinating Committees, also invited American Rivers and the Confederated Tribes of the Umatilla Indian Reservation to participate in Committees meetings. Both parties contributed to the development of the

HCP, yet elected not to sign the document. Neither of these parties participated in the deliberations of the HCP Tributary Committees in 2016.

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 the 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 SRFB and HCP Tributary Committees are complementary, and annual funding rounds by these funding entities have been coordinated during the last several years.

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 BPA. 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, 2016 was $2,309,706.03. Chelan PUD's annual contribution was $341,705.00. Interest received during 2016 was $5,840.91. Project disbursements for 2016 totaled $263,931.98, and $6,671.21 was paid to

Clifton Larson Allen, Chelan PUD, and Cordell Neher & Company for account administration during 2016. The ending balance on December 31, 2016 was $2,386,648.75. The 2016 Annual Financial Report for this Plan Species Account is provided in Appendix U.

In 2016, the Rocky Reach HCP Tributary Committee hired the accounting firm Cordell, Neher & Company, PLLC, to conduct an external financial review of the Plan Species Account. The external audit is to be conducted every 5 years. The accounting firm submitted their results to the Committee in July 2016. The Committee reviewed the results and concluded that there are no issues with the handling of incoming funds, the budgeting process, or the allocation and approval of funds. The Committee was satisfied with the financial performance and position of the financial accounts manager for the Rocky Reach Plan Species Account. The Committee will request another external financial review of the Plan Species Account in 2021.

The Rocky Reach HCP Tributary Committee delegated signatory authority to the chairperson for processing of payments for invoices approved by the 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 Chairperson.

2.3.3 General Salmon Habitat Program

The HCP Tributary Committees established the GSHP as the principle 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 require extensive design, permitting, and public participation to be feasible. 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 provide lesser amounts during a phased project.

In 2014 the HCP Tributary Committees announced that they would accept GSHP applications at any time during the year. They also announced that they would continue to 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).

2.3.3.1 2016 General Salmon Habitat Projects

The SRFB announced its 2016 funding cycle in March, with pre-proposal applications due on April 15, 2016, and full proposals due on July 1, 2016. The HCP Tributary Committees received and reviewed 14 pre-proposal applications. The HCP Tributary Committees identified six projects that they believed warranted full proposals and dismissed eight projects because they were inconsistent with the intent of the Tributary Fund, did not have strong technical merit, or had low benefits per cost.

In July, the HCP Tributary Committees received seven full SRFB proposals to the GSHP. All were cost-shares with the SRFB or other funding entities. The HCP Tributary Committees approved funding for four projects. In addition, the HCP Tributary Committees received four full proposals to the GSHP that were outside the SRFB process. The HCP Tributary Committees approved funding for one of those projects. Table 6 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 6
General Salmon Habitat Program Projects Reviewed by the HCP Tributary Committees (T.C.) in 2016

Project Name	Sponsor[1]	Total Cost	Request from T.C.	Plan Species Account[2]
Salmon Recovery Funding Board Applications				
Wenatchee Sleepy Hollow Floodplain Acquisition	CDLT	$661,000	$165,250	RI: $156,250[3]

Project Name	Sponsor[1]	Total Cost	Request from T.C.	Plan Species Account[2]
Silver Side Channel Acquisition	MSRF	$801,470	$236,406	W: $236,406
Burns-Garrity Restoration Design	CCFEG	$177,335	$45,550	RR: $45,550
Beaver Fever: Restoring Ecosystem Function	TU-WWP	$279,278	$108,226	RI: $108,226
Nason Creek Side Channel Reconnection Design	CCNRD	$149,778	$23,000	Not funded
Thermal Refuge in the Wenatchee Basin	CCNRD	$48,807	$7,321	Not funded
Peshastin Irrigation Dist. Pump Exchange Design	CCNRD	$199,393	$29,909	Not funded
General Salmon Habitat Program Applications				
Leavenworth Diversion Screening Project	TU-WWP	$161,654	$130,255	Not funded
Peshastin Mill Site Preservation Project	TU-WWP	$463,000	$100,000	Not funded
Fish Passage at Ellis Creek Sediment Basin	ONA	$185,638	$39,784	Not funded
Ecommunity Acquisition	ONA	$456,514 (CAN)	$59,676 (CAN)	RI: $59,676 (CAN)

Notes:

1 CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resources Department; CDLT = Chelan-Douglas Land Trust; ONA = Okanagan Nation Alliance; MSRF = Methow Salmon Recovery Foundation; TU-WWP = Trout Unlimited – Washington Water Project.

2 RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

3 The Rock Island HCP Tributary Committee will order and pay for the appraisal and review. Because the sponsor asked for $9,000 for appraisal and review, the Committee subtracted this amount from the Rock Island HCP Tributary Committee request. Thus, the amount the Rock Island HCP Tributary Committee will pay the sponsor for this project is $156,250 ($165,250 - $9,000).

In 2016, the Rocky Reach HCP Tributary Committee agreed to fund the following GSHP project:

- **Burns-Garrity Restoration Design Project for the amount of $45,550 (with cost-share, the total cost of the project was $177,335)** – This project will prepare a restoration design that will improve instream, off-channel, and floodplain habitat on 30 acres of land owned by WDFW on the lower Chewuch River (River Mile [RM] 2.3 to 2.8).

2.3.3.2 Modifications to General Salmon Habitat Program Contracts

In 2016, the Rocky Reach HCP Tributary Committee received the following requests from sponsors asking for modifications to GSHP projects funded by the Committee:

- In January, Chelan-Douglas Land Trust (CDLT) asked the Rocky Reach HCP Tributary Committee for a time extension on the Entiat Stormy Reach Phase 2 Acquisition Project. Because the sponsor was still negotiating with some of the landowners, the sponsor asked to extend the project to June 30, 2016. The Rocky Reach HCP Tributary Committee approved the time extension.

- In May, CDLT asked the Rocky Reach HCP Tributary Committee for a time extension on the Entiat Stillwaters Gray Reach Acquisition Project. Because the sponsor is still negotiating with some of the landowners, the sponsor asked to extend the project to March 31, 2017. The Rocky Reach HCP Tributary Committee approved the time extension.
- In November, Trout Unlimited-Washington Water Project (TU-WWP) asked the Rocky Reach HCP Tributary Committee for a time extension on the Methow Valley Irrigation District Instream Flow Improvement Project. TU-WWP requested a time extension to March 31, 2017. The extra time is needed to complete a few tasks associated with the project. The Rocky Reach HCP Tributary Committee approved the time extension.
- In December, the Okanogan Conservation District asked the Rocky Reach HCP Tributary Committee for a time extension on the Similkameen RM 3.8 Habitat Rehabilitation Project. Because the project sponsor needs additional time to complete the final design and implement the project, they requested a time extension to October 31, 2017. The Rocky Reach HCP Tributary Committee approved the time extension.

2.3.4 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 3 months. The maximum contract allowed under the Small Projects Program is $100,000.

2.3.4.1 2016 Small Projects

In 2016, the HCP Tributary Committees received one request for funding under the Small Projects Program. The Rock Island HCP Tributary Committee approved funding for that project. The Rocky Reach HCP Tributary Committee did not fund any projects under the Small Projects Program in 2016.

2.3.4.2 Modifications to Small Project Contracts

In 2016, the Rocky Reach HCP Tributary Committee received the following requests from sponsors asking for modifications to Small Projects funded by the Committee:

- In June, TU-WWP asked the Rocky Reach HCP Tributary Committee for a budget amendment on the Clear Creek Fish Passage and Instream Flow Enhancement Project. The sponsor asked to move $5,000 from "Contract Labor" to "Professional Services." Thus, the final amount allocated for "Contract Labor" would be $5,000 and the final amount allocated for "Professional Services" would be $10,500. The total budget amount will not change because of this amendment. The Rocky Reach HCP Tributary Committee approved the budget amendment.
- In November, TU-WWP asked the Rocky Reach HCP Tributary Committee for another budget amendment on the Clear Creek Fish Passage and Instream Flow Enhancement Project. The sponsor asked to move $3,000 from "Contract Labor" to a new budget line item titled "Project Materials." The total budget amount will not change because of this amendment. The Rocky Reach HCP Tributary Committee approved the budget amendment.

2.3.5 Tributary Assessment Program

In 2014, at the request of the HCP Tributary Committees, the Okanagan Nation Alliance submitted proposals for the following monitoring projects:

1. **Penticton Channel Monitoring Spawning Platforms –** The objective of this study is to monitor the effects of the proposed spawning platforms as adaptive management for designing and construction of more platforms. This work will focus 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 will occur throughout a 5-year period (2014 to 2018). The amount requested from the

HCP Tributary Committees during the 5-year period was $53,738 (with cost-share, the total cost of the monitoring project during the 5-year period was $168,863).

2. **ORRI Phase II Effectiveness Monitoring –** The objective of this study is to monitor the effects (i.e., channel, hydraulic, and biological responses) of the Okanagan River Restoration Initiative (ORRI)-Phase II restoration work and to continue to monitor the long-term effects of Phase I and Vertical Drop Structure 13 restoration. Monitoring will include all activities associated with channel and hydraulic responses, and aquatic biological responses (except macrophytes and macroinvertebrates). Monitoring will occur throughout a 5-year period (2014 to 2018). The amount requested from the HCP Tributary Committees during the 5-year period was $69,578 (with cost-share, the total cost of the monitoring project during the 5-year period was $175,600).

In 2014, the Rocky Reach HCP Tributary Committee approved funding for the Penticton Channel Monitoring Spawning Platforms, and the Wells HCP Tributary Committee approved funding for the ORRI Phase II Effectiveness Monitoring Project. As required in the HCPs, Chelan and Douglas PUDs will provide funding for the monitoring projects through the Rocky Reach and Wells Tributary Assessment Programs rather than through the Rocky Reach and Wells Plan Species Accounts.

In 2015, the HCP Tributary Committees received a Tributary Assessment Program application from the Okanagan Nation Alliance titled, *Purchase-Installation of Passive Integrated Transponder Tag Array in Shingle Creek Project*. The purpose of the project was to purchase and install a permanent PIT-tag interrogation system near the mouth of Shingle Creek to monitor recolonization of the stream by steelhead and spring Chinook salmon. The site will include remote communications hardware. The total cost of the project was $42,422. The sponsor requested $35,867 from HCP Assessment Funds. The Wells HCP Tributary Committee chose to fund the project through its Tributary Assessment Program.

The Rocky Reach HCP Tributary Committee did not receive any monitoring or assessment applications in 2016.

To date, Chelan PUD has spent $36,956 of the original $200,000 total for the Rocky Reach HCP Tributary Assessment Program. Of the remaining balance in the Rocky Reach HCP Tributary Assessment Program ($163,044), $16,782 is allocated to the Penticton Channel Monitoring Spawning Platforms project and $146,262 is unallocated.

3 HABITAT CONSERVATION PLAN ADMINISTRATION

This section lists events of note that occurred in 2016 related to the administration of the HCPs and provides a list of reports published in 2016 that relate to the HCPs.

3.1 Mid-Columbia HCP Forums

In 2005 and 2006, Mid-Columbia Forums (Forums) were held as a means of communicating and coordinating with the non-signatories and other interested parties on 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 2007 through 2015, these parties were invited by letter in 2016 to attend a Forum, 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 Tributary Committees and Hatchery Committees processes. The non-signatory parties again indicated no interest in attending a Forum in 2016.

3.2 Mid-Columbia HCP Extranet Sites

Prior to 2014, the HCP Committees used a file transfer protocol (FTP) site for the HCP document repository. In 2014, Douglas PUD unveiled a more user-friendly Microsoft SharePoint system (i.e., HCP Extranet site) as a potential option for a new document repository. Following a presentation and brief tutorial of the new site, the HCP Coordinating and Hatchery Committees agreed to transition to the new HCP Extranet sites. In April 2016, following a similar presentation and tutorial, the HCP Tributary Committees also transitioned to the SharePoint system.

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 2016, 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 27, 2016, the HCP Coordinating Committees announced their selection to retain HCP Coordinating and Policy Committees Chairperson, John Ferguson, and support personnel, Kristi Geris, for 3 more years. On October 19, 2016, the HCP Hatchery Committees announced their selection to retain HCP Hatchery Committees Chairperson, Tracy Hillman, and support personnel, Sarah Montgomery, for 3 more years. On November 10, 2016, the HCP Tributary Committees announced their selection to retain HCP Tributary Committees Chairperson, Tracy Hillman, for 3 more years. The next Chairpersons review will occur in August 2019.

3.4 Habitat Conservation Plan Related Reports and Miscellaneous Documents Published in Calendar Year 2016

The following is a list of reports released in 2016 that are related to the implementation of the Rocky Reach HCP:

- Chelan PUD (Public Utility District No. 1 of Chelan County), 2016. *Chelan PUD Rocky Reach and Rock Island HCPs Final 2015 Fish Spill Report.* January 2016.
- Chelan PUD, 2016. *Final 2016 Rocky Reach and Rock Island HCP Action Plans*. March 2016.
- Chelan PUD, 2016. *Chelan PUD Rocky Reach and Rock Island HCPs Final 2016 Fish Spill Report.* September 2016.
- Grant Public Utility District, 2016. Target HRRs.
- Hurst, C. and C. Busack, 2016. *Final Gene Flow Management Standards*. March 2016.
- Keller, L., 2016. Public Utility District No. 1 of Chelan County. *2016 Rocky Reach Juvenile Fish Bypass System Operations Plan*. Final Plan. January 2016.
- Moran, C., M. Johnson, and C. Willard, 2016. *2016 Wenatchee Steelhead Release Plan (Brood Year 2015)*. March 2016.
- Mosey, T., 2015. *2016 Fish Spill Plan: Rock Island and Rocky Reach Dams*. Prepared for Public Utility District No. 1 of Chelan County. January 2016.
- National Marine Fisheries Service, 2016. Revised Methow spring Chinook Gene Flow analysis spreadsheet. March 2016.

APPENDIX A
HABITAT CONSERVATION PLAN COORDINATING COMMITTEES 2016 MEETING MINUTES AND CONFERENCE CALL MINUTES

ANCHOR QEA

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	February 24, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the January 26, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel, in SeaTac, Washington, on Tuesday, January 26, 2016, from 9:30 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Douglas PUD will revise the Subyearling Chinook Salmon Life-history Study dates in the draft 2016 Wells HCP Action Plan, as discussed, and will provide the final plan to Kristi Geris for distribution to the Coordinating Committees (Item III-A). *(Note: Tom Kahler revised the plan, as discussed, and provided the final plan to Geris on January 27, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Douglas PUD will consider revising the historical flows language in the Draft 2016 Wells Dam Gas Abatement Plan (GAP) and Bypass Operating Plan (BOP), as discussed, and will provide the final plan, when available, to Kristi Geris for distribution to the Coordinating Committees (Item III-B). *(Note: The historical flow language was revised, as requested, as distributed to the Coordinating Committees by Geris on February 10, 2016.)*
- Douglas PUD will provide photographs of the lamprey entrance boxes installed in the low-level entrances at Wells Dam to Kristi Geris for distribution to the Coordinating Committees (Item III-C). *(Note: Tom Kahler provided a photograph of the lamprey entrance boxes to Geris on January 29, 2016, which Geris distributed to the Coordinating Committees that same day.)*

- Chelan PUD will discuss with Dr. John Skalski (Columbia Basin Research) possibly adjusting the Data Access in Real Time (DART) database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass (Item IV-A).
- Chelan PUD will add expected dates to receive Hatchery and Genetic Management Plan (HGMP) permits from the National Marine Fisheries Service (NMFS) to the Draft 2016 Rocky Reach and Rock Island HCP Action Plans, as discussed, and will provide the revised draft plans to Kristi Geris for distribution to the Coordinating Committees. Chelan PUD will request approval of the revised draft plans during the Coordinating Committees meeting on February 23, 2016 (Item IV-B). *(Note: Lance Keller updated the draft action plans, as discussed, and provided the revised draft plans to Kristi Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Chelan PUD will develop a trip report regarding progress on the refurbishing of the Rock Island Dam right fish ladder sluice gate, RO4, following a site visit to the contractor's facilities in Massachusetts, and will provide the report to Kristi Geris for distribution to the Coordinating Committees (Item IV-C). *(Note: Lance Keller provided a trip report to Kristi Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Chelan PUD will summarize potential operations scenarios for the Rock Island Dam right fish ladder operating with a bulkhead installed in place of the sluice gate, RO4, including potential effects on salmonid passage past the dam, and will provide the summary to Kristi Geris for distribution to the Coordinating Committees (Item III-C).
- Chelan PUD will provide weekly reports on the progress of repairing and installing the Rock Island Dam right fish ladder sluice gate, RO4, to Kristi Geris for distribution to the Coordinating Committees (Item IV-C). *(Note: Lance Keller provided weekly reports, as requested, on February 4, 16, and 22, 2016, which Geris distributed to the Coordinating Committees those same days.)*
- Chelan PUD will notify the Coordinating Committees when the last denil structure is removed from the Rock Island Dam fishways (Item IV-D). *(Note: Lance Keller provided a notification that denil removal was completed to Kristi Geris on February 16, 2016, which Geris distributed to the Coordinating Committees that same day.)*

- John Ferguson will discuss with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) possibly holding both the PRCC and Coordinating Committees June 2016 meetings on June 21, 2016, and holding the 2016 Subyearling Chinook Salmon Workshop the next day on June 22, 2016 (Item V-A). *(Note: Ferguson discussed the topic with Rohr following the Coordinating Committees meeting on January 26, 2016.)*
- John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item V-A).
- Kristi Geris will contact Julene McGregor (Douglas PUD Information System Staff) to request member access to the HCP Hatchery Committees Extranet site for Deanne Pavlik-Kunkel (Grant PUD), as approved by the Coordinating Committees, and will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) about adding Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists (Item VI-A). *(Note: Geris contacted McGregor and Montgomery following the Coordinating Committees meeting on January 26, 2016, about getting Pavlik-Kunkel Extranet access and on the distribution lists.)*
- **The Coordinating Committees meeting on February 23, 2016, will be held in-person at the Radisson Hotel in SeaTac, Washington (Item VI-C).**

DECISION SUMMARY

- The Wells HCP Coordinating Committee representatives present approved the 2016 Wells HCP Action Plan, as revised (Item III-A).
- The Wells HCP Coordinating Committee representatives present approved the 2016 Wells Dam GAP and BOP, as revised (Item III-B).
- The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2015 Rocky Reach and Rock Island Spill Report, as revised (Item IV-A).

AGREEMENTS

- The Rock Island HCP Coordinating Committee representatives present agreed to extend the 2015/2016 winter maintenance work period for the right fish ladder at

Rock Island Dam by 15 days to allow more time to complete required work, contingent on Chelan PUD providing weekly reports on the progress of repairs. Rather than the typical March 1 completion date, the Rock Island right fish ladder will be fully operational by March 15, 2016 (Item IV-C).

- Coordinating Committees representatives present agreed to reschedule the Coordinating Committees meeting on June 28 to June 21, 2016, to accommodate the 2016 Subyearling Chinook Salmon Workshop (Item V-A).
- Coordinating Committees representatives present agreed to provide Deanne Pavlik-Kunkel member access to the HCP Hatchery Committees Extranet site, and add Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists (Item VI-A).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on January 22, 2016, notifying them that the Draft 2016 Rocky Reach and Rock Island HCP Action Plans were available for review. Chelan PUD will request approval of the draft plans during the Coordinating Committees meeting on February 23, 2016 (Item IV-B).
- Kristi Geris sent an email to the Coordinating Committees on February 8, 2016, notifying them that the Draft 2015 Wells HCP Annual Report was available for a 30-day review, with edits and comments due to Geris by Monday, March 7, 2016 (Item VI-B).
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach and Rock Island Fish Spill Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March 14, 2016.
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach Juvenile Fish Bypass Operations Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March 14, 2016.
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rock Island Bypass Monitoring Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March

14, 2016.

- Kristi Geris sent an email to the Coordinating Committees on February 18, 2016, notifying them that the Draft 2015 Rocky Reach and Rock Island HCP Annual Reports were available for a 30-day review, with edits and comments due to Geris by Wednesday, March 16, 2016 (Item VI-B).

FINALIZED DOCUMENTS

- The Final 2016 Wells HCP Action Plan, which was approved by the Wells HCP Coordinating Committee on January 26, 2016, was distributed to the Coordinating Committees by Kristi Geris on January 27, 2016 (Item III-A).
- The Final 2015 Rocky Reach and Rock Island Spill Report, which was approved by the Rocky Reach and Rock Island HCP Coordinating Committees on January 26, 2016, was distributed to the Coordinating Committees by Kristi Geris on February 3, 2016 (Item IV-A).
- The Final 2016 Wells Dam GAP and BOP that was approved by the Wells HCP Coordinating Committee on January 26, 2016, and the Aquatic Settlement Work Group (SWG) on February 10, 2016, was distributed to the Coordinating Committees by Kristi Geris on February 10, 2016 (Item III-B).

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the Coordinating Committees and asked for any additions or changes to the agenda. No additions or changes were requested from Coordinating Committees representatives present; however, Ferguson added an update on the 2015 HCP Annual Reports.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft December 14, 2015, meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. She said she also noted distribution of the Final 2015 Wells Dam Post-Season Bypass Report to the Coordinating Committees on January 22, 2016, which was finalized following a 30-day review period that ended on

January 14, 2016, and that no comments were received from Coordinating Committees members on the draft report. Coordinating Committees members present approved the December 14, 2015, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on December 14, 2015, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on December 14, 2015):*

- *Chelan PUD will provide the Revised Draft 2015 Rocky Reach and Rock Island Spill Report to Kristi Geris for distribution to the Coordinating Committees, for approval during the Coordinating Committees meeting on January 26, 2016 (Item III-A).* Lance Keller provided the revised draft report to Geris on January 22, 2016, which Geris distributed to the Coordinating Committees that same day. The revised draft plan will be further discussed during today's meeting.
- *Douglas PUD will provide the Draft 2015 Wells Dam Post-Season Bypass Report for review to Kristi Geris for distribution to the Coordinating Committees (Item IV-C).* Tom Kahler provided the draft report to Geris on December 15, 2015, which Geris distributed to the Coordinating Committees that same day. The final report was distributed to the Coordinating Committees by Geris on January 22, 2016, following a 30-day review period.
- *Douglas PUD will provide the Draft 2016 Wells HCP Action Plan for review to Kristi Geris for distribution to the Coordinating Committees (Item IV-D).* Tom Kahler provided the draft plan to Geris on December 21, 2015, which Geris distributed to the Coordinating Committees on December 22, 2015. The draft plan will be further 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 Coordinating Committees on the following actions and discussions that occurred at the last HCP Tributary Committees meeting on January 7, 2016:

- *Time Extension:* The Rocky Reach HCP Tributary Committee approved a time extension request from Chelan Douglas Land Trust on the Entiat Stillwaters Gray Reach Acquisition Project. The extension, to June 30, 2016, provides additional time for negotiating on a pending property. The sponsor also asked the Rocky Reach HCP Tributary Committee if they would be willing to pay more than the appraised value for the pending property ($25,000), because the property owner is asking for $50,000 for the 8-acre parcel. The Rocky Reach HCP Tributary Committee declined to pay more than the appraised value.
- *2016 Wells HCP Tributary Committee Action Plan:* The Wells HCP Tributary Committee approved the tributary portion of the 2016 Wells HCP Action Plan. The 2016 Rocky Reach and Rock Island Action Plans will be reviewed during the next HCP Tributary Committees meeting.
- *Information Updates:* The HCP Tributary Committees discussed scheduling, and decided to continue meeting on the second Thursday of each month in 2016. The HCP Tributary Committees also discussed the project tours in Canada that some of the HCP Tributary Committee members attended last October 2015.
- *Next Steps:* The HCP Tributary Committees' next scheduled meeting will be on February 11, 2016. *(Note: the HCP Tributary Committees meeting on February 11, 2016, was canceled due to lack of agenda items.)*

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on January 20, 2016:

- *NMFS Consultation Update:* Craig Busack (NMFS HCP Hatchery Committees Representative) indicated many career transitions are occurring at NMFS. Will Stelle (NMFS Regional Administrator) is taking a different position, Bob Turner (NMFS Assistant Regional Administrator) is retiring, and Gary Sims (NMFS Tribal Relations Coordinator) is also retiring. NMFS hired two, new term positions and will recruit two more to help with the workload resulting from consultations. Busack will become the NMFS HCP Hatchery Committees Alternate and Justin Yeager (NMFS HCP Tributary Committees Representative and Coordinating Committees Alternate) will become the NMFS HCP Hatchery Committees Representative. Rob Jones (NMFS Anadromous Production and Inland Fisheries Branch Chief) will provide a letter to the Coordinating Committees notifying the Committees of these changes (likely within the next couple of months). Busack also indicated, on January 13, 2016, The Wild Fish Conservancy filed a 60-day Notice of Intent to Sue NMFS and the Department of Commerce for funding Mitchell Act hatchery program, so NMFS is preparing for this lawsuit, which will likely develop in March 2016. Busack is working to complete the Environmental Impact Statement (EIS) for Puget Sound steelhead programs. Completion of this EIS is needed to release steelhead into Puget Sound in 2016. The NMFS Methow Spring Chinook Salmon Consultation is on track for completion by May 2016, so long as the U.S. Fish and Wildlife Service Bull Trout Consultation is completed on time. John Ferguson asked about The Wild Fish Conservancy's objectives with the suit over the Mitchell Act programs. Hillman said Busack explained that NMFS is responsible to fund programs and license hatchery programs, and The Wild Fish Conservancy is claiming NMFS is not meeting the funding obligation. The Wild Fish Conservancy may also sue NMFS based on the licensing of programs (among the approximate 51 programs, only 11 have Endangered Species Act authorization).

- *Five-Year Hatchery Monitoring and Evaluation (M&E) Review Planning – Review Timeline; Objectives 4, 6, and 2:* The HCP Hatchery Committees continued their review of the Five-Year Hatchery M&E Plan Report. So far, everything is on schedule to complete the review of spring Chinook salmon by the end of March 2016. Recall from last month's update, regarding Objective 4 (hatchery replacement rates [HRRs]), the HCP Hatchery Committees approved using the 20th percentile method for calculating HRR targets (harvest not included). However, based on a misunderstanding, an HCP Hatchery Committees representative had an issue with using the 20th percentile method, so the HCP Hatchery Committees discussed it, and now approved using the 40th percentile method (harvest included). With the 20th percentile method, it would have been acceptable for a program to perform below average every year without triggering any remedial action; however, with the 40th percentile method this would be unlikely to happen. With regard to Objective 6 (size at release), it was determined there is no best size at release that optimizes across all management goals. One study using White River spring Chinook salmon was reviewed, where growth was kept low during fall and winter to reduce the probability of precocious maturation; then after February, growth was maximized to reduce predation-based mortality and increase survival. Study fish have not yet returned as adults, so results are pending. The HCP Hatchery Committees decided to maintain the same size-at-release targets, and reevaluate the targets once study results are available. Ferguson asked when the adults will return, and Kirk Truscott guessed around 2017 or 2018.

- *2016 Wells HCP Action Plan:* The Wells HCP Hatchery Committee reviewed and approved the hatchery portion of the 2016 Wells HCP Action Plan.
- *2016 Rocky Reach and Rock Island HCP Action Plans:* The Rocky Reach and Rock Island HCP Hatchery Committees reviewed the hatchery portion of the 2016 Rocky Reach and Rock Island HCP Action Plans. Chelan PUD will request approval of the draft plans during the HCP Hatchery Committees meeting on February 17, 2016.
- *Brood Year (BY) 2014 Methow Spring Chinook Salmon Acclimation:* Chelan PUD currently has approximately 60,000 BY 2014 spring Chinook salmon at Methow Fish Hatchery, with preferred acclimation at the Chewuch Acclimation Facility. The Yakama Nation (YN) has funding to operate this facility; however, details would need to be first discussed with the Colville Confederated Tribes (CCT). The alternative would be for the Washington Department of Fish and Wildlife (WDFW) to operate the facility; however, WDFW is not sure about the feasibility of this option. Three other options were identified: 1) release fish directly into the Methow River from the Methow Fish Hatchery (this option needs contracting, which is not yet in place); 2) truck plant the fish as far upstream in the Chewuch River Basin as possible (unsure about the feasibility to get a truck into the Upper Chewuch River Basin); and 3) final acclimate the fish at Carlton Pond (not much support for this option because these fish were obtained via tangle netting in the Chewuch River, so the preference is to release progeny back to the Chewuch River). Truscott said the CCT have no updates at this time, but hope to provide feedback to the HCP Hatchery Committees by Friday, January 29, 2016. Hillman said the Chewuch Acclimation Facility is also in need of upgrades, which the YN and Chelan PUD are discussing.
- *Wenatchee Summer Chinook Salmon Draft Statement of Agreement (SOA):* Chelan PUD provided a presentation about intentions to design a partial water reuse aquaculture system at Eastbank Fish Hatchery to help Chelan PUD meet the dissolved

oxygen and pH total maximum daily load (TMDL) requirements in the Wenatchee River. Chelan PUD has been conducting baseline studies, including testing different fish feeds with varying levels of phosphorus, testing circular tanks, evaluating size and number of fish at release, and measuring baseline phosphorus levels in the Wenatchee River and at Dryden Acclimation Facility before, during, and after fish are on station. Chelan PUD distributed a draft SOA, which addresses meeting the phosphorus TMDL by modifying feed and reducing waste, and rearing fish to a smaller size. The latter involves colder overwinter temperatures at Eastbank Fish Hatchery, which will require modifications to the Eastbank Fish Hatchery. Chelan PUD believes they can meet the phosphorus TMDL requirements with these modifications. Chelan PUD will request approval of the SOA during the HCP Hatchery Committees meeting on February 17, 2016.

- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on February 17, 2016.

III. Douglas PUD

A. DECISION: Draft 2016 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said Kristi Geris sent an email to the Coordinating Committees on December 22, 2015, notifying them that the Draft 2016 Wells HCP Action Plan was available for review, and that Douglas PUD will request approval of the document during the Coordinating Committees meeting on January 26, 2016. Kahler asked if the Coordinating Committees members have questions before voting on the draft plan. He added that the plan is routine and similar to previous years.

Bob Rose asked about the items under, "Annual Monitoring of Juvenile Migration Run Timing and Bypass Operations." Kahler recalled that this is the analysis Drs. John Skalski and Richard Townsend (Columbia Basin Research) conduct every year to determine if Wells Dam bypass operations met juvenile migration run timing criteria, as outlined in the Wells HCP.

John Ferguson asked about the Subyearling Chinook Salmon Life-history Presentation to the Coordinating Committees scheduled in February 2016. Kahler said Douglas PUD is now planning to provide that presentation during the 2016 Subyearling Chinook Salmon Workshop, and will also adjust final approval of the associated report accordingly. Kirk Truscott asked if these dates can be updated in the final plan, and Kahler agreed to do this.

The Wells HCP Coordinating Committee representatives present approved the 2016 Wells HCP Action Plan, as revised. Kahler said he will revise the Subyearling Chinook Salmon Life-history Study dates in the draft 2016 Wells HCP Action Plan, as discussed, and will provide the final plan to Geris for distribution to the Coordinating Committees. *(Note: Kahler revised the plan, as discussed, and provided the Final 2016 Wells HCP Action Plan to Geris on January 27, 2016, which Geris distributed to the Coordinating Committees that same day.)*

B. Draft 2016 Wells Dam Gas Abatement Plan and Bypass Operating Plan (Tom Kahler)

Tom Kahler said Kristi Geris sent an email to the Coordinating Committees on January 6, 2016, notifying them that the Draft 2016 Wells Dam GAP and BOP was available for review, with edits and comments due to Kahler by Wednesday, February 10, 2016. Kahler explained that the new Wells Project Federal Energy Regulatory Commission (FERC) License No. 2149 issued in 2012, mandated Douglas PUD combine the GAP and BOP into one document, and provide the Wells HCP Coordinating Committee the opportunity to consult on both plans. He said, however, Douglas PUD is only required to obtain Wells HCP Coordinating Committee approval of the BOP. He explained that Appendix 1 of the GAP and comprises the Spill Playbook, and the BOP is Appendix 2. He said, in addition to Wells HCP Coordinating Committee approval of the BOP, the full document (2016 Wells Dam GAP and BOP) also needs to be approved by the Washington State Department of Ecology and the Aquatic SWG, prior to submittal of the final approved document to FERC by the end of February 2016.

Bob Rose asked if the Draft 2016 Wells Dam GAP and BOP is different than last year's Final 2015 Wells Dam GAP and BOP. Kahler said the Final 2015 Wells Dam GAP and BOP used Spillway 5 as the primary spill while Turbine Unit 7 was still under repair. He said, this year, repairs to Turbine Unit 7 are now complete, so the Draft 2016 Wells Dam GAP and

BOP moves the spill configuration back to the original configuration (via Spillway 7), which is based on University of Iowa scale model testing. He said other than that, the plans are exactly the same.

Jim Craig said he has one minor comment on the GAP, Section 1.3.1 Historical Flows, second to the last sentence:

> *"The current hydrograph of the Columbia River is controlled by upstream, federally managed storage and release regimes, but typically mimics historic flow regimes (Figure 2)."*

He suggested revising, "typically mimics historical flow regimes," because throughout history, flow regimes have been vastly altered; therefore, the current hydrograph does not actually mimic historical hydrographs, but rather, mimics the average hydrograph since 1969. Kahler said he will pass Craig's comment onto the author of the document (Andrew Gingerich, Douglas PUD Aquatic SWG Technical Representative). *(Note: The historical flow language was revised, as requested, as distributed to the Coordinating Committees by Geris on February 10, 2016.)*

Kirk Truscott asked if shifting spill to Spillway 7 could impact the volume of spill in Spillway 2, where the new passive integrated transponder (PIT)-tag array will be installed to detect juveniles passing Wells Dam. Kahler said the shift will not change spill volume through Spillway 2; however, it may change the bulk flow characteristics of the project. He added that this shift will only occur during forced spill events, and reiterated this is the same historical configuration implemented prior to taking Turbine Unit 7 offline for repairs. He said the previous studies, which indicated a greater proportion of fish pass Wells Dam via Bypass Bay 2, were conducted before the University of Iowa scale model testing and various relicensing spill studies. He added, he is uncertain about what records Douglas PUD has for spill configurations from that era, so there may be no way to compare historical spill to current spill configurations. Truscott said his only concern is that installing PIT-tag detection in Bypass Bay 2 was designed to provide useful information, and he wants to make sure shifting spill to Spillway 7 will not impact that effort. He added there may be no way to know. Kahler explained that the reason PIT-tag detection is being installed in Bypass Bay 2 is because Spillway 2 and 10 are top spill and fish seem to be more attracted to top spill versus bottom spill. He said all other spillways at Wells Dam are bottom spill. He said the fact that Bypass Bay 2 is top spill and fish seem to prefer passing Wells Dam via Bypass Bay 2 will not change. He said, however, once the forebay drops below a certain elevation, spill has to drop to bottom spill. He said Douglas PUD could outfit another spillway with PIT-tag detection; however, they first want to test detection on surface spill. He said PIT-tag detection could be installed in Spillway 10; however, Spillway 10 has historically passed fewer fish than Spillway 2. He said Douglas PUD also does not intend to install antennas throughout all of Spillway 2, which would require installing 64 antennas equaling at least $500,000 or more. He added that historical data indicate fish pass higher in the water column, and there are also logistical issues for establishing detection in the lowest bypass frames. Kahler asked Truscott if he would like Kahler to investigate this further, and Truscott said the information provided will suffice.

Kahler asked if the Wells HCP Coordinating Committee was ready to vote now, or preferred to vote via email on February 10, 2016, following the close of the review period. He also suggested, if the Wells HCP Coordinating Committee agrees, to vote on the entire document. John Ferguson agreed this would simplify the administrative record. The Wells HCP Coordinating Committee representatives present approved the 2016 Wells Dam GAP and BOP, as revised.

C. Wells Dam Fish Ladder Maintenance (Tom Kahler)

Tom Kahler reviewed maintenance updates at Wells Dam, as follows:

West Fishway

Kahler said the west fishway at Wells Dam has been offline for annual winter maintenance since December 1, 2015, and will be re-watered and in full operation by Thursday, January 28, 2016. He said major maintenance activities include: 1) work on the auxiliary water supply (AWS) pumps; 2) LGL Limited checked all radio-telemetry antennas; 3) the lamprey entrance box was installed in the low-level side entrance; 4) Biomark installed a PIT-tag detection system for the lamprey entrance box; 5) the lamprey enumeration structure (LES) is being assembled to install in the count window; and 6) nylon brushes are being installed to fill gaps in the fishway. Kahler added that installation of the lamprey entrance box went as planned, and he will provide photographs of the installed lamprey entrance box to Kristi Geris for distribution to the Coordinating Committees. Kahler said, regarding the LES, all parts have not yet been received; however, the LES can be installed during a routine outage for count-window cleaning. *(Note: Kahler provided a photograph of the lamprey entrance boxes to Geris on January 29, 2016, which Geris distributed to the Coordinating Committees that same day.)*

East Fishway

Kahler said the east fishway at Wells Dam will be taken offline for annual winter maintenance next Tuesday, February 2, 2016. He said a 2-day fish rescue will be conducted on February 2 and 3, 2016. He said all lamprey modifications completed in the west fishway will also be installed in the east fishway. He said the east fishway outage will be short and should be complete by the end of February 2016.

John Ferguson noted that the Aquatic SWG plans to hold their monthly meeting at Wells Dam on Wednesday, February 10, 2016, with a tour of the fishways to follow. Kahler said, although the tour is for the Aquatic SWG, Coordinating Committees representatives are also welcome to join, if interested.

Bypass Bay 2

Kahler said, as previously discussed, Douglas PUD is also working with Biomark to install a bypass antenna system in Bypass Bay 2 at Wells Dam. Kahler said Biomark developed a prototype antenna that will first be installed in one frame of Bypass Bay 2 to iron out details such as how to position and anchor the antenna, conduct noise testing, determine an exact location for the reader, and determine the location of fiber and power runs to the reader, among other things. Kahler explained that currently at Wells Dam, all detection systems are geared toward adults. He said this new system will be the first juvenile detection system at Wells Dam, which will upload to the PIT-Tag Information System database separately from the adult detection system. He said, once all testing is complete using the prototype antenna, Biomark will build another three antennas to install in Bypass Bay 2 at Wells Dam before the initiation of bypass operations on April 9, 2016. He said Douglas PUD plans to conduct fish testing, likely with summer Chinook salmon from Wells Fish Hatchery, which will involve releasing fish upstream of Bypass Bay 2 or near the debris boom to test detection.

Bob Rose said the plans seem to be on a somewhat aggressive schedule, and Kahler said Biomark is planning to meet the March 2016 deadline. Kahler added that this project has been on Biomark's schedule for quite a while now.

IV. Chelan PUD

A. DECISION: Revised Draft 2015 Rocky Reach and Rock Island Spill Report (Lance Keller)

Lance Keller said the Revised Draft 2015 Rocky Reach and Rock Island Spill Report was distributed to the Coordinating Committees by Kristi Geris on January 22, 2016. Keller recalled, during the last Coordinating Committees meeting on December 14, 2015, Kirk Truscott identified a mislabeling of the graph for summer spill at Rock Island Dam, and also requested on the same graph that Chelan PUD depict the front-end tail of subyearling passage. Keller said the mislabeling was corrected, as requested. He said he has not yet discussed with Dr. John Skalski possibly adjusting the DART database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass; however, Keller said he ran an expansion to depict the front-end tail, as requested. He said the first subyearling was detected on May 3, 2015, and then the tail is flat until a sharp uptick on June 1, 2015, when hatchery releases arrived. He said from May 3 to May 31, 2015, a total of 23 fish were identified, which are now depicted by the expansion. Truscott said the revisions adequately address his comments. Keller said he still plans to discuss with Dr. John Skalski possibly adjusting the DART database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass.

The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2015 Rocky Reach and Rock Island Spill Report, as revised. The Final 2015 Rocky Reach and Rock Island Spill Report was distributed to the Coordinating Committees by Geris on February 3, 2016.

B. Draft 2016 Rocky Reach and Rock Island HCP Action Plans (Lance Keller)

Lance Keller said the Draft 2016 Rocky Reach and Rock Island HCP Action Plans were distributed to the Coordinating Committees by Kristi Geris on January 22, 2016. Keller said, as Tracy Hillman noted, the hatchery portion of the draft plans have already been reviewed and approved by the HCP Hatchery Committees, and the HCP Tributary Committees will review the tributary portion of the draft plans during their next meeting on February 11, 2016. Keller said the draft 2016 plans are essentially the same as the 2015 plans. He said, with regard to the Coordinating Committees, there is one new item, which is a 2016 Subyearling Chinook Salmon Workshop. He explained that Chelan PUD has an SOA that maintained subyearling Chinook salmon in Phase III (Additional Juvenile Studies) until 2016, at which time Chelan PUD needs to annually assess improvements in tag technology and study design to evaluate survival study feasibility (approved by the Rocky Reach and Rock Island HCP Coordinating Committees on June 25, 2013). Keller said this will be further discussed during today's meeting.

Jeff Korth suggested including, under the hatchery portion of the draft plans, expected dates to receive HGMP permits from NMFS. Keller said he will coordinate with the Chelan PUD HCP Hatchery Committees representatives regarding adding these dates, as requested, and will provide the revised draft plans to Geris for distribution to the Coordinating Committees. Chelan PUD will request approval of the revised draft plans during the Coordinating Committees meeting on February 23, 2016.

C. Rocky Reach and Rock Island Adult Fish Ladder Winter Maintenance (Lance Keller)

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

<u>Rocky Reach Dam</u>

Keller said the fish ladder at Rocky Reach Dam was taken offline for annual winter maintenance on January 4, 2016. He said the upper end of the fish ladder was dewatered first and a fish rescue was conducted. He said on January 8, 2016, the lower end of the fish ladder was dewatered and another fish rescue was conducted. He said maintenance is going well, and no major issues have been identified. He did note, however, during the fish rescue on January 4, 2016, while monitoring for fish stranding, a fishway attendant discovered

22 adult lamprey beneath the diffuser grating in Weir A13. Keller said the grating was removed and all 22 fish were rescued and released into the Rocky Reach forebay. He said Chelan PUD now plans to replace the 1-inch diffuser grating floors in Weirs A10 to A13 with 3/4-inch grating. He said Rocky Reach Dam engineers indicated this change in grating width should not affect hydraulic conditions through the area. Keller said he also discussed a possible winter maintenance period extension with Scott Carlon and Jim Craig; however, the current estimated time of arrival (ETA) for the new grating is by the end of January 2016, which should allow enough time to install the new grating within the normal maintenance period. Keller said if an extension is needed, Chelan PUD will request Rocky Reach HCP Coordinating Committee approval via email.

Bob Rose said this seems to be a unique situation, as this many lamprey have not been discovered in the past. Keller agreed, and he added that the lamprey were scanned for half-duplex PIT-tags; however, no tags were detected. Jeff Korth asked if it seemed the lamprey accessed the area and then became trapped. Keller said he was unsure and suggested they may have accessed the area to overwinter there. Carlon asked if fish overwintering in that area typically leave in the spring, and Keller said there is no way to know unless the ladder remains watered up all year-round. Keller added that the lamprey were found in very dark crevices, which may suggest overwintering. Rose asked about the other fish species encountered during the fish rescue. Keller said other species included, chiselmouth, six to seven sculpins, and rainbow trout/steelhead.

<u>Rock Island Dam</u>
Keller recalled that at Rock Island Dam, up to two ladders can be offline for maintenance, so long as one ladder remains operational for fish passage at all times.

Left Ladder
Keller said the left ladder at Rock Island Dam was taken offline for annual winter maintenance on January 5, 2016. He said a fish rescue was conducted, and very few fish were found. He said activities included: 1) general maintenance; 2) removal of the denil structure; and 3) filling of the in-water modifications where concrete was split to provide swim-through passage (reconstructed back to normal).

Middle Ladder

Keller said the middle ladder at Rock Island Dam was taken offline for annual winter maintenance on December 15, 2015. He said the middle ladder had the shortest outage of the three ladders at Rock Island Dam. He said activities included: 1) general maintenance; and 2) inspections on the diffusion gratings and valves. Keller said the middle ladder was returned to service on December 30, 2015.

Right Ladder

Keller said the right ladder at Rock Island Dam was taken offline for annual winter maintenance on December 1, 2015. He said the right ladder is the longest outage this year at Rock Island Dam. He said the main maintenance activity on the right ladder is the refurbishing of the AWS sluice gate, RO4, which is at the end of its lifespan. He explained that RO4 is a fine-scale, auto-adjusting gate, which adjusts based on elevations to maintain the right ladder in compliance as far as differentials at the fishway entrances. Keller said Chelan PUD worked with the contractor to develop a schedule for repair. He said the sluice gate was removed on December 10, 2015, which needed to be chiseled out, and will need to be grouted back in once returned. He said the gate was shipped to the contractor (located in Massachusetts) on December 11, 2015. He said, on December 14, 2015, Rock Island Dam staff noticed a fibrous material around the existing gasket where the gate had been removed. He said the material tested positive for asbestos, so Chelan PUD notified the contractor that there is asbestos in the gate, which added 12 days to the repair schedule. Keller said Chelan PUD periodically checked in with the contractor via email on progress of repair of the 60-inch-by-60-inch sluice gate, with no response. He said on December 21, 2015, Chelan PUD received an email from the contractor indicating they lost part of the gate in a snow bank. Keller said Chelan PUD is still waiting for a report on what repairs are still needed, and based on the current timeline, Chelan PUD is not optimistic the refurbished gate will be received before the end of the winter maintenance period. He said Chelan PUD is now engaging in weekly conference calls with the contractor, including with its Chief Executive Officer, to emphasize how important this gate is to the operation of Rock Island Dam. Keller said Chelan PUD is also sending the lead mechanic and engineer to the contractor's facility in Massachusetts to help move the process forward. He added that Chelan PUD will develop a trip report regarding progress on the refurbishing of the Rock Island Dam right fish ladder sluice gate, RO4, following the site visit to the contractor's facilities in Massachusetts, and will provide the report to Kristi Geris for distribution to the Coordinating Committees. *(Note: Keller provided a trip report to Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day.)*

Jim Craig noted that heavy snowfall had not even occurred along the east coast until just lately. Keller agreed, and said Chelan PUD is extremely frustrated with the contractor at this time. He added that if the ladder is operated without RO4 installed, this may result in operations out of compliance. Craig asked if staff can manually regulate flow conditions in the ladder to meet criteria, and Keller said the ladder cannot be manually fine-tuned without the gate. Keller said Chelan PUD also considered requesting that the contractor return the gate, as is; however, Rock Island Dam engineers were not confident the gate would be returned in proper working order (considering the gate had been disassembled and parts lost).

Keller said, considering all of this, Chelan PUD is requesting an extension of the 2015/2016 winter maintenance work period at Rock Island Dam by 15 days (from March 1 to March 15, 2016). He said the left and center ladders will be watered up and fully operational, and added that Thad Mosey (Chelan PUD Fish Biologist) believes steelhead and spring Chinook salmon migrating during that time will find alternate passage routes via the left and middle ladders. Keller said the extension will allow time for Chelan PUD to receive the refurbished gate from the contractor (ETA third week in February 2016), install the gate, and ensure all ladders are in criteria for the 2016 adult fish passage season. He said if the ladder is watered up without installing the gate, the ladder will need to be taken offline again to install the gate at a later date. He said this option is not preferred, considering 70% of adults pass Rock Island Dam via the right ladder. Korth asked about fish passage numbers on March 15, and Keller said there are few and numbers increase in April.

Korth asked who the original contractor is who built the gate, and Keller said he does not have that information available. Keller said Chelan PUD did consider fabricating a new gate; however, this option would cost approximately $50,000 to $60,000 and would take 6 to

8 months to fabricate, which was not an option at this point. Korth said this information addressed his comment. Craig asked if Chelan PUD has previously worked with this contractor in Massachusetts, and Keller said they have, and have mixed reviews. Keller said, however, he understands that this particular contractor is the only option for this type of work.

Kirk Truscott asked if the gate is returned in disrepair or cannot be installed, what might be the impacts to adult passage on the right ladder in absence of the sluice gate. Keller said he is not sure, and suggested possibly installing a bulkhead in place of the sluice gate; however, he is uncertain what that would look like in terms of head differentials. He said Chelan PUD will summarize potential operations scenarios for the Rock Island Dam right fish ladder operating with a bulkhead installed in place of the sluice gate, RO4, including potential effects on salmonid passage past the dam, and will provide the summary to Geris for distribution to the Coordinating Committees.

The Rock Island HCP Coordinating Committee representatives present agreed to extend the 2015/2016 winter maintenance work period for the right fish ladder at Rock Island Dam by 15 days to allow more time to complete required work, contingent on Chelan PUD providing weekly reports on the progress of repairs. Rather than the typical March 1 completion date, the Rock Island right fish ladder will be fully operational by March 15, 2016. Chelan PUD will provide weekly reports on the progress of repairing and installing the Rock Island Dam right fish ladder sluice gate, RO4, to Geris for distribution to the Coordinating Committees. *(Note: Lance Keller provided weekly reports, as requested, on February 4, 16, and 22, 2016, which Geris distributed to the Coordinating Committees those same days.)*

D. Rock Island Denil Removal (Lance Keller)

Lance Keller recalled that the initial plan was to first remove the right ladder tailrace entrance denil structure (i.e., TRE; the one installed against bedrock), followed by the left powerhouse entrance denil structure (LPE), and then move across the tailrace to remove the left ladder denil structures. He said, however, due to the extended unit outage, the schedule was flip-flopped and the LPE was removed first. He said he does not know the exact LPE removal date; however, based on the TRE removal date of January 17, 2016, he estimated the

LPE was removed sometime between January 8 and January 12, 2016. He said removal of the TRE took longer than removal of the LPE because strict flow regimes from upstream were required to complete the work and were difficult to maintain. He said Rock Island Dam operators had to start spill to reduce headwater, and once divers were in the water, operators had to start Turbine Unit 4 to produce a velocity jet to shield the divers. He said operations were moved to nighttime hours in order to complete the work. He said crews have now moved to the left ladder to begin removing the upper and lower denil extensions on the left bank. He said work will likely begin today, January 26, 2016, which will also involve in-water work to remove the denil structures. He said Chelan PUD will notify the Coordinating Committees when the last denil structure is removed from the Rock Island Dam fishways. *(Note: Keller provided a notification that denil removal was completed to Kristi Geris on February 16, 2016, which Geris distributed to the Coordinating Committees that same day.)*

V. Douglas PUD/Chelan PUD

A. 2016 Subyearling Chinook Salmon Workshop (John Ferguson/Tom Kahler/Lance Keller)

John Ferguson said, last fall 2015, Denny Rohr contacted him about holding another Subyearling Chinook Salmon Workshop. Ferguson said Rohr suggested holding the workshop in early 2016; however, this did not seem feasible. Ferguson said he and Rohr, along with Douglas PUD, Chelan PUD, and Grant PUD, further discussed the need for a 2016 Subyearling Chinook Salmon Workshop to update information discussed during the last Subyearling Chinook Salmon Workshop held in November 2009. Ferguson said the 2009 workshop was held at SeaTac, Washington, and convened members of the Coordinating Committees and PRCC, as well as regional expert guest presenters. He recalled discussing subyearling Chinook salmon life histories, tag technology and tag effects, and behavioral data, among other topics. He said, considering individual PUD schedules and requirements, it was agreed to convene a 2016 Subyearling Chinook Salmon Workshop sometime in May or June 2016. He said a subgroup has been formed to discuss possible agenda items, and Rohr plans to discuss the 2016 Subyearling Chinook Salmon Workshop with the PRCC during their meeting tomorrow on January 27, 2016.

Lance Keller said, as noted earlier, Chelan PUD has an SOA that maintained subyearling Chinook salmon in Phase III (Additional Juvenile Studies) until 2016. He said language in the 3-year SOA, which was approved in 2013, requires Chelan PUD to assess improvements in tag technology and study design to evaluate survival study feasibility at the expiration of the SOA. He said information discussed during the 2016 Subyearling Chinook Salmon Workshop will dictate how Chelan PUD moves forward with regard to subyearling Chinook salmon.

Tom Kahler recalled, that following the 2009 workshop, Douglas PUD discussed with the Coordinating Committees a path forward. He said Chelan PUD and Douglas PUD agreed to monitor PIT-tagged subyearling Chinook salmon in the Rocky Reach Reservoir for 1 year. He said, due to minimal data collected during this first year (few PIT-tagged subyearlings upstream of Rocky Reach Dam), Douglas PUD kicked off a 3-year subyearling Chinook salmon study. He said 1 additional year of monitoring data was also collected following the 3-year study, and the data are currently being compiled in a comprehensive subyearling Chinook salmon report. He agreed with Ferguson and Keller that it is time for an update on the state of science, and then determine a path forward.

Ferguson said May or June 2016 were chosen because those months are far enough away to make arrangements with guest speakers and get this workshop on the Coordinating Committees' and PRCC's schedules. He said the workshop will likely be an all-day event, and will likely be held at the Radisson at SeaTac, Washington. The Coordinating Committees discussed individual schedules and agreed to reschedule the Coordinating Committees meeting on June 28 to June 21, 2016, to accommodate the 2016 Subyearling Chinook Salmon Workshop. Ferguson said he will discuss with Rohr possibly holding both the PRCC and Coordinating Committees June 2016 meetings on June 21, 2016, and holding the 2016 Subyearling Chinook Salmon Workshop the next day on June 22, 2016.
(Note: Ferguson discussed the topic with Rohr following the Coordinating Committees meeting on January 26, 2016.)

Bob Rose suggested one central theme to discuss might be about what types of studies are feasible that will identify behavioral traits. He asked if behavioral traits can be identified to help document assumptions, and what does that information look like. Ferguson agreed, and added that some sort of framework is needed. Kahler said he would like to schedule plenty of time for questions and answers with the presenters. He recalled, during the 2009 workshop, it seemed there was plenty of opportunity to distill the information, which was really helpful. He suggested scheduling even more discussion time during the 2016 workshop, including intermittent periods of discussion after individual topics, and then a collective discussion at the end of the workshop. Jeff Korth asked who is invited. Ferguson suggested holding a small enough workshop to facilitate valuable discussion; however, not to exclude too many people because this is an important topic. The Coordinating Committees discussed several options and decided to invite HCP representatives and alternates, not to exceed three to four people per agency. Ferguson also suggested making it clear this is a working workshop for the Coordinating Committees, and people invited should keep in mind the intent of the workshop.

Ferguson said he will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings.

VI. HCP Administration

A. HCP-HC Distribution Lists and Extranet Access – Deanne Pavlik-Kunkel (Grant PUD)

John Ferguson said a request from Tracy Hillman, on behalf of Grant PUD, requesting that Deanne Pavlik-Kunkel be included on the HCP Hatchery Committees distribution list (Attachment B), was distributed to the Coordinating Committees by Kristi Geris on December 28, 2016. Ferguson reviewed the request, and Coordinating Committees representatives present agreed to provide Deanne Pavlik-Kunkel member access to the HCP Hatchery Committees Extranet site, and add Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists. Geris said she will contact Julene McGregor to request member access to the HCP Hatchery Committees Extranet site for Deanne Pavlik Kunkel, as approved by the Coordinating Committees, and will and coordinate with Sarah Montgomery about adding Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists. *(Note: Geris contacted McGregor and*

Montgomery following the Coordinating Committees meeting on January 26, 2016, about getting Pavlik-Kunkel Extranet access and on the distribution lists.)

Tom Kahler further explained that Grant PUD's interest in plugging in Pavlik-Kunkel to HCP Hatchery Committees discussions is that Grant PUD is a funding partner with Douglas PUD, for production of steelhead at Wells Hatchery and spring Chinook salmon at Methow Fish Hatchery; therefore, there is a lot of overlap in interests in results of HCP Hatchery Committees discussions. Kahler added that Pavlik-Kunkel is Todd Pearson's (Grant PUD) and Peter Graf's (Grant PUD) supervisor. Kirk Truscott added that Grant PUD also has summer Chinook salmon production with Chelan PUD at the Dryden Facility, so Grant PUD's interests spans multiple HCPs.

B. 2015 HCP Annual Reports

John Ferguson reminded the Coordinating Committees that the Draft 2015 Wells HCP Annual Report will be available for a 30-day review on Monday, February 8, 2016, and the Draft 2015 Rocky Reach and Rock Island HCP Annual Reports will be available for a 30-day review on Thursday, February 18, 2016.

C. Next Meetings

The next scheduled Coordinating Committees meeting is on February 23, 2016, to be held in-person at the Radisson Hotel in SeaTac, Washington. The March 22, 2016, and April 26, 2016, meetings will be held by conference call, in Eastern Washington, or in person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Request to Include Deanne Pavlik-Kunkel to Hatchery Committees Distribution List

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood†††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Bob Rose*	Yakama Nation
Kirk Truscott*†	Colville Confederated Tribes

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

BioAnalysts, Inc.
4725 N. Cloverdale Rd.
Suite 102
Boise, Idaho 83713
Phone: 208.321.0363
Fax: 208.321.0364

Memorandum

To: John Ferguson, HCP Coordinating Committees Chair

From: Tracy Hillman, HCP Hatchery Committees Chair

CC: HCP Hatchery Committees

Date: 28 December 2015

Re: Request to Include Deanne Pavlik-Kunkel to Hatchery Committees Distribution List

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects HCPs Hatchery Committees received a request from Grant County Public Utility District (GCPUD) asking if Deanne Pavlik-Kunkel can be included on the HCP Hatchery Committees distribution list. Deanne is the Fisheries Program Supervisor at GCPUD and she participates in joint HCP HC and PRCC Hatchery Subcommittee discussions. Specifically, GCPUD is asking that Deanne be included on the following e-mail distribution lists:

- HCP-HC Final Agendas and Minutes only
- HCP-HC M&E Monthly and Annual Reports
- PRCC HSC: GCPUD and Facilitation

GCPUD is also requesting that Deanne have Extranet access as a “Member.” These privileges are the same as those granted to Todd Pearsons.

The HCP Hatchery Committees approved the requests during their December meeting. They are asking if the HCP Coordinating Committees will also approve the requests.

Please let me know if you have any questions.

Thanks!

720 Olive Way, Suite 1900
Seattle, Washington 98101
Phone 206.287.9130
Fax 206.287.9131
www.anchorqea.com

FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	March 22, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the February 23, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel, in SeaTac, Washington, on Tuesday, February 23, 2016, from 9:30 a.m. to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Chelan PUD will discuss with Dr. John Skalski (Columbia Basin Research) possibly adjusting the Data Access in Real Time (DART) database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass (Item I-C).
- John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).
- Tracy Hillman (BioAnalysts, HCP Hatchery and Tributary Committees Chairman) will provide a paper on imprinting of hatchery-reared salmon by Andy Dittman (National Marine Fisheries Service [NMFS] Science Center), published in *Fisheries* last March 2015, to Kristi Geris for distribution to the Coordinating Committees (Item II-A). *(Note: this paper was distributed to the Coordinating Committees by Geris on February 24, 2016.)*
- Lance Keller will notify the Coordinating Committees when the Rocky Reach Dam Adult Fish Ladder is back online from annual winter maintenance and fully operational (Item III-E). *(Note: Keller provided notification that the Rocky Reach Dam Adult Fish Ladder was returned to service on March 9, 2016, which Geris*

distributed to the Coordinating Committees that same days)

- Lance Keller will provide updates on receipt and installation of the refurbished sluice gate, RO4, as well as notify the Coordinating Committees when the Rock Island Dam right fish ladder is back online from annual winter maintenance and fully operational (Item III-E). *(Note: Keller provided notification of receipt of the refurbished sluice gate on March 3, 2016, and that the Rock Island Dam Right Fish Ladder was returned to service on March 9, 2016, which Geris distributed to the Coordinating Committees those same days.)*
- Lance Keller will provide the combined generation capacity of Rock Island Dam Powerhouses 1 and 2, minus Units B-1, B-2, B-3, and B-4 in Powerhouse 1, and Unit U-3 in Powerhouse 2, to Kristi Geris for distribution to the Coordinating Committees (Item III-G). *(Note: Keller provided these data on March 21, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Lance Keller will provide an update on the Rock Island Dam Powerhouse 2 Unit U-3 inspection, during the Coordinating Committees meeting on March 22, 2016 (Item III-G).
- Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B-2, to Kristi Geris for distribution to the Coordinating Committees (Item III-G).
- Tom Kahler will verify the estimated completion date for the Wells Hatchery Modernization, and will provide photographs discussed during today's meeting to Kristi Geris for distribution to the Coordinating Committees (Item IV-A). *(Note: Kahler provided the photographs to Geris on February 24, 2016, and verified the estimated completion date on February 29, 2016, which Geris distributed to the Coordinating Committees those same days.)*
- Tom Kahler will notify the Coordinating Committees when the Wells Dam east fish ladder is back online from annual winter maintenance and fully operational (Item IV-B).
- **The Coordinating Committees meeting on March 22, 2016, will be held in-person at the Radisson Hotel in SeaTac, Washington (Item VI-D).**

DECISION SUMMARY

- The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island HCP Action Plans, as revised (Item III-A).

AGREEMENTS

- There were no agreements discussed during today's meeting.

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on February 8, 2016, notifying them that the Draft 2015 Wells HCP Annual Report was available for a 30-day review, with edits and comments due to Geris by Monday, March 7, 2016 (Item VI-B).
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach and Rock Island Fish Spill Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March 14, 2016 (Item III-B).
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach Juvenile Fish Bypass Operations Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March 14, 2016 (Item III-C).
- Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rock Island Bypass Monitoring Plan was available for a 32-day review, with edits and comments due to Lance Keller by Monday, March 14, 2016 (Item III-D).
- Kristi Geris sent an email to the Coordinating Committees on February 18, 2016, notifying them that the Draft 2015 Rocky Reach and Rock Island HCP Annual Reports were available for a 30-day review, with edits and comments due to Geris by Wednesday, March 16, 2016 (Item VI-B).
- Kristi Geris sent an email to the Coordinating Committees on March 11, 2016, notifying them that the Draft 2016 Broodstock Collection Protocols were available for review, and that Tom Kahler intends to request Wells HCP Coordinating Committee approval of the document during the Coordinating Committees meeting on March 22, 2016.

- Kristi Geris sent an email to the Coordinating Committees on March 19, 2016, notifying them that the Draft Statement of Agreement (SOA) for Modified Wells Dam Trapping for Bull Trout in 2016 was available for review, and would be further discussed during the Coordinating Committees meeting on March 22, 2016.

FINALIZED DOCUMENTS

- The Final 2016 Wells Dam Gas Abatement Plan and Bypass Operating Plan that was approved by the Wells HCP Coordinating Committee on January 26, 2016, and the Aquatic Settlement Work Group on February 10, 2016, was distributed to the Coordinating Committees by Kristi Geris on February 29, 2016.

I. Welcome

A. Review Agenda (John Ferguson)

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

- Lance Keller added an update on Rock Island Dam Powerhouse 2 Unit U-3 to Chelan PUD's existing update on Rock Island Dam Powerhouse 1 Units B-1 to B-4.
- Scott Carlon added a discussion on: 1) fishway inspections; and 2) Coordinating Committees meeting location.
- Ferguson added an update on the Draft 2015 HCP Annual Reports.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft January 26, 2016, meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. She said she also added the Draft 2015 Rocky Reach and Rock Island HCP Annual Reports under the review items. Coordinating Committees members present approved the January 26, 2016, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on January 26, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on January 26, 2016):*

- *Douglas PUD will revise the Subyearling Chinook Salmon Life-history Study dates in the draft 2016 Wells HCP Action Plan, as discussed, and will provide the final plan to Kristi Geris for distribution to the Coordinating Committees (Item III-A).*
  Tom Kahler revised the plan, as discussed, and provided the final plan to Geris on January 27, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Douglas PUD will consider revising the historical flows language in the Draft 2016 Wells Dam Gas Abatement Plan (GAP) and Bypass Operating Plan (BOP), as discussed, and will provide the final plan, when available, to Kristi Geris for distribution to the Coordinating Committees (Item III-B).*
  The historical flow language was revised, as requested, as distributed to the Coordinating Committees by Geris on February 10, 2016.
- *Douglas PUD will provide photographs of the lamprey entrance boxes installed in the low-level entrances at Wells Dam to Kristi Geris for distribution to the Coordinating Committees (Item III-C).*
  Tom Kahler provided a photograph of the lamprey entrance boxes to Geris on January 29, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will discuss with Dr. John Skalski (Columbia Basin Research) possibly adjusting the DART database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass (Item IV-A).*
  This action item will be carried forward.
- *Chelan PUD will add expected dates to receive Hatchery and Genetic Management Plan (HGMP) permits from NMFS to the Draft 2016 Rocky Reach and Rock Island HCP Action Plans, as discussed, and will provide the revised draft plans to Kristi Geris for distribution to the Coordinating Committees. Chelan PUD will request approval of the revised draft plans during the Coordinating Committees meeting on February 23, 2016 (Item IV-B).*
  Lance Keller updated the draft action plans, as discussed, and provided the revised draft plans to Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day. Alene Underwood (Chelan PUD HCP Hatchery Committees Representative) provided second revised draft action plans to Geris on

February 23, 2016, which Geris distributed that same day, prior to the meeting. This will be further discussed during today's meeting.

- *Chelan PUD will develop a trip report regarding progress on the refurbishing of the Rock Island Dam right fish ladder sluice gate, RO4, following a site visit to the contractor's facilities in Massachusetts, and will provide the report to Kristi Geris for distribution to the Coordinating Committees (Item IV-C).*
  Lance Keller provided a trip report to Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will summarize potential operations scenarios for the Rock Island Dam right fish ladder operating with a bulkhead installed in place of the sluice gate, RO4, including potential effects on salmonid passage past the dam, and will provide the summary to Kristi Geris for distribution to the Coordinating Committees (Item III-C).*
  This will be further discussed during today's meeting.
- *Chelan PUD will provide weekly reports on the progress of repairing and installing the Rock Island Dam right fish ladder sluice gate, RO4, to Kristi Geris for distribution to the Coordinating Committees (Item IV-C).*
  Lance Keller provided weekly reports, as requested, on February 4, 16, and 22, 2016, which Geris distributed to the Coordinating Committees those same days. This will be further discussed during today's meeting.
- *Chelan PUD will notify the Coordinating Committees when the last denil structure is removed from the Rock Island Dam fishways (Item IV-D).*
  Lance Keller provided a notification that denil removal was completed to Kristi Geris on February 16, 2016, which Geris distributed to the Coordinating Committees that same day. This will be further discussed during today's meeting.
- *John Ferguson will discuss with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) possibly holding both the PRCC and Coordinating Committees June 2016 meetings on June 21, 2016, and holding the 2016 Subyearling Chinook Salmon Workshop the next day on June 22, 2016 (Item V-A).*
  Ferguson discussed the topic with Rohr following the Coordinating Committees meeting on January 26, 2016. This will be further discussed during today's meeting.
- *John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly*

Coordinating Committees meetings (Item V-A).
This will be further discussed during today's meeting, and will also be carried forward.

- *Kristi Geris will contact Julene McGregor (Douglas PUD Information System Staff) to request member access to the HCP Hatchery Committees Extranet site for Deanne Pavlik-Kunkel (Grant PUD), as approved by the Coordinating Committees, and will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) about adding Pavlik-Kunkel to the requested HCP Hatchery Committees email distribution lists (Item VI-A).*
  Geris contacted McGregor and Montgomery following the Coordinating Committees meeting on January 26, 2016, about getting Pavlik-Kunkel Extranet access and on the distribution lists.

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 2016 due to lack of agenda items, and plan to meet next on March 10, 2016. Hillman noted that the Rocky Reach, Rock Island, and Wells Plan Species Accounts all received funding allocations, and specific details will be discussed during next month's update.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on February 17, 2016:

- *Imprinting and Homing Presentation and Discussion:* The HCP Hatchery Committees have long been discussing how to improve homing fidelity of spring Chinook salmon to the Chewuch River. The HCP Hatchery Committees invited Andy Dittman to share his presentation titled, "Effects of Hatchery Rearing and Release Practices on Olfactory Imprinting and Homing." Early studies indicated imprinting was associated with increased thyroxin during the smoltification stage; however, Dittman has been researching sequential imprinting, which involves imprinting throughout the embryo stage to the juvenile rearing stage. Results from the Yakima River Spring Chinook Salmon Supplementation Program may help explain homing fidelity issues in the upper Methow Basin. Dittman says fish stray naturally due to various causes, such as age (older fish stray more than younger fish), memory loss, and exhaustion. This straying naturally occurs in natural-origin recruits and also hatchery-origin recruits (HORs). However, depending on how HORs are reared, stray rates may increase. One study found that stray rates are low when fish are released at a location at which they were reared or at distances greater than 47 kilometers from that location. Related to sequential imprinting, fish in the Chewuch River are migrating up the Methow Basin and picking up stronger cues from the Methow Fish Hatchery, so they pass the Chewuch River. Similar findings have been observed in the upper Yakima Basin. Strategies to decrease staying include: 1) incubating fish in natural or distinct waters; 2) embryonic imprinting; 3) artificial imprinting cues (however, morpholine and phenyl ethyl alcohol used for this are hazardous chemicals); 4) out-of-basin rearing and transporting fish to acclimation sites far from rearing location; and 5) monitoring release timing. Prior to Dittman's presentation, the Hatchery Evaluation Technical Team drafted a study plan to improve homing fidelity based on sequential and embryonic rearing. However, at this point, there are several issues with the plan, and Chelan PUD, Douglas PUD, and the Yakama Nation (YN) are working to resolve them for HCP Hatchery Committees' review. Hillman said Dittman recently published these findings, as presented to the HCP Hatchery Committees, in *Fisheries* last March 2015, and he will provide the paper to Kristi Geris for distribution to the Coordinating Committees. *(Note: this paper [Attachment B] was distributed to the Coordinating Committees by Geris on February 24, 2016.)*

- *Methow Spring Chinook Salmon Gene Flow Sliding Scale:* The HCP Hatchery Committees discussed a proposal from Craig Busack (NMFS HCP Hatchery Committees Alternate) to meet gene flow standards, which proposes an overall population goal of proportionate natural influence greater than or equal to 50%, when the natural run size estimated at Wells Dam is greater than or equal to 300 fish, and a total spawner escapement of 500 fish when the natural run size is fewer than 300 fish. Broodstock collection will also be limited to less than or equal to 33% of the natural run, except no natural broodstock will be collected, when the natural run size is fewer than 100 fish. Based on escapement numbers, different equations would be used for the three different categories. The HCP Hatchery Committees will vote on the proposal within the next couple of weeks, and NMFS needs to issue their permit by the end of May 2016.

- *5-Year Hatchery Monitoring and Evaluation (M&E) Review Planning—Objectives 4, 5, 7, and 1:* This effort is ongoing. All objectives have been reviewed for spring Chinook salmon, and now Catherine Willard (Chelan PUD HCP Hatchery Committees Alternate) is drafting the results. The HCP Hatchery Committees revisited the hatchery replacement rate (HRR) discussion, and decided to use the 40th percentile during a 5-year evaluation period, with the caveats that: 1) they will not be concerned if HRR targets are not achieved in 1 or 2 years, but will become concerned if targets are not achieved in 3 or more years; and 2) each program will have its own HRR target, except Nason Creek (which will use the Chiwawa spring Chinook salmon target because there are no data for the Nason Creek program to calculate its target), and the Methow spring Chinook salmon and Chewuch spring Chinook salmon programs (which will use the higher of their two targets because they both include MetComp stock and should be assessed together). A draft report summarizing the results will be available for review in the next few weeks. Current progress of this review has also met the SOA established for this effort.
- *NMFS Consultation Update:* No new updates on the Wenatchee Steelhead Biological Opinion (BiOp; it is still with NMFS Legal Counsel). The Methow Spring Chinook Salmon BiOp is pending HCP Hatchery Committees approval of gene flow standards. Once approved, Craig Busack indicated he will attempt to complete the BiOp by May 2016. Jim Craig asked if the Methow Spring Chinook Salmon BiOp will go back to NMFS Legal Counsel review, and Scott Carlon said it would.
- *2016 Broodstock Collection Protocols:* The Washington Department of Fish and Wildlife (WDFW) provided the Draft 2016 Broodstock Collection Protocols for HCP Hatchery Committees' review. The draft protocols will be discussed during the next HCP Hatchery Committees meeting on March 16, 2016.
- *2016 Rocky Reach and Rock Island HCP Action Plans:* The Rocky Reach and Rock Island HCP Hatchery Committees approved the hatchery portion of the 2016 Rocky Reach and Rock Island HCP Action Plans.
- *Wenatchee Summer Chinook Salmon SOA:* The Rock Island and Rocky Reach HCP Hatchery Committees approved Chelan PUD's Wenatchee Summer Chinook SOA. The intent of the SOA is to design a chilled, partial water reuse system for Wenatchee summer Chinook salmon that will help Chelan PUD meet phosphorus discharge

requirements under the Wenatchee River Total Maximum Daily Load for dissolved oxygen and pH.

- *Brood Year 2014 Methow Spring Chinook Salmon Acclimation:* The YN was interested in operating the Chewuch Acclimation Facility; however, other parties were interested in WDFW operating the facility. WDFW indicated they were unable to hire staff to operate the facility this year, so the YN will operate the Chewuch Acclimation Facility in 2016. WDFW will likely operate the facility in future years.
- *Draft 2016 Steelhead Release Plan:* Chelan PUD provided a Draft 2016 Steelhead Release Plan for HCP Hatchery Committees' review. The plan is essentially identical to last year's plan. The HCP Hatchery Committees will vote on the draft plan at the same time they vote on the gene flow standards in the Methow Basin in a couple of weeks.
- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on March 16, 2016.

III. Chelan PUD

A. DECISION: Revised Draft 2016 Rocky Reach and Rock Island HCP Action Plans (Lance Keller)

Lance Keller said he coordinated with Catherine Willard to incorporate into the Draft 2016 Rocky Reach and Rock Island HCP Action Plans expected dates to receive Hatchery and Genetic Management Plan permits from NMFS, per Jeff Korth's recommendation during the Coordinating Committees meeting on January 26, 2016. Keller said he provided the revised draft plans to Kristi Geris on February 22, 2016, which Geris distributed to the Coordinating Committees that same day. Keller said Alene Underwood also incorporated a minor clarifying edit and provided second revised draft action plans to Geris on February 23, 2016, which Geris distributed that same day, prior to the Coordinating Committees meeting. Keller said no edits were received from Coordinating Committees representatives on the Coordinating Committees section of the revised draft action plans.

The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island HCP Action Plans, as revised.

B. Draft 2016 Rocky Reach and Rock Island Fish Spill Plan (Lance Keller)

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on

February 11, 2016, notifying them that the Draft 2016 Rocky Reach and Rock Island Fish Spill Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller said the plan is largely the same as last year's, with updated numbers. He asked that Coordinating Committees representatives contact him with questions, if needed.

C. Draft 2016 Rocky Reach Juvenile Fish Bypass Operations Plan (Lance Keller)

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach Juvenile Fish Bypass Operations Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller said the plan is largely the same as last year's, with updated numbers. He asked that Coordinating Committees representatives contact him with questions, if needed.

Keller said he also plans to provide the Coordinating Committees a 2015 bypass report that will also cover the previous year that was not reported on due to the Wanapum Drawdown.

D. Draft 2016 Rock Island Bypass Monitoring Plan (Lance Keller)

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rock Island Bypass Monitoring Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller said the draft plan includes a slight change from last year. He said language was incorporated into the draft plan that outlines procedures should the fish trap accumulate too many fish. He explained, when the carrying capacity of the fish trap trough is exceeded, a subsample is collected and incorporated into the DART algorithm, similar to procedures at Rocky Reach Dam. He said, historically, these procedures have been in place verbally, but now they have been added to the plan.

E. Rocky Reach and Rock Island Adult Fish Ladder Winter Maintenance (Lance Keller)

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

<u>Rocky Reach Dam</u>

Keller recalled that during the Coordinating Committees meeting on January 26, 2016, he notified the Coordinating Committees of adult lamprey discovered beneath a diffuser grating while conducting a fish rescue at Rocky Reach Dam on January 4, 2016. He also recalled that new 3/4-inch grating was ordered to replace the existing 1-inch diffuser grating floor where the lamprey were discovered, and that a possible winter maintenance period extension was discussed, should the new grating not arrive before the normal maintenance period ended. Keller said the materials arrived early, and crews installed the new grating floors in Weirs A10 to A13, as discussed. He said rewatering of the fish ladder began on February 19, 2016, and it should be fully operational by the end of this week. He said he will notify the Coordinating Committees when the Rocky Reach Dam Adult Fish Ladder is back online from annual winter maintenance and fully operational. *(Note: Keller provided notification that the Rocky Reach Dam Adult Fish Ladder was returned to service on March 9, 2016, which Kristi Geris distributed to the Coordinating Committees that same days)*

Jim Craig asked if the 1-inch diffuser grating floor is everywhere in the fish ladder, and Keller replied that it is. Keller added that this was an opportunistic repair, which did not affect hydraulics, but there may be opportunities in the future to replace other grating floors. John Ferguson noted that NMFS requires 1-inch gratings for salmonid passage, so future repairs will need to be further discussed with NMFS.

<u>Rock Island Dam</u>
Keller recalled that the middle ladder at Rock Island Dam was returned to service on December 30, 2015. He said maintenance was then completed on the left ladder, which was returned to service on February 11, 2016. He said the middle and left ladders at Rock Island Dam are now fully operational.

Right Ladder
Keller recalled requesting and obtaining Rock Island Coordinating Committee approval of an extended maintenance outage to March 15, 2016, due to complications with the auxiliary water supply sluice gate, RO4. He also recalled that Chelan PUD has provided various updates and a trip report, as requested.

Keller said, since the last Coordinating Committees meeting on January 26, 2016, Chelan PUD's phone calls and emails to the contractor continued to go unanswered, so Chelan PUD sent an engineer and lead foreman mechanics to Massachusetts for a site visit with the contractor. He said the contractor tried to push the site visit back, but Chelan PUD went anyway. Keller said when the Chelan PUD engineer and mechanics arrived onsite, they discovered the gate was in the state it had been sent. He said while Chelan PUD was onsite, in the following days, significant work was put into refurbishing the gate, and Chelan PUD was confident the shop was indeed operational and progress was being made. Keller said, following the site visit, Chelan PUD and the contractor held daily conference calls and the contractor provided photographs of continued progress. He said the refurbished gate is being picked up today, will be shipped direct freight, and should arrive to Rock Island Dam on March 1, 2016. He said the concrete needed for grouting is already onsite, so once the gate arrives, installation can begin immediately. He said if transport goes as planned and the gate arrives March 1, 2016, Chelan PUD may not need an outage extension past the previous approved extension of March 15, 2016, or need to develop alternate operations scenarios due to the gate not being in place.

Keller recalled how frustrated Chelan PUD was about not even getting a response from the contractor. He said when Chelan PUD asked the contractor about this, the contractor said they did not know what to say, so they chose not to say anything at all. Ferguson asked if there is any risk when the gate arrives that something might be wrong with it. Keller said the refurbishments were straightforward; however, there is always the possibility of something going wrong during shipping. He said he will provide updates on receipt and installation of the refurbished sluice gate, RO4, as well as notify the Coordinating Committees when the Rock Island Dam Right Fish Ladder is back online from annual winter maintenance and fully operational. *(Note: Keller provided notification of receipt of the refurbished sluice gate on March 3, 2016, and that the Rock Island Dam Right Fish Ladder was returned to service on March 9, 2016, which Geris distributed to the Coordinating Committees those same days.)*

F. Rock Island Dam Denil Removal (Lance Keller)

Lance Keller recalled he provided a notification that denil removal was completed to

Kristi Geris on February 16, 2016, which Geris distributed to the Coordinating Committees that same day. Keller reviewed the following removal dates:

Denil structure	Removal date
Right Ladder Left Powerhouse Entrance Denil	January 9, 2016
Right Ladder Tailrace Entrance Denil	January 17, 2016
Left Ladder Denil (and in-ladder modifications)	January 26, 2016

Keller said, prior to February 1, 2016, all denil structures were removed, which was a significant milestone for the whole effort.

G. Rock Island Dam Powerhouse 1 Units B-1 to B-4, and Powerhouse 2 Unit U-3 (Lance Keller)

Rock Island Dam Powerhouse 1 Units B-1 to B-4

Lance Keller recalled he provided an update on Rock Island Dam Powerhouse 1 Units B-1 to B-4 to Kristi Geris on February 11, 2016, which Geris distributed to the Coordinating Committees that same day. Keller recalled that Rock Island Dam Powerhouse 1 Unit B-2 has been out of service for turbine crack repairs since last October 2015. He said repairs consisted of a survey for surface cracks on each of the six turbine unit blades. He said when cracks were discovered, the cracked area was excavated with a grinder, filled with weld material, and then ground smooth back to the original contour of the blade. He said during the initial survey, some of the Unit B-2 blades were determined to be crack-free. He said after identifying and repairing surface cracks in other blades, a follow-up survey was conducted on all the blades, and cracks were found in additional blades in high-stress locations, despite some blades being crack-free during their initial survey (i.e., just sitting in place was causing stress). Keller said these units are old, and the surface cracks have been attributed to corrosion fatigue. He said because Units B-1, B-2, B-3, and B-4 are all similar, and because Chelan PUD was not confident about operating the units until a visual inspection can be completed on each unit, the units were removed from service.

Jim Craig asked if the units were dewatered, and Keller replied that they are not. Keller added that the wicket gates are 100% closed, and the turbine units are unavailable to spin. He said Unit B-3 will be inspected February 29 to March 20, 2016, and if no cracks are discovered, he believes that unit will be made available for generation. He added that having

Units B-1 to B-4 out of service means reduced hydraulic capacity, and if river flow is high, Rock Island Dam may be forced to spill earlier than usual. He said the 2016 Rocky Reach and Rock Island Fish Spill Plan will be implemented as outlined; however, Rock Island Dam may need to spill farther in the outlined spill sequence, and total dissolved gas (TDG) will be closely monitored. He said the Chelan PUD Fish and Wildlife Department does not foresee issues with regard to juvenile and adult fish passage (i.e., unit outages will not compromise fish passage). He added that a TDG probe is in place at Rock Island Dam to obtain readings.

John Ferguson asked about the combined generation capacity of Rock Island Dam Powerhouses 1 and 2, minus Units B-1, B-2, B-3, and B-4 in Powerhouse 1, and Unit U-3 in Powerhouse 2. Keller said this information is not currently available; however, he will obtain it and provide it to Geris for distribution to the Coordinating Committees. *(Note: Keller provided these data on March 21, 2016, which Geris distributed to the Coordinating Committees that same day.)*

Jeff Korth asked about the age of the existing turbine unit blades. Keller said the blades are the originals, which were installed when the dam was constructed in the 1930s. He noted that the units still have wood bearings.

Keller said following the Unit B-3 inspection, Unit B-1 will be inspected March 21 to April 10, 2016, and Unit B-4 will be inspected April 11 to May 2, 2016. He added that he will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B-2, to Geris for distribution to the Coordinating Committees.

<u>Rock Island Dam Powerhouse 2 Unit U-3</u>

Keller said rehabilitation efforts on Rock Island Dam Powerhouse 2 Unit U-3 had been ongoing for quite some time, and recently the unit was returned to service. He said, however, staff discovered a trunnion seal failure in the blade hub, which keeps oil in the Kaplan-style blade. He said on February 18, 2016, an oil sheen was observed in the Rock Island Dam tailrace. He said it was obvious where the oil was leaking from, and staff removed Unit U-3 from service. He said over 4 days, approximately 105 gallons of oil were leaked into the river. He said Chelan PUD notified the Washington State Department of

Ecology and the U.S. Environmental Protection Agency, and is now undergoing the necessary processes to address the leak. He added that Rock Island Dam Powerhouse 2 Unit U-3 will be unavailable until the trunnion seal is repaired.

Korth asked how the source of the leak was obvious. Keller explained that, given the Powerhouse operations at that time, staff were able to easily identify which unit was leaking. He added that this issue is unique to Unit U-3, and should not be an issue in the other Powerhouse 2 units. He also said he will provide an update on the Rock Island Dam Powerhouse 2 Unit U-3 inspection, during the Coordinating Committees meeting on March 22, 2016.

IV. Douglas PUD

A. Wells Hatchery Modernization (Tom Kahler)

Tom Kahler handed out photographs depicting progress on components of the Wells Hatchery Modernization. He said he will provide these photographs to Kristi Geris for distribution to the Coordinating Committees after the meeting. *(Note: Kahler provided the photographs [Attachments C to G] to Geris on February 24, 2016, which Geris distributed to the Coordinating Committees that same day.)*

Kahler reviewed the photographs, as follows:

<u>Wells Hatchery Adult-handling Facility Photograph</u> (Attachment C)
Kahler noted a section of the old volunteer channel located behind the new Adult-handling Facility and between the two electrical towers. He said that channel used to run into the foreground of the photograph and terminate in a trap near where the yellow super structure frame is located, and staff would manually sort fish there. He said with the new Adult-handling Facility, fish move up the volunteer channel into the new building, and will be ultimately sorted into one of six ponds. He said five of six ponds are already poured, and the sixth is underway. He said, from those ponds, fish can be guided back to the river or to transport trucks or spawned in the facility. He said the west fish ladder trap will also be piped to the new Adult-handling Facility.

Kahler said Attachment C also depicts a portion of the new utilities corridor located along the dirt pond with the yellow silt curtain. He said all utilities are now located in a single corridor and branch off as necessary. He said, also in Attachment C, the newly installed netting can be seen over one of the ponds. He said netting will be installed on Pond 1 this summer.

Wells Hatchery Adult-handling Facility Close-up Photograph (Attachment D)
Kahler noted the vertical slots in each concrete box where a false weir will be installed, and he said fish will volunteer themselves into the sorting containers. He said the new Adult-handling Facility is scheduled to be fully operational by May 1, 2016, in time for spring Chinook salmon broodstock collection.

Wells Hatchery Utilities Corridor and Dirt Ponds Photograph (Attachment E)
Kahler said the new utilities corridor is located under the row of construction equipment adjacent to the dirt pond.

Wells Hatchery Utilities Corridor and Head Tank Photograph (Attachment F)
Kahler noted the four aboveground concrete raceways and the existing bureau ponds to the right. He said the new Head Tank Facility is the building, with the rows of windows, located in the upper right corner of the photograph.

Wells Hatchery Head Tank Close-up Photograph (Attachment G)
Kahler said all groundwater and surface water are routed through this new facility.

Kahler said, to date, the modernization is on schedule. Jim Craig asked about the total cost of the modernization. Kahler said contracted work only is about $37 million. He said, however, he is not certain about design, construction supervision, and other costs. John Ferguson asked what the estimated completion date is, and Kahler said he was uncertain, but can find out and let Geris know for distribution to the Coordinating Committees. *(Note: Kahler verified the estimated completion date of August 31, 2017, on February 29, 2016, which Geris distributed to the Coordinating Committees that same day.)*

B. Wells Dam Fish Ladder Maintenance (Tom Kahler)

Tom Kahler said annual winter maintenance on the west fishway at Wells Dam was completed later in the week following the last Coordinating Committees meeting on January 26, 2016. He said the east fishway at Wells Dam was then dewatered for annual winter maintenance the following week. He said a fish rescue was performed, and then maintenance work started right away. He said Biomark was onsite last week installing a passive integrated transponder (PIT)-tag antenna on the lamprey entrance box. He handed out a photograph of the installed PIT-tag antenna on the lamprey entrance box (Attachment H), which he provided to Geris via email on February 24, 2016, and Geris distributed to the Coordinating Committees that same day. He explained that the antenna is the white, circular object attached to the entrance. He said he is unsure if all maintenance is now complete, but will notify the Coordinating Committees when the Wells Dam east fish ladder is back online from annual winter maintenance and fully operational.

Bob Rose asked if the PIT-tag antennas have been tested. Kahler said the antenna installed on the west fishway lamprey entrance box is detecting test tags. He also noted the prerequisite of getting fish to approach and seek to pass Wells Dam via the low-level entrances before they could be detected on the new antennas.

C. Bypass Bay 2 PIT-tag Detection (Tom Kahler)

Tom Kahler said Biomark is still intending to complete construction and installation of PIT-tag detection in Bypass Bay 2 in time for routine bypass operations at Wells Dam, starting at 0000 hours on April 9, 2016. Kirk Truscott asked if those data will be uploaded to the PIT-Tag Information System. Kahler said they will, via a new Wells Dam juveniles site that is separate from the Wells Dam adults site. He added that Douglas PUD has requested that Biomark install the PIT-tag detection system by the last week in March 2016 to allow time to test the system prior to the start of bypass operations.

V. NMFS

A. Fishway Inspections (Scott Carlon)

Scott Carlon said there may be a shift in NMFS staff who administer fishway inspections for the Mid-Columbia hydropower projects. He asked who administers inspections at Wells, Rocky Reach, and Rock Island dams. Tom Kahler said the Fish Passage Center contracts WDFW to conduct inspections at Wells Dam. Lance Keller said the same is for Rocky Reach and Rock Island dams. Carlon said Aaron Beavers (NMFS) is in charge of conducting inspections now, and for a number of reasons it is difficult for Beavers to get onsite every month, so NMFS is exploring alternative options.

VI. HCP Administration

A. 2016 Subyearling Chinook Salmon Workshop

John Ferguson recalled that Chelan PUD has an SOA that maintained subyearling Chinook salmon in Phase III (Additional Juvenile Studies) until 2016, at which time Chelan PUD needs to annually assess improvements in tag technology and study design to evaluate survival study feasibility (approved by the Rocky Reach and Rock Island HCP Coordinating Committees on June 25, 2013). Ferguson said, since last discussing a 2016 Subyearling Chinook Salmon Workshop during the Coordinating Committees meeting on January 26, 2016, the Priest Rapids Coordinating Committee (PRCC) also agreed to reschedule their June 2016 meeting to June 21 or June 22, 2016, to accommodate the workshop (as previously agreed by the Coordinating Committees on January 26, 2016).

Ferguson said the subgroup planning the workshop has also drafted an agenda, which entails the following five potential agenda topics:

<u>1. Fish Passage Survival Model Updates</u>
Ferguson said the planning subgroup envisioned this topic would be presented by Dr. John Skalski; however, workshop speakers are not yet confirmed.

<u>2. Subyearling Life History</u>
Ferguson said this portion of the workshop could include updates on subyearling Chinook salmon outside of the Mid-Columbia Basin, and he suggested inviting Billy Connor (U.S. Fish and Wildlife Service) to discuss studies in the lower Snake River and someone from the U.S. Army Corps of Engineers, Portland District, to discuss Willamette Reservoir studies. Ferguson noted that, as previously discussed, the planning subgroup built several discussion periods into the agenda to facilitate dialogue with the Coordinating Committees

and PRCC members and offer question and answer opportunities.

3. Study Fish

Ferguson said this section could address behavioral patterns observed in the Mid-Columbia Basin and whether enough study fish could be collected to meet study needs.

4. Tagging Effects

Ferguson said this section would include updates from researchers.

5. Tag Hardware

Ferguson said this section could include updates from vendors and other resources on size, dimensions, weight, tag longevity, and other information for tags currently available in the marketplace. Jim Craig said this section could also include updates from developers on research and development.

Ferguson said the planning subgroup plans to meet again on March 2, 2016, to further discuss the agenda and workshop details. He said there may be a more solid agenda by the next Coordinating Committees meeting on March 22, 2016. He said, with regard to attendees, the planning subgroup thought the previously discussed three to four representatives from each agency may be too many. He said the subgroup wants the workshop to be intimate, where the PRCC and Coordinating Committees can speak freely with researchers and have a good exchange of ideas. He said the bigger the attendance, the less functional the exchange is in a workshop setting. He said the subgroup is now thinking each PRCC and Coordinating Committees representative can invite one or two staff members to join, which will equal about 30 to 35 attendees, plus speakers.

B. Draft 2015 HCP Annual Reports

John Ferguson reminded the Coordinating Committees that Kristi Geris sent an email to the Coordinating Committees on February 8, 2016, notifying them that the Draft 2015 Wells HCP Annual Report was available for a 30-day review, with edits and comments due to Geris by Monday, March 7, 2016. Ferguson said Geris also sent an email to the Coordinating Committees on February 18, 2016, notifying them that the Draft 2015 Rocky

Reach and Rock Island HCP Annual Reports were available for a 30-day review, with edits and comments due to Geris by Wednesday, March 16, 2016.

C. Coordinating Committees meeting location (Scott Carlon)

Scott Carlon asked the Coordinating Committees if everyone is still supportive of holding the monthly Coordinating Committees meetings in Western Washington. He said he now has approval to travel to Wenatchee for Coordinating Committees meetings and wanted to discuss the location of future meetings. The Coordinating Committees supported the arrangement but were open to discuss this further since most members travel to Western Washington to attend the meetings. John Ferguson said he will let Denny Rohr (PRCC Facilitator) know this was briefly discussed.

D. Next Meetings

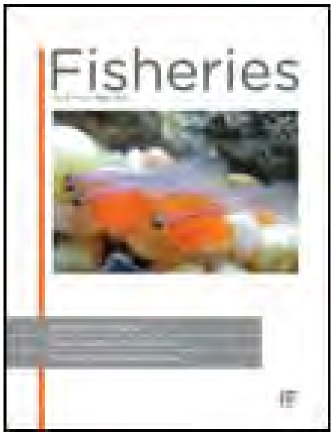
The next scheduled Coordinating Committees meeting is on March 22, 2016, to be held in-person at the Radisson Hotel in SeaTac, Washington. The April 26, 2016, and May 24, 2016, meetings will be held by conference call, in Eastern Washington, or in-person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	"Imprinting of Hatchery-Reared Salmon to Targeted Spawning Locations: A New Embryonic Imprinting Paradigm for Hatchery Programs" (Dittman 2015)
Attachment C	Wells Hatchery Adult-handling Facility Photograph
Attachment D	Wells Hatchery Adult-handling Facility Close-up Photograph
Attachment E	Wells Hatchery Utilities Corridor and Dirt Ponds Photograph
Attachment F	Wells Hatchery Utilities Corridor and Head Tank Photograph
Attachment G	Wells Hatchery Head Tank Close-up Photograph
Attachment H	PIT-tag Antenna Installed on Lamprey Entrance Box Photograph

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood†††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*†	Washington Department of Fish and Wildlife
Bob Rose*†	Yakama Nation
Kirk Truscott*†	Colville Confederated Tribes

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



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Imprinting of Hatchery-Reared Salmon to Targeted Spawning Locations: A New Embryonic Imprinting Paradigm for Hatchery Programs

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FEATURE

Imprinting of Hatchery-Reared Salmon to Targeted Spawning Locations:

A New Embryonic Imprinting Paradigm for Hatchery Programs

Straying by hatchery-reared salmon is a major concern for conservation and recovery of many salmon populations. Fisheries managers have attempted to minimize negative ecological and genetic interactions between hatchery and wild fish by using parr-smolt acclimation facilities to ensure successful olfactory imprinting and homing fidelity. However, the effectiveness of offsite acclimation for returning adults to targeted locations has been mixed. Since laboratory and field studies indicate that the period of hatching and emergence from the natal gravel is a sensitive period for olfactory imprinting, we propose an alternative imprinting approach wherein salmon are exposed as embryos to targeted waters transferred to their rearing hatchery. To test the feasibility of this approach, we conducted a series of electrophysiological and behavioral experiments to determine whether water can be successfully transferred, stored, and treated for pathogens without jeopardizing its chemical integrity. Stream water could be frozen or stored for one week at 4° or 10° C without affecting the olfactory signature. Ultraviolet light treatment altered the responses of the olfactory epithelium to stream water; however, behavioral studies suggested that this treatment did not alter the attractiveness of this water. Finally, we describe several alternative approaches to embryonic imprinting using artificial odors.

Impronta en salmones cultivados para incidencia en sitios de desove: un nuevo paradigma embrionario de impronta en programas de cultivo

La fuga de salmones cultivados es un asunto considerable para la conservación y recuperación de muchas poblaciones naturales de salmón. Los manejadores de pesquerías han intentado minimizar las interacciones negativas de orden ecológico y genético entre los peces cultivados y los silvestres mediante el uso de instalaciones en las que se asegure una impronta olfatoria y una filopatría exitosas. Sin embargo, la efectividad de la aclimatación remota para que los adultos regresen a los sitios de desove, no ha sido contundente. En virtud de que los estudios de laboratorio y de campo indican que el periodo de cultivo y emergencia en el sitio de nacimiento es un lapso sensible para que se establezca la impronta olfatoria, en este trabajo se propone un enfoque alternativo de impronta en el que el salmón, siendo embrión, es expuesto a sitios seleccionados a los que se les traslada desde las áreas de cultivo. Con el fin de probar la efectividad de este enfoque, se realizaron una serie de experimentos electrofisiológicos y etológicos para determinar si el agua puede ser exitosamente transferida, almacenada y tratada contra patógenos sin comprometer su integridad química. El agua de río puede ser congelada y almacenada por una semana a 4º C o 10º C sin afectar su firma olfatoria. El tratamiento con rayos UV alteró las respuestas del epitelio olfatorio al agua de río; sin embargo, los estudios etológicos sugieren que este tratamiento no altera la atracción hacia este tipo de agua. Finalmente, se describen diversos enfoques alternativos a la impronta embrionaria utilizando olores artificiales.

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INTRODUCTION

Hundreds of millions of hatchery-reared salmon are released into waters of the United States annually (Rand et al. 2012). The hatchery programs that produce these fish are designed primarily to increase commercial, recreational, and tribal fishing opportunities, but increasingly they have become integral to recovery efforts designed to conserve native populations. The magnitude of these hatchery releases has raised concerns about potentially deleterious ecological and genetic interactions that may occur between wild and hatchery-reared salmon (Rand et al. 2012). One area of particular concern is that rearing and release practices used by many hatcheries may increase straying, the term for dispersal of individuals to nonnatal areas for reproduction, which can further increase undesirable interactions (Brenner et al. 2012). These concerns have led to calls for strict guidelines for hatchery programs to minimize straying to levels that will not impact native salmon populations. For example, a common guideline is that straying outside of the targeted area for a hatchery program should not exceed 5% or 10% (Paquet et al. 2011). Salmon are well known for their extraordinary homing migrations from the ocean to their natal stream for reproduction (Quinn 2005). Though some low level of dispersal from the natal site is normal in both wild and hatchery populations, some hatchery practices can dramatically increase the rate of straying (Pascual et al. 1995). Many hatchery rearing and release practices have been developed to increase survival and to optimize imprinting, but straying by hatchery fish remains a major concern for salmon managers. In particular, one of the most common approaches for imprinting fish to a specific location is to transfer and hold fish at sometimes expensive and logistically challenging acclimation facilities on the river or specific stream reaches that are targeted for homing. Here, we propose a new embryonic imprinting approach to improve successful imprinting and reduce straying by exposing embryonic salmon to waters collected from their targeted return location.

Homing is governed by olfactory discrimination of home-stream water, and exposure to the home stream during appropriate juvenile stages is critical for olfactory learning (imprinting) and successful completion of the adult homing migration (Dittman and Quinn 1996). Ensuring that juvenile salmon experience specific water sources during appropriate periods for imprinting can be a challenging problem for artificial production programs because logistical realities (e.g., access to ground water, ability to obtain construction permits, and financial cost) often require that salmon are incubated and reared at large centralized hatcheries that use water sources that are different than target waters. Furthermore, salmon are often transported between facilities and released off-site to supplement specific populations or fisheries. While most salmon will typically return as adults to their juvenile release site after transfer (Donaldson and Allen 1957), such transfers and off-site releases tend to increase the rate of straying from the targeted return site (Pascual et al. 1995; Hard and Heard 1999). To address this concern, many hatchery programs have developed specific acclimation and release facilities designed to optimize the imprinting process by allowing salmon to experience imprinting cues for an extended period prior to release during the parr-smolt transformation (PST), the developmental period characterized by endocrine, physiological, and behavioral changes that prepare salmon for life in the ocean (Hoar 1976).

PARR-SMOLT IMPRINTING AND ACCLIMATION

The PST acclimation strategy has been employed because the PST has been identified as a critical period for successful olfactory imprinting in both Pacific *Oncorhynchus* spp. (Hasler and Scholz 1983) and Atlantic *Salmo salar* (Morin et al. 1989) salmon. A long history of transport studies (Lister et al. 1981) and a series of experimental assessments of imprinting using artificial odors (Hasler and Scholz 1983; Morin et al. 1989; Dittman et al. 1996) have pointed to the PST as a sensitive period during which imprinting occurs. Subsequent laboratory studies have also demonstrated that the peripheral olfactory system is sensitized to imprinted odorants (Nevitt et al. 1994) and olfactory sensitivity increases during the PST (Morin and Doving 1992). Among the many endocrine changes that are associated with the PST is a distinct surge in the plasma levels of the hormone thyroxine (Dickhoff et al. 1978) that has been linked to successful olfactory imprinting (Hasler and Scholz 1983). This was demonstrated most clearly in experiments wherein Coho Salmon *O. kisutch* exposed to odors prior to the PST did not demonstrate long-term imprinting memories for these odors unless their thyroxine levels were also experimentally elevated (Hasler and Scholz 1983). Elevated thyroxine levels also stimulated proliferation of olfactory sensory neurons (Lema and Nevitt 2004) and have been linked to imprinting in other vertebrate species (Yamaguchi et al. 2012).

Though the PST is an important developmental period for imprinting, freshwater migratory patterns of wild juvenile salmon suggest that the process and timing of imprinting may be much more complex (Quinn 2005). The best example of this is Sockeye Salmon *O. nerka*, which typically spawn in streams flowing into lakes, and then, upon emergence from their natal sites, their offspring migrate to a nursery lake and rear 1–3 years before the PST and seaward migration. Upon returning from the ocean as adults, these fish spawn in their natal streams rather than the nursery lake they experienced during the PST. Complex and extensive migrations away from the natal site before PST are common for many salmon species (e.g., Daum and Flannery 2011), particularly in association with changing seasons, temperatures, flows, densities, and other ecological factors (Beckman et al. 2000), yet adults almost invariably return to their natal location to spawn. For example, Chinook Salmon *O. tshawytyscha* populations can migrate away from their natal site as either fry, parr, or smolts, and different populations have different proportions of migrants at different life stages (Healey 1991; Figure 1). These observations led us to hypothesize that the process of imprinting involves a complex interaction between developmentally regulated periods for imprinting, environmental stimuli (e.g., flow and temperature), and migration (Dittman and Quinn 1996). The diversity of juvenile migratory patterns coupled with extensive transport studies (reviewed in Lister et al. 1981) led Harden Jones (1968) and Brannon (1982) to propose a sequential imprinting hypothesis for salmon homing: salmon learn a series of olfactory waypoints, beginning at the natal site, as they migrate downstream to the ocean, and later retrace their path as returning adults using these waypoints to guide them (Figure 1). Under this scenario, returning salmon would be expected to return to their site of release and then, if available or detectable, seek an earlier imprinting signal until they reach their natal site (Figure 1).

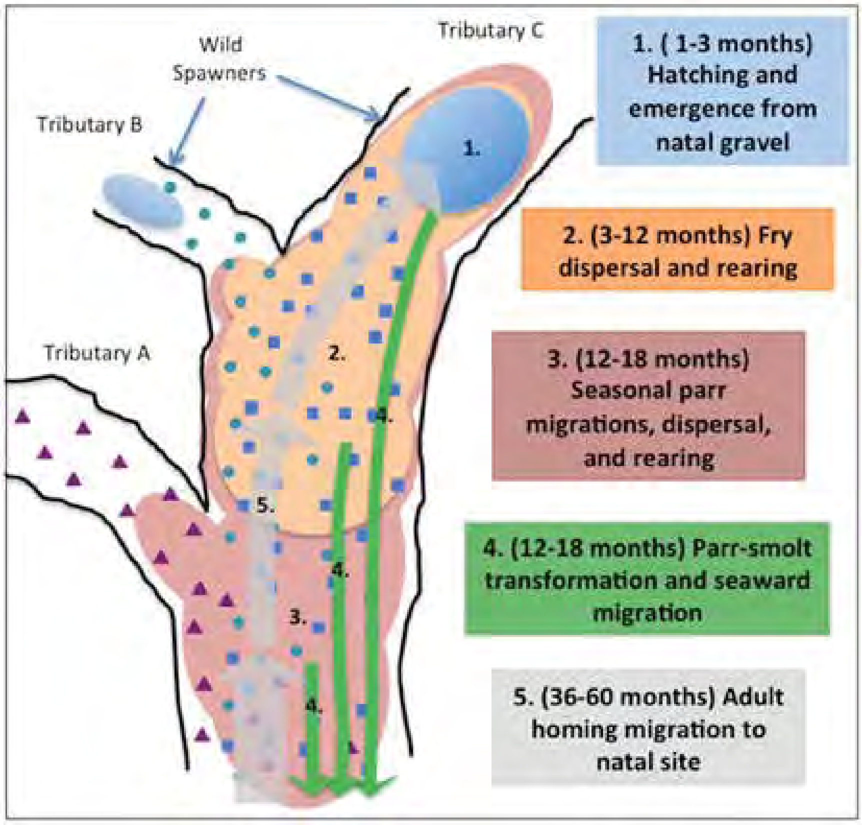

Figure 1. Example of sequential imprinting hypothesis for Chinook Salmon. In this scenario, spring Chinook Salmon learn a series of olfactory waypoints, beginning at hatching and emergence at the natal site and continuing as they disperse and make seasonal downstream migrations. Typically in their second spring, salmon initiate the parr-smolt transformation and migrate to the ocean. Later, adult salmon retrace their path using these waypoints to ultimately guide them back to their natal site.

The complexity of the imprinting process, combined with logistical realities of salmon artificial production programs, makes the management of salmon populations extremely challenging. The infrastructure required for large-scale artificial production (hatcheries, personnel, pumps, wells, etc.) essentially requires that fish are reared at large central facilities, whereas the population dynamics of these species require fine-scale outplants to ensure appropriate spatial and genetic segregation or integration of hatchery and wild fish, depending upon the program goals (Paquet et al. 2011). For segregated hatchery programs, designed to enhance harvest, the goal is typically to outplant salmon that will be captured in fisheries and also to ensure that those fish that avoid capture return to locations where broodstock can be collected or spawn when and where they will not interact with wild populations. On the other hand, the goal of integrated hatchery programs is to return hatchery-produced salmon to the same locations where wild fish spawn to enhance the wild population (Paquet et al. 2011). Finally, conservation hatchery programs are designed to reintroduce fish into historical or recovered habitat with the strategy of releasing fish that will imprint and ultimately return to these locations as adults.

All of these programs share a common dilemma: releasing salmon into the wild at earlier life stages provides a better opportunity for successful imprinting and homing, but releasing salmon at later life stages (i.e., larger sizes) provides a better opportunity for survival (Zabel and Achord 2004) and may reduce deleterious ecological interactions with other species (Pearsons and Temple 2010). These two competing concerns force managers of hatchery programs to weigh the likely tradeoffs of managing for natal homing versus managing for survival. In most cases, hatchery programs have adopted the smolt release strategy, taking advantage of the PST sensitive window for imprinting and the increased survival of larger fish reared through the PST in the hatchery. In many cases this strategy requires dedicated acclimation facilities, ranging from natural ponds to complete small-scale hatcheries, near the targeted site for returning adults (Figure 2). Most acclimation facilities are only operated during the spring prior to release, but some (e.g., Clarke et al. 2012) acclimate fish beginning in the winter prior to release. Parr-smolt acclimation and imprinting facilities have been developed or proposed as part of most hatchery supplementation programs in the Pacific Northwest, and hundreds of millions of dollars have been spent or proposed for construction, operation, and maintenance of these facilities.

For the most part, acclimation prior to release improves survival (e.g., Clarke et al. 2010, although see Kenaston et al. 2001), and most salmon tend to return to the vicinity of their release site (Garcia et al. 2004). However, offsite acclimation (i.e., moving parr from a central rearing hatchery to a smaller facility on a different stream prior to release) has not always been successful in providing adult returns to targeted locations (Dittman et al. 2010; Williamson et al. 2010). The major problem with acclimation sites is their locations relative to

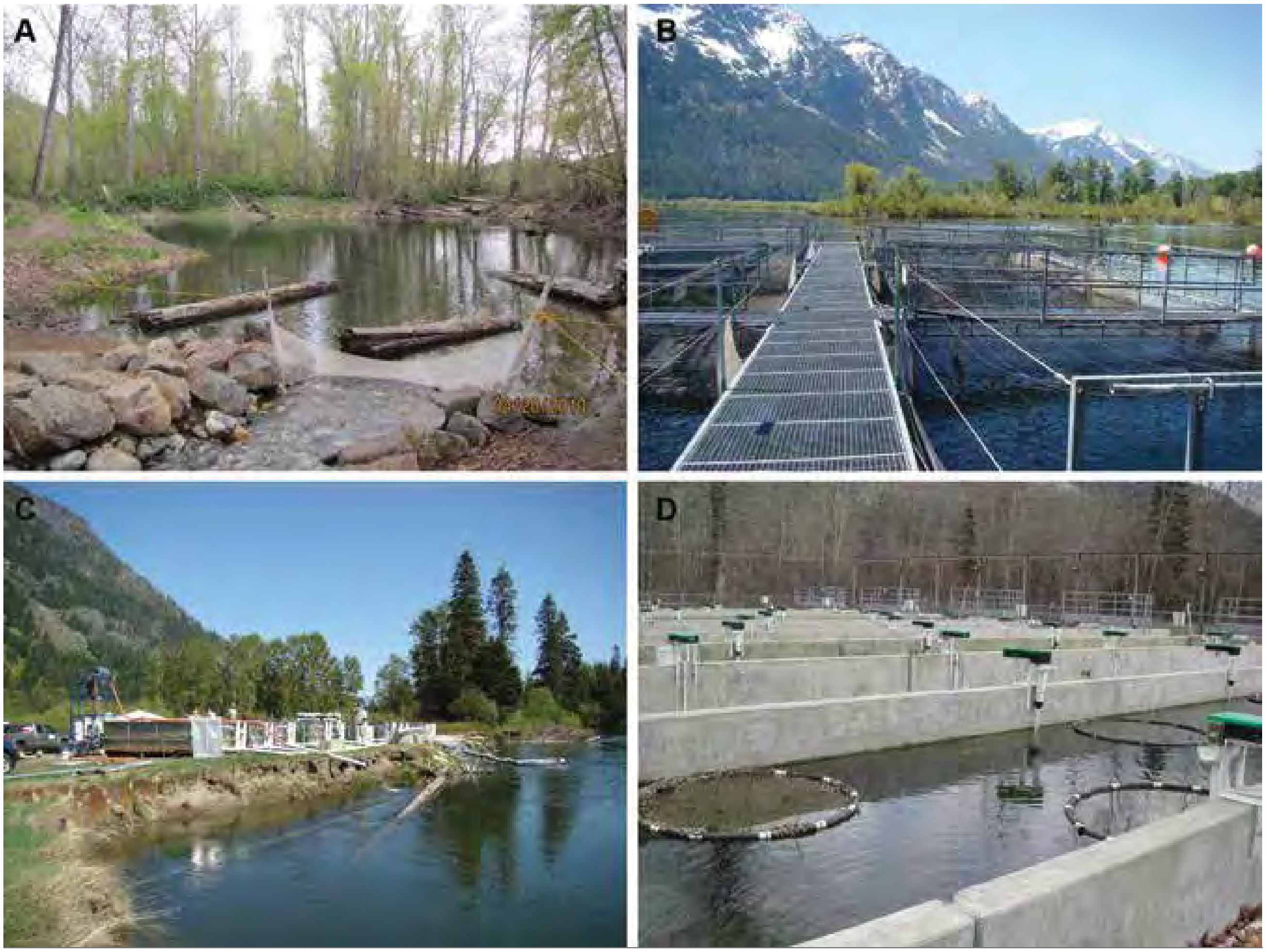

Figure 2. Parr-smolt acclimation, imprinting, and release facilities. Parr-smolt acclimation is the primary tool for imprinting salmon to release locations. Acclimation sites range from (A) natural ponds and side channels, (B) net pens in lakes, and (C) temporary mobile acclimation tanks, (D) to complete small-scale hatcheries near the targeted site for returning adults (Photos A, B, C by T. Pearsons; Photo D by A. Dittman). Facilities costing hundreds of millions of dollars have been developed or proposed as part of most Pacific Northwest hatchery supplementation programs.

desired spawning locations for returning adults (Dittman et al. 2010; Williamson et al. 2010). If acclimation sites are located too close to initial rearing hatcheries, adults tend to return to hatchery locations rather than juvenile release sites (Lister et al. 1981; Dittman et al. 2010). Many acclimation sites were developed years ago before improvements in our understanding of the imprinting process and for different programmatic needs. Furthermore, siting of acclimation facilities is often driven by cost, site availability, environmental permitting, and physical access (e.g., roads and snow) issues rather than biology. This means that acclimation and release sites frequently must be located away from, and often downstream of, appropriate spawning habitat. It was hypothesized that salmon would return to their acclimation sites and then seek appropriate spawning habitat upstream, but in most cases studied, spawning was observed closer to acclimation sites rather than at locations farther upstream typically used by wild spawners (Dittman et al. 2010; Williamson et al. 2010). Thus, for parr-smolt acclimation and release strategies to successfully meet the needs of salmon management programs seeking to supplement spawning populations in specific tributaries or at even finer spatial scales, multiple expensive acclimation sites may be needed within each drainage system.

EMBRYONIC IMPRINTING

As an alternative, or complementary, approach to the use of parr-smolt acclimation facilities, we hypothesize that embryonic imprinting might be a useful management tool for achieving successful imprinting and homing fidelity to targeted spawning locations without moving fish from their central rearing hatchery prior to release. This new imprinting paradigm is based on the observation that while the PST is an important period for imprinting, salmon also imprint to their natal sites much earlier during development. In the wild, embryonic imprinting is evident from a range of studies that demonstrate very fine-scale homing to the natal site by multiple salmon species (Bentzen et al. 2001; Quinn et al. 2006). Furthermore, laboratory studies have demonstrated that embryonic salmon can distinguish and learn different natural waters based on chemosensory cues (Bodznick 1978), possibly even as early as prehatch eyed embryos (Courtenay 1989). This occurs during a sensitive window for imprinting during hatching and emergence from their natal gravel (Tilson et al. 1994; Figure 3). Using juvenile Sockeye Salmon, Tilson et al. (1994) demonstrated that these imprinting windows coincided with developmentally regulated surges in thyroid hormone levels as evidenced by strong attraction of maturing adult salmon to odors they were exposed

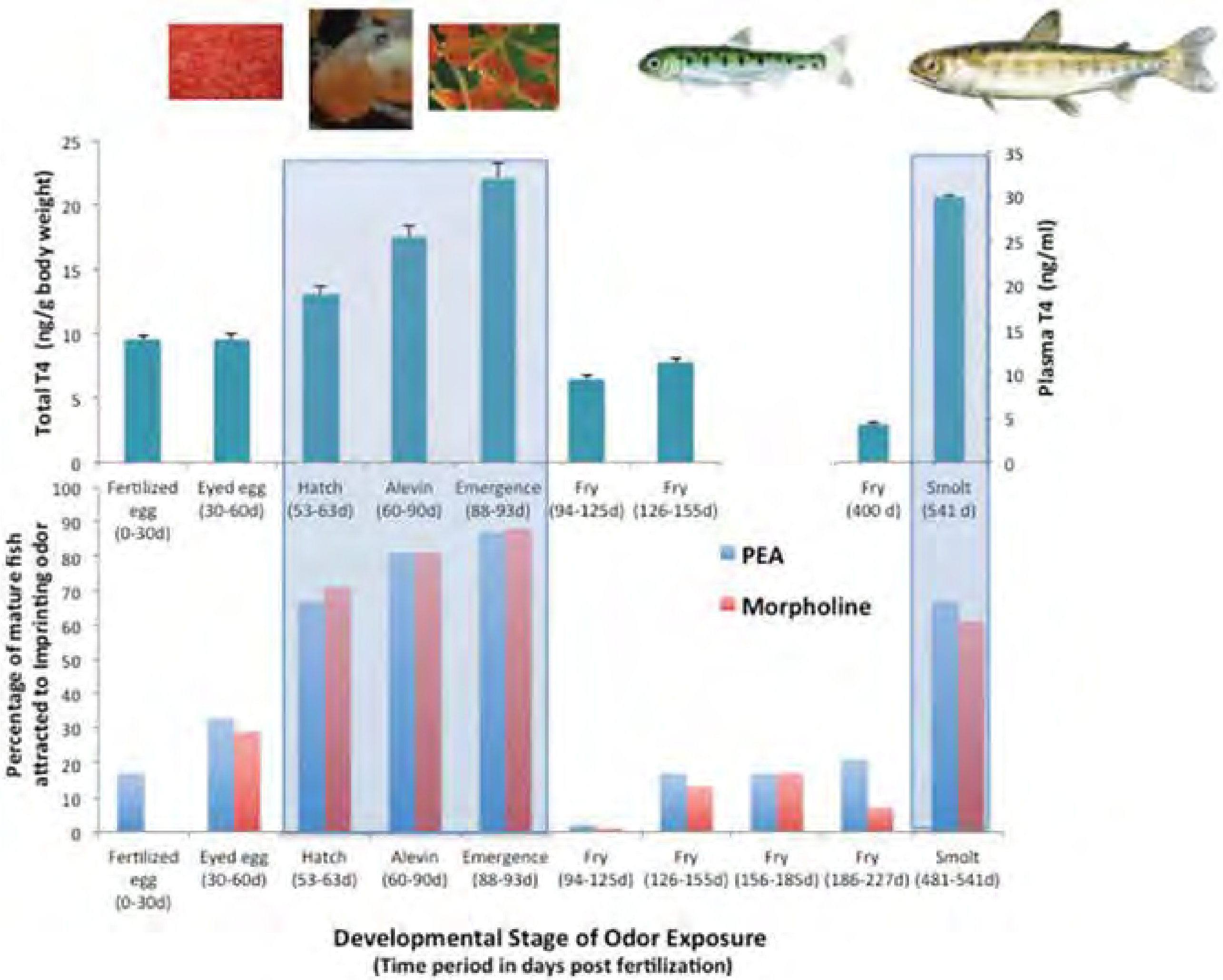

Figure 3. Salmon demonstrate a sensitive window for imprinting during hatching and emergence from their natal gravel in addition to a sensitive period for imprinting during PST (Tilson et al. 1994). Kokanee (lacustrine Sockeye Salmon), exposed to the artificial odorants, morpholine or phenylethyl alcohol, for short periods at hatching, as alevins, at emergence, and during PST showed successful imprinting as evidenced by attraction of these fish to these odorants as maturing adults (bottom panel). These sensitive windows for imprinting corresponded with surges in thyroxine (upper panel), which is associated with successful imprinting. Adapted from Tilson et al. (1994).

to at hatching and emergence (Figure 3). As suggested by the sequential imprinting hypothesis, it appears that wild adult salmon terminate their spawning migration upon reaching the area associated with olfactory cues learned in their natal redd. Therefore, we hypothesize that hatchery-reared salmon returning as adults will seek their earliest detectable imprinted olfactory waypoint as the appropriate location to terminate their spawning migration. Furthermore, if salmon are exposed as embryos to water derived from a targeted location upstream of their release site, they will, as adults, migrate past the release site and spawn at the targeted location.

We suggest that an alternative embryonic imprinting protocol may be useful for many hatchery programs. Using this protocol, hatchery salmon embryos would be exposed to natural waters from locations that managers want them to return to as adults (Figure 4). Rather than transport juvenile salmon from a central hatchery to desired spawning locations, we propose that water from these locations be collected and transported to a central hatchery for use during incubation and early rearing (Figure 4B). At these developmental stages, salmon embryos require relatively small volumes of water for incubation, so large numbers of embryos could be maintained in several small independent single-pass or recirculating systems within the hatchery. Upon emergence and ponding, salmon would be reared under normal hatchery protocols until release. Depending on the goals of the program and availability of parr-smolt acclimation facilities, juveniles would be directly released at locations downstream from the embryonic exposure sites or, ideally, acclimated at existing facilities downstream from the embryo water-exposure sites (Figure 4B). Fish from different upstream embryo-rearing sites could all be acclimated and released from a common site. We predict that returning adults would follow the sequence of odors they experienced as migrating juveniles to home to their release site. At that point, they would continue to migrate upstream to the source of the water they were exposed to as emergent embryos, where they would ultimately spawn (Figure 4C). We designed this protocol to facilitate reestablishment of sustainable natural populations of Pacific salmon in the Columbia River without the need for expensive, potentially environmentally harmful, and logistically challenging acclimation facilities, but we believe that this approach could be effective for all salmon species and locations.

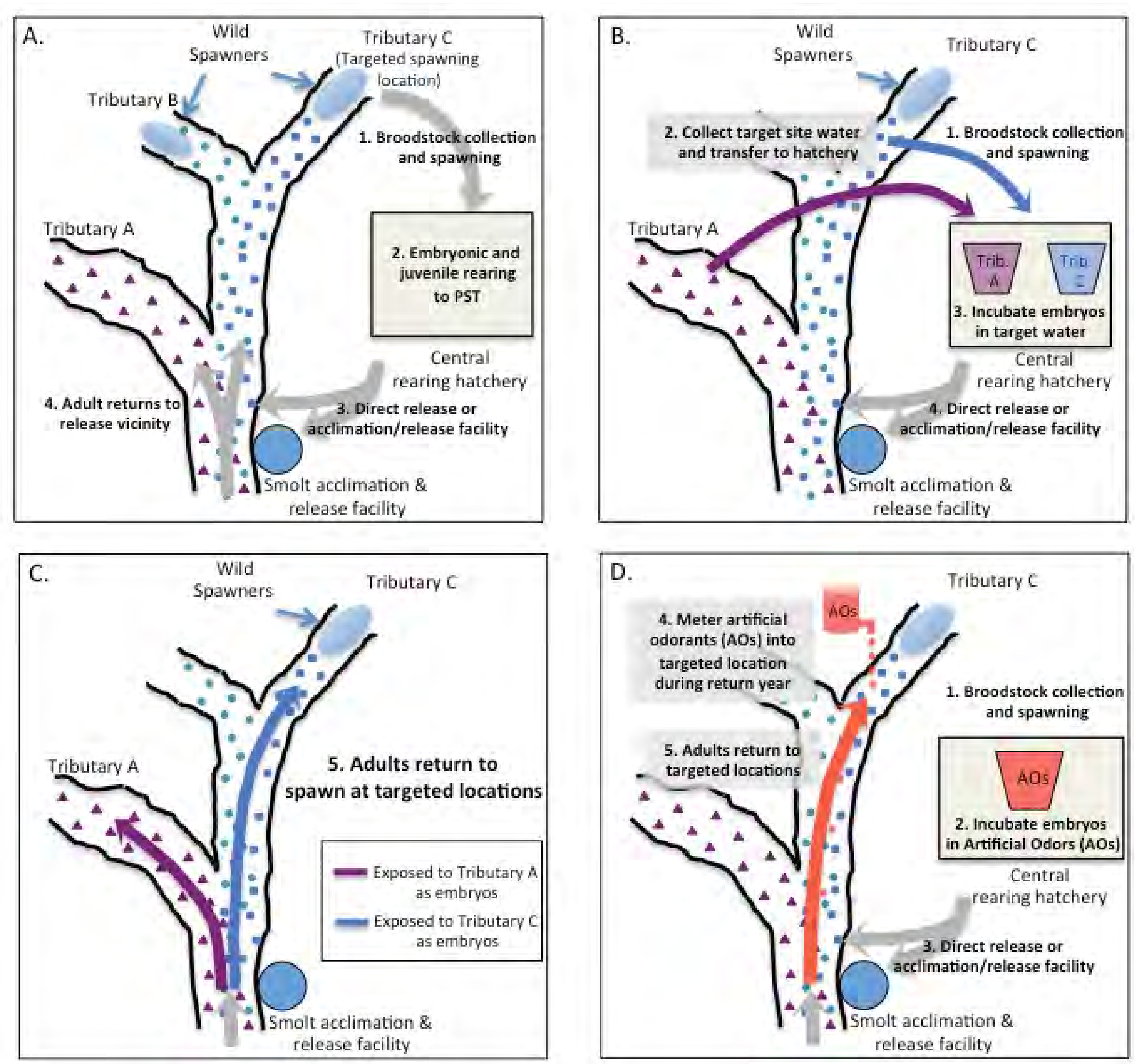

Figure 4. Schematic showing how embryonic imprinting could be applied to a supplementation hatchery program. (A) In a typical integrated hatchery program, wild adults are collected and spawned artificially, reared through the PST at a central hatchery, and then acclimated and released from dedicated acclimation sites. Upon return, adults often return to the vicinity of the release site rather than spawning at a targeted location upstream. (B) Using embryonic imprinting, fertilized embryos are exposed to stream waters collected and transported from targeted spawning sites. In this hypothetical case, water from Tributary A, which no longer has a spawning population, is used to imprint embryos and then to lure returning adults to Tributary A to help recolonize it. Water from Tributary C, which has a small wild spawning population, is used to imprint embryos and then lure returning adults to Tributary C to rehabilitate the wild spawning population. After embryo exposure, fish would be reared under normal protocols through the PST at the central hatchery and then acclimated and released directly or from dedicated acclimation sites. (C) We hypothesize that returning adults would follow the sequence of odors they learned as seaward migrating juveniles until they return to their release site. At that point, fish would seek an earlier imprinting cue, in this case the upstream water source (Tributary A or C) they learned as emergent embryos, and ultimately spawn in the vicinity of this "earliest" imprinting cue. (D) Under an alternative scenario, embryos could also be imprinted to artificial odors chosen by program managers. After normal rearing and release procedures, returning adults could be lured to targeted spawning sites they have never experienced by metering these artificial odorants into waters at the site.

PRACTICAL ISSUES

For embryonic imprinting to be useful and effective, several practical concerns must be addressed before widespread application. First, it is critical that water be collected and maintained in a manner that retains its odor qualities. Though the chemical nature of the odorant profile used by salmon to discern their natal stream is not known, it is hypothesized that these odors are a complex mixture of inorganic and organic chemicals from soil, plants, and aquatic organisms (Hasler and Scholz 1983). Recent work has demonstrated that different combinations of amino acids present in natural stream waters act as chemoattractants for homing salmon, and these compounds may represent part of the chemical signature salmon use to discriminate their homestream water (Shoji et al. 2003). Because organic compounds can be rapidly removed or altered by microbial consumers, care must be taken to ensure that the odor qualities of transported and stored water are retained during embryonic imprinting.

To explore this question, we collected water from a proposed spring Chinook Salmon acclimation site on the White River, Washington, a tributary of the Wenatchee River in the Columbia River Watershed. To test odor stability under different storage regimes, we used an electro-olfactogram (EOG) technique that measures the olfactory responses of the salmon's olfactory epithelium (Baldwin and Scholz 2005). Specifically, we used a technique termed "cross-adaptation" (Quinn and Hara 1986), wherein the epithelium is continuously exposed to the odors of freshly collected White River water (ambient temperature ~1°C) until the olfactory epithelium adapts and no longer responds to those odors. We then applied stored White River water. If storage alters the chemical nature of the water, then the olfactory epithelium will respond to these different chemicals and a response will be detected. A reciprocal test with each odor pair was also conducted. Using this technique, we found that White River water collected in January could be held for 7 days at either 4°C or 10°C or frozen (−20°C) for 7 days and thawed without altering the olfactory signature (Figure 5). This suggests that under the proper conditions, water can be collected, transferred, and stored for use in embryonic imprinting. However, more research needs to be conducted on different water sources, water collection and storage protocols, and water replacement procedures during imprinting. We also examined effects of using reconstituted White River water samples that had been freeze dried. For freeze drying, a known volume of water was frozen on dry ice–methanol and then lyophilized under vacuum until all water was removed. The freeze-dried residue was then reconstituted in deionized water to the same volume as the original water sample. The reconstituted water elicited a response from olfactory epithelium that had been adapted to White River water, so this storage method did alter odor qualities of the original water sample (Figure 5). Further study of this method may be warranted to determine whether olfactory cues from the original water source can be preserved.

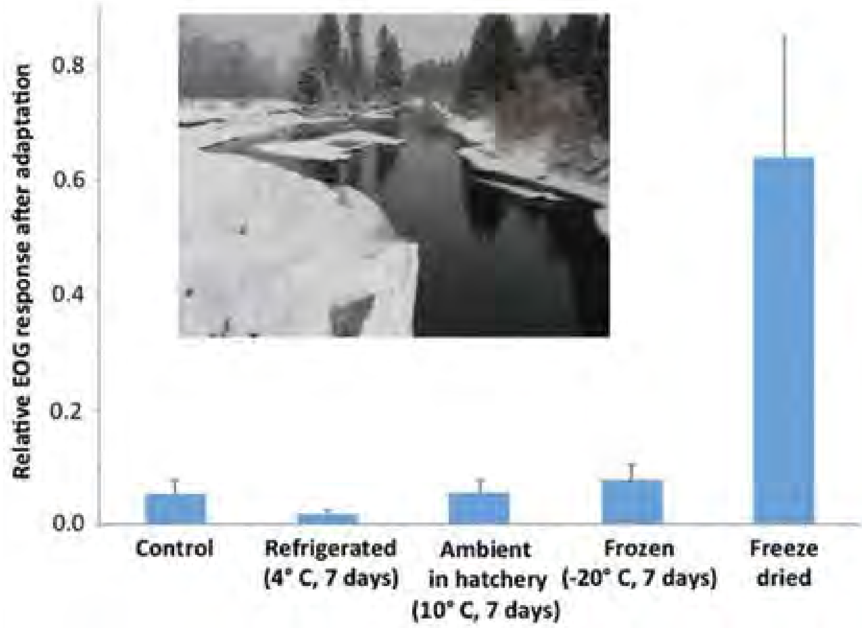

Figure 5. Cross-adaptation EOG studies to assess effects of storage on odor quality of stream water. Using a cross-adaptation technique, we found that natural stream water could be held for 7 days at 4°C or 10°C or frozen (−20°C) for 7 days and thawed without altering the olfactory signature of the water. However, freeze drying (water volume was measured, frozen on dry ice–methanol, and then lyophilized under vacuum until all water was removed) and reconstituting in an equal volume of deionized water did alter the odor qualities. Methods: Water was collected in January from the site of a proposed spring Chinook Salmon acclimation site on the White River, Washington, a tributary of the Wenatchee River in the Columbia River system (inset). To test the stability of water under different storage regimes, we utilized a technique termed cross-adaptation, wherein the olfactory epithelium of juvenile Coho Salmon was continuously exposed to the odors of fresh White River water until the olfactory epithelium adapted and no longer responded to those odors. We then applied a second water source. If the second water (e.g., stored White River water) had the same chemical constituents as fresh White River water, no response was elicited. If holding water altered the chemical nature of the water, the olfactory epithelium would respond to these different chemicals and a response would be detected. We also performed the reciprocal experiment with each odor pair. Data shown are EOG responses to each water source after adaptation to control White River water. Data are presented as responses relative to the response to a 10^{-4} M L-serine control (mean ± SEM; N = 4–6 fish per odor pair).

Additionally, because transferring natural stream water into a central hatchery for embryo imprinting has the potential to introduce pathogens, we were also interested in assessing whether treating the water to kill pathogens altered the water's olfactory signature. Embryonic salmon are often initially reared in pathogen-free well water, but where stream water is used, it is typically treated with ultraviolet (UV) light or ozone to kill pathogens. In many cases, transferring natural stream water into a hatchery for embryonic imprinting would be prohibited unless that water was treated to remove pathogens. This could alter the water's chemical composition and, therefore, the olfactory signature. To address this question, we again utilized the cross-adaptation technique using fresh White River water that was either treated with UV light to remove pathogens or left untreated. Interestingly, UV treatment apparently altered the chemical nature of White River water because UV-treated water elicited a different olfactory response than untreated water (Figure 6A). However, we wondered whether the overall odor qualities of the water were conserved enough to provide salmon with the chemical cues necessary to still allow them to distinguish this as White River water. To determine whether salmon could still recognize UV-treated water as equivalent to untreated river water, we conducted behavioral experiments on emergent fry, which tend to be attracted to water in which they were incubated (Bodznick 1978). For these experiments, we were unable to rear embryos in White River water, so we conducted a separate experiment using steelhead *O. mykiss* embryos incubated in Carnes Creek water at the Oregon Hatchery Research Center near Alsea, Oregon, and then tested fish for attraction to different waters at emergence. Emergent fry demonstrated a strong attraction to Carnes Creek water when given a choice of Carnes Creek water vs. well water in a two-choice maze. To assess the effect of UV treatment on the perception of Carnes Creek odor qualities, we tested whether emergent fry would choose untreated Carnes Creek water

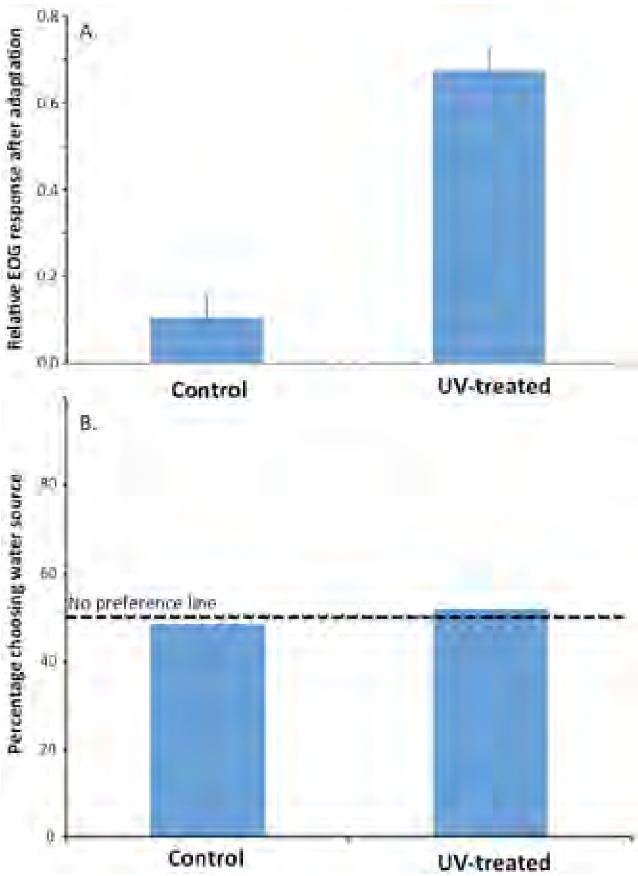

Figure 6. Effects of UV treatment on stream water odor qualities. (A) Cross-adaptation EOG analysis indicated that UV treatment may have altered the chemical nature of White River water. (B) We then tested whether chemical changes affected how salmon perceive UV-treated stream water relative to natural water (i.e., do they distinguish these waters behaviorally?). Recently emerged steelhead demonstrated no preference for untreated water vs. UV-treated water. Methods: (A) White River water was collected in January and either treated with UV light or maintained untreated at 4°C. The cross-adaptation technique described in Figure 5 was used to examine whether White River water was perceived differently by the salmon olfactory epithelium after UV treatment. Data shown are EOG responses to each water source after adaptation to control White River water. Data are presented as responses relative to the response to a 10^{-4} M L-serine control (mean ± SEM; N = 4 fish per odor pair). (B) Behavioral assessments were conducted at the Oregon Hatchery Research Center using recently emerged steelhead that had been incubated in Carnes Creek water. For these experiments, we tested whether emergent fish chose untreated Carnes Creek water over UV-treated Carnes Creek water in a two-choice maze. Data represent the responses of 200 fish tested in 20 trials (10 fish/trial).

over UV-treated Carnes Creek water in a two-choice maze. We predicted that more fish would choose the untreated arm of the maze, if UV treatment altered the attractive qualities of the water. However, we observed no difference in attraction to treated and untreated water (Figure 6B). Though these results do not show that UV treatment did not alter the odor qualities that allow fish to distinguish Carnes Creek water, they suggest that any changes to treated water that occurred did not influence its attractiveness. Further studies of the effects of UV treatment and other sterilization techniques on odor qualities are needed before embryonic imprinting is accepted for use as a salmon rehabilitation or enhancement tool.

ARTIFICIAL ODORS

In some circumstances, concerns about disease, water stability, water volume requirements, and other logistical challenges may make transporting stream water to a central hatchery for embryonic imprinting impractical. However, this does not preclude the use of embryonic imprinting as a management tool. One alternative that has been proposed is the use of artificial imprinting odors to lure returning adult salmon to desired locations. Much of our understanding about olfactory imprinting comes from a series of groundbreaking experiments by Arthur Hasler and his colleagues in the 1960–1970s, in which they exposed juvenile salmon to the artificial odors morpholine and phenylethyl alcohol during the PST and then lured these salmon years later as returning adults into unfamiliar streams scented with these chemicals (reviewed in Hasler and Scholz 1983). Based on these studies, it has been suggested that artificial odorants could be used by salmon managers to manipulate migratory patterns and promote increased homing fidelity (Hasler and Scholz 1983). Initial studies indicated that adding artificial odorants to hatchery outlet water had little effect on homing fidelity (e.g., Rehnberg et al. 1985). However, combining artificial odorants with embryonic imprinting may provide a useful tool for integrated hatchery and supplementation programs to direct salmon to specific tributaries or reaches for spawning. Under this scenario, salmon would be exposed to artificial odorants in the central rearing hatchery using the same embryonic exposure system described earlier. We hypothesize that salmon will imprint to these artificial odorants and use them during the final stages of their adult homing migration. Therefore, fish imprinted to artificial odorants and released at a downstream location or acclimation site could be lured to an upstream site they had never experienced by metering the artificial imprinted odorant(s) into the river at the target site (Figure 4D).

One obstacle to utilizing artificial odorants is the lack of safe, inexpensive, and effective odorants for these studies. Early imprinting studies successfully used morpholine and phenylethyl alcohol; however, a more stringent regulatory environment may make these chemicals inappropriate for large-volume releases into natural waters. To be effective as a management tool for homing manipulation, artificial odorants ideally will (1) be safe for release into natural waters, (2) not impact nontarget taxa, (3) be inexpensive and readily available, (4) be stable for storage and after release into natural waters, (5) be detected by the salmon olfactory epithelium at relatively low concentrations, (6) not elicit innate behavioral (attraction or avoidance) or physiological (e.g., endocrine) responses, (7) elicit a learned behavioral response by juvenile salmon, and (8) allow imprinting of juvenile salmon and prove to be an effective cue for adult homing. Further research to identify and test appropriate chemicals will be required before this approach can be utilized.

Finally, another alternative approach to transporting water from a targeted homing location to the central hatchery would be to identify the chemical signature of stream water present at the targeted location and artificially recreate it for use in embryonic imprinting at the hatchery. As indicated earlier, Hasler and Scholz (1983) hypothesized that the odors allowing salmon to discriminate between waters consist of complex mixtures of inorganic chemicals, organic chemicals from soil and plants, and aquatic organisms. Ueda (2012) proposed that the primary chemical cues utilized by homing salmon are amino acids present in natural stream waters, and Shoji et al. (2003) demonstrated that amino acids present in natural stream waters can act as chemoattractants for homing salmon. Therefore, by exposing embryos to an artificial solution of amino acids that matches the amino acid profile present in the targeted water, it may be possible to imprint hatchery fish to natural waters they have never experienced. Assuming the amino acid profile is sufficient as a homing cue, the natural amino acid signal present in the stream waters at the target location may attract homing adults to this location for spawning.

CONCLUSION

Whether managers use transported natural water, artificial odorants, or artificial natural waters, embryonic imprinting may provide an important new management tool for reducing negative interactions between hatchery and wild salmon populations, facilitating recovery of endangered populations and recolonization of recovered habitat, and increasing the homing precision of hatchery-reared fish. Furthermore, embryonic imprinting may significantly reduce costs associated with building and operating new acclimation sites, reduce mortality risks for cultured fish in harsh remote locations by keeping them in safe centralized locations longer, and lessen environmental degradation associated with construction and operation of acclimation facilities in targeted spawning areas. Each hatchery program is unique in terms of its program goals, infrastructure and logistic realities, and geographic complexities, so the use of embryonic imprinting and the specific application of these tools must be developed on a case-by-case basis. Embryonic imprinting is already being employed as part of a kokanee recovery program in Lake Sammamish Washington (Lake Sammamish Kokanee Work Group 2012) and could also be appropriate for a number of conservation and supplementation hatchery programs in the Northwest. The principles underlying this approach are well founded in our understanding of salmon biology and life history strategy, but full-scale tests of this approach within existing hatchery programs are required to confirm the utility of embryonic imprinting.

ACKNOWLEDGMENTS

We thank Christian Torgersen for helping to facilitate this study. We are grateful to Joseph O'Neil and Coulter Dittman for assistance with behavioral trials and Abby Tillotson for providing experimental fish for EOG studies. We are also grateful to Thomas Quinn, Steve Schroder, and Christian Torgersen for their thoughtful and helpful reviews of earlier versions of this article. The ideas for this article were inspired by many fruitful discussions and collaborations with Tom Quinn.

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Attachment C

Attachment D


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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	April 28, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the March 22, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel in SeaTac, Washington, on Tuesday March 22, 2016, from 9:30 a.m. to 11:45 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).
- Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B2 to Kristi Geris for distribution to the Coordinating Committees (Item I-C).
- Tom Kahler will coordinate with Douglas PUD Information System (IS) staff to launch the HCP Tributary Committees Extranet Site (Item II-A).
- Lance Keller will discuss internally how to properly address Pacific lamprey passage at Tumwater Dam as it relates to HCP Plan Species broodstock collection (Item II-A).
- Tom Kahler will review bull trout trapping activities at Wells Dam in 2016 with the HCP Hatchery Committees and request an expedited approval, in order to request and receive email approval from the Wells HCP Coordinating Committee of the Draft Statement of Agreement (SOA) for Modified Wells Dam Trapping for Bull Trout in 2016 and the Draft 2016 Broodstock Collection Protocols prior to April 15, 2016 (Item III-A).
- Coordinating Committees representatives will discuss bull trout trapping activities at Wells Dam in 2016 with their respective HCP Hatchery Committees representatives

to help expedite the approval process (Item III-A).

- Tom Kahler will provide the 2016 Trapping Activities at Douglas PUD Facilities spreadsheet to Kristi Geris for distribution to the Coordinating Committees (Item III-C).
- **The Coordinating Committees meeting on April 26, 2016, will be held by conference call (Item V-B).**

DECISION SUMMARY

- The Rocky Reach HCP Coordinating Committee representatives present approved the 2016 Rocky Reach Juvenile Fish Bypass Operations Plan (Item IV-A).
- The Rock Island HCP Coordinating Committee representatives present approved the 2016 Rock Island Bypass Monitoring Plan (Item IV-A).
- The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island Fish Spill Plan (Item IV-B).
- The Wells HCP Coordinating Committee approved the 2015 Wells HCP Annual Report after no disapprovals were received prior to the 30-day review deadline.
- The Rocky Reach and Rock Island HCP Coordinating Committees approved the 2015 Rocky Reach and Rock Island HCP Annual Reports after no disapprovals were received prior to the 30-day review deadlines.
- The Wells HCP Coordinating Committee approved the 2016 Broodstock Collection Protocols via email, as follows: Douglas PUD, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), and the Colville Confederated Tribes (CCT) approved April 11, 2016; and the Yakama Nation (YN) approved April 13, 2016 (Item III-A).
- The Wells HCP Coordinating Committee approved the SOA for Modified Wells Dam Trapping for Bull Trout in 2016 via email, as follows: Douglas PUD approved April 13, 2016; NMFS, USFWS, and the CCT approved April 14, 2016; and WDFW and the YN approved April 15, 2016 (Item III-A).

AGREEMENTS

- There were no agreements reached during today's meeting.

REVIEW ITEMS

- Kristi Geris sent an email to the Wells HCP Coordinating Committee on April 11, 2016, notifying them that the Draft 2016 Broodstock Collection Protocols were available for an expedited review, with an email vote due to Tom Kahler by April 13, 2016 (Item III-A).

FINALIZED DOCUMENTS

- The Final 2016 Rocky Reach and Rock Island HCP Action Plans that were approved by the Rocky Reach and Rock Island HCP Hatchery, Coordinating, and Tributary Committees on February 17, February 23, and March 10, 2016, respectively, were distributed to the Coordinating Committees by Kristi Geris on March 22, 2016.
- Kristi Geris sent an email to the Coordinating Committees on March 25, 2016, notifying them that the 2015 Wells HCP Annual Report was finalized following a 30-day review period, which ended on March 7, 2016. One comment was received on the draft report, which was incorporated into the final report.
- Kristi Geris sent an email to the Coordinating Committees on April 8, 2016, notifying them that the 2015 Rocky Reach and Rock Island HCP Annual Reports were finalized following a 30-day review period, which ended on March 16, 2016. One comment was received on the Draft 2015 Rocky Reach HCP Annual Report, which was incorporated into the final report.
- The Final 2016 Broodstock Collection Protocols that were approved by the Wells HCP Coordinating Committee and HCP Hatchery Committees on April 13, 2016, were distributed to the Coordinating Committees by Kristi Geris on April 14, 2016 (Item III-A).

I. Welcome

A. Review Agenda (John Ferguson)

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

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft February 23, 2016, meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes, and there are no outstanding items remaining to be discussed. Coordinating Committees members present approved the February 23, 2016, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on February 23, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on February 23, 2016):*

- *Chelan PUD will discuss with Dr. John Skalski (Columbia Basin Research) possibly adjusting the Data Access in Real Time (DART) database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass (Item I-C).*
  This will be discussed during today's meeting.
- *John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).*
  This will be discussed during today's meeting and will also be carried forward.
- *Tracy Hillman (BioAnalysts, HCP Hatchery and Tributary Committees Chairman) will provide a paper on imprinting of hatchery-reared salmon by Andy Dittman (NMFS Science Center), published in Fisheries last March 2015, to Kristi Geris for distribution to the Coordinating Committees (Item II-A).*
  This paper was distributed to the Coordinating Committees by Geris on February 24, 2016.
- *Lance Keller will notify the Coordinating Committees when the Rocky Reach Dam Adult Fish Ladder is back online from annual winter maintenance and fully operational (Item III-E).*
  Keller provided notification that the Rocky Reach Dam Adult Fish Ladder was returned to service on February 25, 2016, which Geris distributed to the Coordinating Committees that same day.

- *Lance Keller will provide updates on receipt and installation of the refurbished sluice gate, RO4, as well as notify the Coordinating Committees when the Rock Island Dam right fish ladder is back online from annual winter maintenance and fully operational (Item III-E).*
  Keller provided notification of receipt of the refurbished sluice gate on March 3, 2016, and that the Rock Island Dam Right Fish Ladder was returned to service on March 9, 2016, which Geris distributed to the Coordinating Committees those same days.
- *Lance Keller will provide the combined generation capacity of Rock Island Dam Powerhouses 1 and 2, minus Units B-1, B-2, B-3, and B-4 in Powerhouse 1, and Unit U-3 in Powerhouse 2, to Kristi Geris for distribution to the Coordinating Committees (Item III-G).*
  Keller provided these data on March 21, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Lance Keller will provide an update on the Rock Island Dam Powerhouse 2 Unit U-3 inspection, during the Coordinating Committees meeting on March 22, 2016 (Item III-G).*
  Keller said inspection of the Rock Island Dam Powerhouse 2 Unit U-3 was completed. Trunnion seals were replaced and the unit was operational on March 2, 2016.
- *Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B-2, to Kristi Geris for distribution to the Coordinating Committees (Item III-G).*
  This action item will be carried forward.
- *Tom Kahler will verify the estimated completion date for the Wells Hatchery Modernization, and will provide photographs discussed during today's meeting to Kristi Geris for distribution to the Coordinating Committees (Item IV-A).*
  Kahler provided the photographs to Geris on February 24, 2016, and verified the estimated completion date on February 29, 2016, which Geris distributed to the Coordinating Committees those same days.
- *Tom Kahler will notify the Coordinating Committees when the Wells Dam east fish ladder is back online from annual winter maintenance and fully operational (Item IV-B).*
  Kahler said the Wells Dam east fish ladder was back in service on February 23, 2016.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Tributary Committees meeting on March 10, 2016:

- *Small Projects Proposal:* The Cascade Columbia Fisheries Enhancement Group submitted a Small Projects Program application titled, "Permitting Nutrient Enhancement in the Chiwawa." The proposal is to develop a treatment and effectiveness monitoring plan, and obtain permits from the U.S. Forest Service and Washington State Department of Ecology to conduct a 4-year, nutrient-enhancement pilot project in the Chiwawa River. The total cost of the project is about $11,000, with no cost share. The Rock Island HCP Tributary Committee approved funding for the project.
- *Review Policies and Procedures Documents:* The HCP Tributary Committees reviewed these documents, which are in place for funding and operating procedures. Members found nothing to change and approved the documents for another year.
- *Plan Species Accounts Financial Audit:* According to the Policies and Procedures for Funding Projects document, the HCP Tributary Committees are to undergo an external review every 5 years, unless the Tributary Committees agree not to. It has been 5 years since the last audit. This applies only to the Rocky Reach and Rock Island accounts, because the Wells account is audited every year. The Rocky Reach and Rock Island HCP Tributary Committees agreed to have the audit completed in 2016. They will coordinate with Cordell, Neher, & Company to conduct the audit, and results will be available around July or August 2016.
- *Draft 2016 Rock Island and Rocky Reach Action Plans:* The Rock Island and Rocky Reach HCP Tributary Committees reviewed and approved the tributary portions of the 2016 Rock Island and Rocky Reach Action Plans.
- *Annual Deposits to the Plan Species Accounts:* Chelan PUD and Douglas PUD deposited funds into each Plan Species Account, as follows: Chelan PUD deposited $721,475 into the Rock Island account and $341,705 into the Rocky Reach account; and Douglas PUD deposited $261,970 into the Wells account. Total unallocated funds within each account are as follows: Rock Island $5,528,216; Rocky Reach $2,042,757;

and Wells $1,300,397 (approximately $9 million total).

- *Salmon Recovery Funding Board and Tributary Committees Funding Schedule:* The HCP Tributary Committees' policy allows project sponsors to submit General Salmon Habitat Program proposals at any time; however, the HCP Tributary Committees continue to coordinate with the Salmon Recovery Funding Board (SRFB) proposal process. This year, draft proposals are due to the HCP Tributary Committees on April 15, 2016, and the HCP Tributary Committees will review the draft proposals during their meeting on June 9, 2016. Project tours are tentatively scheduled for May 4 and 5, 2016, in the Methow and Okanogan basins, and May 11 and 12, 2016, in the Wenatchee and Entiat basins. Final proposals are due to the HCP Tributary Committees on July 1, 2016. The HCP Tributary Committees will make funding decisions on July 14, 2016. Typically, all projects are cost shares. Tour dates still need to be coordinated with other entities. Tours will occur in Washington (not Canada). The HCP Tributary Committees will have a tour in Canada in fall 2016.
- *Meeting Schedule:* The HCP Tributary Committees agreed to continue meeting on the second Thursday of each month.
- *Project Tours:* A document summarizing projects funded by the HCP Tributary Committees (Attachment B) was distributed to the Coordinating Committees by Kristi Geris on March 18, 2016. In the tables, green text indicates projects in progress and includes the total cost and total contributions for the project. Plan Species Account numbers are briefly summarized at the bottom of each table, and more comprehensively summarized in pie charts at the bottom of the document. The first set of pie charts combine all three Plan Species Accounts together, and the last set summarizes each individual account. John Ferguson asked if the HCP Tributary Committees have discussed how they intend to spend their $9 million of unallocated funds. Hillman said they have not, and explained that when projects arise, they are discussed on a case-by-case basis. He added that it seems preferred to fund projects that have the greatest return on investment. Tom Kahler also added that typically, in each funding round the HCP Tributary Committees select only a subset of projects for funding consideration, and only a subset of those is chosen for funding. He said there is no requirement to spend account funds in any year, so the HCP Tributary Committees can wait for a good project. He said that, in addition to the SRFB,

funding decisions are also coordinated with the Bonneville Power Administration and the Priest Rapids Coordinating Committee (PRCC), so there are three to four major funding entities coordinating on these decisions. Hillman noted that HCP Tributary Committees funds can be used in Canada, whereas SRFB and Bonneville Power Administration funds are restricted to the United States. He said the HCP Tributary Committees are reviewing the list of projects in Attachment B and will decide which projects to tour this summer. The purpose of these tours is to see what has worked and what has not. He added that Coordinating Committees representatives are welcome to join on these tours, and asked that they notify him if interested.

- *Extranet Access:* Hillman explained that once a project is complete, the HCP Tributary Committees receive a final report, and often times those reports are large in file size. The YN asked if these reports can be retrieved from a website. Hillman said he indicated the Coordinating Committees have an extranet site, and he thought all HCP Tributary Committees representatives and alternates had access; however, discovered this is not true. During this discussion, it became apparent that no HCP Tributary Committees materials are posted to an extranet site. The HCP Tributary Committees are requesting to post agendas, notes, correspondence with sponsors, and final reports on an extranet site. Kahler said all HCP Tributary Committees materials are compiled and ready to post to an extranet site; however, Douglas PUD IS staff have not yet had a chance to set up a site. He said the HCP Tributary Committees have not previously expressed interest in the extranet site when it was discussed with them, so the work to populate the site has never been completed. Kahler said he will coordinate with Douglas PUD IS staff to launch the HCP Tributary Committees Extranet Site. He added that he will also have Douglas PUD IS staff provide a presentation to the HCP Tributary Committees when launching their extranet site, similar to what was done for the Coordinating Committees. He said Hillman will also be set up as the administrator and trained on how to upload data.
- *Next Steps:* The HCP Tributary Committees' next scheduled meeting will be on April 14, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on March 16, 2016:

- *Five-Year Hatchery M&E Review Planning – Objective 5:* The HCP Hatchery Committees are currently working on Objective 5, which is homing and straying issues. The goal is to increase spring Chinook salmon homing to the Twisp and Chewuch rivers and decrease straying to the Methow Fish Hatchery. Some HCP Hatchery Committees members, hatchery managers, and fish-health personnel plan to meet tomorrow, March 23, 2016, for a 2-hour work session. Anyone is invited to participate. The purpose of the meeting is to further discuss the details of the proposal the YN presented to the HCP Hatchery Committees. A key issue is logistical and fish-health constraints at hatcheries. If Coordinating Committees representatives are interested in additional information, please notify Hillman.
- *USFWS Bull Trout Consultation Update:* USFWS bull trout consultations are moving forward.
- *NMFS Consultation Update:* The Wenatchee Biological Opinion (BiOp) is with the National Oceanic and Atmospheric Administration General Counsel (NOAA GC) for review. The Methow BiOp is pending approval of the gene flow standards. Recall that NMFS developed a proportionate natural influence model, and the gene flow standards establish use of that model. The HCP Hatchery Committees and USFWS approved the model, and it now is pending NOAA GC approval, which will hopefully be completed in April or May 2016 and allow the BiOp to move forward.
- *Broodstock Collection Protocols:* WDFW provided draft protocols for review. HCP Hatchery Committees comments are due March 25, 2016. WDFW will request approval of the draft protocols via email by April 12, 2016. The final protocols are due to NMFS by April 15, 2016. USFWS expressed concern regarding the operation and collection of broodstock at Tumwater Dam as it relates to Pacific lamprey passage at the dam. The HCP Hatchery Committees agreed this issue may be more appropriately addressed by the Coordinating Committees. Jim Craig said this has been a USFWS concern for a while now, and the agency is currently discussing how to address it. Bob Rose said about 125 or more Pacific lamprey will be translocated upstream of Tumwater Dam and about 100 Pacific lamprey will be translocated downstream of the dam. He said he expects this will be the first of many years the

YN will be translocating Pacific lamprey upstream of Tumwater Dam until there is adequate passage at the dam. He said the translocated Pacific lamprey are from John Day Dam, but in future years, the fish may come from Priest Rapids Dam or Rocky Reach Dam. Rose asked why a Pacific lamprey issue would be the purview of the Coordinating Committees. Craig agreed with the question, noting that Pacific lamprey are not a HCP Plan Species. Jeff Korth said this seems more applicable to the Fish Forums, and suggested they address this. Kahler said this is a passage issue, which is the purview of the Coordinating Committees; however, agreed that Pacific lamprey are not addressed by this committee. Lance Keller said he will discuss internally how to properly address Pacific lamprey passage at Tumwater Dam as it relates to HCP Plan Species broodstock collection. Hillman said the HCP Hatchery Committees suggested the Coordinating Committees address this because modifications to the fishway at Tumwater Dam to improve Pacific lamprey passage could affect Plan Species passage and would require approval by the Coordinating Committees. He clarified that the HCP Hatchery Committees plan to address the broodstock collection aspect of this issue. Ferguson asked Hillman to let the HCP Hatchery Committees know that the Coordinating Committees are looking into this.

- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on April 20, 2016.

III. Douglas PUD

A. DECISION: Bull Trout Trapping SOA (Tom Kahler and Andrew Gingerich)

Tom Kahler said the Douglas PUD 2016-2017 Bull Trout Study Plan and Draft SOA for Modified Wells Dam Trapping for Bull Trout in 2016 were distributed to the Coordinating Committees by Kristi Geris on March 16 and 19, 2016, respectively.
John Ferguson noted that the study plan has already been reviewed and approved by the Aquatic Settlement Work Group (SWG). Kahler introduced Andrew Gingerich, Douglas PUD Aquatic SWG Technical Representative, who will lead this discussion.

Gingerich said Douglas PUD and the Aquatic SWG are requesting approval from the Wells HCP Coordinating Committee to trap bull trout at Wells Dam in 2016. He explained that the Federal Energy Regulatory Commission (FERC) License Order 2149-52, issued to

Douglas PUD on November 9, 2012, included a requirement to implement a Bull Trout Passage Evaluation Study at the Twisp Weir in Year 1 of the license. He said, following consultation with USFWS and the Aquatic SWG, Douglas PUD and agency staff decided to postpone the study for 4 years to combine the study with a Bull Trout Passage Evaluation Study scheduled to take place at Wells Dam during Year 5 of the license term. He said FERC approved deferring the study as requested and required that the comprehensive study be conducted by November 2017.

Gingerich said Douglas PUD and the Aquatic SWG were hoping for an expedited Wells HCP Coordinating Committee review to allow adequate time to prepare for the study. He said the study involves trapping 30 bull trout at Wells Dam and 30 bull trout at the Twisp Weir. He said Douglas PUD is requesting 7 weeks of trapping at the east fish ladder at Wells Dam during the same time as spring Chinook salmon trapping. He said the SOA includes language that trapping spring Chinook salmon will be avoided unless it benefits other programs. He said the SOA also includes a figure showing bull trout run timing at Wells Dam during the last 10 years, which demonstrates how the trapping period was selected for this study. He said, additionally, the SOA includes a table summarizing the number of bull trout expected to be captured at Wells Dam in 2016, assuming a 73-fish run. The table assumes trapping occurs during 80% of the observed passage hours and 80% of the passage period. The number of estimated fish captured is shown to differ depending on whether one or both ladder traps are operating and depending on how many days of the week trapping occurs.

Jeff Korth asked if data are available that indicate a preference for bull trout passage at Wells Dam, via the east or west fish ladder. Gingerich said, based on available data, there is no obvious preference. He said trapping for this study will occur only at the east fish ladder; however, if bull trout are trapped during spring Chinook salmon trapping at the west fish ladder, those bull trout can be used in the study as well. Korth noted that it may be difficult to obtain the proposed amount of bull trout for the study, and Gingerich agreed.

Kirk Truscott said the proposal is to trap 7 days per week, 10 hours per day, which equals 70 hours of trapping per week for 7 weeks. He said trapping spring Chinook salmon at Wells Dam is limited to 3 days per week, 16 hours per day, or no more than 48 cumulative hours per week. He said, in the past, later in the trapping periods, fish movement through the ladders diminishes the more that trapping takes place. He said he has concerns about trapping that much and potential impacts on spring Chinook salmon passage. Kahler said, currently, there is no trapping scheduled at the west ladder; however, if the ladder becomes operational (modernization complete), this could change. He said if operational, trapping at the west fish ladder will be limited to 48 hours per week, and the east fish ladder trap will be operated 7 days per week. He noted that bull trout do not seem to be trap averse like Chinook salmon (i.e., no change in passage behavior). Gingerich said passive integrated transponder-tag data at the Twisp Weir indicate bull trout pass that location during evening hours (i.e., most movement is in the dark); however, at Wells Dam, bull trout have been detected passing during midday into late afternoon.

Bob Rose asked if this request has been vetted with the HCP Hatchery Committees, and Kahler said it has not, but will be. Rose said he would like to first discuss this internally with the YN hatchery staff before voting on the SOA. Ferguson asked if a Wells HCP Coordinating Committee decision should wait until after the request is vetted with the HCP Hatchery Committees. Kahler said all trapping operations included in the request will be incorporated into the 2016 Broodstock Collection Protocols, which will be reviewed by the HCP Hatchery Committees and need to be approved by April 15, 2016. He asked if the Wells HCP Coordinating Committee is in general support of this request, pending HCP Hatchery Committees' approval.

Jim Craig asked if the HCP Hatchery Committees will have time to review revisions to the draft protocols before April 15, 2016. Kahler said the HCP Hatchery Committees already agreed to submit edits and comments on the draft protocols by March 25, 2016, and vote via email on April 12, 2016. Truscott noted that the HCP Hatchery Committees were not aware of these revisions at that time, and Kahler said he did notify them he would have changes, but did not yet know the details. Truscott said he would like the opportunity to discuss these changes with WDFW prior to voting on the SOA, to verify WDFW does not foresee any issues with collection of spring Chinook salmon broodstock. Kahler explained that although bull trout trapping will occur 7 days per week at the east fish ladder, 3 days will still be spent targeting spring Chinook salmon.

Ferguson asked if the west fish ladder trap is operational on June 1, 2016, could trapping occur at both fish ladders to obtain the 30 bull trout quicker. He also asked about reducing trapping at each ladder if both were operational. Kahler said the trapping schedule outlined in the SOA is a starting point and can be adjusted as needed. He said the main point of the SOA is that it approves a deviation from trapping requirements.

Kahler said he will review bull trout trapping activities at Wells Dam in 2016 with the HCP Hatchery Committees and request an expedited approval, in order to request and receive email approval from the Wells HCP Coordinating Committee of the Draft SOA for Modified Wells Dam Trapping for Bull Trout in 2016 and the Draft 2016 Broodstock Collection Protocols prior to April 15, 2016. Coordinating Committees representatives will also discuss bull trout trapping activities at Wells Dam in 2016 with their respective HCP Hatchery Committees representatives to help expedite the approval process.

Geris sent an email to the Wells HCP Coordinating Committee on April 11, 2016, notifying them that the Draft 2016 Broodstock Collection Protocols were available for an expedited review, with an email vote due to Kahler by April 13, 2016. The Wells HCP Coordinating Committee approved the 2016 Broodstock Collection Protocols via email, as follows: Douglas PUD, NMFS, USFWS, WDFW, and the CCT approved April 11, 2016; and the YN approved April 13, 2016. The Final 2016 Broodstock Collection Protocols, which were also approved by the HCP Hatchery Committees on April 13, 2016, were distributed to the Coordinating Committees by Geris on April 14, 2016.

The Wells HCP Coordinating Committee approved the SOA for Modified Wells Dam Trapping for Bull Trout in 2016 via email, as follows: Douglas PUD approved April 13, 2016; NMFS, USFWS, and the CCT approved April 14, 2016; and WDFW, and the YN approved April 15, 2016. The final SOA was distributed to the Coordinating Committees by Geris on April 21, 2016.

B. DECISION: Draft 2016 Broodstock Collection Protocols (Tom Kahler)

Tom Kahler said Kristi Geris sent an email to the Coordinating Committees on

March 11, 2016, notifying them that the Draft 2016 Broodstock Collection Protocols were available for review and that Kahler intended to request Wells HCP Coordinating Committee approval of the document during the Coordinating Committees meeting on March 22, 2016. Kahler recalled that the Wells HCP stipulates, "Broodstock Collection Protocols are developed by WDFW and are annually submitted to the Wells HCP Coordinating Committee and NMFS Hydro Program for annual approval prior to trapping at the Dam." He said the Broodstock Collection Protocols SOA, approved by the Coordinating Committees on October 28, 2014 (and approved by the HCP Hatchery Committees on September 17, 2014), delegated NMFS' approval of the annual Broodstock Collection Protocols jointly to the NMFS HCP Hatchery Committees and Coordinating Committees representatives.

Kahler explained that when the Draft 2016 Broodstock Collection Protocols were first drafted, he mistakenly reported that the Adult Handling Facility at Wells Dam would be completed by May 1, 2016. He said, however, the facility will not be completed until June 1, 2016, which means trapping at the west fish ladder at Wells Dam will not be available until that time. He said this also means he needs to revise the Draft 2016 Broodstock Collection Protocols to indicate that the east fish ladder will be the primary trapping location for broodstock at Wells Dam, until the west fish ladder trap is back online. He said he plans to make this revision, along with the previously discussed bull trout revisions, for HCP Hatchery Committees' review and approval. He said he also noticed he needs to add language about the YN Coho salmon trapping at Wells Dam (same trapping as approved in the past). Kirk Truscott asked if the YN Coho salmon trapping schedule is the same as what is currently authorized in the YN Coho salmon permit. Kahler said he understands this is true.

C. 2016 Trapping Activities at Douglas PUD Facilities (Tom Kahler)

Tom Kahler handed out a 2016 Trapping Activities at Douglas PUD Facilities spreadsheet. He said he will provide the spreadsheet to Kristi Geris for distribution to the Coordinating Committees. Kahler said the spreadsheet outlines all trapping activities scheduled for Douglas PUD facilities in 2016. He also noted that he needs to update the spreadsheet with additional trapping, as previously discussed.

IV. Chelan PUD

A. DECISION: Draft 2016 Rocky Reach and Rock Island Bypass Operations Plans (Lance Keller)

Rocky Reach Dam

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach Juvenile Fish Bypass Operations Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller said Jim Craig requested to review the 2004 Rocky Reach Juvenile Fish Bypass Operations Plan, which Geris distributed to the Coordinating Committees on March 14, 2016. Keller said no other comments were received on the draft plan.

The Rocky Reach HCP Coordinating Committee representatives present approved the 2016 Rocky Reach Juvenile Fish Bypass Operations Plan.

Keller noted that this Thursday, March 24, 2016, Chelan PUD will begin the marked fish release in the Rocky Reach Juvenile Fish Bypass. He recalled that this is the preseason test conducted each year.

Rock Island Dam

Keller said Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rock Island Bypass Monitoring Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller recalled that the only change from the 2015 plan was language incorporated that outlines procedures should the fish trap accumulate too many fish. He said, when the carrying capacity of the fish trap trough is exceeded, a subsample is collected and incorporated into the DART algorithm. This procedure has been followed in recent years by facility operators, but is now being added to the 2016 Rock Island Bypass Monitoring Plan. He said no comments were received on the draft plan.

The Rock Island HCP Coordinating Committee representatives present approved the 2016 Rock Island Bypass Monitoring Plan.

B. DECISION: Draft 2016 Rocky Reach and Rock Island Spill Plan (Lance Keller)

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on February 11, 2016, notifying them that the Draft 2016 Rocky Reach and Rock Island Fish Spill Plan was available for a 32-day review, with edits and comments due to Keller by Monday, March 14, 2016. Keller said no comments were received on the draft plan.

Keller said, regarding his action item to discuss with Dr. John Skalski (Columbia Basin Research) possibly adjusting the DART database outputs to better capture the early portion (prior to June 1) of the annual subyearling Chinook salmon counts at the Rock Island Bypass, he discovered this adjustment can be made. Keller said he will request this adjustment in the future if needed.

The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island Fish Spill Plan.

C. Rocky Reach and Rock Island Adult Fish Ladder Winter Maintenance Update (Lance Keller)

Lance Keller said an update on the Rocky Reach and Rock Island adult fish ladder winter maintenance was distributed to the Coordinating Committees by Kristi Geris on March 9, 2016, as follows:

<u>Rocky Reach Dam</u>

All maintenance was completed on the Rocky Reach Adult Fish Ladder, and it was returned to service on February 25, 2016.

<u>Rock Island Dam</u>

The left and middle ladders have been online, as previously discussed. Sluice Gate R04 on the right ladder was installed and grouted in place, and the operator was installed. On March 9, 2016, the right ladder was watered up and returned to service ahead of extension date approved by the Coordinating Committees of March 15, 2016. Keller thanked the Coordinating Committees for their flexibility on water up dates.

D. 2015 Rocky Reach Juvenile Fish Bypass System Report (Lance Keller)

Lance Keller said this report is being drafted and will be available for review soon.

E. 2015 Rock Island Juvenile Bypass Report (Lance Keller)

Lance Keller said this report is being drafted and will be available for review soon.

V. HCP Administration

A. 2016 Subyearling Chinook Salmon Workshop

John Ferguson said planning for this workshop is still underway and progress is being made in terms of identifying the main components. He said the planning subgroup is meeting about every 2 weeks and will meet again today. He said he expects the next iteration of the agenda will be available for review soon. He said Dr. John Skalski and Billy Connor (USFWS) have confirmed they can attend. Ferguson said Skalski will only be available in the morning, and then Dr. Rebecca Buchannan (Columbia Basin Research) will attend the rest of the day. Ferguson said the workshop will be held on June 21, 2016, at the Red Lion, the monthly Coordinating Committees meeting will be held the morning of June 22, 2016, at the Radisson Hotel, and the monthly PRCC meeting will be held that afternoon following the Coordinating Committees meeting. Ferguson said the planning subgroup is currently discussing what materials the PUDs want to address. He said the group is discussing with Theresa (Marty) Liedtke (U.S. Geological Survey) about possibly presenting on tagging affects and applicability of current tagging equipment. Ferguson said the planning subgroup is also discussing agency and tribal participation. He said they are also considering how much time will be available to possibly discuss scale and smolt-to-adult ratio (SAR) data. Tom Kahler said he started looking into SAR data; however, the sample sizes are limited. Kahler also noted that because the speakers are all presenting about fish in the Mid-Columbia Basin, a level of coordination needs to occur to reduce overlap. Kirk Truscott said he will have Casey Baldwin (CCT) contact Ferguson regarding a CCT presentation on SARs. Scott Carlon asked about attendance numbers. Ferguson said he believes the subgroup agreed on three attendees per agency, including the Coordinating Committees representative. Kahler said the conference room capacity is 34 people. He also recalled that during the 2009 workshop, 22 people attended.

B. Next Meetings

The next scheduled Coordinating Committees meeting is on April 26, 2016, to be held by conference call. The May 24, 2016, meeting will be held by conference call, in Eastern Washington, or in-person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined. The June 21, 2016 meeting will be held at the Radisson Hotel in SeaTac, Washington.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Projects Funded by the HCP Tributary Committees

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
Jeff Korth*	Washington Department of Fish and Wildlife
Bob Rose*†	Yakama Nation
Kirk Truscott*†	Colville Confederated Tribes

Notes:

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

Rock Island Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 White River Floodplain & Habitat Protection	Chelan-Douglas Land Trust	General	Protection	$1,986,200	$693,548	$693,548	Complete
05 Nason Creek Off-Channel Habitat Restoration	Chelan County NRD	General	Off-Channel Habitat	$125,034	$18,787	$18,787	Complete
05 Alder Creek Culvert Replacement	Chelan County NRD	General	Fish Passage	$89,804	$89,804	$89,804	Complete
05 McDevitt Diversion Project	Cascadia Conservation District	Small	Fish Passage	$5,278	$5,278	$2,831	Complete
07 LWD Removal and Relocation	Chelan County NRD	Small	Instream Structures	$5,000	$5,000	$871	Complete
07 WRIA's 45/46 Riparian Restoration	Cascadia Conservation District	Small	Riparian Habitat	$50,000	$25,000	$24,779	Complete
07 Entiat PUD Canal System Conversion	Cascadia Conservation District	General	Instream Flows	$496,584	$99,360	$99,360	Complete
07 Roaring Creek Flow Enhancement	Cascadia Conservation District	General	Instrm Flows/Fish Passage	$147,069	$25,000	$987	Cancelled
07 Wildhorse Spring Creek Conservation Easement	Colville Confederated Tribes	General	Protection	$67,826	$62,826	$62,826	Complete
08 Twisp River Conservation Acquisition II	Methow Salmon Recovery Found	General	Protection	$481,814	$220,000	$200,500	Complete
08 Twisp River Riparian Protection (Zinn)	Methow Conservancy	General	Protection	$349,988	$104,996	$104,996	Complete
08 Cashmere Pond Off-Channel Habitat Project	Chelan County NRD	General	Off-Channel Habitat	$914,076	$249,110	$240,139	Complete
08 Keystone Canyon Habitat Project	Cascadia Conservation District	General	Off-Channel Habitat	$0	$0	$0	Cancelled
09 LWD/Rootwad Acquisition and Transport II	Cascadia Conservation District	Small	Instream Structures	$35,000	$35,000	$35,000	Complete
09 Sleepy Hollow Reserve Protection Feasibility	Chelan-Douglas Land Trust	Small	Assessment	$25,000	$20,000	$16,599	Complete
09 White River Nason View Acquisition	Chelan-Douglas Land Trust	General	Protection	$639,000	$76,635	$76,635	Complete
09 Upper Methow II (Tawlks) Riparian Protection	Methow Conservancy	General	Protection	$411,943	$61,948	$61,948	Complete
09 Nason Creek UWP Floodplain Reconnection - PUD Powerline Reconnection Alternatives Analysis	Chelan County NRD	General	Assessment	$53,500	$53,500	$45,569	Complete
09 Lower Wenatchee Instream Flow Enhancement	Washington Rivers Conservancy	General	Instream Flows	$4,954,466	$167,500	$167,499	Complete
10 White River Dally-Wilson Conservation Easement	Chelan-Douglas Land Trust	General	Protection	$194,000	$120,000	$120,000	Complete
10 Mission Creek Fish Passage	Cascadia Conservation District	Small	Fish Passage/Instrm Structures	$0	$0	$0	Cancelled

Rock Island Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
10 Assessing Nutrient Enhancement	CC Fisheries Enhancement Group	Small	Assessment	$9,875	$9,875	$6,670	Complete
11 Boat Launch Off-Channel Pond Reconnection	Chelan County NRD	General	Off-Channel Habitat	$136,500	$62,000	$62,000	Complete
11 White River Van Dusen Conservation Easement	Chelan-Douglas Land Trust	General	Protection	$440,000	$60,000	$60,000	Complete
12 Wenatchee Nutrient Enhancement - Treatment Design	CC Fisheries Enhancement Group	General	Assessment/Instream Structures	$240,000	$80,000	$80,000	Complete
12 White River Large Wood Atonement	CC Fisheries Enhancement Group	General	Instream Structures	$352,392	$100,000	$100,000	Complete
12 Lower White Pine Upper Connection B+	Chelan County NRD	General	Off-Channel Habitat	$2,162,290	$250,000	$0	On hold
12 Wenatchee Levee Removal & Riparian Restoration	Chelan County NRD	Small	Off-Channel Habitat	$67,450	$56,700	$20,386	Complete
14 Twisp to Carlton Reach Assessment	CC Fisheries Enhancement Group	General	Assessment	$173,016	$46,500	$46,483	In progress
14 Post Fire Landowner Assist/Habitat Protection	Methow Salmon Recovery Found	Small	Fish Passage	$100,000	$57,328	$50,796	Complete
14 Icicle Irrigation District Flow Control Structure	Chelan County NRD	General	Instream Flows	$140,633	$70,000	$30,653	Complete
14 Lehman Riparian Restoration	Methow Conservancy	Small	Riparian Habitat	$40,267	$9,053	$9,053	Complete
14 MVID Instream Flow Improvement	TU - Washington Water Project	General	Instream Flows	$9,747,000	$300,000	$112,438	In progress
15 Barkley Irrigation Company - Under Pressure	TU - Washington Water Project	General	Instream Flows	$3,293,180	$300,000	$0	In progress
15 White River Floodplain Connection (RM 3.4)	CC Fisheries Enhancement Group	Small	Off-Channel Habitat	$35,500	$35,500	$4,487	In progress
16 Icicle Creek-Boulder Field-Wild Fish to Wilderness	TU - Washington Water Project	General	Fish Passage	$1,571,189	$250,000	$0	In progress
16 Permitting Nutrient Enhancement in the Chiwawa	CC Fisheries Enhancement Group	Small	Assessment	$11,348	$11,348	$0	In progress
16 Peshastin Creek RM 10.5 PIT-Tag Detection Site	WA Dept of Fish & Wildlife	Small	Assessment	$66,859	$36,256	$0	In progress
Total				**$29,619,081**	**$3,867,852**	**$2,645,644**	

Current Rock Island Plan Species Account Balance (unallocated): $5,528,216
Contribution to the Rock Island Account is made annually (January 31): $485,200 (in 1998 dollars)

Rocky Reach Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
05 Entiat Instream Structure Engineering	Cascadia Conservation District	General	Instream Structures	$59,340	$59,340	$48,659	Complete
05 Twisp River Conservation Acquisition	Methow Salmon Recovery Found	General	Protection	$200,835	$40,000	$40,000	Complete
05 Clees Well and Pump	Okanogan Conservation District	General	Instream Flows	$40,875	$15,000	$14,924	Complete
05 Entiat Instream Habitat Improvements	Chelan County NRD	General	Instream Structures	$250,000	$37,500	$37,500	Complete
06 Entiat PUD Canal Juv Habitat Enhancement	Cascadia Conservation District	Small	Instream Structures	$23,640	$23,640	$3,059	Complete
07 LWD Removal & Relocation	Chelan County NRD	Small	Instream Structures	$5,000	$5,000	$871	Complete
07 LWD/Rootwad Acquisition & Transport	Cascadia Conservation District	Small	Instream Structures	$24,600	$24,600	$24,600	Complete
07 Harrison Side Channel	Chelan County NRD	General	Off-Channel Habitat	$797,300	$90,105	$68,647	Complete
08 Entiat PUD Canal Log-Boom Installation	Cascadia Conservation District	Small	Instream Structures	$10,660	$7,160	$4,526	Complete
08 Twisp River Riparian Protection (Buckley)	Methow Conservancy	General	Protection	$299,418	$89,825	$89,825	Complete
08 Below the Bridge	Cascadia Conservation District	General	Instream Structures	$398,998	$150,000	$115,353	Complete
09 Foreman Floodplain Reconnection	Chelan County NRD	General	Off-Channel Habitat	$0	$0	$0	Cancelled
09 Entiat NFH Habitat Improvement Project	Cascadia Conservation District	General	Off-Channel Habitat	$285,886	$61,373	$61,373	Complete
10 Methow Subbasin LWD Acquisition & Stockpile	Methow Salmon Recovery Found	Small	Instream Structures	$50,000	$50,000	$49,914	Complete
11 Chewuch River Permanent Instream Flow Project	TU – Washington Water Project	General	Instream Flow	$1,200,000	$325,000	$306,752	Complete
11 Christianson Conservation Easement	Methow Conservancy	Small	Protection	$16,350	$15,000	$15,000	Complete
12 Entiat Stormy Reach Phase 2 Acquisition	Chelan-Douglas Land Trust	General	Protection	$165,000	$46,800	$44,003	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection	$660,000	$0	$0	Cancelled
12 Nason Creek Lower White Pine Coulter Creek Barrier Replacement	Chelan County NRD	General	Fish Passage	$83,126	$12,469	$12,469	Complete
12 Nason Creek LWP Alcove Acquisition	Chelan-Douglas Land Trust	General	Protection	$353,000	$72,000	$72,000	Complete
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	$59,225	$180,950	$59,225	Complete

Rocky Reach Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	$674,600	$102,613	$68,982	Complete
13 Okanogan Basin Stream Discharge Monitoring	Colville Confederated Tribes	Small	Instream Flows	$90,954	$74,984	$65,515	In Progress
14 Silver Side Channel Design	CC Fisheries Enhancement Group	General	Design	$180,733	$132,000	$132,000	Complete
14 Similkameen RM 3.8 Design	Okanogan Conservation District	General	Design	$84,640	$84,640	$79,483	Complete
14 Entiat Stillwaters Gray Reach Acquisition	Chelan-Douglas Land Trust	General	Protection	$559,625	$174,000	$30,000	In progress
14 Clear Creek Fish Passage & Flow Enhancement	TU – Washington Water Project	Small	Fish Passage/Instrm Flows	$96,116	$69,500	$5,850	In progress
14 MVID Instream Flow Improvement	TU – Washington Water Project	General	Instream Flows	$9,747,000	$300,000	$0	In progress
15 Similkameen RM 3.8 Rehabilitation	Okanogan Conservation District	General	Instream Structures	$392,370	$67,370	$0	In progress
16 Lower Nason Creek KG Protection	Chelan-Douglas Land Trust	General	Protection	$192,500	$24,625	$0	In progress
Total				**$17,001,791**	**$2,335,494**	**$1,450,530**	

Current Rocky Reach Plan Species Account Balance (unallocated): $2,042,757
Contribution to the Rocky Reach Account is made annually (January 31): $229,800 (in 1998 dollars)

Wells Plan Species Account

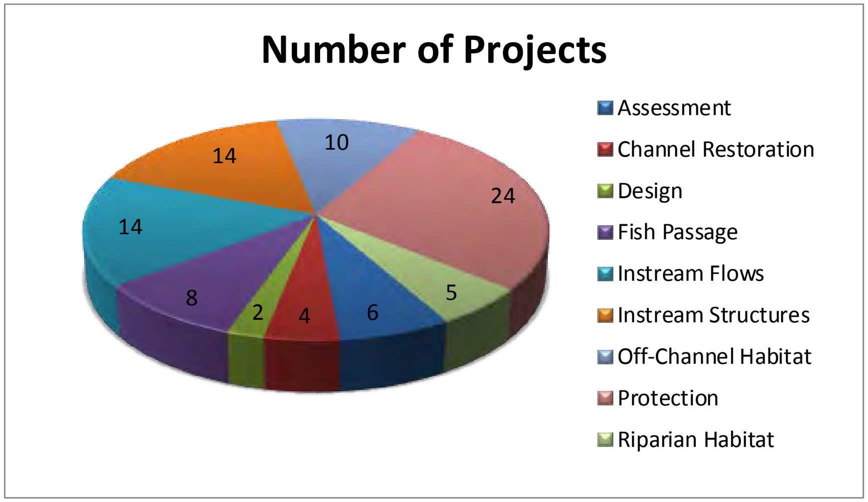
Project Name	Sponsor	Fund Type	Project Type	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
05 Okanagan River Restoration – Phase III	Okanagan Nation Alliance	General	Instream Structures	$219,121	$219,121	$197,681	Complete
05 Methow Riparian Protection (Heath)	Methow Conservancy	General	Protection	$2,684,500	$1,177,500	$812,700	Complete
05 Methow Riparian Protection (Prentice)	Methow Conservancy	General	Protection			$1,749	Complete
05 Methow Riparian Protection (MacDonald)	Methow Conservancy	General	Protection			$345,400	Complete
07 Lower Beaver Creek Livestock Exclusion	Okanogan Conservation District	Small	Riparian Habitat	$24,670	$18,559	$16,561	Complete
07 Heath Floodplain Restoration	Methow Salmon Recovery Found	Small	Off-Channel Habitat	$48,695	$48,695	$43,915	Complete
07 Okanogan River Restoration – Phase IV	Okanagan Nation Alliance	General	Instream Structures	$1,022,000	$411,000	$411,000	Complete
08 Riparian Regeneration & Restoration Initiative	Methow Conservancy	Small	Riparian Habitat	$22,737	$15,537	$15,537	Complete
08 Fort Thurlow Pump Project	Methow Salmon Recovery Found	Small	Instream Flows	$48,150	$7,000	$7,009	Complete
08 Goodman Livestock Exclusion Project	Okanogan Conservation District	Small	Riparian Habitat	$8,080	$7,980	$6,829	Complete
08 Poorman Creek Barrier Removal	Methow Salmon Recovery Found	General	Fish Passage	$191,579	$53,748	$53,748	Complete
08 Twisp River Riparian Protection (Pampanin)	Methow Conservancy	General	Protection	$119,720	$48,649	$48,649	Complete
08 Twisp River Riparian Protection (Neighbor)	Methow Conservancy	General	Protection	$260,000	$55,000	$55,000	Complete
08 Twisp River Riparian Protection (Speir)	Methow Conservancy	General	Protection	$79,976	$23,993	$23,993	Complete
10 Prevent Fish Entrainment on Inkaneep Creek	Okanagan Nation Alliance	Small	Instream Flows	$24,000	$0	$0	Cancelled
11 Methow River Acquisition MR 39.5 (Hoffman)	Methow Salmon Recovery Found	General	Protection	$195,048	$74,415	$74,415	Complete
11 Methow River Acquisition MR 48.7 (Bird)	Methow Salmon Recovery Found	General	Protection	$292,140	$111,680	$109,786	Complete
11 Methow River Acquisition MR 41.5 (Risley)	Methow Salmon Recovery Found	General	Protection	$148,210	$31,854	$26,518	Complete
12 Twisp River Acquisition 2011 (Hovee)	Methow Salmon Recovery Found	General	Protection	$140,700	$29,000	$1,074	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection	$660,000	$0	$0	Cancelled
12 Twisp River Well Conversion	Trout Unlimited	Small	Instream Flows	$87,739	$68,023	$68,023	Complete

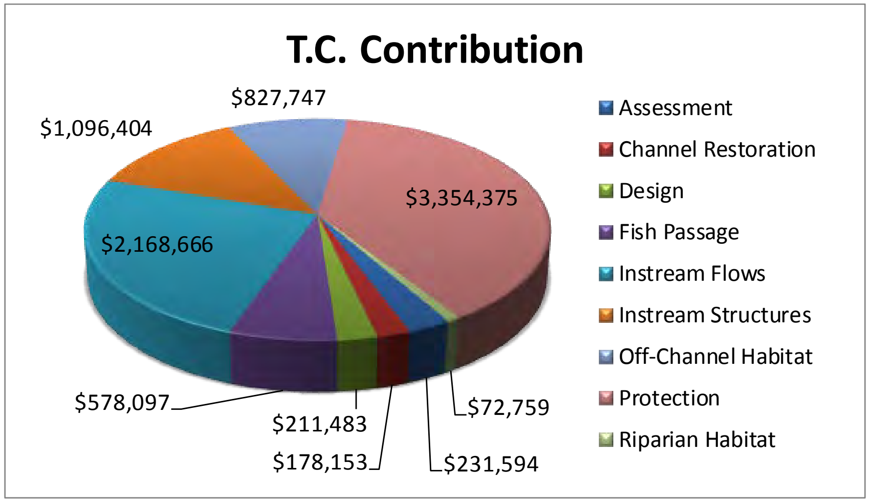
Wells Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
13 Twisp River Poorman Crk Wetland Acquisition	Methow Salmon Recovery Found	General	Protection	$423,000	$338	$338	Cancelled
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	$180,950	$59,225	$59,224	Complete
13 Methow/Chewuch Groundwater Monitoring	Cascade Columbia Fisheries Enhancement	Small	Instream Flows	$34,180	$30,580	$29,962	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	$674,600	$102,613	$68,982	Complete
13 Lower Chewuch Beaver Restoration	Methow Conservancy	General	Off-Channel Habitat	$247,985	$27,000	$27,000	Complete
13 MVID Instream Flow Improvement Project	Trout Unlimited	General	Instream Flows	$9,747,000	$400,000	$201,553	In progress
14 Remove Collapsed Bridge from Shingle Creek	Okanagan Nation Alliance	Small	Channel Restoration	$8,193	$6,693	$6,689	Complete
15 Methow Watershed Beaver Reintroduction	Methow Salmon Recovery Found	General	Channel Restoration	$216,000	$33,500	$0	In progress
15 M2 Sugar Acquisition	Methow Salmon Recovery Found	General	Protection	$119,652	$15,185	$0	In progress
Total				**$17,928,625**	**$3,076,888**	**$2,713,335**	

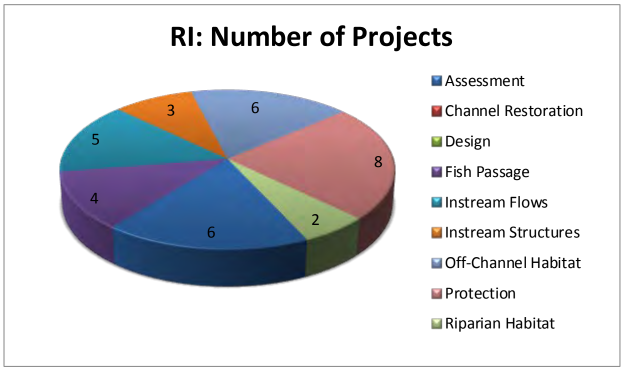
Current Wells Plan Species Account Balance (unallocated): $1,300,397
Contribution to the Wells Account will be made annually beginning in 2010: $176,178 (in 1998 dollars)

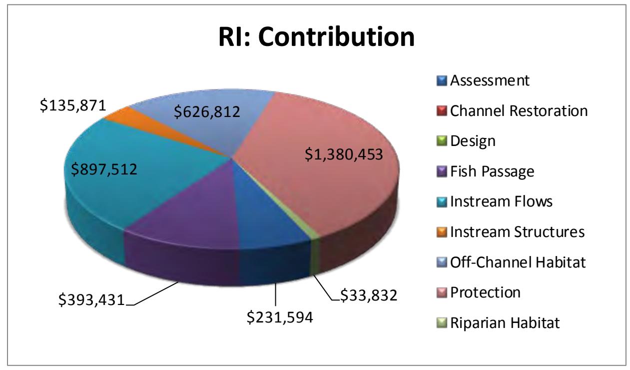
Projects Funded by the Tributary Committees

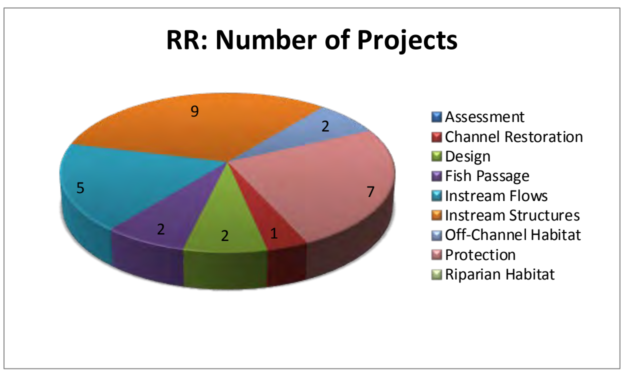


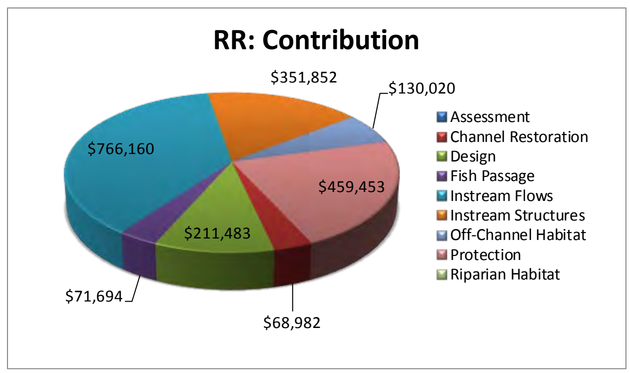


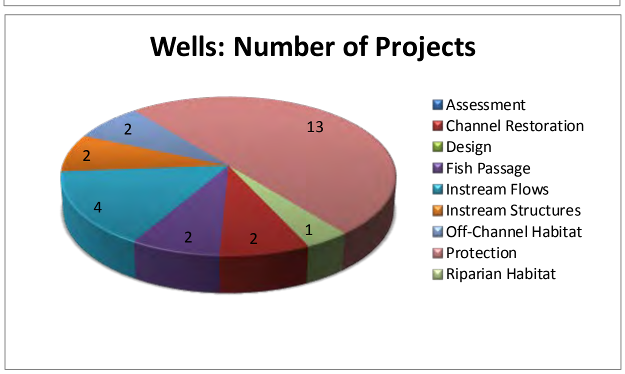
Projects Funded by each Plan Species Account

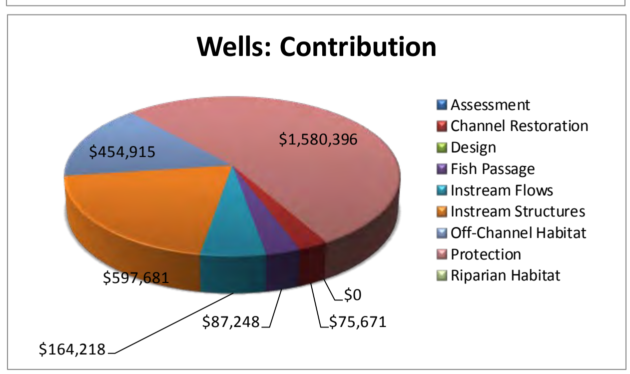












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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	May 25, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the April 26, 2016, HCP Coordinating Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday April 26, 2016, from 9:30 a.m. to 12:15 p.m. Attendees are listed in Attachment A to these conference call minutes.

ACTION ITEM SUMMARY

- John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).
- Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B2 to Kristi Geris for distribution to the Coordinating Committees (Item I-C).
- Tom Kahler will discuss with Jeff Fryer (Columbia River Inter-Tribal Fish Commission [CRITFC]) the Coordinating Committees' contingencies for approving CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, including: 1) using AQUI-S to anesthetize any fish and tagged in excess of the 800 specified in the CRITFC request letter, and tagging no more than 1,000 fish throughout the entire run; or 2) using MS-222 to anesthetize the fish and tagging no more than 800 fish throughout the entire run (Item III-A). *(Note: Kahler discussed this with Fryer, as requested.)*
- Chelan PUD will provide a summary of discussions held in the early-2000s regarding a request to close orifice gates (OGs) at Rocky Reach Dam, including historical radio telemetry data demonstrating use of the OGs for adult fish passage (Item IV-A).

- Chelan PUD will provide the Draft 2015 Rocky Reach and Rock Island Juvenile Fish Bypass Reports for Coordinating Committees review by Friday, April 29, 2016 (Item IV-B). *(Note: Lance Keller provided the Draft 2015 Rocky Reach Juvenile Fish Bypass Report to Kristi Geris on May 17, 2016, which Geris distributed to the Coordinating Committees on May 18, 2016.)*
- **The Coordinating Committees meeting on May 24, 2016, will be held by conference call (Item V-B).**

DECISION SUMMARY

- Wells HCP Coordinating Committee representatives present approved the request from Charles Frady (Washington Department of Fish and Wildlife [WDFW]) to conduct real-time trapping at the Wells Dam west fish ladder during the second half of May 2016 (Item III-C).
- Wells HCP Coordinating Committee representatives approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, via email, as follows: Douglas PUD and the National Marine Fisheries Service [NMFS] approved April 29, 2016; the U.S. Fish and Wildlife Service [USFWS], WDFW, and the Colville Confederated Tribes [CCT] approved May 2, 2016; and the Yakama Nation [YN] approved May 9, 2016 (Item III-A).

AGREEMENTS

- Wells HCP Coordinating Committee representatives present agreed to consider approval of CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, via email, after Douglas PUD receives additional information from Jeff Fryer (Item III-A).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on May 18, 2016, notifying them that the Draft 2015 Rocky Reach Juvenile Fish Bypass System Report is available for a 30-day review, with edits and comments due to Lance Keller by Thursday, June 16, 2016 (Item IV-B).

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the Coordinating Committees and asked for any additions or changes to the agenda. Tom Kahler added an update on the Wells Dam bypass passive integrated transponder (PIT)-tag detection system and also a Wells Dam west fish ladder trapping request.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft March 22, 2016, meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. She said she also added to the Decision Items Wells HCP Coordinating Committee approval of the Statement of Agreement (SOA) for Modified Wells Dam Trapping for Bull Trout in 2016. Coordinating Committees members present approved the March 22, 2016, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on March 22, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on March 22, 2016):*

- *John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).*
  This will be discussed during today's conference call, and will also be carried forward.
- *Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B2 to Kristi Geris for distribution to the Coordinating Committees (Item I-C).*
  Keller said he still needs to confirm this schedule with Rock Island Dam engineers. This action item will be carried forward.
- *Tom Kahler will coordinate with Douglas PUD Information System (IS) staff to launch the HCP Tributary Committees Extranet Site (Item II-A).*

Kahler said the HCP Tributary Committees Extranet Site is up and running. He said Julene McGregor (Douglas PUD IS Staff) presented the site to the HCP Tributary Committees during their last meeting on April 14, 2016. Kahler said a contact list still needs to be added to the site and Coordinating Committees access to the site needs to be arranged. This will be further discussed during the HCP Tributary Committees update.

- *Lance Keller will discuss internally how to properly address Pacific lamprey passage at Tumwater Dam as it relates to HCP Plan Species broodstock collection (Item II-A).* This will be discussed during today's conference call.
- *Tom Kahler will review bull trout trapping activities at Wells Dam in 2016 with the HCP Hatchery Committees and request an expedited approval, in order to request and receive email approval from the Wells HCP Coordinating Committee of the Draft SOA for Modified Wells Dam Trapping for Bull Trout in 2016 and the Draft 2016 Broodstock Collection Protocols prior to April 15, 2016 (Item III-A).* This was completed and the SOA and protocols were approved.
- *Coordinating Committees representatives will discuss bull trout trapping activities at Wells Dam in 2016 with their respective HCP Hatchery Committees representatives to help expedite the approval process (Item III-A).* This was completed, and the SOA and protocols were approved.
- *Tom Kahler will provide the 2016 Trapping Activities at Douglas PUD Facilities spreadsheet to Kristi Geris for distribution to the Coordinating Committees (Item III-C).* Kahler provided the spreadsheet to Geris on April 26, 2016, which Geris distributed to the Coordinating Committees that same day.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Tributary Committees meeting on April 14, 2016:

- *Extranet Site:* Julene McGregor provided a presentation introducing the HCP Tributary Committees Extranet Site. Representatives and Alternates have member access to the site, and Hillman and Becky Gallaher (Chelan PUD) have administrator access. McGregor discussed logging in, navigating, searching, and uploading to the site. The

HCP Tributary Committees intend to use the site as a repository for agendas, final meeting notes, monitoring reports, presentations, correspondence with project sponsors, final reports from project sponsors, and photographs of projects. John Ferguson noted that the Coordinating Committees should have access to the site, as well. Tom Kahler agreed, recalling that the Coordinating Committees should have access to all HCP Extranet sites. Hillman said the HCP Tributary Committees also discussed providing all HCP Tributary Committees Representatives administrator access (which allows users to upload documents directly to the viewable Document Library). Kahler said providing administer access to all users may complicate things, and suggested that members use the Document Drop and Hillman and Gallaher (as administers) post the documents accordingly. Hillman said he believes Gallaher can do this. *(Note: Kristi Geris contacted McGregor on April 28, 2016, and requested Coordinating Committees Representatives and Alternates visitor access to the HCP Tributary Committees Extranet site.)*

- *Presentation on the White River Restoration Project:* Recall, the HCP Tributary Committees requested presentations on projects funded by the Committees to review progress to date. Robes Parrish (USFWS) and Jason Lundgren (Cascade Columbia Fisheries Enhancement Group) provided a presentation on the White River Wood Atonement Project. The purpose of the project was to place log pilings in locations on the lower White River where wood would naturally accumulate. In 2014, they installed 128 pilings and 28 wood structures, and since installation, only five pilings have been lost, most of which were sheared off at the riverbed. These structures have experienced 2-, 5-, and 10-year flow events, have successfully racked wood, and continue to provide habitat for salmonids in the White River. Overall, the project is meeting its goals. Jim Craig noted that all of this has been done without the use of cables. Hillman said it was all just pile driving.
- *Presentation on Restoration Projects in the Okanogan River Basin:* Chris Fisher (CCT) provided a presentation on six restoration activities in the Okanogan River Basin. Activities included working with a local science class to monitor the reconnection of a side channels at Conservancy Island. Hillman said there were few salmon present prior to opening of the side channels, and now there are many. He said the channels will continue to be monitored. Other activities included screening irrigation intakes

and modifying the Okanogan River-Similkameen River cross channel. Hillman explained that as flow decreases in the Okanogan River, water diverts through the cross channel into the Similkameen River, dewatering portions of the Okanogan River. Therefore, a structure was installed in the cross channel to prevent this from happening, and is working well. Additional activities also included restoration projects in Canada and eliminating water loss in the Pleasant Valley Water Users Association Irrigation Canal. If eliminating water loss in the canal works, this will improve stream flow conditions in Loup Loup Creek. Fisher also discussed a proposed project to upgrade the North Fork Diversion on Salmon Creek.

- *Plan Species Accounts Audit:* The audit on the Rock Island and Rocky Reach Plan Species Accounts began on April 20, 2016, and results will be available soon.
- *Next Steps:* The HCP Tributary Committees' next scheduled meeting will be on May 12, 2016, following project tours.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on April 20, 2016:

- *USFWS Bull Trout Consultation Update:* USFWS plans to have a final version of the Wenatchee River Steelhead Biological Opinion (BiOp) completed in May 2016.
- *NMFS Consultation Update:* NMFS received the Wenatchee River Steelhead BiOp from the National Oceanic and Atmospheric Administration General Counsel (NOAA GC), and now NOAA GC is requesting a take surrogate for ecological interactions. Regarding Methow spring Chinook salmon, a draft permit is now complete. Historically, one permit was issued, which covered all PUDs; however, the PUDs are now requesting their own permits. NMFS agreed to comply with this request; however, NMFS indicated this will cause a delay in issuing the permits. NMFS is also undergoing a new National Environmental Policy Act process for the Methow Program permits, and is awaiting approval from NOAA GC. NMFS is planning to complete an Environmental Assessment or Environmental Impact Statement by mid-July 2016. Regarding the Mitchell Act lawsuit, NMFS is developing a BiOp to cover the funding of the Mitchell Act programs, which could cause delay to the programs. Lastly, NMFS hired four new staff to work on consultations to expedite the process.
- *Draft Chewuch Homing Study Proposal:* An Imprinting and Homing Workgroup met

on March 23, 2016, and discussed a study plan for an embryonic imprinting study. The workgroup agreed the treatment will be confined to the Chewuch River, and the Twisp River will serve as the control. The treatment will consist of applying Chewuch River water from the eye-up through feeding stages. A specific incubation system is needed to conduct the proposed study. The Issaquah Salmon Hatchery has such a system, and the HCP Hatchery Committees plan to visit it to attempt to replicate it. The timeline for implementation of the embryonic imprinting study will start with brood year 2017 fish, which will allow time to make and test the incubation system, as well as time for planning any infrastructure modifications. The plan is to run trials with hatchery-by-hatchery (HxH) fish before using wild broodstock, so that wild-by-wild (WxW) fish from endangered broodstock are not placed into a system that could potentially fail. However, using HxH spring Chinook salmon at a production scale could also create issues in meeting proportionate natural influence (PNI) objectives. Therefore, once the system appears to be successful, WxW fish will be used moving forward. Jeff Korth asked how success will be measured. Hillman replied, via PIT-tags and coded wire tags from carcass retrieval to estimate stray rates. Korth asked if there is a way to collect data prior to spawning, and Hillman said data will be obtained via PIT tag interrogation sites and carcass recovery.

- *Carrying Capacity Estimates:* Hillman provided a presentation on carrying capacity for Chiwawa spring Chinook salmon. The purpose of the presentation was to obtain feedback from the HCP Hatchery Committees about how carrying capacity should be estimated in Appendix 1 of the Draft Hatchery Monitoring and Evaluation (M&E) Plan. There are several methods for estimating carrying capacity, including via habitat (the maximum number of fish a given area can support) and via population (the maximum equilibrium population). Carrying capacity is regulated by density-dependent and -independent factors. Three types of stock-recruitment models were discussed, including Ricker, Beverton-Holt, and Smooth Hockey Stick. Using population data, one can calculate estimated population and habitat capacity for parr, smolts, and adults. Example results were discussed using a habitat model, and those results were compared to the results from the different stock-recruitment models. Precision was discussed, and also that carrying capacity estimates stabilize over time.

The next steps are to complete these analyses for other spring Chinook salmon stocks (steelhead are more difficult). Ferguson asked if the number of adult spawners can be calculated that need to escape into the Chiwawa River to fully seed it. Hillman said this can be easily calculated with the Ricker and Smooth Hockey Stick models; however, adult management may add bias (i.e., removing adults who otherwise would migrate to an area and spawn adds some bias). He said there are also confounding effects due to differences in wild and hatchery spawners. He said Andrew Murdoch (WDFW) is conducting work that shows HxH fish have lower fitness than WxW, and also that hatchery fish spawn in the lower Chiwawa River where there is relatively poor habitat, but densities do not change much in preferred habitat. He said what changes is distribution in the tributaries, so at high escapement there are more fish present, and vice versa. He said stock-recruitment modeling needs a long time series of data with adequate contrast, and the Chiwawa River has more than 23 years of those data (i.e., both low and high escapement years). Bob Rose asked how river flow is calculated into carry capacity. Hillman said when evaluating the stock-recruitment relationships, spawning escapement explains about 60% of the variation in recruits (smolts). He said the remaining 40% unexplained variation is based on density-independent factors such as river flow and rain on snow events, among other things. He said an analysis can also be run using these factors as covariates in the models. Thus, flows can be included in the analyses. Rose asked if environmental factors include a hatchery component. Hillman said yes, and added that he is now evaluating genetic issues arising from the fitness studies Murdoch is conducting. Rose asked if there is funding set aside to develop these ideas for monitoring in the Douglas and Chelan PUDs Habitat Committees. Hillman said that each HCP has a fixed amount of money in a Tributary Assessment Program Account that can be used for monitoring or assessments. The Wells Assessment Fund has been used to assess restoration projects primarily in Canada. The Wells Tributary Assessment funds are nearly exhausted. Money still exists within the Rocky Reach and Rock Island Assessment Accounts. Following the guidelines within the Agreements, the HCP Habitat Committees determine how the money is spent.

- *Adult Pacific Lamprey Release within Tumwater Dam Fish Ladder:* The YN presented a Scope of Work to conduct a study to evaluate how adult Pacific lamprey navigate through the Tumwater Dam fishway. Thirty fish will be released directly into the ladder, including ten near the entrance, ten in the middle, and ten in the upper portion. The HCP Hatchery Committees discussed concerns regarding releasing PIT-tagged fish directly into the ladder. Lamprey could potentially attach to an array for a long time, which could affect the monitoring of Chinook salmon delays by inundating the PIT detector with tag signals. The HCP Hatchery Committees agreed to conduct the study now, prior to the Chinook salmon run. If river flow reaches 10,000 cubic feet per second (cfs), the ladder will be shut down. In this situation, it was noted there is the potential for lamprey to become trapped in the fishway. The HCP Hatchery Committees discussed how to detach lamprey from arrays if it should happen, including nudging the lamprey off the array with a stick, or adding odors to the water to draw them off. The HCP Hatchery Committees had no objections to the proposal. Rose said he believes the release will occur next week, after staff are trained.

- *Blackbird Pond Acclimation PIT-tag Data Results:* Chelan PUD provided a presentation about straying of fish released from Blackbird Pond. Chelan PUD coordinated with Trout Unlimited to acclimate steelhead at Blackbird Pond, with Trout Unlimited providing the water right, and WDFW operating the pond. Currently, approximately 25,000 steelhead are acclimated in Blackbird Pond, with the objective to create more steelhead fishing opportunities in the Wenatchee River near Blackbird Island, including providing residualized steelhead as a fishery for kids. Steelhead were first reared in Blackbird Pond in 2010. From 2013 to 2015, juvenile survival from release to McNary Dam was comparable to truck-plant releases in the Wenatchee River. Date of transfer to Blackbird Pond is significantly associated with juvenile survival to McNary Dam. Juvenile survival is higher for fish that are transferred to the pond at a later date. One of the purposes of acclimating steelhead at Blackbird Pond is to reduce stray rates to non-Wenatchee River sub-basin streams. There is no significant difference in stray rates between Blackbird Pond and combined truck-plant releases for 2010 or 2011. The purpose of this presentation was that there are structural issues with the intake screen, which would take significant investments and a permitting process, so the HCP Hatchery Committees are considering the costs and benefits associated with operating Blackbird Pond. The facility was built before the Chiwawa Acclimation Facility, and needs improvements. To summarize, the fate of the pond needs to be decided. Korth noted that prior to the last recalculation of the HCP hatchery programs, there was no place to raise steelhead. He said Turtle Rock stray rates were huge, and WDFW was focused on reducing stray rates, so Blackbird Pond was initially the best option available. He said now, other acclimation facilities are available.

- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on May 18, 2016.

III. Douglas PUD

A. *DECISION: CRITFC Sockeye Tagging (Tom Kahler)*

Tom Kahler said CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016 (Attachment B) was distributed to the Coordinating Committee by Kristi Geris on March 31, 2016, and a revision to the request (Attachment C) was distributed on April 22, 2016. Kahler said Attachment B is CRITFC's formal request for routine tagging that Jeff Fryer conducts at Wells Dam each year. Kahler added that in 2015, more adult sockeye salmon than usual were observed moving upstream through the fish ladders late in the migration at Mid-Columbia River dams. He said, Fryer is interested in whether those late arrivals successfully make it to the spawning grounds because he has never tagged that portion of the run in the past. Kahler said Attachment C requests tagging of up to 200 late-run fish in addition to the 800 fish in the original request. He said Fryer is not expecting to tag very many, but hopes for at least 50 fish, and 200 fish would be ideal.

John Ferguson asked about the proposed trapping operations for sockeye tagging. Kahler said Fryer is proposing that sockeye tagging coincide with WDFW's routine stock assessment and steelhead broodstock collection efforts. Kahler said Fryer would provide WDFW with PIT tags, and WDFW would tag the fish while conducting their assessment, so there will be no additional trap operations. Ferguson asked if there are any issues from WDFW's standpoint. Jeff Korth said he has no concerns. Kahler also clarified that Fryer has already coordinated with Charlie Snow (WDFW), and any additional costs will be handled via the M&E contract.

Kirk Truscott asked if Fryer could just reapportion the 800 fish instead of tagging an additional 200 fish. Truscott suggested monitoring Priest Rapids and Rocky Reach dams run timing to reapportion the tagging, as needed. He added that it seems if 200 fish are tagged late in season, the distribution of the sample will be more heavily loaded on the back end. Kahler said he believes this request was simply an afterthought that Fryer tacked onto the original request, and the intention was not to redo the whole assessment. Kahler said he also is not sure how Truscott's suggestion would affect tagging crews. He said another concern may be that in the past, tagging efforts were affected by river temperature conditions. He said late August has the highest river temperatures. Truscott also asked if Fryer plans on using MS-222. Kahler said he believes so. He added that the electronarcosis system will also be available; however, he is not sure Fryer would want to use the system because that method would be different than past years. Kahler said Fryer may also use AQUI-S. Kahler added that Fryer also floy tags the fish, so people know not to consume them. Truscott said he prefers AQUI-S. Kahler asked if AQUI-S is used, would the CCT approve tagging the additional 200 fish. Truscott said the CCT would approve.

Kahler said he will discuss with Fryer the Coordinating Committees' contingencies for approving CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, including: 1) using AQUI-S to anesthetize any fish tagged in excess of the 800 specified in the CRITFC request letter, and tagging no more than 1,000 fish throughout the entire run; or 2) using MS-222 to anesthetize the fish and tagging no more than 800 fish throughout the entire run. The Wells HCP Coordinating Committee representatives present agreed to consider approval of CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, via email, after Douglas PUD receives additional information from Fryer. *(Note: Kahler discussed this with Fryer, as requested.)*

Wells HCP Coordinating Committee representatives approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, via email, as follows: Douglas PUD and NMFS approved April 29, 2016; USFWS, WDFW, and the CCT approved May 2, 2016; and the YN approved May 9, 2016.

B. Wells Dam Bypass PIT-Tag Detection System (Tom Kahler)

Tom Kahler said Biomark installed the new PIT-tag antennas in the top frame section of Bypass Bay 2 on April 7, 2016, and that routine bypass operations at Wells Dam started at 0000 hours on April 9, 2016. Kahler said, however, Biomark did not provide to the Wells electricians the full layout of conduit runs needed, so when Biomark arrived onsite to install the system, one of the necessary conduits had not yet been installed. He said this installation involves accessing an area below the intake deck that requires a barge, and at the time, a barge was not available for service. He said Douglas PUD had hoped to have the new system fully operational in time for the releases of fish from hatcheries upstream of Wells Dam; however, this was ultimately not accomplished. He said in this temporary state, data are being collected and downloaded to a flash drive instead of directly to the PIT-tag Information System database. He said, once a barge is available for service, the conduit will be installed. He added that there are still additional tagged fish planned for release upstream of Wells Dam; however, now there are not as many fish available to test the new system as he had hoped. He said he will still likely lobby to install PIT-tag detection in all the openings in the top two sections of Bypass Bay 2 at Wells Dam. Kirk Truscott said he believes Chief Joseph Dam will be releasing about 5,000 to 6,000 PIT-tagged subyearling Chinook salmon during the first week of June 2016. Kahler said, in the past, those fish have been observed in beach seine catches for about 2 weeks following release.

C. DECISION: Wells Dam West Fish Ladder Trapping Request (Tom Kahler)

Tom Kahler said he just provided to Kristi Geris a request from Charles Frady to conduct real-time trapping at the Wells Dam west fish ladder during the second half of May 2016 (Attachment D), and Geris distributed the request to the Wells HCP Coordinating Committee during the meeting on April 28, 2016. Kahler explained that Frady, who leads WDFW's stock assessment each year at Wells Dam, is concerned about obtaining enough spring Chinook salmon broodstock with the west fish ladder trap out of service. Kahler also said, that based on historical data, there is concern that a large proportion of the spring Chinook salmon run will be missed for broodstock collection and stock assessment because those fish seem to favor passing Wells Dam via the west fish ladder. Kahler said Frady is requesting real-time trapping at the west fish ladder even though the conveyance pipe from the trap to the new Adult Handling Facility will be disconnected. Kahler said the plan is to divert fish into the return-to-ladder chute, collect them from that chute, transport target fish via a boot, and anesthetize and process the fish on the west fish deck; then non-broodstock fish will be recovered in fresh water prior to being released back into the west fish ladder. He said this proposed real-time trapping will occur during regularly scheduled trapping operations.

John Ferguson asked what dates the proposed real-time trapping would occur. Kahler said most spring Chinook salmon pass Wells Dam in May, and the west fish ladder modifications are scheduled to be complete and operational by June 1, 2016; therefore, the proposed real-time trapping will likely start May 14, 2016, and end May 31, 2016. He said, during this window, trapping will occur on both fish ladders, and after May 31, 2016, trapping will revert back to regular operations. Jeff Korth asked about the proportion of total broodstock collected during this time. Kahler said he did not currently have this information; however, he can inquire about it. Kirk Truscott said the CCT does not have concerns about operating both traps during the proposed time period; however, his concern is about handling the fish. Jim Craig asked if there will be a gate operator to ensure handling will be conducted one fish at a time. Kahler explained that fish will enter a flume where it will be held or let to pass back into the fish ladder. He added that he has not observed fish ever piling up in the flume. Craig said it still is not clear to him how this will work.

Kahler asked that the Wells HCP Coordinating Committee review the email request from Frady for clarification, which was distributed to them by Geris during this discussion. Kahler said Douglas PUD will need approval of this request by next week in order to schedule staff for the effort. The Coordinating Committees took a moment to review the email request from Frady.

Wells HCP Coordinating Committee representatives present approved the request from Frady to conduct real-time trapping at the Wells Dam west fish ladder during the second half of May 2016.

IV. Chelan PUD

A. Proposed Rocky Reach Orifice Gate Closure (Lance Keller, Thad Mosey, Chris Nystrom)

Lance Keller said a proposal to close OGs in the Rocky Reach Dam fishway during the late summer and fall of 2016 (Attachment E), as well as two photographs of the OG structures (Attachments F and G), were provided to Kristi Geris on April 25, 2016, which Geris distributed to the Coordinating Committees on April 26, 2016. Keller said this is just a discussion item at this time; however, Chelan PUD will likely request approval of the request in a couple of months. Thad Mosey (Chelan PUD Biologist and Spill Coordinator) introduced Chris Nystrom (Chelan PUD Fishway Operator). Mosey said Nystrom has been employed with Chelan PUD for more than 20 years and has a wealth of knowledge about operations at Chelan PUD facilities.

Mosey said the reason for this request is to improve hydraulic conditions throughout the powerhouse collection channel at Rocky Reach Dam. He explained that Rocky Reach Dam operates 6 of 22 OGs across the downstream face of the powerhouse, in addition to three main entrances for adult fish passage. He said three OGs are operated on the north end of the powerhouse near the left powerhouse entrance (LPE), and three are operated on the south end of the powerhouse near the right powerhouse entrance (RPE). He further reviewed the layout of the Rocky Reach fishway in Photograph 2 of Attachment E.

Mosey said the issue is regarding two pairs of rotary gates installed immediately inside of the RPE slots. He said the purpose of the gates in the original design was to provide velocity regulation of attraction water discharged through the entrances; however, in 1971, an agreement was reached to permanently position the rotary gates to maintain at least a 3-foot opening. He said this change in gate operation removed any regulation capability at the six OGs. He explained that the designed flow requirement for each OG is 64 cfs, or 384 cfs total flow out all six OGs. He said, when river flow is high, tailwater elevations are high, so there is a sufficient auxiliary water supply (AWS) flow to maintain the 1-foot differential criterion at the three main entrances and also the 384 cfs required for the OGs. He said the issues arise when tailwater elevations decline with declining river flow. He said less AWS water is required to maintain the differential at the fishway entrances; however, the flow requirement at the OGs remains at 384 cfs.

Mosey said Attachment E outlines three options to compensate for this lack of water at the RPE. He said Option 1 is to restrict flow through the rotary gates at the RPE; however, this option is not realistic because operation of the rotary gates has already been restricted. He said Option 2 is to restrict flow to the LPE and middle spillway entrance using wing gates. He said Option 3 is to introduce additional water through sluice gates in diffuser chambers along the collection channel; however, this will slow the water velocity through the collection channel due to the upwelling of water from individual diffusion chambers located along the entire length of the channel, which may affect fish passage. Mosey said Nystrom has been using the wing gates option (Option 2) opposed to altering fishway operations.

Mosey said, however, Chelan PUD is proposing to close the six OGs in the collection channel to provide additional flow to the RPE. He said annual fishway inspection reports from area hydroelectric projects during the early 2000s indicated the OGs were closed during this period, and there were positive results and no negative effects observed on fish passage. He said, based on these results, Chelan PUD would like to try the same operations at Rocky Reach Dam along with monitoring of fish counts. He said, if no issues are observed based on the count data, Chelan PUD would like to keep the gates closed. Nystrom added that the option Chelan PUD is exercising now (with the wing gates) is less desirable than what Chelan PUD ultimately prefers (i.e., to close the OGs).

Bob Rose recalled discussions about this during the early 2000s; however, he could not recall the details of those discussions. He said the discussions were captured in meeting notes, and suggested Chelan PUD review those discussions and concerns expressed. He said, for some reason, the decision was made to leave the gates open, and requested that Chelan PUD summarize those discussions for the Coordinating Committees to consider. Scott Carlon also asked if Chelan PUD has any historical radio telemetry data demonstrating use of the OGs for adult fish passage and said he will discuss this with Aaron Beavers (NMFS fish passage engineer). Mosey said those data are available, and that Chelan PUD will provide a summary of discussions held in the early-2000s regarding a request to close OGs at Rocky Reach Dam, including historical radio telemetry data demonstrating use of the OGs for adult fish passage.

B. Draft 2015 Rocky Reach and Rock Island Juvenile Fish Bypass Reports (Lance Keller)
Lance Keller said he will provide these draft reports for Coordinating Committees review by Friday, April 29, 2016. *(Note: Keller provided the Draft 2015 Rocky Reach Juvenile Fish Bypass*

Report to Kristi Geris on May 17, 2016, which Geris distributed to the Coordinating Committees on May 18, 2016.)

C. 10% Spring Spill Initiation at Rock Island Dam (Lance Keller)

Lance Keller said a notification of the initiation of spring fish spill at Rock Island Dam was distributed to the Coordinating Committees by Kristi Geris on April 11, 2016. Keller said spring spill at Rock Island Dam started at midnight on April 10, 2016. He said spill was initiated based on: 1) fish counts past Rock Island Dam (specifically the sockeye salmon count); 2) counts at the screw trap located on the Wenatchee River, indicating fish were migrating early; and 3) the Data Access in Real Time (DART) database. He said 4.6% passage of sockeye salmon on April 9, 2016, at Rock Island Dam initiated spill on April 10, 2016, at midnight. He said DART is estimating that April 10, 2016, was at about the 10.5% passage mark for sockeye salmon, but will continually adjust as the season progresses. He said daily counts have been in the 400 to 700 fish range, and it is earlier than normal to observe this number of fish counted. He said, however, based on available data and also that spill was initiated late last year, Chelan PUD was conservative and started spill earlier than normal.

D. Pacific Lamprey Passage at Tumwater (Lance Keller)

Lance Keller recalled Chelan PUD's action item from the March 22, 2016, meeting to discuss internally how to properly address Pacific lamprey passage at Tumwater Dam as it relates to HCP Plan Species broodstock collection. Keller said he and Alene Underwood (Chelan PUD HCP Hatchery Committees Representative) agreed the HCP Hatchery Committees have oversight regarding trapping for broodstock, and the Coordinating Committees have oversight regarding fish passage. Keller said these same principles apply to Pacific lamprey at Tumwater Dam when either collection of broodstock or adult passage of HCP Plan Species is of concern. He added that discussions will likely be presented to both Committees because they typically are interconnected.

Jim Craig said, irrespective of individual Committees' oversight, he believes everyone has a responsibility to resolve the passage impediment currently present at Tumwater Dam. He said he hopes everyone can collectively work together, especially with the YN, to assess passage issues at the entire dam, including the fishway. Bob Rose agreed and also stated that Chelan PUD's interpretation of Committee responsibilities was correct.

V. HCP Administration

A. 2016 Subyearling Chinook Salmon Workshop

John Ferguson said a draft Subyearling Chinook Salmon Workshop Agenda was distributed to the Coordinating Committees by Kristi Geris on April 21, 2016. Ferguson said the draft agenda was developed by a subgroup of PUDs representatives and Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator). Ferguson said the workshop is scheduled for June 21, 2016. He noted that the workshop is structured as a full-day meeting; however, 2 hours are allocated for round-table discussion sessions. He said the intent of the workshop is to communicate information and bring everyone up to speed on the latest aspects of summer and fall Chinook salmon in the Mid-Columbia Basin. He said the workshop sponsors are all three PUDs (Chelan, Douglas, and Grant).

Ferguson said the workshop will start with him and Rohr introducing and reviewing roles. He said Dr. John Skalski will then present the current survival model, bringing everyone up to speed on the latest survival models developed by the University of Washington for application on subyearling Chinook salmon. Ferguson said Billy Connor (USFWS) will then review his research on Snake River life-history patterns. Ferguson said, following a break, the Mid-Columbia Basin will be discussed by five speakers. He said the workshop will then break for lunch (provided by Grant PUD), and reconvene to discuss availability of fish to meet model requirements (e.g., what is known about collecting fish at different facilities). Ferguson said, following another break, tagging effects will be discussed, including presentations by Rich Brown (Pacific Northwest National Laboratory) on barotrauma and Marty Liedtke (U.S. Geological Survey) on tagging effects and hardware. Ferguson said the final discussion is intended to provide Committees members an opportunity to ask questions of the speakers.

Ferguson said he would like to finalize the draft agenda during the Coordinating Committees meeting on May 24, 2016. Jim Craig asked if there will be a section addressing what tag technology will be available to conduct subyearling Chinook salmon studies. Ferguson said Liedtke will address that topic. Ferguson added that the planning subgroup chose not to invite vendors to avoid sales pitches; however, Liedtke plans to discuss what is working and what is not, as well as other various hardware questions.

Ferguson noted that some speakers still need to be finalized, including WDFW speakers for the Mid-Columbia Basin section. Jeff Korth said he spoke with Andrew Murdoch about presenting for that item. Craig said USFWS is coordinating with Peter Graf (Grant PUD) about who will present Entiat River PIT-tagging efforts and will provide that name when it is available. Kirk Truscott said Casey Baldwin (CCT) will contact Tom Kahler to coordinate information on subyearling Chinook salmon upstream of Wells Dam. Kahler said he also plans to schedule a meeting with the CCT, WDFW, Grant PUD, Douglas PUD, and USFWS to confirm information is not being duplicated or overlooked. Ferguson also noted that Skalski was originally only available for the first hour, but now will be available all day.

B. Next Meetings

Jim Craig noted that the PRCC's meeting in May 2016 will be held in Eastern Washington. Lance Keller said he will be in Oregon; however, can attend an in-person meeting if needed. He said Chelan PUD will also agree to a conference call. Tom Kahler said Douglas PUD will likely have a light agenda. Scott Carlon said he will not be present for the Coordinating Committees meeting on May 24, 2016.

The next scheduled Coordinating Committees meeting is on May 24, 2016, to be held by conference call. The 2016 Subyearling Chinook Salmon Workshop will be held June 21, 2016, at the Red Lion Hotel in SeaTac, Washington, and the regularly scheduled Coordinating Committees meeting will be held June 22, 2016, at the usual Radisson Hotel location. The July 26, 2016, meeting will be held by conference call, or in-person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam in 2016
Attachment C	Revision to CRITFC's Annual Request to Tag Sockeye Salmon at Wells Dam In 2016

Attachment D	Request from Charles Frady to Conduct Real Time Trapping at the Wells Dam West Fish Ladder during the second half of May 2016
Attachment E	Proposal to Close OGs in the Rocky Reach Dam Fishway during the Late Summer and Fall of 2016
Attachment F	Photograph of Rocky Reach OG Structure
Attachment G	Photograph of Rocky Reach OG Structure Close-up

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood†††	Chelan PUD
Chris Nystrom††	Chelan PUD
Thad Mosey††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Bob Rose*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Coordinating Committees member or alternate
† Joined for the HCP Tributary and Hatchery Committees Update
†† Joined for the Proposed Rocky Reach Orifice Gate Closure
††† Joined for the Pacific Lamprey Passage at Tumwater

Attachment B

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
700 NE Multnomah Street, Suite 1200
Portland, Oregon 97232

(503) 238-0667
F (503) 235-4228
www.critfc.org

March 22, 2016

Tom Kahler
Fisheries Biologist
Public Utility District #1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, WA 98801

Dear Mr. Kahler:

Since 1995, the Columbia River Inter-Tribal Fish Commission (CRITFC) has conducted a scientific study near Wells Dam. The project is currently funded by Bonneville Power Administration, and is entitled, "Studies into Factors Limiting the Abundance of Okanagan and Wenatchee Sockeye Salmon". CRITFC requests permission to access and conduct sampling activities at Wells Dam.

The purpose of this study is to determine the effect of temperature on the survival of sockeye salmon returning to their spawning grounds in the Okanagan Basin. It is anticipated that a maximum of 800 sockeye will be sampled for scales, genetics samples, and tagged with PIT and Floy tags. We do not plan to do any acoustic tagging of sockeye in 2016. The sampling activity will take place daily, Monday-Friday, from late June, 2016 through early August, 2016, and will be coordinated with the Wells Hatchery broodstock collection programs.

The sampling team will consist of three to five individuals from three separate organizations, they are as follows: Dr. Jeff Fryer of CRITFC; Kraig Mott, Casey Heemsah, Kory Kuhn, and Terri Benson of Confederated Tribes and Bands of the Yakama Nation; and Byron Sam, Brooklyn Hudson, and Darin Hathaway of the Confederated Tribes of the Colville Reservation.

Thank you for your consideration. If you have any questions or need further information, please contact Project Leader, Dr. Jeff Fryer at (503) 238-0667.

Sincerely,

Babtist P. Lumley

Babtist P. Lumley
Executive Director

NOTED
MAR 30 2016
MEM

From:	Kristi Geris
To:	Bob Rose (rosb@yakamafish-nsn.gov); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keller, Lance; kirk.truscott@colvilletribes.com; Korth, Jeff (DFW) (Jeff.Korth@dfw.wa.gov); Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc:	(Carmen.andonaegui@dfw.wa.gov); Aaron Beavers; Alene.Underwood@chelanpud.org; Bill Tweit; Dale Bambrick; Gallaher, Becky; Justin Yeager; Keith Truscott; "Mary Mayo"; Ritchie Graves; Shane Bickford (sbickford@dcpud.org); Steve Hemstrom (steven.hemstrom@chelanpud.org); Steve Parker; Verhey, Patrick M (DFW); "william_gale@fws.gov"
Subject:	FW: Revision to request for sockeye tagging
Date:	Friday, April 22, 2016 8:11:07 PM

Hi HCP-CC: please see the email below from Tom regarding CRITFC's request for sockeye tagging at Wells Dam, to be further discussed at next week's CC 4/26 conference call. Thanks! –kristi ☺

Kristi Geris

ANCHOR QEA, LLC

kgeris@anchorqea.com

T 509.491.3151 x104

C 360.220.3988

From: Tom Kahler [mailto:tomk@dcpud.org]
Sent: Friday, April 22, 2016 3:32 PM
To: Kristi Geris <kgeris@anchorqea.com>
Cc: John Ferguson <jferguson@anchorqea.com>
Subject: Revision to request for sockeye tagging

Hi Kristi,

Jeff Fryer, CRITFC, requests to tag some late-season sockeye at Wells in addition to the 800 requested via the official letter from CRITFC (B. P. Lumley, 22 March) that we circulated earlier. He doesn't expect to get more than 50 additional fish, but has requested up to 200. Please circulate to the CC, and we'll discuss this along with the original request on the call next week.

Thanks,

Tom

See Jeff's request below:

HI Tom,

In 2015, it was observed that more adult sockeye than usual were observed moving upstream through the fish ladders late in the migration at mid-Columbia River dams. Given the warm water temperatures in 2015, finding a good holding location downstream and migrating upstream after waters cool would seem a plausible survival strategy for sockeye salmon that may become more important in the future. This assumes that these fish actually do successfully make it to the spawning grounds.

There are too few sockeye migrating after early August to justify a sampling effort such as we conduct annually from late June to early August at Wells Dam. My proposal is to give PIT tags and sampling supplies to the WDFW steelhead crew operating the trap so that they could sample any sockeye that they encounter. I have talked with Charlie Snow and he does not see any problem with doing this. We could then track these sockeye upstream to see if they do successfully make it to our OKC site immediately downstream of the Okanagan sockeye spawning grounds. I propose tagging up to 200 late migrating sockeye salmon, though actual numbers tagged are likely to be much smaller.

Please let me know if you have any questions or need any additional information.

Jeff

From: Kristi Geris
To: Bob Rose (rosb@yakamafish-nsn.gov); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keller, Lance; kirk.truscott@colvilletribes.com; Korth, Jeff (DFW) (Jeff.Korth@dfw.wa.gov); Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc: (Carmen.andonaegui@dfw.wa.gov); Aaron Beavers; Alene.Underwood@chelanpud.org; Bill Tweit; Dale Bambrick; Gallaher, Becky; Justin Yeager; Keith Truscott; "Mary Mayo"; Ritchie Graves; Shane Bickford (sbickford@dcpud.org); Steve Hemstrom (steven.hemstrom@chelanpud.org); Steve Parker; Verhey, Patrick M (DFW); "william_gale@fws.gov"
Subject: FW: proposed Wells Dam West Ladder trapping
Date: Tuesday, April 26, 2016 11:01:45 AM

Hi HCP-CC: please see email below from Tom re: proposed Wells Dam West Ladder trapping. Thanks! –kristi ☺

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com
T 509.491.3151 x104
C 360.220.3988

From: Tom Kahler [mailto:tomk@dcpud.org]
Sent: Tuesday, April 26, 2016 11:00 AM
To: Kristi Geris <kgeris@anchorqea.com>
Subject: FW: proposed Wells Dam West Ladder trapping

Hi Kristi,

Please circulate to the CC.

Thanks,

Tom

From: Frady, Charles H (DFW) [mailto:Charles.Frady@dfw.wa.gov]
Sent: Friday, April 22, 2016 1:10 PM
To: Tom Kahler
Subject: proposed Wells Dam West Ladder trapping

Hi Tom,

Here is what we are proposing on the West Ladder the second half of May during the construction shutdown:

- Trap fish in real time at the West Ladder trap
- Incidental species can be released immediately into the West Ladder upstream of the gate
- Collect one spring Chinook at a time in the chute, transport via boot ~20 feet to West Ladder pad
- Sampling occurs similar to East Ladder sampling (on pad)

- Potential NO broodstock are retained and held in Steelhead Shed pending scale and DNA analysis
  and subsequent transfer to Methow Hatchery
- All non-broodstock fish are recovered in fresh water prior to being released back in West Ladder
  upstream of gate
- Real-time sampling and release will decrease delay in the run

Please let me know if you have any questions.

Thanks Tom.

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Proposal from Chelan County PUD to close orifice gates in the Rocky Reach fishway during the late summer and fall of 2016

For at least 20 years, Rocky Reach Dam has operated six out of the twenty two orifice gates (OGs) across the downstream face of the powerhouse in addition to three main entrances (one at each end of the powerhouse and one in the middle of the spillway) for adult fish passage. Three OGs have been and are operated on the north end of the powerhouse (OG numbers 1, 2, and 3) near the left powerhouse entrance (LPE), and three have been and are operated on the south end of the powerhouse (OG numbers 16, 18, and 20) near the right powerhouse entrance (RPE). The only exception occurred from 1995 through 2002 when OG 14 was operated in place of OG 18, because the outflow pipe for the prototype Juvenile Fish Bypass System was routed through the OG 18 slot. The operation of these gates has been documented in the annual fishway inspection reports back to 1998 which are posted on the Fish Passage Center (FPC) website.

Photo 1. OG slots as viewed from the Rocky Reach Juvenile Sampling Facility

The OGs and RPE lead fish into a collection channel. The RPE is on the extreme downstream end of the channel. The channel meets up with a trifurcation pool at its extreme upstream end (near OGs 1, 2 and 3).

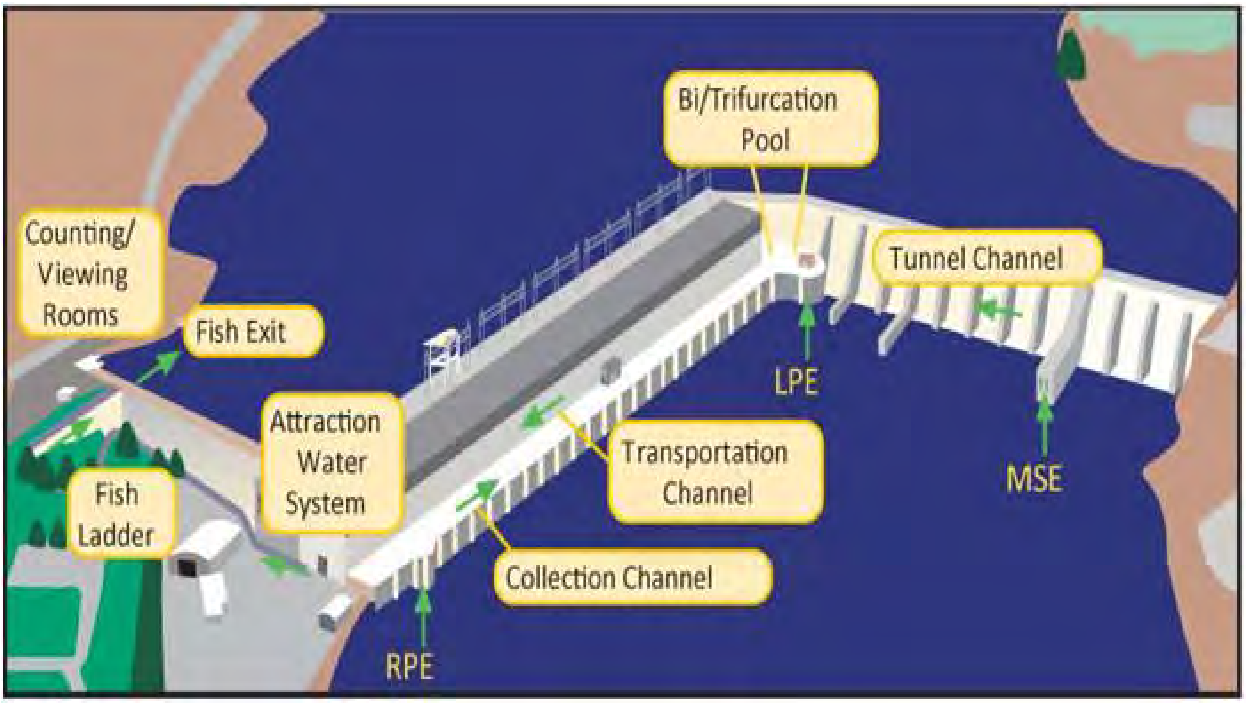

Photo 2. Rocky Reach Fishway Overview

The RPE has two vertical entrance slots which are three feet in width. Immediately inside of these openings are two pairs of rotary gates. The purpose of the gates in the original fishway and attraction water system (AWS) design was to provide velocity regulation of attraction water discharged through the entrances. Depending on tailwater elevation, the angle position of the rotary gates provided the means by which the required one foot differential was maintained between the fishway channel elevation and tailwater elevation. In 1971, Chelan County PUD and the fisheries agencies reached an agreement to permanently position the rotary gates to maintain at least a three foot opening. This change in gate operation removed any regulation capability at the entrance and resulted in two fixed-width vertical openings.

The designed flow requirement for each OG is 64 cfs. The total (constant) flow requirement for all six OGs is 384 cfs. When tailwater elevations are higher in the spring, a larger AWS flow is required to keep a one foot differential at the three main entrances. The flow directed down the collection channel is sufficient to provide 384 cfs for the OGs and still deliver enough water to the RPE to maintain a one foot differential. The difficulty in maintaining the required one foot differential occurs during low tailwater elevations in late summer and fall, when tailwater elevations decline with declining river flows. Less AWS water is required to maintain the differential at the fishway entrances. However, the flow requirement at the OGs remains at 384 cfs. At low tailwater elevations, the flow that remains for the RPE, after flow for the OGs is removed, is insufficient to reach a one foot differential.

The only three options which the fishway attendants have to compensate for this lack of water at the RPE are 1) restrict flow through the rotary gates at the RPE; 2) restrict flow to the LPE and middle spillway entrance (MSE) using wing gates located at the upstream end of the LPE channel and upstream end of the tunnel leading to the MSE; or 3) provide additional water through sluice gates in diffuser chambers along the collection channel. Option 1 is obviously not realistic, since operation of the rotary gates has been restricted. If the District could operate the gates as designed, the one foot differential could be easily achieved. With regard to option 2, the wing gates are located just downstream of the trifurcation pool which is the junction point for the LPE channel, MSE tunnel and the collection channel. By partially closing the wing gates (angled approximately 40 degrees from the fishway wall), the elevation of the trifurcation pool is increased, and the extra water in the pool is shunted down the collection channel. The possible adverse effect of option 2 is altering hydraulics in the trifurcation pool, e.g. slowing water velocity through the pool. With regard to option 3, the possible adverse effect is slowing down the water velocity through the collection channel due to the upwell of water from individual diffusion chambers located along the entire length of the channel.

To resolve the issue of insufficient flow at the RPE during low tailwater elevations, the Chelan County PUD (District) proposes to close the six orifice gates in the collection channel and evaluate the redistribution of flow to the RPE. We would rely solely on fish passage through the three main entrances. The additional 384 cfs of flow supplied to the RPE should allow the District to meet the one foot differential without altering fishway operations at the trifurcation pool or in the collection channel. While the OGs are closed, the District would monitor daily fish counts at Rocky Reach Dam and compare them with daily counts at Wanapum Dam in addition to daily historical counts for Rocky Reach Dam during the same time period. As soon as the District noticed any unusual deviation from current or historical counts, we would immediately re-open all six OGs.

Between 2000 and 2002, The Dalles, Lower Monumental, Little Goose, Priest Rapids, and Wanapum dams were allowed to close their fishway OGs. Larry Basham (FPC) reported in annual fishway reports between 2000 and 2004 that the closure of OGs at these projects did not adversely affect fish passage or result in delays. In the 2000 annual fishway inspection report, Larry reported that “the increased velocity along the powerhouse collection channel was far superior to all previous years with the closure of the OGs in 2000. Visually, flow through the channel without the OGs should have provided adult fish improved opportunity to move from the collection channel to the junction pool section with the new modification to operations at The Dalles Dam.” He also noted that “with the closure of the OGs as the Dalles, velocity through the collection channel is now within the desired range.” In the 2001 report, he reported that “OGs along the collection channel (Wanapum Dam) were closed from the July inspection through the end of the season and may have contributed to improved water velocity readings recorded this season.” In the 2003 and 2004 reports, Larry reported that “OGs along the channel (Wanapum Dam) have remained sealed since summer 2001 and this action contributes to the excellent water velocity readings recorded again this season.”

If agreeable with the Habitat Conservation Plan Coordinating Committee (HCPCC), the District would appreciate the opportunity to move forward with the closed OG proposal in early August 2016. If the evaluation of adult fish passage in-season and post-season shows no deleterious effect, we kindly request the HCPCC’s agreement to leave the OGs closed throughout 2017, while continuing to monitor fish passage using daily fish counts.

References

Bair, S.H. 1982. Operation manual: Upstream migrant fish passage facilities – Rocky Reach Project. Report prepared by Consulting Hydro-Civil Engineer for Public Utility District No. 1 of Chelan County. 53 p. + appendices.

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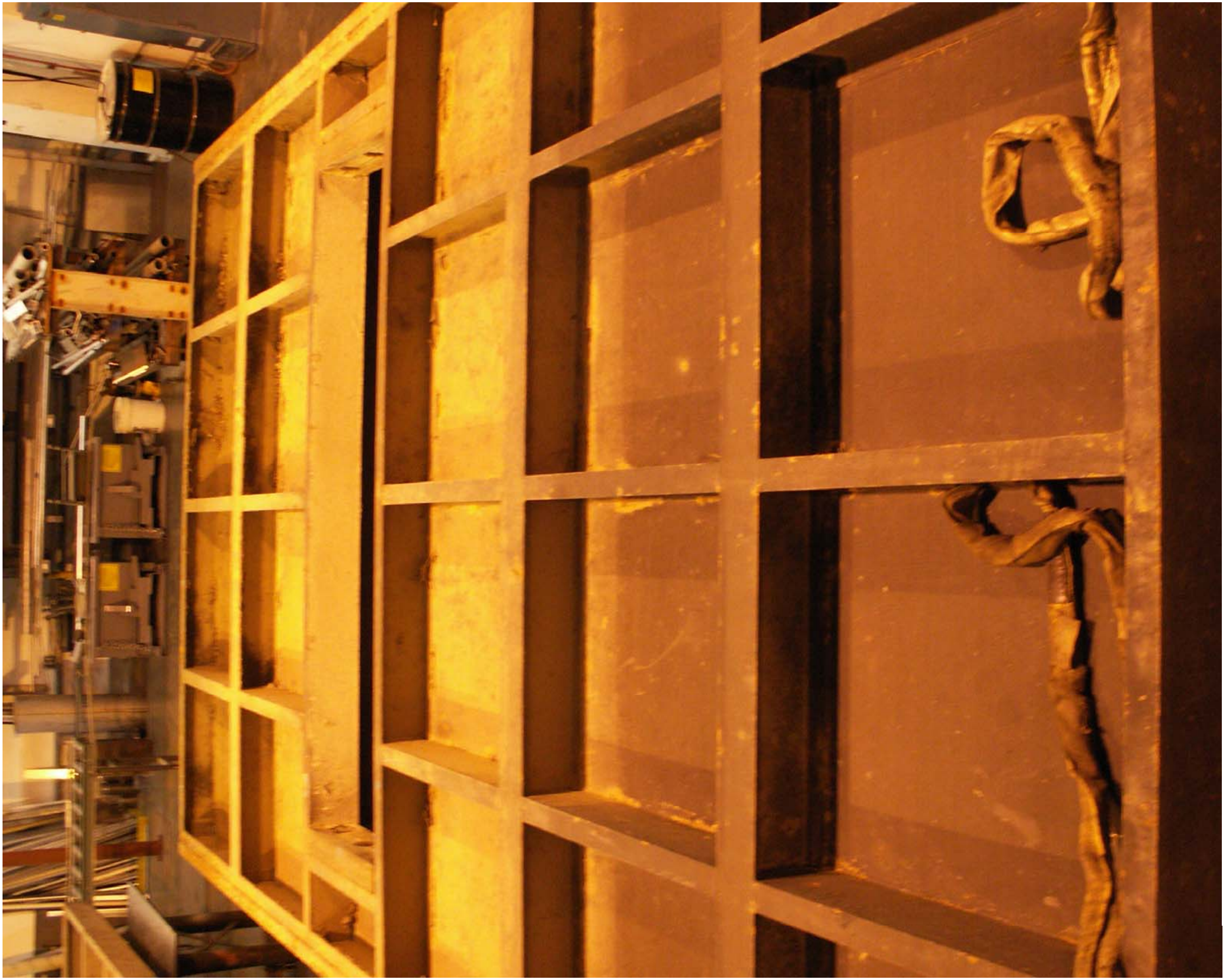

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	June 22, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the May 24, 2016, HCP Coordinating Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday May 24, 2016, from 9:30 to 10:45 a.m. Attendees are listed in Attachment A to these conference call minutes.

ACTION ITEM SUMMARY

- Tracy Hillman will present an overview of the National Oceanic and Atmospheric Administration's (NOAA's) Salmon Population Summary (SPS) database following the Coordinating Committees meeting on July 26, 2016 (Item II-A).
- Jeff Korth will provide project documents regarding Trout Unlimited's Leavenworth Diversion Screening Project to Kristi Geris for distribution to the Coordinating Committees (Item II-A). *(Note: Korth provided these documents following the meeting on May 24, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item IV-A).
- Chelan PUD will provide a summary of historical radio telemetry data demonstrating use of the orifice gates (OGs) at Rocky Reach Dam for adult fish passage (Item IV-C). *(Note: Lance Keller provided this summary following the meeting on May 24, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)*
- Chelan PUD will provide details regarding the logistics and mechanics of the proposed closure of the OGs at Rocky Reach Dam (Item IV-C). *(Note: Lance Keller provided these details on June 17, 2016, which Kristi Geris distributed to the*

Coordinating Committees that same day.)

- Chelan PUD will provide the Draft 2015 Rock Island Juvenile Fish Bypass Report for Coordinating Committees review (Item IV-D). *(Note: Lance Keller provided the draft report on May 25, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)*
- Anchor QEA will finalize and distribute the agenda for the 2016 Subyearling Chinook Salmon Workshop (Item V-A). *(Note: Kristi Geris distributed the final workshop agenda to the Coordinating Committees on June 16, 2016.)*
- Coordinating Committees representatives will provide to Kristi Geris a list of attendees to the 2016 Subyearling Chinook Salmon Workshop, as those lists are finalized (Item V-A).
- **The 2016 Subyearling Chinook Salmon Workshop on June 21, 2016, will be held in-person at the Red Lion Hotel in SeaTac, Washington (Item V-B).**
- **The Coordinating Committees meeting on June 22, 2016, will be held in-person at the Radisson Hotel in SeaTac, Washington (Item V-B).**

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

- Kristi Geris sent an email to the Coordinating Committees on May 18, 2016, notifying them that the Draft 2015 Rocky Reach Juvenile Fish Bypass System Report is available for a 30-day review, with edits and comments due to Lance Keller by Thursday, June 16, 2016 (Item IV-D).
- Kristi Geris sent an email to the Coordinating Committees on May 25, 2016, notifying them that the Draft 2015 Rock Island Juvenile Fish Bypass System Report is available for a 30-day review, with edits and comments due to Lance Keller by Friday, June 24, 2016 (Item IV-D).

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

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

- Tom Kahler added updates on: 1) trapping at Wells Dam; and 2) Wells Dam bypass passive integrated transponder (PIT)-tag detection system.
- Lance Keller added a notice to the Federal Energy Regulatory Commission (FERC) to cancel installation of microturbines at Rocky Reach and Rock Island dams.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft April 26, 2016, conference call minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. She said she also added the Draft 2015 Rocky Reach Juvenile Fish Bypass System Report under the review items. Coordinating Committees members present approved the April 26, 2016, conference call minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on April 26, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on April 26, 2016):*

- *John Ferguson will communicate developing details about the 2016 Subyearling Chinook Salmon Workshop to the Coordinating Committees during the monthly Coordinating Committees meetings (Item I-C).*
  This will be discussed during today's conference call.
- *Lance Keller will provide the schedule for repairing Rock Island Dam Powerhouse 1 Unit B2 to Kristi Geris for distribution to the Coordinating Committees (Item I-C).*
  This will be discussed during today's conference call.
- *Tom Kahler will discuss with Jeff Fryer (Columbia River Inter-Tribal Fish*

Commission [CRITFC]) the Coordinating Committees' contingencies for approving CRITFC's annual request to tag sockeye salmon at Wells Dam in 2016, including: 1) using AQUI-S to anesthetize any fish and tagged in excess of the 800 specified in the CRITFC request letter, and tagging no more than 1,000 fish throughout the entire run; or 2) using MS-222 to anesthetize the fish and tagging no more than 800 fish throughout the entire run (Item III-A).
Kahler discussed this with Fryer, as requested, and the Wells Coordinating Committee approved the request, as memorialized in last month's meeting minutes.

- *Chelan PUD will provide a summary of discussions held in the early-2000s regarding a request to close orifice gates (OGs) at Rocky Reach Dam, including historical radio telemetry data demonstrating use of the OGs for adult fish passage (Item IV-A).*
  This will be discussed during today's conference call.
- *Chelan PUD will provide the Draft 2015 Rocky Reach and Rock Island Juvenile Fish Bypass Reports for Coordinating Committees review by Friday, April 29, 2016 (Item IV B).*
  Lance Keller provided the Draft 2015 Rocky Reach Juvenile Fish Bypass Report to Kristi Geris on May 17, 2016, which Geris distributed to the Coordinating Committees on May 18, 2016. This will be further discussed during today's conference call.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on May 18, 2016:

- *U.S. Fish and Wildlife Service (USFWS) Bull Trout Consultation Update:* USFWS is currently working on the Wenatchee River Spring Chinook Salmon, Steelhead, and Summer Chinook Salmon programs. Comments were received from permit applicants, and USFWS is now incorporating those comments into the final draft permits. Regarding the Methow Spring Chinook Salmon Program consultation, USFWS is still working on the technical assistance letter stating that the existing 2012 Biological Opinion (BiOp) for the Wells Project license provides sufficient language for the program.

- *National Marine Fisheries Service (NMFS) Consultation Update:* The Wenatchee River Steelhead BiOp is almost complete. Progress is also being made on the Methow Spring Chinook Salmon BiOp. NMFS is drafting an Environmental Assessment to complete the National Environmental Policy Act process. NMFS is also working on gene-flow guidelines for Methow River steelhead.
- *Chelan Falls Summer Chinook Salmon Broodstock Collection:* Chelan, Douglas, and Grant PUDs are discussing different methods for collecting summer Chinook salmon broodstock for the Chelan Falls Program at Wells Hatchery.
- *Straying and Homing Fidelity Vernacular:* Chelan PUD expressed frustration with the inconsistency of how "straying" and "homing" are defined. The term "straying" is typically used to address genetic straying; however, it is also used to describe behavioral straying. Chelan and Douglas PUDs are working together to develop clear definitions of the terms to help keep HCP documents and permits clear and consistent. Hillman also introduced a new tool to interpret data contained in the NOAA SPS database. He suggested the tool will be helpful when drafting the 5-Year Hatchery Monitoring and Evaluation reports. He said the tool was developed with the Bonneville Power Administration as part of the Federal Columbia River Power System BiOp. He said the purpose of the tool is to process data from the NOAA SPS database and provide outputs in easily interpreted formats regarding population age structure, status, and trends. He further explained that the NOAA SPS database is simply a huge spreadsheet, and through this tool, the user can request certain data, and the tool can generate plots and show correlations so the user does not need to do this manually. He said the tool was mainly structured for managers, and added that he will provide a presentation on the NOAA SPS database and application of the tool to the HCP Hatchery Committees during their next meeting on June 15, 2016.
  John Ferguson asked about the location of the database and who maintains it. Hillman said Rich Hinrichsen (Hinrichsen Environmental Services) maintains the database, and there is a web address to access the database; however, Hillman plans to provide that link after the presentation. Hillman said he obtained permission to share the tool; however, it still needs minor tweaking. He offered to provide a presentation of the database and tool to the Coordination Committees, and some members expressed interest. Jeff Korth suggested providing the presentation at the end of a

monthly meeting, so those interested can stick around, and those not interested in it may leave. Ferguson also suggested holding the presentation following the meeting in July 2016, because the June 2016 meeting will be followed directly by the Priest Rapids Coordinating Committee meeting. Hillman agreed to present an overview of the NOAA SPS database following the Coordinating Committees meeting on July 26, 2016.

- *HETT Update:* The HCP Hatchery Committees will review Appendices 2 through 6 during the next HCP Hatchery Committees meeting on June 15, 2016.
- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on June 15, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Tributary Committees meeting on May 12, 2016:

- *General Salmon Habitat Program Draft Proposals:* The HCP Tributary Committees received 14 draft proposals, all of which are cost shares with the Salmon Recovery Funding Board. The HCP Tributary Committees reviewed and identified eight projects that did not warrant a full proposal, because they were inconsistent with the intent of the Tributary Fund, did not have strong technical merit, or had low benefits per cost. Full proposals were solicited from the remaining six projects, which are due on Friday, July 1, 2016. The proposed projects are located in the Okanogan, Methow, and Wenatchee river basins. No projects are located in the Entiat River Basin.
- *General Salmon Habitat Program Application:* Trout Unlimited submitted an application titled, Leavenworth Diversion Screening Project. The purpose of the project is to install a NMFS-compliant fish screen on the City of Leavenworth Icicle Creek Diversion to prevent salmonid entrainment. The diversion is located at river mile 5.7 on Icicle Creek upstream from the Boulder Field. The total cost of the project is about $162,000, of which the sponsor requested about $130,000 and the remaining cost share will be covered by the fish screen vendor. The HCP Tributary Committees were unable to make a funding decision, because they were surprised that the City of Leavenworth was not contributing financially to the project. The HCP Tributary Committees asked the sponsor to seek some level of funding (match) from the City, and recommended that the City contribute up to about 25% of the

total cost. The HCP Tributary Committees sent Trout Unlimited a letter with this request and will revisit the proposal after the sponsor responds. The HCP Tributary Committees were in favor of the proposed project, but are hoping the City will contribute to the cost share. Ferguson asked how this project is applicable to the HCP Tributary Committees. He said it seems more like a bioengineering project instead of a tributary or habitat production project. Hillman said the HCP Tributary Committees have funded screening projects in the past and these projects improve freshwater survival by reducing entrainment. He said fish passage will be provided at the boulder field. Bob Rose asked if the plans are available for the proposed fish passage structure at the boulder field. Hillman said he believes the plans are mostly developed, and construction is scheduled to start soon. Tom Kahler said he also recalled seeing some plans; however, he was not sure what stage of development they were in. He also said he believes the project is permit-ready; however, he is unsure of the start date. He recalled, for some reason, the start date was pushed back 1 year. Hillman said, at one point the County raised concerns with the project, which may have delayed the start date; however, everything is now moving forward. Rose asked who is discussing this process. Jim Craig said this project is being vetted within the Icicle Workgroup, and Korth said the project is also being vetted within a subcommittee of the Icicle Workgroup. Korth said he has the project documents, which include three options. He said he believes Option 1 is being implemented. He said he will provide project documents regarding Trout Unlimited's Boulder Field Passage Project to Kristi Geris for distribution to the Coordinating Committees. *(Note: Korth provided these documents following the meeting on May 24, 2016, which Geris distributed to the Coordinating Committees that same day.)*

- *Time Extension:* The Rocky Reach HCP Tributary Committee received a time extension request from Chelan-Douglas Land Trust on the Entiat Stillwaters Gray Reach Acquisition Project. The sponsor indicated they are still negotiating with two property owners and requested to extend the period of the project to March 31, 2017. The Rocky Reach HCP Tributary Committee approved the time extension.
- *Next Steps:* The HCP Tributary Committees' next scheduled meeting will be on June 9, 2016.

III. Douglas PUD

A. Trapping at Wells Dam (Tom Kahler)

Tom Kahler said the contractor constructing the new Adult Handling Facility as part of the Wells Hatchery Modernization scheduled an arbitrary date to disconnect and reconnect the pipeline from the west fish ladder to the new facility. Kahler said Douglas PUD requested that the contractor not disconnect the pipe any earlier than necessary. He said the contractor was amenable to this request and will execute the process at the last possible moment. He added that disconnecting and reconnecting the pipe is not a lengthy process. He said trapping at the west fish ladder has experienced only a brief hiatus when the contractor had proposed to disconnect and reconnect the pipe, but normal trapping resumed when it was determined that the cessation for trapping was not necessary since the contractor was not ready to implement that action. He said trapping is back to its normal configuration, and everything is functioning routinely. He said the modernization is still on schedule and commissioning of the new Adult Handling Facility is scheduled for June 1, 2016.

B. Wells Dam Bypass PIT-tag Detection System (Tom Kahler)

Tom Kahler said the new PIT-tag antennas installed in the top frame section of Bypass Bay 2 are operational with a temporary cable configuration. He recalled the issue with installation of the proper conduit run below the intake deck. He said installation of the conduit will be completed this week, and the readers will be momentarily disconnected in order to pull the cables through the conduit and reconnect to the master controller.

Kahler said the sampler began sampling on April 27, 2016, and to date has had 45 detections. He said, during part of that time, the reservoir was low and the antennas were out of the water; therefore, there was a gap in the capability of the readers to detect tags. He said detections include a few Winthrop Fish Hatchery steelhead, several coho salmon, and a number of orphan tags from tag files that still need to be downloaded.

IV. Chelan PUD

A. Rock Island Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller recalled that Chelan PUD identified issues with the turbine blades on

Rock Island Dam Powerhouse 1 Unit B2. He said Rock Island Dam Powerhouse 1 Units B1, B3, and B4 are similar to Unit B2, and an initial analysis of the turbine blades on Units B1, B3, and B4 showed the same signs of metal fatigue that were identified on Unit B2. He said Chelan PUD took all units out of service for further analysis to determine the severity of the fatigue; however, to his knowledge, the results have not yet been released. He said an internal meeting to discuss the status of the metal in the turbine blades keeps getting postponed. He suggested that this be a revolving agenda item, and said that Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting. He also noted that the work on Unit B2 will not affect the rehabilitation schedule for Units B5 to B8 (described during the Coordinating Committees meeting on October 27, 2015).

B. Rocky Reach Large Turbine Unit Maintenance Update (Lance Keller)

Lance Keller recalled, during the Coordinating Committees meeting on January 28, 2014, Chelan PUD provided a maintenance update on the Rocky Reach large turbine units. He recalled, as described in a fact sheet distributed to the Coordinating Committees by Kristi Geris on January 24, 2014, Chelan PUD's plan to bring the Kaplan units back online one by one in a temporary, fixed blade, 31-degree position. He also recalled the servo rod repairs (stainless steel rod that delivers oil to the servo motor) in Units C8, C9, C10, and C11. He said Unit C8 was scheduled to be brought back online, but then head-cover issues were identified, so the unit remained offline. He said at the same time, cracks were identified in the wheels of the bridge crane required to hoist the turbines for repair. He said Chelan PUD intends to restore all four Kaplan units to service; however, this is largely dependent on fabrication and delivery of repair components. He said Rocky Reach engineers provided a new repair schedule for the Rocky Reach large turbine units, as follows:

Repair	Estimated Date
Bridge Crane	December 2017
Unit C8	May 2017
Unit C9	October 2018
Unit C10	December 2020
Unit C11	November 2019

Keller said the repair date for Unit C8 is largely driven by the issue with the bridge crane and head cover. He said repair of the bridge crane is being fast tracked internally, with an emergency declaration. He said these are the best repair date estimates available at this time.

C. Proposed Rocky Reach Orifice Gate Closure (Lance Keller)

Lance Keller recalled Chelan PUD's action item to provide a summary of discussions held in the early 2000s regarding a request to close OGs at Rocky Reach Dam. He recalled that these discussions took place when Chelan, Douglas, and Grant PUDs convened under one Mid-Columbia Coordinating Committee. He said upon his review, the discussions in question were all regarding OGs at Grant PUD projects, and there was no mention of OGs at Rocky Reach Dam.

Bob Rose said he recalled the decision was made to close the OGs at Grant PUD projects. Keller said that is correct; all Grant PUD project OGs were closed in the early 2000s and remain closed to date. Rose asked if the concern at that time was whether fish would migrate in and out of the gates, and Keller said that is correct. Rose said he recalled the Mid-Columbia Coordinating Committee concluded it was better to close the OGs than to let fish fall out of the gates. Keller said that is also Chelan PUD's interpretation of the discussions. He said the ultimate conclusion was that closing additional entrances and improving entrance velocities by holding an appropriate head differential will have an overall positive benefit compared to leaving those entrances open.

Keller recalled another Chelan PUD action item to provide a summary of historical radio telemetry data demonstrating use of the OGs at Rocky Reach Dam for adult fish passage. He said Thad Mosey (Chelan PUD Biologist and Spill Coordinator) already provided this summary, and Keller will provide it for distribution following the conference call. Keller said Mosey copied verbatim graphs and summary conclusions from applicable studies. Keller said analyses include adult spring, summer, and fall Chinook salmon use of the gates. He said the data summarize net entrance per fish, per species, and per orifice, among other things. He encouraged Coordinating Committees members to review the summary and noted that he or Mosey will gladly review the results with members, as requested. *(Note: Keller provided this summary following the meeting on May 24, 2016, which Kristi Geris distributed to the*

Coordinating Committees that same day.)

Bob Rose asked if Pacific lamprey are included in the analyses. Keller said there are Pacific lamprey data associated with the 2004 analyses, which are included in the summary. He said Chelan PUD also discussed closing the OGs at Rocky Reach Dam during the last Rocky Reach Fish Forum (RRFF) meeting, and members asked Chelan PUD to coordinate with the Rocky Reach HCP Coordinating Committee to address any concerns.

John Ferguson asked about timing for the proposed implementation date. Keller said, if the Rocky Reach HCP Coordinating Committee approves closing the OGs at Rocky Reach Dam, Chelan PUD plans to implement the proposal in mid- to late-August 2016. He said Chelan PUD is looking forward to a healthy discussion regarding this topic during next month's in-person Coordinating Committees meeting on June 22, 2016, and is open to voting during that time. He said, however, a vote can also wait until the meeting in July 2016. He said Chelan PUD will provide a draft Statement of Agreement to discuss in June 2016, in case members are ready to vote at that time.

Rose asked about the logistics and mechanics of the proposed OG closures at Rocky Reach Dam. Keller recalled photos of the OGs, which were distributed to the Coordinating Committees by Geris on April 26, 2016. Keller said it is his understanding the closure is fairly easy; however, he said he can provide further details for distribution regarding the logistics and mechanics of the proposed closure of the OGs at Rocky Reach Dam. *(Note: Keller provided these details on June 17, 2016, which Geris distributed to the Coordinating Committees that same day.)*

D. Draft 2015 Rocky Reach and Rock Island Juvenile Fish Bypass Reports (Lance Keller)
Lance Keller said Kristi Geris sent an email to the Coordinating Committees on May 18, 2016, notifying them that the Draft 2015 Rocky Reach Juvenile Fish Bypass System Report is available for a 30-day review, with edits and comments due to Keller by Thursday, June 16, 2016. Keller said the Draft 2015 Rock Island Juvenile Fish Bypass Report will be distributed soon. *(Note: Keller provided the draft Rock Island report on May 25, 2016, which Geris distributed to the Coordinating Committees that same day.)*

E. Notice to FERC to Cancel Installation of Microturbines at Rocky Reach and Rock Island Dams (Lance Keller)

Lance Keller said, in response to the 2000-2001 Western U.S. Energy Crisis, FERC issued a FERC Order on March 14, 2001, requesting that licensees increase generation at their respective projects. Keller said Chelan PUD developed a conceptual plan to deploy microturbines in the fishways to increase generation capacity. He said the plan was submitted on May 1, 2001, and FERC approved the plan on March 14, 2002. He said, however, subsequent analyses showed that upgrading the existing turbines to increase their efficiency would provide a greater increase in generation than installing the new microturbines; therefore, the new microturbines were never installed. He said Chelan PUD plans to provide a letter to FERC by mid-June 2016, canceling installation of the microturbines. He added that Chelan PUD will also notify the RRFF during the meeting in June 2016.

V. HCP Administration

A. 2016 Subyearling Chinook Salmon Workshop

John Ferguson said no comments were received on the draft workshop agenda, and Anchor QEA will finalize and distribute the final agenda for the 2016 Subyearling Chinook Salmon Workshop. Ferguson said he received an email from Jeff Korth indicating that Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will provide a presentation on scale data, and Mike Tonseth (WDFW) will be the third WDFW representative to attend the workshop. Ferguson said Marty Leidtke (U.S. Geological Survey) did not want to focus on tag technology; however, Curt Dotson (Grant PUD) said he can present on that. Ferguson said he still needs to coordinate with Tom Kahler regarding presenters and presentation titles for Session 4, and also touch base with Billy Connor (U.S. Fish and Wildlife Service) and John Skalski (Columbia Basin Research). *(Note: Kristi Geris distributed the final workshop agenda to the Coordinating Committees on June 16, 2016.)*

Kahler said Douglas PUD convened an internal call, and all presenters are now identified; however, the order of presenting still needs to be decided. Lance Keller said Chelan PUD is still pulling together data, and he plans to coordinate with Peter Graf (Grant PUD) to verify there is no overlap in presentation materials. Bob Rose asked if each entity is allowed three attendees, and Ferguson said that is correct. Ferguson asked that Coordinating Committees representatives provide to Geris a list of attendees to the 2016 Subyearling Chinook Salmon Workshop, when those lists are finalized.

B. Next Meetings

The 2016 Subyearling Chinook Salmon Workshop will be held June 21, 2016, at the Red Lion Hotel in SeaTac, Washington, and the regularly scheduled Coordinating Committees meeting will be held June 22, 2016, at the usual Radisson Hotel location.

The July 26 and August 23, 2016, meetings will be held by conference call, or in-person at the Radisson Hotel in SeaTac, 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
Alene Underwood††	Chelan PUD
Tom Kahler*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Bob Rose*	Yakama Nation

Notes:
* Denotes Coordinating Committees member or alternate
† Joined for the HCP Tributary and Hatchery Committees Update
†† Joined for the Chelan PUD agenda items

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	July 27, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the June 22, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel, in SeaTac, Washington, on Wednesday June 22, 2016, from 9:30 a.m. to 1:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Tracy Hillman will present an overview of the National Oceanic and Atmospheric Administration's (NOAA's) Salmon Population Summary (SPS) database following the Coordinating Committees meeting on July 26, 2016 (Item I-C).
- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).
- Anchor QEA, LLC, will inquire with Greg Fraser (U.S. Fish and Wildlife Service [USFWS]) his interest in sharing with the Coordinating Committees his presentation on Entiat River History and Impacts to Chinook Salmon, which Fraser recently presented to the HCP Hatchery Committees (Item II-A). *(Note: Fraser offered to provide this presentation during the Coordinating Committees meeting on August 23, 2016; Fraser's presentation will be distributed to the Coordinating Committees closer to that meeting date.)*
- Jeff Korth will provide a statement for Coordinating Committees review and approval regarding the Yakama Nation's (YN's) request concerning obtaining Chelan and Grant PUDs Methow spring Chinook salmon broodstock; the statement will be distributed by Friday, June 24, 2016, and a vote via email will be due Friday, July 1, 2016 (Item II-A). *(Note: Korth provided a Statement of Agreement [SOA] for*

approval on Friday, July 1, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)

- Chelan PUD will consult with Grant PUD regarding the process undertaken when completing turbine blade modernizations at Priest Rapids Dam (Item III-A).
- Chelan PUD will provide a summary regarding the Rock Island Powerhouse 1 Units B1 to B4 modernization outage through 2020, and what effects this may have on spill and overall generation capacity at the project (Item III-A).
- Scott Carlon will contact Bryan Nordlund (National Marine Fisheries Service [NMFS], retired) and Lance Keller will contact Grant PUD regarding any assessments conducted following the closure of the orifice gates (OGs) at Priest Rapids Dam (Item III-B).
- Chelan PUD will provide a draft SOA for the proposed Rocky Reach OG closure to Kristi Geris for distribution to the Coordinating Committees no later than 10 calendar days prior to the Coordinating Committees meeting on July 26, 2016; Chelan PUD will request approval of the SOA during the meeting on July 26, 2016 (Item III-B). *(Note: Keller provided the draft SOA to Geris on July 12, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- John Ferguson and Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) will further discuss logistics for quarterly, joint HCP/PRCC sessions convened to continue discussions regarding subyearling Chinook salmon passage studies (Item IV-A).
- **The Coordinating Committees meeting on July 26, 2016, will be held in-person at the Radisson Hotel in SeaTac, Washington (Item VI-A).**

DECISION SUMMARY

- There were no decisions approved during today's meeting.

AGREEMENTS

- The Coordinating Committees members present agreed to convene quarterly, joint HCP/PRCC sessions to continue discussions regarding subyearling Chinook salmon passage studies (Item IV-A).
- The Coordinating Committees members present agreed to move the monthly Coordinating Committees meetings from the Radisson Hotel in SeaTac, Washington,

to Wenatchee, Washington, starting with the Coordinating Committees meeting on October 25, 2016 (Item IV-A).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on May 25, 2016, notifying them that the Draft 2015 Rock Island Juvenile Fish Bypass System Report is available for a 30-day review, with edits and comments due to Lance Keller by Friday, June 24, 2016.
- Kristi Geris sent an email to the Coordinating Committees on July 1, 2016, notifying them that the Methow Spring Chinook Salmon Broodstock SOA is available for a 1-week review, with a vote via email due to Jeff Korth by Friday, July 8, 2016 (Item II-A).

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

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

- Jeff Korth added a request from the HCP Hatchery Committees for increased trapping for natural-origin Methow spring Chinook salmon broodstock. *(Note: This was discussed during the HCP Hatchery Committees Update, Broodstock Collection for Methow Programs.)*
- Ferguson added a meeting logistics discussion under the joint HCP/PRCC session.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft May 24, 2016, conference call minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. She said she also added follow-up dates on completed actions items. Coordinating Committees members present approved the

May 24, 2016, conference call minutes, as revised. NMFS abstained, because an NMFS representative was not present during the May 24, 2016, conference call.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on May 24, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on May 24, 2016):*

- *Tracy Hillman will present an overview of NOAA's SPS database following the Coordinating Committees meeting on July 26, 2016 (Item II-A).*
  This action item will be carried forward.
- *Jeff Korth will provide project documents regarding Trout Unlimited's Leavenworth Diversion Screening Project to Kristi Geris for distribution to the Coordinating Committees (Item II-A).*
  Korth provided these documents following the meeting on May 24, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item IV-A).*
  This will be discussed during today's meeting and will also be carried forward.
- *Chelan PUD will provide a summary of historical radio telemetry data demonstrating use of the orifice gates (OGs) at Rocky Reach Dam for adult fish passage (Item IV-C).*
  Lance Keller provided this summary following the meeting on May 24, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will provide details regarding the logistics and mechanics of the proposed closure of the OGs at Rocky Reach Dam (Item IV-C).*
  Lance Keller provided these details on June 17, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will provide the Draft 2015 Rock Island Juvenile Fish Bypass Report for Coordinating Committees review (Item IV-D).*
  Lance Keller provided the draft report on May 25, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.
- *Anchor QEA will finalize and distribute the agenda for the 2016 Subyearling Chinook Salmon Workshop (Item V-A).*

Kristi Geris distributed the final workshop agenda to the Coordinating Committees on June 16, 2016.

- *Coordinating Committees representatives will provide to Kristi Geris a list of attendees to the 2016 Subyearling Chinook Salmon Workshop, as those lists are finalized (Item V-A).*
  This action item was completed.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the last HCP Tributary Committees conference call on June 16, 2016.

- *Budget Amendment*: The Rocky Reach HCP Tributary Committee received a budget amendment request from Trout Unlimited on the Clear Creek Fish Passage and Instream Flow Enhancement Project, requesting to move $5,000 from "Contract Labor" to "Professional Services." The Rocky Reach HCP Tributary Committee approved the budget amendment. The total budget amount did not change as a result of this amendment.
- *General Salmon Habitat Program Application*: The HCP Tributary Committees reviewed an application received from Trout Unlimited titled, "Peshastin Mill Site Riverfront Preservation Project." The purpose of the project is to protect about 0.8 miles of streambank and 14 acres of riparian habitat along the Wenatchee River near the town of Peshastin, Washington. The total cost of the project is $463,000, and the sponsor requested $100,000 from HCP Tributary Funds. The HCP Tributary Committees declined the opportunity to fund the project because of limited biological benefit and minimal restoration opportunities because of the existing incised channel.
- *Next Steps*: The next meeting of the HCP Tributary Committees will be on July 14, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred at the last HCP Hatchery Committees meeting on June 15, 2016:

- *USFWS Bull Trout Consultation Update:* USFWS plans to circulate the revised draft

Wenatchee River Steelhead Biological Opinion (BiOp) by June 17, 2016.

- *NMFS Consultation Update:* The Methow Spring Chinook Salmon BiOp is currently under review, and the revised permits are currently available for comment until June 22, 2016. The Environmental Assessment is being drafted and is expected to be complete in July 2016. Regarding the Methow steelhead consultation, NMFS will be contacting permit applicants about gene flow soon.
- *Review Hatchery Monitoring and Evaluation (M&E) Plan Draft Appendices 2-6:* Most Hatchery M&E Plan appendices are now complete. The HCP Hatchery Committees approved Hatchery M&E Plan Appendix 2 (Hatchery Replacement Rates), Appendix 4 (Spatial Distribution of Spawners), and Appendix 6 (Rearing Targets). Draft Appendix 3 (Proportionate Natural Influence and Percent Hatchery Origin Spawner Targets and Sliding Scales) needs additions and will be reviewed during the HCP Hatchery Committees meeting on July 20, 2016. The HCP Hatchery Committees want to rewrite Draft Appendix 5 (Stray Rate Objectives), focusing on straying metrics, management, and definitions.
- *History of Entiat River Chinook Salmon:* Greg Fraser provided this presentation about the history of dams in the Entiat River Sub-basin and the extirpation of anadromous fish, specifically, the causes of the lack of summer and fall Chinook salmon. In the past, this was thought to be due to temperature; however, it was discovered there was a natural cascade near the mouth of the Entiat River. During higher flows, spring Chinook salmon could pass; however, during lower flows, summer/fall Chinook salmon could not pass. Also discussed was the occasional overlap of summer Chinook salmon redds on spring Chinook salmon redds in the sub-basin (in one reach there is about 60% superimposition). USFWS is continuing to monitor this. John Ferguson suggested Fraser provide this presentation to the Coordinating Committees, as well. Anchor QEA will inquire with Fraser his interest in sharing with the Coordinating Committees his presentation on Entiat River History and Impacts to Chinook Salmon. *(Note: Fraser offered to provide this presentation during the Coordinating Committees meeting on August 23, 2016; Fraser's presentation will be distributed to the Coordinating Committees closer to that meeting date.)*
- *Broodstock Collection for Methow Programs:* WDFW has collected 90 adult natural-origin recruit spring Chinook salmon, of which 60 can be used as broodstock

for the Methow Conservation Program. There is concern that not enough natural-origin fish will be collected to meet this year's target of 122 natural-origin fish because the spring Chinook salmon run timing at Wells Dam was compressed and is nearly finished. Most of the spring Chinook salmon passed Wells Dam in a 2-week period, and given trapping constraints, WDFW staff have not been able to collect the target number of broodstock. Therefore, the HCP Hatchery Committees are considering tangle-netting in the Chewuch River or Methow River to acquire natural-origin recruits for the Methow Conservation Program. Collecting the full complement of 122 fish will not exceed the permit conditions of 33% of the run size. There are sufficient natural-origin fish in the population; however, not enough have been collected at Wells Dam for the Methow Conservation Program. Most HCP Hatchery Committees representatives are supportive of tangle-netting, with conditions on the operation. For example, water temperatures cannot be so high where unacceptable mortality is expected, and there should be no adverse impacts to bull trout. However, the YN do not generally support tangle-netting because it could potentially delay the USFWS permitting process for Methow programs, and also because of the potential local response and social implications of collection actions. Keely Murdoch (YN HCP Hatchery Committees Alternate Representative) provided an email explaining the YN's position, which Kristi Geris distributed to the Coordinating Committees on June 17, 2016. The YN is requesting that the Coordinating Committees extend trapping at Wells Dam, which is currently limited to three, 16-hour days per week for a total of 48 hours. The YN would like to add a fourth day of trapping, starting in 2017 and beyond, to eliminate the need for tangle-netting in the future. The YN also is requesting that the number of tangle-netting days implemented in 2016 be limited to no more than 8 days (or 2 weeks), and that all the temperature, fish harassment, and other fish handling procedures implemented in 2014 still stand. That is, with regard to the Coordinating Committees, the YN will approve tangle-netting in 2016, provided that the Coordinating Committees approve increased trapping at Wells Dam in 2017 and beyond. Jim Craig asked if these discussions have been communicated to USFWS Ecological Services. Hillman said he believes so regarding trapping, and is certain this is true regarding tangle-netting. Bob Rose asked if the HCP Hatchery Committees seemed agreeable that 8 days of tangle-netting is sufficient time to collect the remaining broodstock in 2016. Hillman said, based on past efforts, they believe this can be achieved, or at least will achieve a proportion of natural-origin fish in hatchery broodstock (pNOB) value of 0.7. Rose asked about the disposition of HCP Hatchery Committees representatives regarding tangle-netting. Hillman said, during the meeting, most representatives were agreeable. He said Keely Murdoch did not provide the YN's vote, as she first needed to discuss this internally; and then she distributed her email with conditions. Grant PUD also requested to first discuss this internally, and it is still uncertain where they stand. NMFS abstained, and also requested to first discuss this internally. USFWS was in favor of achieving a pNOB value as high as possible; however, was also not in favor of using tangle-netting as a tool in the future to obtain natural-origin broodstock. USFWS also did not want to state too much support without first discussing internally regarding the permitting aspect. Hillman said, in general, it seems the HCP Hatchery Committees are in support of what the YN is proposing. Ferguson asked about a timeline for the HCP Hatchery Committees. Hillman said last week, Mike Tonseth (WDFW HCP Hatchery Committees Representative) indicated he needs a decision in no more than 30 days. Tonseth would like to be collecting the remaining natural-origin broodstock in mid- to late-July 2016. Hillman said, given the time sensitivity, the YN would like to receive a decision relatively soon. He added that the way the permits and management plan are written, if the full natural-origin contingent cannot be obtained, the program can be backfilled with hatchery-origin broodstock. However, there are enough natural-origin recruits to fill the program, they just came through so quickly they could not all be trapped at Wells Dam. Jeff Korth said he is not sure adding an additional day of trapping will make a difference, and suggested it would be more effective if trapping could be extended on days when a lot of fish are being trapped. Tom Kahler said the existing permit stipulates three days, 16 hours per day. Scott Carlon said the permit would need to be amended. Ferguson asked, permit aside, if Douglas PUD has objections to extending trapping hours at Wells Dam. Kahler said Douglas PUD has no objections. He said he believes if an additional day is added the target broodstock numbers will be obtained, because it seems trapping success improves over time. Kirk Truscott noted that sometimes, trapping success is opposite (over time, trapping success gets progressively worse); however, generally, he agreed it improves over time. Kahler said, with regard to Korth's suggestion, if trapping success is optimal, why stop. Kahler said the draft permits include no restriction on trapping. He said the restrictions were included in Hatchery Permit 1196 and the BiOp for the Wells HCP. He suggested asking NMFS to include language in the new replacement Hatchery Permit 1196 clarifying that trapping will be left to the discretion of the HCP Committees. Rose agreed if there are no operational or biological constraints, the permit should be rewritten to provide assurance in achieving pNOB targets. Kahler said the original intent of restricted trapping was to avoid fish passage delay and to ensure trapping does not exceed 33% of the run. Korth said WDFW spoke with NMFS, and although not definitive, it seemed NMFS would have no objections to the change in trapping. Korth said this is also a good opportunity to revisit the size of the conservation program. He said the entire Methow Program became the Conservation Program, and it was never discussed how large this program should be in terms of smolt-to-adult return ratios (SARs). Kahler said the idea of tailored conservation releases was to release a calculated number of fish (progeny of wild-by-wild parents) at each location to result in a specific number of hatchery-origin returns so that no returns from the conservation program would need to be removed. The remainder of the production obligation would comprise progeny of hatchery-by-hatchery parents specifically targeted for removal upon return. Kahler said Greg Mackey (Douglas PUD HCP Hatchery Committees Representative) calculated what releases would have to be at each location to generate the desired hatchery-origin returns on top of natural-origin returns to achieve a target percent hatchery-origin spawners (pHOS) of 0.25 at each location. Kahler said he cannot recall the exact calculations; however, theoretically, the general thought was that this was feasible, but there was concern about derailing the permitting process by introducing a topic likely to require months of discussion to reach consensus. Korth said, when these discussions were initially underway, adult management had not yet been implemented in this manner. He said, now he believes USFWS is more confident regarding the ability to control pHOS based on return rates of hatchery-by-hatchery progeny to the volunteer channel as adults. He suggested, with regard to the YN's request, drafting a statement for Coordinating Committees approval that contains trapping sideboards and a condition to revisit appropriate sizing of the Methow Conservation Program. Ferguson asked how the statement can be worded so as to not constrain the permitting process. Korth said changing trapping at Wells Dam is connected to the size of the conservation program. Rose said he does not want broodstock collection in 2017 and beyond to be constrained by a longer-term decision. Korth said, in the past, there has not been pressure to make a decision, and now there is. He also suggested establishing a deadline, and noted that mitigation is not changing; rather, it is marking that becomes the issue. Rose asked if the issue in the past was lack of pressure, or the realization that an agreement could not be reached. Korth said he is confident agreement can be reached in some fashion. He added that, ultimately, conservation of natural-origin recruits should be the main concern. Ferguson asked if conservation program sizing is the purview of the Coordinating Committees or HCP Hatchery Committees. Korth said program sizing is addressed in the permitting process. Kahler said NMFS wants to avoid mining, and if mining becomes a consistent problem, NMFS will require modifications to the permits to avoid this. He said these discussions should start within the HCP Hatchery Committees, although the Coordinating Committees have purview over passage issues. He said, however, the HCPs are written such that the Coordinating Committees may have the final ruling, if necessary. Korth said he understands why Rose may not want to address this at this time. Kahler said he spoke with Keely Murdoch and she thought revisiting the conservation program size was a practical idea conceptually; Kahler suggested having Mackey review his calculations with the HCP Hatchery Committees. Ferguson asked if the Coordinating Committees would be willing to consider approval of the YN's operational request in 2016, with the caveat that between now and 2017 there will be more discussion regarding resizing the Methow Conservation Program. Kahler suggested the timeline for resizing the conservation program should align with approving the annual Broodstock Collection Protocols. Rose requested that the statement the Coordinating Committees are approving does not indicate the conservation program will be reshaped; rather, it indicates the HCP Committees will start these discussions. Steve Hemstrom asked if the reasoning behind the YN's request to the Coordinating Committees is due to prolonged disagreement within the HCP Hatchery Committees (i.e., are the

Coordinating Committees resolving a dispute). Kirk Truscott explained that the only reason this request is to the Coordinating Committees is due to the trapping issue. He said this is not a dispute. Korth added that the YN will not agree to tangle-netting in 2016, unless the Coordinating Committees approve Keely Murdoch's conditions for trapping in the future. Ferguson asked which committees this affects, and Lance Keller said it affects the Rocky Reach and Rock Island HCP Coordinating Committees because the Methow Conservation Program is Chelan PUD's (and Grant PUD's) recovery program. The Wells HCP Coordinating Committee is also affected because trapping is conducted at Wells Dam. Korth noted that this decision will also be vetted within the Priest Rapids Coordinating Committee Hatchery Subcommittee due to Grant PUD's involvement. Korth said he will provide a statement for Coordinating Committees review and approval regarding the YN's request concerning obtaining Chelan and Grant PUDs Methow spring Chinook salmon broodstock. The statement will be distributed by Friday, June 24, 2016, and a vote via email will be due Friday, July 1, 2016. *(Note: Korth provided an SOA for approval on Friday, July 1, 2016, which Kristi Geris distributed to the Coordinating Committees that same day, with vote via email due to Korth by Friday, July 8, 2016.)*

- *Next Meeting:* The HCP Hatchery Committees' next scheduled meeting will be on July 20, 2016.

III. Chelan PUD

A. Rock Island Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller recalled discussing, during the last Coordinating Committees meeting on May 24, 2016, that Chelan PUD was awaiting results of the metal analysis for Rock Island Dam Powerhouse 1 Units B1, B2, B3, and B4, to determine whether the deterioration discovered in one blade was present in all four units. Keller said the analysis came back, the deterioration was identified in all four units, and now all of these units are out of service. He said Chelan PUD now plans to completely rehabilitate Units B1 to B4 from the ground up, with a target completion date of 2020. He said the design specifications for the new blades are not yet finalized; however, he will continue to provide a Rock Island Powerhouse 1 Maintenance update each month. He said he believes the new blade design will be fish-friendly.

Bob Rose recalled undergoing a process in the PRCC regarding selecting a new turbine design for Priest Rapids Dam, and asked if Chelan PUD plans to do the same. Keller said he is not familiar with that process, and Rose explained that the PRCC discussed characteristics of the turbine such as sheer, strike, and improvements for all species. Rose said this process required more than 1 year to complete. Keller suggested that if Chelan PUD completes the same analysis, it may take less time because it has been done before. Rose said it will be interesting to see what can be achieved with new turbines. Keller said Chelan PUD is seeking fish-friendly turbines, with a goal to return the turbines back to service in time for a study in 2020. He said Chelan PUD also hopes this modernization will not interfere with the Rock Island Dam Powerhouse 1 Units B5 to B8 rehabilitation. Scott Carlon noted that part of the Priest Rapids Dam turbine evaluation was competition by designers. He said a scoring process was developed for power production and hydraulic capacity, and there was a biological component as well. Kirk Truscott said the proponents needed to demonstrate that their turbines are as good as, or better than, the existing turbines. Keller said Chelan PUD will consult with Grant PUD regarding the process undertaken when completing turbine blade modernizations at Priest Rapids Dam.

John Ferguson asked, because these units will be offline for two to three spring passage seasons, do the Coordinating Committees need to review spill schedules or potential total dissolved gas issues, in the event a high-flow season occurs. Keller said Chelan PUD will provide a summary regarding the Rock Island Powerhouse 1 Units B1 to B4 modernization outage through 2020, and what effects this may have on spill and overall generation capacity at the project.

B. Proposed Rocky Reach Orifice Gate Closure (Lance Keller)

Lance Keller said Chelan PUD initially planned to provide an SOA for discussion and possible approval today; however, Chelan PUD needs more time internally to discuss the SOA. Keller recalled Bob Rose's question about how quickly the OGs could be closed, and Keller said a response to this question, along with a photograph of the OG slot, was distributed to the Coordinating Committees by Kristi Geris on June 17, 2016. Keller said, in summary, the closure would take roughly 1 day. He said, in order to close an OG, stop logs are placed into the OG stop log slot; in order to put an OG back into service, the stop logs are simply removed. He said the latter can easily be done on short notice. Kirk Truscott asked if closing all OGs can be accomplished in 1 day, or if it takes 1 day to close one OG. Keller said it takes about 1 to 1.5 hours to close a single gate, and all proposed OG closures could occur in 1 day. He said the requested radio telemetry data was also distributed to the Coordinating Committees by Geris on May 24, 2016. Keller said, however, those data are somewhat limited. Truscott agreed, noting that he was unable to make significant correlations based on the limited data provided.

Keller explained that the location of the OGs are fairly close to the fixed entrances (left powerhouse entrance [LPE] and right powerhouse entrance [RPE]). He said sockeye salmon, specifically, encounter several exits and entrances. He said one negative movement is through OG 20, which is located closest to RPE. He said frequent fallout has been observed at OG 20, due to what Chelan PUD believes is confusion caused by so many openings. He suggested an overall benefit may result from reducing the number of openings to the collection channel. He said also, during low tailwater elevations, it is difficult to maintain head differentials within criteria. Steve Hemstrom also noted that, based on radio telemetry data, Pacific lamprey may benefit by closing the OGs. Keller said closing the OGs is something Chelan PUD wants to try; however, Chelan PUD is not asking for a permanent closure.

Rose said he does not recall having a discussion after Grant PUD closed the OGs at Priest Rapids Dam (i.e., not sure if there was a discernable difference). Scott Carlon recalled an engineer indicating conditions improved. Rose suggested asking Grant PUD if an analysis was completed following the closure of the OGs at Priest Rapids Dam. Carlon asked when Chelan PUD is proposing to close the OGs at Rocky Reach Dam, and Keller said in August 2016, following the spring migration. John Ferguson asked if Chelan PUD has developed metrics to determine whether to leave the OGs closed or reopen them. Keller said Chelan PUD is still working on that, and he believes this will entail developing a level of difference in fishway counts that will trigger the need for a change. Ferguson agreed Rose's suggestion may be a good idea. Carlon recalled that Bryan Nordlund supported closing the OGs and believed the closure would improve hydraulics. Carlon said he will contact

Nordlund, and Keller will contact Grant PUD regarding any assessments conducted following the closure of the OGs at Priest Rapids Dam. Truscott asked about which gates Chelan PUD was proposing to close, and Keller said all six (OGs 20, 18, 16, 1, 2, and 3).

Chelan PUD will provide a draft SOA for the proposed Rocky Reach OG closure to Geris for distribution to the Coordinating Committees no later than 10 calendar days prior to the Coordinating Committees meeting on July 26, 2016. Chelan PUD will request approval of the SOA during the meeting on July 26, 2016. *(Note: Keller provided the draft SOA to Geris on July 12, 2016, which Geris distributed to the Coordinating Committees that same day.)*

IV. Joint PRCC/HCP

A. Subyearling Chinook Salmon Workshop (All)

John Ferguson welcomed PRCC members, and asked all Committees members to share their thoughts about the subyearling Chinook Salmon Workshop held yesterday, June 21, 2016, at the Red Lion Hotel in SeaTac, Washington.

Tom Skiles (Columbia River Inter-Tribal Fish Commission [CRITFC]) said he thought the workshop was fascinating. He said, compared to the workshop in 2009, this year was more technical, included more data, and there were also interesting side conversations. He said it seemed the underlying factor was the methodology issue. He said it seems, at this point, a study about subyearling Chinook salmon could be done if it were absolutely necessary; however, there would be issues. He said he believes conducting a study right now is a non-starter.

Scott Carlon agreed with Skiles. Carlon said he also thought Bob Rose's comment was interesting about revisiting the schedule, compliance, and understanding constraints.

Kirk Truscott said subyearling Chinook salmon are a tough species to analyze and study. He asked, along with compliance, even if studies are conducted and project survival is less than expected, what will be done with this information. He said regarding tag technology, there have been considerable advances; however, tags still are not at a size that subyearlings can be tagged. He said he is not so concerned with which fish are active migrants versus which are not, as long as study fish are randomly selected into control groups. He said he believes it will be difficult to reach a consensus on defining what an active migrant is, and suggested reviewing the HCPs. He said, just because a fish slows down, does not mean the fish is not an active migrant.

Curt Dotson (Grant PUD) agreed this year's workshop improved since the last workshop in 2009. He said there was more variety in the data presented. He said, however, he feels the results from this year are the same as in 2009, only this year there were more datasets that validated the conclusions. He said studying subyearlings include several issues that are not encountered when studying other species. He asked, for example, regarding Peter Graf's (Grant PUD) presentation on subyearling paired release studies, does migrating from faster moving water to slower moving water trigger the desire to holdover (i.e., if the control group is released in the Wanapum Reservoir, will the slower water conditions in the Priest Rapids dam tailrace result in holdover fish). Skiles asked if Graf evaluated survival of the holdover study fish, and Ferguson recalled Graf intending to do so; however, there were issues with the study design and the evaluation has not yet taken place. Dotson agreed that was correct.

Tom Kahler agreed with sentiments shared so far. He agreed active migrants need to be defined, per requirements in the HCPs to study active migrants. He said he and Casey Baldwin (Colville Confederated Tribes [CCT]) are also interested in understanding summer versus fall subyearlings. Kahler questioned whether they behave differently and if they are two different groups. He said this is important because subyearling studies will be conducted from the mouth of the river with the assumption that all fish are migrating from the tributaries; however, if there are mainstem spawners, it will be important to know where they are coming from. He explained, for example, a three-piece treatment study design with one control and releases at Bridgeport, Washington, the mouth of the Okanogan River, and the Methow River confluence. He said, with this design, travel times would need to be known in order for metrics to match up. He said this, along with other study design details, needs to be addressed. Ferguson suggested obtaining those data from spill bypass passive integrated transponder (PIT) detectors, and Kahler said he considered that, as well. Kahler noted, however, that summer Chinook salmon pass deeper in the water column. He said the bypass detection system at Wells Dam only covers the top 8 feet of the water column, so detecting subyearlings may be challenging. He added that installing detection deeper than 8 feet is logistically challenging, but may be necessary.

Lance Keller said he enjoyed the workshop, specifically noting John Skalski's (Columbia Basin Research) presentation. Keller said it still seems difficult to evaluate project survival as tag technology continues to evolve. He noted the variability in data due to the plasticity of species. He agreed defining migrant versus non-migrant is key in terms of a survival study. He said, to conduct a study in the Rocky Reach Reservoir, there needs to be subsequent detections to evaluate and exclude false detections. He said he is also interested in what triggers subyearlings to change from a migrant to a non-migrant, and asked if this is consistent year to year and if there are cues. Steve Hemstrom added that the same capabilities are not available for studying subyearlings because of the lack of tag technology.

Denny Rohr said he attended the last workshop in 2009, and he agreed this workshop was better. He said there was more information, more focus, and it was more refined. He said he appreciates the discussion and now the HCP Coordinating Committees and PRCC need to determine where to go from here.

Jim Craig said he appreciated the more localized information presented during this year's workshop. He said the data, or lack thereof, point out deficiencies in juvenile monitoring at facilities during winter months. Data do indicate some juvenile Chinook salmon move out of tributary streams in the fall and into the mainstem Columbia River; however, there is currently no way to document if downstream passage through the hydrosystem is occurring during the winter. Craig agrees with others on the difficulty of determining project survival for subyearling Chinook salmon. He suggested, however, perhaps considering conducting tests of dam survival of active migrant subyearling Chinook salmon.

Rose said he is struggling between the due diligence required by the HCPs and the fact that subyearlings are doing pretty well. He said comparatively, subyearlings seem to be a low priority. He agreed with everything already discussed about tag technology and noted his interest in further discussing injectable tags. He also noted the importance of the compliance component.

Tom Dresser (Grant PUD) agreed good information was presented at the workshop. He said the workshop was very timely and set the platform for future discussions. He cautioned that decisions do not need to happen overnight; rather, everything should be well thought out. He said it was interesting that similar discussions are happening in 2016 that were happening in 2004. He recalled, in 2004, everyone understood summer subyearlings are difficult to assess. He said it was suggested then to implement predator-control programs to benefit the species. He said, based on dam counts at Priest Rapids Dam from 1960 to present, he believes summer subyearlings have benefited. He said he is not implying nothing should be done; however, he reiterated that there should be no rush.

Jeff Korth recognized there are several issues with understanding the life history and studying subyearling Chinook salmon. He said, for example, there is no way to track residualized fish. He 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.

Ferguson said he was surprised the statistical model could not resolve the issues with studying subyearlings. He said the plasticity of fish, fish size, migration behavior, and flux in environmental conditions were also interesting. Kahler said regarding climate, if conditions are such that this is routine (e.g., high summer temperatures), the population will adapt and will have a more compressed spring migration and may be easier to study.

Next Steps

Ferguson asked where to go from here. He recalled that Chelan PUD has an SOA that maintained subyearling Chinook salmon in Phase III (Additional Juvenile Studies) until 2016, which, following the workshop, now needs to be addressed. Ferguson asked, collectively, in terms of the Committees, what are the next steps. Rose suggested using lampara nets (as discussed during yesterday's workshop) to obtain larger fish, and then tag and study those fish. He also suggested, at some point, developing a sequence of events to accomplish that will inform the compliance component. He also recalled Andrew Murdoch (WDFW) indicating there are some things that can be evaluated at this time. Korth suggested reviewing data from the mid-1990s to late-2000s to establish a baseline about conditions in the hydrosystem, which may inform future conditions. Truscott said route-specific data are known for yearling migrants and sockeye salmon at Wanapum, Priest Rapids, Rocky Reach, and Wells dams. He said, however, approach patterns are still unknown. He asked if active migrant subyearlings are needed to obtain these data, and asked about management implications if it is determined utilization is different from yearling migrants. He asked what would be done with those data. Kahler noted the increase in subyearling detections at Rocky Reach Dam in 2011 (8%), 2012 (6%), and 2013 (11%), which may suggest some dependency on spill. Keller noted that in 2012, the average daily flow from May 23 to August 2012 was in the range of 300,000 cubic feet per second. He said these high flows forced more spill due to hydraulic capacity limits, which can affect bypass detection efficiency.

Kahler said Kirk Schroeder's (Oregon Department of Fish and Wildlife, Oregon State University) students presented at an American Fisheries Society conference a study that found morphometric differences in spring Chinook salmon from tributaries to the Willamette River. Kahler said some study fish remained in the natal tributaries and some exhibited ocean-type behavior. He said these two groups of fish exhibited morphological differences—one group had a more compressed (shorter) head and deeper body and the other had a more elongated head and body shape. He said the two groups shared a common rearing vessel; however, they volitionally segregated while in the vessel, with one group preferring the bottom and the other actively feeding at the surface. He said perhaps such behavioral and morphometric differences could be observed in the Mid-Columbia population as well, and that could help distinguish migrants from rearing fish.

Hemstrom said he does not believe the fish will change, and suggested instead changing study methods. He said study methods may not be universally applicable across all species, which may require looking further into what is compliant with regard to HCP requirements. Dresser said Grant PUD has done this before under the Salmon and Steelhead Settlement Agreement.

Ferguson said the next steps seem to be continuing discussions both in the Committees and internally within respective agencies. Truscott suggested quarterly check-ins, and Rohr noted that it may be beneficial to hold joint HCP Coordinating Committees and PRCC check-ins because of the joint involvement. Dotson agreed joint discussions would be most efficient, and further suggested discussing any regulatory requirements separately, as appropriate. Rohr noted that this same arrangement is coordinated between the HCP Hatchery Committees and PRCC Hatchery Subcommittee, and similar arrangements also took place during the former Mid-Columbia Coordinating Committee era. The Coordinating Committees members present agreed to convene quarterly, joint HCP/PRCC sessions to continue discussions regarding subyearling Chinook salmon passage studies.

Ferguson proposed starting these joint sessions in October 2016. Rohr also suggested holding the joint sessions at the Grant PUD office in Wenatchee, Washington. Ferguson and Rohr will further discuss logistics for quarterly, joint HCP/PRCC sessions, which will be convened to continue discussions regarding subyearling Chinook salmon passage studies.

B. HCP Coordinating Committees and PRCC Meeting Location (All)

John Ferguson said there has been consideration regarding moving the monthly meetings for the HCP Coordinating Committees and PRCC to Wenatchee, Washington. He said he and Denny Rohr agree the goal is to facilitate as much committee functionality and attendance as possible. He asked if HCP Coordinating Committees and PRCC members were supportive of this idea, and if yes, what date should the location switch. Rohr further suggested holding meetings at the Grant PUD office in Wenatchee, Washington.

Tom Skiles said moving meeting locations will work for him. Scott Carlon agreed, but asked if the move can start in October 2016 when the new budget cycle begins for NMFS. He also suggested perhaps a later start time to allow for travel. Kirk Truscott said the proposed meeting location will make it easier for him to attend in-person (opposed to the current location). Curt Dotson said the new location will work for Grant PUD, and suggested maybe convening the HCP meeting an hour later, and the PRCC meeting starting at 8:00 a.m. Lance Keller said the new location will work for Chelan PUD. He recalled that, typically, one meeting per year was scheduled in eastern Washington for a site visit; but this new location will facilitate more project visits. Ferguson asked if there would be any cost ramifications for Chelan PUD, and Keller said there should not be. Jim Craig said the new location will work for him. Bob Rose agreed and suggested another possibility was to alternate between SeaTac and Wenatchee, Washington. Tom Dresser and Jeff Korth also agreed the move would work for them.

The Coordinating Committees members present agreed to move the monthly Coordinating Committees meetings from the Radisson Hotel in SeaTac, Washington, to Wenatchee, Washington, starting with the Coordinating Committees meeting on October 25, 2016. Ferguson said meeting logistics will be further discussed at a later date.

V. Douglas PUD

A. Ongoing Wells Project Studies Update (Tom Kahler)

Bull Trout Study

Tom Kahler said Douglas PUD is conducting a bull trout radio telemetry study at Wells Dam and the Twisp Weir. He said Douglas PUD was targeting 30 fish at Wells Dam; however, the District was unable to achieve those numbers. He said the target number of fish at the Twisp Weir was achieved. He said he does not have the final numbers available at this time, but he knows an adequate number of study fish were tagged to meet the study objectives.

Pacific Lamprey Study

Kahler said one modification for the upcoming Douglas PUD 2016 Pacific lamprey study was installation of lamprey enumeration structures in each fish ladder. He said there were issues with obtaining the needed construction materials, and it took a long time to fabricate the structures. He said the structure was installed in one ladder but not at the other ladder due to increased sockeye salmon passage counts.

Kahler said fish counters observed a sockeye salmon enter the newly installed lamprey enumeration structure backwards, turn around, and exit the structure. He said Douglas PUD now needs to modify the design so that salmon cannot access the structure from the upstream side. He said he contacted Chas Kyger (Douglas PUD Aquatic Settlement Work

Group Alternate) and informed him not to install the other structure until the design is modified.

B. Trapping at Wells Dam (Tom Kahler)

Tom Kahler said progress on the Wells Hatchery Modernization is not as far along as originally planned. He said, therefore, trapping on the west fish ladder has been occurring but trapped fish are directed to the old processing location rather than to the new Adult Handling Facility. He said the new schedule for completing the Adult Handling Facility is a July 5, 2016. He said summer trapping is now underway and CRITFC sockeye tagging will begin on June 27, 2016. He said Jayson Wahls (WDFW) asked CRITFC to conduct all sockeye tagging at the east fish ladder, which is actually simpler because the infrastructure allows fish to be worked up in real-time.

C. Wells Hatchery Modernization (Tom Kahler)

Tom Kahler said the new head tank structure is now complete and all main lines are installed and functioning. He said there have been design issues with the Adult Handling Facility; however, this is not the sole issue delaying progress. He said there is a large list of construction and design issues, including the function and fit of the crowders, incorrectly installed drain elevations (now all perched), and other things.

VI. HCP Administration

A. Next Meetings

The next scheduled Coordinating Committees meeting is on July 26, 2016, to be held in-person at the Radisson Hotel in SeaTac, Washington.

The August 23, 2016, and September 27, 2016, meetings will be held by conference call or in-person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Denny Rohr†	Denny Rohr Consultants
Tracy Hillman**	BioAnalysts
Tom Skiles†	Columbia River Inter-tribal Fish Commission
Lance Keller*	Chelan PUD
Steve Hemstrom*	Chelan PUD
Tom Kahler*	Douglas PUD
Tom Dresser†	Grant PUD
Curt Dotson†	Grant PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Bob Rose*	Yakama Nation

Notes:

* Denotes Coordinating Committees member or alternate

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

† Joined for the Joint PRCC/HCP portion of the meeting

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	August 23, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the July 26, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel, in SeaTac, Washington, on Tuesday July 26, 2016, from 9:30 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).
- Chelan PUD will provide a summary regarding the Rock Island Powerhouse 1 Units B1 to B4 modernization outage through 2020 and what effects this may have on spill and overall generation capacity at the project (Item I-C).
- Jeff Korth will inquire internally whether the Washington Department of Fish and Wildlife (WDFW) still has fixed radio telemetry sites installed at Rock Island or Rocky Reach dams (Item III-A).
- Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item III-B).
- Anchor QEA, LLC, will coordinate with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) to determine meeting logistics for future Coordinating Committees meetings to be held in Wenatchee, Washington, including logistics for the quarterly, joint HCP/PRCC sessions (Item VI-A). *(Note: Kristi Geris distributed an*

email to the Coordinating Committees and PRCC on August 8, 2016, indicating that future Coordinating Committees meetings and joint Coordinating Committees/PRCC sessions will be held at the Grant PUD office located at 11 Spokane Street (second floor), Wenatchee, Washington, beginning with the Coordinating Committees meeting on October 25, 2016.)

- **The Coordinating Committees meeting on August 23, 2016, will be held via conference call (Item VI-B).**

DECISION SUMMARY

- The Rocky Reach HCP Coordinating Committee representatives present approved the Closure of Rocky Reach Adult Fishway Orifice Gates Statement of Agreement (SOA; Item III-A).
- The Rocky Reach HCP Coordinating Committee representatives approved via email on August 15, 2016, ending spill at Rocky Reach Dam at midnight that night.

AGREEMENTS

- The Coordinating Committees representatives present agreed that per the Wells Project HCP, 2000 Wells Project Interim Biological Opinion (BiOp), 2003 BiOp, and Hatchery Permits 1196, 1347, and 1395, trap operators at Wells Dam have the flexibility to trap spring Chinook salmon outside the protocols used to date (16 hours per day, 3 days per week), in order to achieve broodstock collection targets as prescribed and in consultation with the annual Wells HCP Coordinating Committee-approved Broodstock Collection Protocols (Item V-A).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on August 10, 2016, notifying them that a Wells Project Land-use Permit Application (City of Pateros) was available for a 60-day review period, with edits and comments due to Kahler by Monday, October 10, 2016.
- Kristi Geris sent an email to the Coordinating Committees on August 15, 2016, notifying them that Amendment Requests to Remove Unconstructed Small Turbines from Licenses were available for review, with comments due to Lance Keller by

September 15, 2016.

FINALIZED DOCUMENTS

- The 2015 Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System Report was finalized following a 30-day review period, which ended June 16, 2016, and the final report was distributed to the Coordinating Committees by Kristi Geris on July 25, 2016.
- The 2015 Rock Island Dam Smolt Monitoring Program and Gas Bubble Trauma Evaluation Report was finalized following a 30-day review period, which ended June 24, 2016, and the final report was distributed to the Coordinating Committees by Kristi Geris on July 25, 2016.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the Coordinating Committees and asked for any additions or changes to the agenda. Lance Keller added a Chelan PUD Subyearling Chinook Salmon Phase III Designation update.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft June 22, 2016, meeting minutes. Kristi Geris said a second revised version was distributed on July 25, 2016, which included clarifications by Jeff Korth on two statements he made during the HCP Hatchery Committees Update, Broodstock Collection for Methow Programs. Coordinating Committees members present approved the late revisions. Geris said all other comments and revisions received from members of the Committees were incorporated into the revised minutes. Coordinating Committees members present approved the June 22, 2016, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on June 22, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on June 22, 2016):*

- *Tracy Hillman will present an overview of the National Oceanic and Atmospheric Administration's (NOAA's) Salmon Population Summary (SPS) database following the Coordinating Committees meeting on July 26, 2016 (Item I-C).*
  This will be discussed following today's meeting.
- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).*
  This will be discussed during today's meeting and will also be carried forward.
- *Anchor QEA, LLC, will inquire with Greg Fraser (USFWS) his interest in sharing with the Coordinating Committees his presentation on Entiat River History and Impacts to Chinook Salmon, which Fraser recently presented to the HCP Hatchery Committees (Item II-A).*
  Fraser offered to provide this presentation during the Coordinating Committees meeting on August 23, 2016. Fraser's presentation will be distributed to the Coordinating Committees closer to the meeting date. *(Note: Fraser's presentation will be postponed until the next in-person meeting.)*
- *Jeff Korth will provide a statement for Coordinating Committees review and approval regarding the Yakama Nation's (YN's) request concerning obtaining Chelan and Grant PUDs Methow spring Chinook salmon broodstock; the statement will be distributed by Friday, June 24, 2016, and a vote via email will be due Friday, July 1, 2016 (Item II-A).*
  This will be discussed during today's meeting.
- *Chelan PUD will consult with Grant PUD regarding the process undertaken when completing turbine runner modernizations at Priest Rapids Dam (Item III-A).*
  This will be discussed during today's meeting.
- *Chelan PUD will provide a summary regarding the Rock Island Powerhouse 1 Units B1 to B4 modernization outage through 2020, and what effects this may have on spill and overall generation capacity at the project (Item III-A).*
  This action item will be carried forward.
- *Scott Carlon will contact Bryan Nordlund (National Marine Fisheries Service [NMFS], retired) and Lance Keller will contact Grant PUD regarding any assessments conducted following the closure of the orifice gates (OGs) at Priest Rapids Dam (Item III-B).*

This will be discussed during today's meeting.

- *Chelan PUD will provide a draft SOA for the proposed Rocky Reach OG closure to Kristi Geris for distribution to the Coordinating Committees no later than 10 calendar days prior to the Coordinating Committees meeting on July 26, 2016; Chelan PUD will request approval of the SOA during the meeting on July 26, 2016 (Item III-B).*
  Lance Keller provided the draft SOA to Geris on July 12, 2016, which Geris distributed to the Coordinating Committees that same day. This will be further discussed during today's meeting.
- *John Ferguson and Denny Rohr will further discuss logistics for quarterly, joint HCP/PRCC sessions convened to continue discussions regarding subyearling Chinook salmon passage studies (Item IV-A).*
  This 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 said the HCP Hatchery Committees did not meet in July 2016, due to lack of agenda items. He said they did discuss a couple items via email. He said the Rock Island and Rocky Reach HCP Hatchery Committees approved the use of surplus summer Chinook salmon from the Entiat National Fish Hatchery (NFH) if sufficient numbers of summer Chinook cannot be collected from the Eastbank Outfall for the Chelan Falls Summer Chinook Salmon Program in 2016. Hillman said Chelan PUD also distributed a proposal to conduct a pilot adult trapping effort at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station. He said the purpose of the pilot effort is to find a more reliable location for collecting broodstock in 2017 and beyond. He added that the pump station provides flow to Reach 4 of the Chelan River Habitat Channel, and summer Chinook salmon aggregate there. The next HCP Hatchery Committees meeting will be on August 17, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the last HCP Tributary Committees conference call on July 14, 2016.

- *General Salmon Habitat Program Proposals*: The HCP Tributary Committees reviewed seven full proposals. Prior to review, an update was provided on how much money is currently in each Plan Species Account—about $5.5 million in the Rock Island account, about $2 million in the Rocky Reach account, about $1.3 million in the Wells account, equaling about $8.9M total. The following four proposals were approved:

1. The Wenatchee Sleepy Hollow Floodplain Acquisition proposal, submitted by the Chelan-Douglas Land Trust, intends to protect 2,700 feet of riverbank and 37 acres of high-quality riparian and floodplain habitat on the lower Wenatchee River (river mile [RM] 2.7 to 3.2). The total cost of the project is $661,000, and the sponsor requested $165,250. The Rock Island HCP Tributary Committee approved.
2. The Silver Side Channel Acquisition proposal, submitted by the Methow Salmon Recovery Foundation, intends to protect 95.8 acres, including off-channel floodplain habitat, wetlands, riparian habitat, and agricultural lands on the middle Methow River (RM 34.3 to 35.3). The total cost of the project is $801,470, and the sponsor requested $236,406. The Wells HCP Tributary Committee approved.
3. The Burns-Garrity Restoration Design proposal, submitted by Cascade Columbia Fisheries Enhancement Group, intends to prepare a restoration design that will improve instream, off-channel, and floodplain habitat on 30 acres of land on the lower Chewuch River (RM 2.3 to 2.8). The total cost of the project is $177,335, and the sponsor requested $45,550. The Rocky Reach HCP Tributary Committee approved.
4. The Beaver Fever proposal, submitted by Trout Unlimited, intends to install beaver dam analogs (BDAs) in tributaries of the Wenatchee River basin, to reestablish beavers, increase habitat complexity, moderate water temperatures, augment stream flows, trap fine sediments, and improve riparian and off-channel connectivity. The total cost of the project is $279,278, and the sponsor requested $108,226. The Rock Island HCP Tributary Committee approved. Hillman said all project approvals included conditions; however, with this project it was especially emphasized that all money from the Rock Island Plan Species Account will be used to purchase and install BDAs, and no funds from the account will be used to trap, acclimate, or relocate

beavers. John Ferguson asked what a BDA entails. Hillman explained that a BDA is simply wooden fence posts driven into the streambed perpendicular (or at an angle to) flow, with woody material racked around the fence posts. He said the BDA functions like a beaver dam, and often times beavers also build on top of the structure. He said research on BDAs in the John Day Basin show significant benefits, as described in a paper titled, "Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*)" (Attachment B), which was distributed to the Coordinating Committees by Kristi Geris following the meeting on July 26, 2016. Hillman said Trout Unlimited is trying to replicate these successes. Hillman cautioned, however, that BDAs must be used wisely; BDAs need to be installed in somewhat entrenched areas with some wood recruitment. Jim Craig suggested sharing research on BDAs with the U.S. Forest Service, considering their reluctance to install such structures. Jeff Korth agreed site selection is key, and said he is somewhat reluctant to relocate beavers because it seems if habitat in a certain area supports beavers, then the beavers would already be there.

Hillman said three proposals were rejected, as follows:

1. The Nason RM 2.3 Side Channel Reconnection Design proposal, submitted by Chelan County Natural Resource Department (CCNRD), intends to reconnect a 0.36- to 0.53 mile-long, high-flow channel to the mainstem on lower Nason Creek near RM 2.3. The total cost of the project is $149,778, and the sponsor requested $23,000. The HCP Tributary Committees elected not to fund this project because it has become too complex and expensive, and those complex and expensive additions may not provide significant additional benefit. Specifically, the HCP Tributary Committees questioned the proposed creation of a right-angle connection at the upstream end of the side channel, considering the amount of fine sediment that recruits to Nason Creek. The HCP Tributary Committees recommended looking farther upstream for a reconnection point. Hillman said this project may still move forward via funding from the Salmon Recovery Funding Board (SRFB).

2. The Thermal Refuge in the Wenatchee Basin proposal, submitted by CCNRD, intends to identify locations of cold-water seeps and functioning cold-water refugia, as well as identify possible protection and restoration opportunities to increase thermal refugia within the Upper Wenatchee River, Nason Creek, Chiwawa River, and the Little Wenatchee River. The total cost of the project is $48,807, and the sponsor requested $7,321. The HCP Tributary Committees elected not to fund this project because the proposed approach (ground-based longitudinal profiles and spot-checking cold seeps) is more expensive and somewhat flawed compared to late-fall or early-winter forward-looking infrared (FLIR) imaging, which is more practical for identifying and characterizing thermal refugia. During review of draft proposals, the HCP Tributary Committees recommended that the sponsor include FLIR imaging in the final proposal; however, the sponsor did not.
3. The Peshastin Irrigation Pump Exchange Preliminary Design proposal, submitted by CCNRD, intends to increase late summer flows by up to 30 cubic feet per second (cfs) in the lower 2.4 miles of Peshastin Creek, via a newly designed pump exchange facility. The total cost of the project is $199,393, and the sponsor requested $29,909. The HCP Tributary Committees elected not to fund this project because they believe the most biological benefit would come from removing the irrigation diversion from Peshastin Creek (as also stated during the draft proposal process). Ferguson said 30 cfs is fairly substantial. Hillman agreed, and said the project will likely receive funding from SRFB. Hillman said the HCP Tributary Committees received a letter from Mike Kaputa (CCNRD Director) indicating he understood the HCP Tributary Committees' position.

- *Okanagan Nation Alliance Field Trip*: Another field trip in Canada is planned for October 12 and 13, 2016. The HCP Tributary Committees and PRCC Habitat Subcommittee will attend the tour, and the HCP Coordinating Committees are also invited.
- *Next Steps*: The next meeting of the HCP Tributary Committees will be on August 11, 2016.

III. Chelan PUD

A. DECISION: Rocky Reach Orifice Gate Closure SOA (Lance Keller)

Lance Keller said the Closure of Rocky Reach Adult Fishway Orifice Gates Draft SOA was distributed to the Coordinating Committees by Kristi Geris on July 12, 2016. Keller recalled discussing this proposal at length, including distributing: 1) an initial proposal with photographs on April 26, 2016; 2) a summary of historical radio telemetry data demonstrating use of the OGs for adult fish passage on May 24, 2016; and 3) a description of logistics and mechanics of the proposed closure of the OGs on June 17, 2016.

Keller read the Agreement Statement of the draft SOA (see final SOA; Attachment C). He said he spoke with Scott Carlon about comparing daily fish count data with historical counts to determine any delays (as a result from closing the OGs), and they both agreed this method should suffice. Keller said he also spoke with Curt Dotson (Grant PUD), and Dotson did not recall completing an analysis following the closure of the OGs at Priest Rapids Dam. Keller said this SOA is an effort to achieve appropriate entrance differentials at Rocky Reach Dam without requiring modifications inside the fishways.

Bob Rose said the Yakama Nation (YN) is supportive of the SOA, and also requested that Steve Hemstrom and Tracy Hillman discuss this during the next Rocky Reach Fish Forum to establish a monitoring strategy for Pacific lamprey. Keller emailed the request to Hemstrom during the meeting on July 26, 2016.

Kirk Truscott suggested that Chelan PUD monitor passive integrated transponder (PIT)-tag data from Rock Island Dam through Rocky Reach Dam, and compare those data to past years as a means to assess passage delays associated to the OGs. Keller said Chelan PUD can do this. He added that PIT-tag analysis opportunities are few and far between in this area; however, Chelan PUD will monitor the available locations. John Ferguson asked where detection points are located, and Keller replied they are downstream of the count windows at Rock Island and Rocky Reach dams. Truscott asked if there are any fixed radio telemetry sites installed at Rock Island or Rocky Reach dams. Jeff Korth said he does not believe so, but will inquire internally.

The Rocky Reach HCP Coordinating Committee representatives present approved the Closure of Rocky Reach Adult Fishway Orifice, Gates SOA. The final SOA (Attachment C) was distributed to the Coordinating Committees by Geris on July 27, 2016.

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

Lance Keller recalled providing updates to the Coordinating Committees about turbine blade issues discovered in Rock Island Dam Powerhouse 1 Units B1, B2, B3, and B4, which are the original units installed at Rock Island Dam in 1933. Keller said he misspoke during the Coordinating Committees meeting on June 22, 2016, when he stated that Chelan PUD planned to completely rehabilitate Units B1 to B4 from the ground up. He said the rehabilitation will actually be of a smaller scale, and based on discussions with FERC, the effort will fall under what FERC views as maintenance. Keller said this effort is different from the process Grant PUD undertook, because modifications at Priest Rapids Dam involved redesign of a significant number of turbine and flow control components, and the redesign at Rock Island Dam will only involve some of the turbine components. Keller reviewed what will and what will not change, as follows.

The following components of the turbine will not change:

- No change to generator nameplate (i.e., capable power generation) or authorized project hydraulic capacity (i.e., 220,000 cfs). (*Keller noted that FERC considers changes to the project hydraulic capacity to be beyond maintenance.*)
- No change to authorized capacity (i.e., 20,700 kilowatt).
- No civil works.
- No change to diameter of the intake or draft tube discharge structures.
- No change to wicket gate height (i.e., the unit cannot pass more flow).
- No change to operations with fixed blades (HCP No-Net-Impact met under these conditions).
- No change to the partially spherical discharge liner (although, minimize gaps where blade tips meet liner).
- No work on stator core.

The following components of the turbine will change:

- Turbine horsepower (HP) will change from 32,000 HP to 30,000 HP (head for Powerhouse 1 units updated to 39.7 feet). (*Keller noted that he believes the lower HP is related to newer, more efficient technology.*)
- Smaller oil-free hub (no gaps at hub).
- New fixed propeller runner optimized for the current operating head and flow (currently manually adjustable Nagler-type propeller turbines).
- More efficient four-blade turbine runner, instead of six-blade turbine runner.
- Replaced governor controls.
- Rated operating head will change from 45-foot head to 39.7-foot head to provide consistency with the operating head of Powerhouse 2.
- Upon installation and testing, revised best gate operation for the units will be submitted to FERC.

Keller said the timeline is the same for the units to be fully operational by March 2020 in time for a 2020 confirmation study when Chelan PUD will evaluate survival through the new units. He said the proposed modern design is structured for optimum flow, more power generation, and benefits to fish passage survival. He said Chelan PUD is moving forward and very conscious of the survival standard, which is why the runner design will not change to a Kaplan style, and there will be a decrease in blade number to decrease strike points. He said, with regard to Chelan PUD's action item to provide a summary on what effects the outage/rehabilitation may have on spill and overall generation capacity at the project, he still needs to contact Marcie Steinmetz (Chelan PUD Water Resource Specialist), who has been away on vacation.

John Ferguson asked how many units will be rehabilitated. Keller replied seven, including Units B1 to B4 and B5 to B7 (the latter have a slightly larger capacity). He added that the rehabilitation of Units B5 to B7 was scheduled prior to and separate from the rehabilitation of Units B1 to B4, due to the discovery of cracked blades. Keller said Units B9 and B10 were recently rehabilitated around 2008 to 2010. Ferguson asked what role, if any, the Coordinating Committees will have in the design process. Keller said the Rock Island Dam rehabilitation will not require the same participation from the Coordinating Committees as the Priest Rapids Dam rehabilitation needed from the PRCC, because the Rock Island Dam rehabilitation involves so much less, as formerly discussed. He said FERC has requested that Chelan PUD provide a notification letter that the maintenance will be performed, and meeting minutes will be appended to the letter to demonstrate consultation with the Coordinating Committees. He said Brett Bickford (Chelan PUD Engineering and Project Management Director) has also offered to field questions about the rehabilitation during a future meeting. Alene Underwood (Chelan PUD HCP Hatchery Committees Representative) said Chelan PUD will provide this draft letter to the Coordinating Committees for review, prior to submitting to FERC. Kirk Truscott requested that the draft letter include an explanation of what will change compared to existing conditions. Underwood said Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to FERC for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions. Underwood also suggested that the Coordinating Committees first review the draft letter to determine whether Bickford is needed for further explanations.

IV. Douglas PUD

A. Ongoing Wells Project Studies Update (Tom Kahler)

Bull Trout Study

Tom Kahler said, during the last Coordinating Committees meeting on June 22, 2016, he mistakenly reported that collection of bull trout for the study was complete; however, at that time, collection was not complete (although no more fish were collected at Wells Dam). He said collection extended into July 2016, and ultimately 14 bull trout were captured at Wells Dam; the remaining study fish were obtained from the Twisp Weir. He said because most study fish were obtained from the Twisp Weir, the focus of the study switched more on the Twisp River, which Kahler believes is appropriate considering the bulk of the Methow River run is from the Twisp River.

Pacific Lamprey Study

Kahler recalled discussing during the last Coordinating Committees meeting on June 22, 2016, fish counters observing a sockeye salmon entering the newly installed lamprey enumeration structure backwards, turning around, and exiting the structure. Kahler said since then, more sockeye salmon have done this, and one did not make it out. He said Wells

Dam staff removed the upper portion of the enumeration structure in the west fish ladder and will modify and replace it in August 2016, between the sockeye salmon and steelhead runs. He said the reason this happened is because the dimensions of the parts received were larger than those specified in the design, and the parts were not cut down to size. Thus, the tunnel exit was 3 inches tall rather than 1.5 inches. He said an enumeration structure with correct entrance and exit dimensions is also ready to be installed in the east fish ladder, which should be installed soon because lamprey counts at Rocky Reach Dam are increasing.

B. Wells Hatchery Modernization (Tom Kahler)

Adult Handling Facility

Tom Kahler said the Adult Handling Facility is generally complete (functional), and now only needs finishing work. He said, in addition to the design problems previously described during past Coordinating Committees meetings, the electronarcosis system was not performing as expected, so the contractor worked with hatchery staff to make the necessary adjustments.

Volunteer Channel

Kahler said the volunteer channel is a structure that has been in place since the hatchery was built in the 1960s, and was the means by which hatchery returns entered the hatchery. He said the channel, which in the past was largely fed by surface water, has always been attractive to fish, and now is even more attractive because cold groundwater is discharged down the channel from the new Adult Handling Facility (rather than down the facility drain as in the past). He said groundwater from the four large dirt ponds still drains into the channel downstream of the trap, and once those ponds are filled later this summer when river temperatures are high, the attractiveness of the channel will only increase. Because of the increased attractiveness from the cold groundwater from the Adult Handling Facility, hatchery staff are now burdened with processing a larger number of fish during broodstock collection than in past years. He said they would likely retrofit the trap system to enable fish not needed for broodstock or surplus to voluntarily return to the river.

West Fish Ladder Trap

Kahler said, originally, fish from the west fish ladder trap were conveyed to a pond to sort, via a 30-inch pipe that went through a dewatering structure, and by the time the pipe dropped into the steelhead pond, flow was a trickle. He said the pipe now leads directly into a raceway without passing through a dewatering structure. To reach the raceway, a section of 18-inch pipe was added to the end of the 30-inch pipe. Consequently, the pipe now discharges at an extremely high velocity and, since the pipe enters perpendicular to the long-axis of the raceway, the fish can hit the raceway wall opposite the pipe mouth. He said a fix for this is still under discussion, and in the meantime, the trap is not being used. At the very least, the discharge volume of the pipe will be reduced to prevent fish from hitting the opposite wall.

Conveyance Fishway

Kahler said the newly constructed fishway between the upstream end of the volunteer channel and the Adult Handling Facility now includes two 90-degree angles where fish have started jumping out of the fishway. He said a contractor installed netting over the fishways to prevent fish from jumping out.

Dirt Ponds

Kahler said last summer a contractor installed bird netting over two of the four dirt ponds, dramatically increasing steelhead survival from ponding to release. He said the contractor could not cover the remaining two dirt ponds last summer because of excavation activity and access issues associated with the ongoing hatchery modernization project. He said this summer a contractor is installing bird netting over Dirt Pond 1, and that project is nearly complete. He said a transmission tower in Dirt Pond 2 precludes using the same methods used for covering the other ponds. However, since Pond 2 is used for summer Chinook subyearlings, which only occupy the ponds for a few months and are released early at a smaller size than the steelhead, those fish are not subjected to the degree of avian predation observed in the steelhead ponds.

V. All

A. Methow Spring Chinook Broodstock / Tangle-netting (All)

John Ferguson said, following several email discussions, tangle-netting for Methow spring Chinook salmon broodstock was approved by the HCP Hatchery Committees and began last week. He said the Coordinating Committees are now tasked with continuing discussions regarding trapping protocols. Jeff Korth said nothing is needed in terms of modifications to permit language; rather, he believes the task will be addressing the correct size of the Methow Conservation Program. Ferguson suggested first addressing the trapping protocol discussion and memorializing an agreement or decision in the administrative record. Scott Carlon said he spoke with Craig Busack (NMFS HCP Hatchery Committees Alternate), and Busack prefers trapping to tangle-netting. Korth suggested reviewing the email distributed by Kahler on July 8, 2016, which Korth believes succinctly summarizes trapping provisions in the respective permits (Attachment D). Tom Kahler read his email (Attachment D) and noted that the typical trapping protocols have been modified in the past, per Coordinating Committees approval, which has served as the vehicle by which the NMFS Hydropower Division exercised their authority to modify the protocols. Ferguson suggested developing an agreement to allow additional trapping, as needed, without requiring Coordinating Committees approval each time. Kahler countered that the Wells HCP Coordinating Committee must not relinquish their prerogative for supervising activities that could potentially impede fish passage, and clarified that no specific agreement was necessary because, per the requirements of the Wells HCP, the Wells HCP Coordinating Committee already reviews the annual broodstock collection protocols that include the trapping schedules.

The Coordinating Committees representatives present agreed that per the Wells Project HCP, 2000 Wells Project Interim BiOp, 2003 BiOp, and Hatchery Permits 1196, 1347, and 1395, trap operators at Wells Dam have the flexibility to trap spring Chinook salmon outside the protocols used to date (16 hours per day, 3 days per week), in order to achieve broodstock collection targets as prescribed and in consultation with the annual Wells HCP Coordinating Committee-approved Broodstock Collection Protocols.

Ferguson asked how best to address the size of the Methow Conservation Program. Korth suggested that WDFW add this as an agenda item for the next HCP Hatchery Committees meeting. He added that, pending discussions, the topic may also be elevated to the Coordinating Committees.

B. Subyearling Chinook Salmon Workshop Additional Debrief (All)

John Ferguson noted that the draft workshop minutes are out for PUD review and will be finalized and distributed to the committees soon. Ferguson said, after review of the draft workshop minutes, it seems the objectives of the workshop were met. He also recalled the Coordinating Committees agreement to convene quarterly, joint HCP/PRCC sessions to continue discussions regarding subyearling Chinook salmon passage studies.

Tom Kahler thanked Jim Craig, Jeff Korth, and Kirk Truscott for inviting their respective fellow agency members to provide presentations and discussions.

Lance Keller recalled that an impetus for the workshop was that Grant and Chelan PUDs are due under their respective agreements to evaluate the phase designation for subyearling Chinook salmon. He said, based on discussions from the workshop, it seems everyone agrees that survival studies are not yet feasible for subyearlings. He said Chelan PUD plans to present a draft SOA maintaining subyearling Chinook salmon in Phase III (Additional Juvenile Studies) during the Coordinating Committees meeting on August 23, 2016. He said this SOA is not intended to end discussions on subyearlings. Korth asked if Grant PUD is planning the same thing, and Keller said yes, Grant PUD is thinking along the same lines.

VI. HCP Administration

A. Eastern Washington and HCP/PRCC Joint Session Meeting Locations

John Ferguson recalled his action item to coordinate with Denny Rohr about future meeting logistics in Wenatchee, Washington. He said Rohr plans to confirm arrangements with the PRCC during their meeting tomorrow on July 27, 2016. Anchor QEA will coordinate with Rohr following the PRCC meeting to determine meeting logistics for future Coordinating Committees meetings to be held in Wenatchee, Washington, including logistics for the quarterly, joint HCP/PRCC sessions. *(Note: Kristi Geris distributed an email to the Coordinating Committees and PRCC on August 8, 2016, indicating that future Coordinating Committees meetings and joint Coordinating Committees/PRCC sessions will be held at the Grant PUD office located at 11 Spokane Street (second floor), Wenatchee, Washington, beginning with the Coordinating Committees meeting on October 25, 2016.)*

B. Next Meetings

The next scheduled Coordinating Committees meeting is on August 23, 2016, to be held by conference call. Jim Craig said he will let Greg Fraser know the Coordinating Committees plan to postpone Fraser's presentation on Entiat River History and Impacts to Chinook Salmon until the next in-person meeting (to be determined).

The September 27, 2016, meeting will be held by conference call or in-person at the Radisson Hotel in SeaTac, Washington, as is yet to be determined.

The October 25, 2016, meeting will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (to be confirmed).

VII. PRESENTATION: NOAA's Salmon Population Summary Database

A. PRESENTATION: NOAA's Salmon Population Summary Database (Tracy Hillman)

Following the Coordinating Committees meeting, Tracy Hillman provided an overview of NOAA's Salmon Population Summary database and browser.

VIII. List of Attachments

Attachment A	List of Attendees
Attachment B	Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*) (Bouwes et al. 2016)
Attachment C	Closure of Rocky Reach Adult Fishway Orifice Gates, Final SOA
Attachment D	Wells Dam Trapping Provisions Email (Kahler, July 8, 2016)

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Kirk Truscott**	Colville Confederated Tribes
Bob Rose**	Yakama Nation

Notes:

* Denotes Coordinating Committees member or alternate

** Denotes Coordinating Committees member or alternate, joined by phone

† Joined by phone for the HCP Tributary and Hatchery Committees Update and NOAA's Salmon Population Summary Database presentation

†† Joined by phone for the Chelan PUD items

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Attachment B

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Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*)

Nicolaas Bouwes[1,2], Nicholas Weber[1], Chris E. Jordan[3], W. Carl Saunders[1,2], Ian A. Tattam[4], Carol Volk[5], Joseph M. Wheaton[2] & Michael M. Pollock[3]

Beaver have been referred to as ecosystem engineers because of the large impacts their dam building activities have on the landscape; however, the benefits they may provide to fluvial fish species has been debated. We conducted a watershed-scale experiment to test how increasing beaver dam and colony persistence in a highly degraded incised stream affects the freshwater production of steelhead (*Oncorhynchus mykiss*). Following the installation of beaver dam analogs (BDAs), we observed significant increases in the density, survival, and production of juvenile steelhead without impacting upstream and downstream migrations. The steelhead response occurred as the quantity and complexity of their habitat increased. This study is the first large-scale experiment to quantify the benefits of beavers and BDAs to a fish population and its habitat. Beaver mediated restoration may be a viable and efficient strategy to recover ecosystem function of previously incised streams and to increase the production of imperiled fish populations.

Beaver in Eurasia and North America were once abundant and ubiquitous[1]. Their dense and barbed fur has great felting properties, and as early as the 1500s, intense trapping to provide pelts mainly for making hats occurred throughout Eurasia[2]. By the early 1700s, beaver were nearly extirpated in Eurasia, and North America became the new source of pelts for international commerce. The exploration, settlement, and many territorial claims of North America by several European countries were driven mainly by the search for beaver-trapping opportunities[2].

When Lewis and Clark explored the Pacific Northwest in 1805, salmon and steelhead coexisted with beavers in very high densities[1,3]. Fur trade in this region began around 1810, attracting pioneers to settle the area. When the British and United States jointly occupied the Oregon Territories (which included the Columbia River Basin), the Hudson Bay Company implemented their "scorched earth" or "fur desert" policy to eliminate all fur-bearing animals, in an attempt to discourage American settlement[2,4]. As a result, beaver were nearly extirpated from the region by 1900. Around this time, a decrease in the great harvests of Pacific salmon and steelhead was first perceived. Anadromous salmon and steelhead populations have since declined precipitously in the Columbia River Basin, leading to their listing under the U.S. Endangered Species Act (ESA)[5,6]. Agriculture, timber harvest, mining, grazing, urban development, and water storage and hydroelectric dam construction are commonly cited as the causes for salmonid habitat degradation and population declines[7], with rare mention of the loss of beaver and their ability to alter aquatic ecosystems with their dam-building activities[8].

Human activities, including the removal of beaver, have exacerbated the occurrence of stream channel incision, where a rapid down-cutting of the stream bed disconnects the channel from its floodplain[8,9]. Channel incision is a ubiquitous environmental problem in the Columbia River Basin and throughout the world[10–12].

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Attachment B

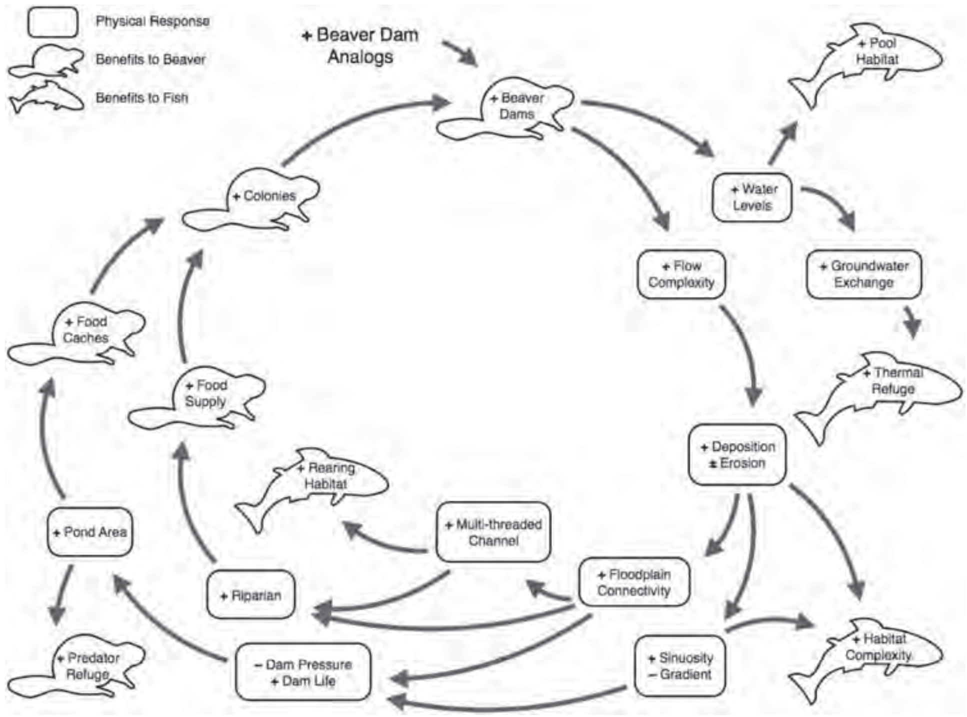

Figure 1. Expected changes following the installation of beaver dam analogs (BDAs). Beaver-made dams and BDAs slow and increase the surface height of water upstream of the dam. Beaver ponds above, and plunge pools below dams change the plane bed channel to a reach of complex geomorphic units providing resting and efficient foraging opportunities for juveniles. Deep pools allow for temperature stratification and greater hydraulic pressures forcing downwellings to displace cooler groundwater to upwell downstream, increasing thermal heterogeneity and refugia. Dams and associated overflow channels produce highly variable hydraulic conditions resulting in a greater diversity of sorted sediment deposits. Gravel bars form near the tail of the pond and just downstream from the scour below the dam, increasing spawning habitat for spawners and concealment substrates for juveniles. Complex depositional and erosional patterns cause an increase in channel aggradation, widening, and sinuosity and a decrease in overall gradient, also increasing habitat complexity. Frequent inundation of inset floodplains creates side channels, high-flow refugia and rearing habitat for young juveniles, and increasing recruitment of riparian vegetation. Flows onto the floodplain during high discharge dissipates stream power, and the likelihood of dam failure. The increase in pond complexes and riparian vegetation increases refugia for beavers, their food supply and caching locations, resulting in higher survival, and more persistent beaver colonies. Beaver will maintain dams and the associated geomorphic and hydraulic processes that create complex fish habitat.

Consequences of channel incision include a lowering of the water table, decreased base flows, warmer water temperatures, and reduced morphological complexity leading to a substantial loss of riparian plant biomass and diversity, and declines in fish populations and other aquatic organisms[13]. The succession of channel incision can be described by four phases: phase 1) rapid incision and disconnection of the floodplain, phase 2) widening of the incised trench, phase 3) building of inset floodplains and long-term aggradation, and phase 4) returning to a channel in dynamic equilibrium that is reconnected to its floodplain[13]. Incised channels can take centuries to millennia to fully recover to the dynamic equilibrium phase[14]. We hypothesized that beaver dams or simulated beaver dams that we construct (referred to as beaver dam analogs or BDAs) can greatly accelerate the incision recovery process[14]. We further hypothesized that advancing channel incision recovery would alter the hydrologic, thermal, geomorphic, and vegetation characteristics of stream reaches and their associated riparian habitats, which in turn would improve habitat conditions for steelhead (Fig. 1).

Ecosystem scale experiments have greatly improved our understanding of watershed processes and are a powerful method for evaluating and predicting responses to environmental change[15]. Such experiments generally involve large-scale perturbations simulating human impacts (e.g., logging, nutrient additions) and have led to changes in strategies to minimize environmental degradation[16–18]. While insightful, these experiments are often costly and destructive, and do not necessarily address mechanisms of recovery processes. Implementing restoration as a watershed-scale experiment could greatly increase our understanding of ecosystem function, and our ability to achieve recovery goals while making better and more efficient use of the financial investments in mitigation[19]. We describe the results of a watershed-scale experiment designed to test whether constructing beaver dam analogs to encourage natural beaver dam development could aggrade a highly incised stream and improve habitat quantity and quality. Our focus here is to evaluate whether this manipulation resulted in an increase in juvenile steelhead density, growth, survival, and production.

Attachment B

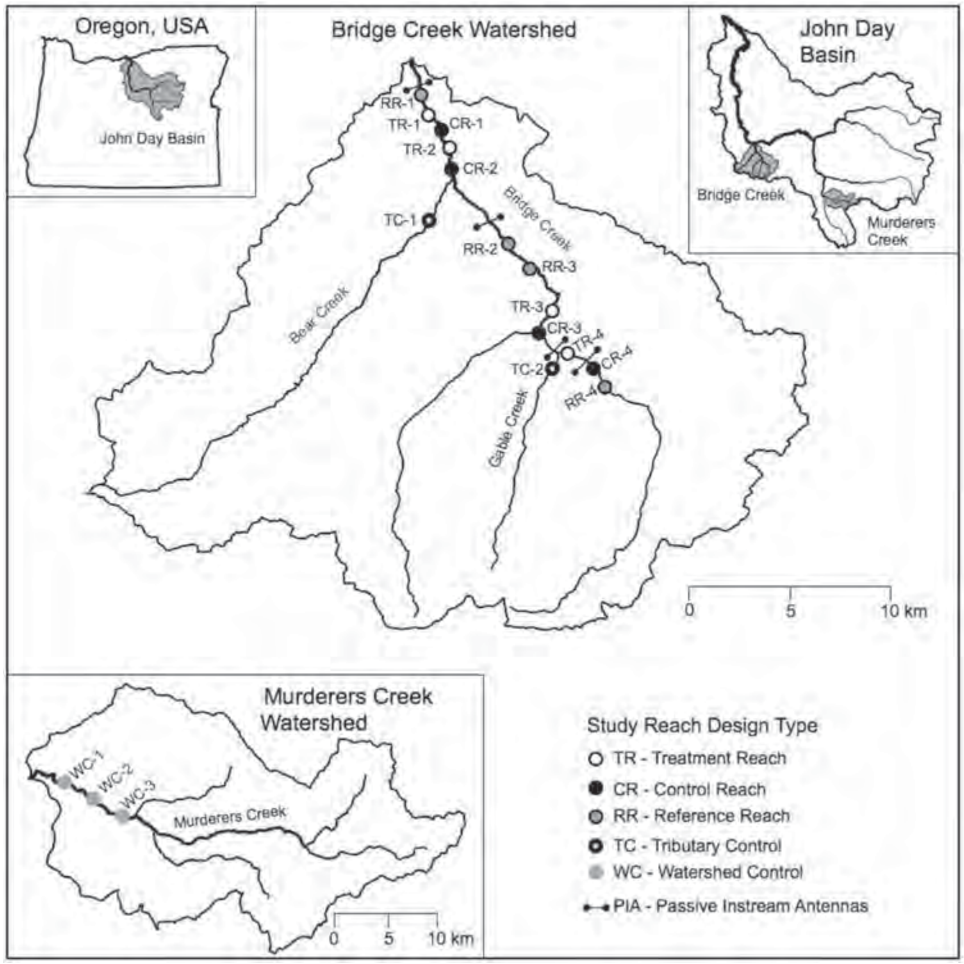

Figure 2. Map of the study areas. TR and CR dots represent treatment and control (similar to treatment reaches with beaver activity) study reach location. RR represent reference study reaches, which generally have minimal inset floodplains and minimal beaver influence. Reaches in tributaries to Bridge Creek (TC) and Murderers Creek (WC) served as additional controls. Passive Instream Antennas (PIAs) distributed throughout Bridge Creek detect Passive Integrated Transponder (PIT) tagged fish to determine viability and movement. Maps were created in ArcGIS version 10.1 (http://desktop.arcgis.com/) and Pixelmator version 3.4 (http://www.pixelmator.com/mac/).

Watershed-Scale Manipulation

Our experiment was conducted in the lower 32 km of Bridge Creek, a 710 km^2 watershed draining into the John Day River in north-central Oregon, USA. (Fig. 2). Steelhead are anadromous *Oncorhynchus mykiss* and are the targeted species for recovery in this watershed (hereafter referred to by their freshwater life stages as juveniles or spawners). Prior to the manipulation, steelhead habitat in Bridge Creek exhibited low complexity and poor quality. Most of the mainstem and lower tributary reaches of Bridge Creek were deeply incised, with riparian vegetation limited to a narrow band along the stream[8]. The stream morphology consisted of a plane-bed system with gradients from 0.5–3.0%, very poor pool habitat, and substrate dominated by coarse and embedded gravel and cobble. In addition, stream temperatures in the summer were warm for juveniles, with the lower portion of the study area approaching lethal thermal limits (~26 °C).

Previous research indicated that aggradation behind beaver dams in Bridge Creek can be rapid, and that connection to inset floodplains could be achieved within a decadal scale[8]. However, surveys of beaver dam distributions spanning the last 3 decades showed that dams within Bridge Creek are generally short lived[20]. Due to the lack of large woody riparian vegetation, beaver dams in Bridge Creek were made with small-diameter materials (e.g., willow shoots). Consequently, dams consistently failed (e.g., 1–2 year lifespan) when subject to the typical annual flood in which all the flow energy was concentrated on the dams, as opposed to spreading out over a floodplain.

Our goal was to encourage beaver to build on stable structures (i.e., BDAs) that would increase dam life spans to facilitate channel aggradation, and eventually floodplain creation and reconnection[14]. BDAs were built by pounding wooden fence posts vertically into the channel bed and potential floodplain surfaces. Posts were spaced 0.3–0.5 m apart and at a height intended to mimic the crest elevation of an active beaver dam[21]. Willow branches were woven between the posts, and bed sediment was used to plug the base of structures. BDAs were designed

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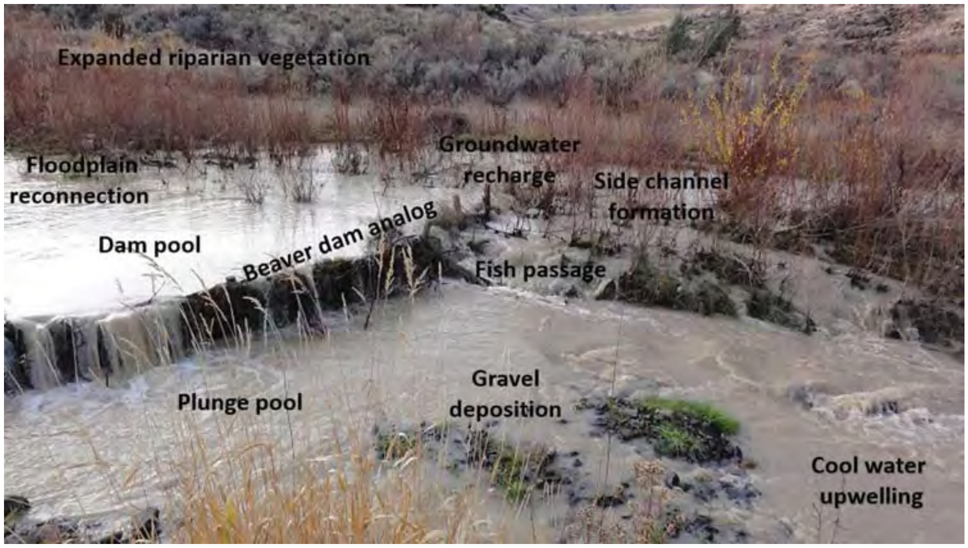

Figure 3. Example of a beaver dam analog (BDA) annotated with some of the expected responses.

to partially replicate many of the basic functions of a natural beaver dam (Fig. 3). The treatment design aimed to saturate four distinct reaches with BDAs, thereby providing resident beavers stable platforms that would encourage the establishment of stable multi-dam complexes to support persistent colonies (Fig. 1). This meant we added BDAs at the maximum frequency that beaver dams are found under natural conditions for a similar stream size and gradient[1]. For most situations at the project site, water from a downstream structure is backed up to the base of the structure upstream during average discharge.

When BDAs were introduced we expected to effectively increase the number and longevity of functional natural and acting beaver dams that, in turn, would initiate a series of alterations that would ultimately restore processes that maintain a new stable state of floodplain reconnection[14]. Changes in both the quantity and quality of fish habitat accompanying this process were expected to elicit a fish population level response (Fig. 1).

The manipulation was implemented in a hierarchical[22] experimental design where we established four of each treatment, control (both in the early phase 3 stage) and reference (in the early phase 2 stage with minimal beaver influence) reaches within Bridge Creek (Fig. 2). We also selected one control reach in each of two tributaries to Bridge Creek, and three reaches in a control watershed, Murderers Creek (Fig. 2). To assess localized habitat and steelhead responses we made comparisons between treatment, control, and reference reaches within Bridge Creek and its tributaries. To assess population level responses, we compared changes in juveniles in Bridge Creek (across all reach types) to Murderers Creek.

We monitored for three years pre-manipulation (2007–2009) and four years post-manipulation (2010–2013). We conducted an annual census of beaver dams and BDA locations and documented functionality. We monitored fish habitat attributes at sites within reaches once per year. Aerial imagery from 2005 and 2013 was also used to quantify changes in channel area and morphology. We monitored sites for juveniles, which were collected and tagged with Passive Integrated Transponder (PIT) tags each year in June, September, and January. In addition, we compared juvenile densities in impounded and unimpounded portions of three reaches in August and September of 2013 to evaluate their use of these different habitats. We also captured and PIT tagged spawners at a fish weir installed during their upstream migration in lower Bridge Creek (Fig. 2). Recapture of tagged fish provided information on density, growth, survival, and production, as well as the ability of spawners and juveniles to migrate throughout the study area. In general, we used intervention analyses to evaluate changes in habitat and fish responses pre- versus post-manipulation relative to controls[23] (see Methods for more details).

Results

Beaver Dam and BDA Abundance. Twenty years of beaver dam surveys in the study area prior to 2009 indicates dam-building activity was highly variable ($\overline{x} = 40$ dams counted per year, min = 9, max = 103, SD = 25; Fig. 4). After 2009, the year in which BDAs were first constructed, the total number of dams (natural beaver dams and BDAs) was on average four times more abundant than pre-manipulation ($\overline{x} = 160$, min = 122, max=236, SD=43; Fig. 4). In 2009, 76 BDAs were installed over 3.4 km of stream in the four treatment reaches. During 2010–2012, additional BDAs were built to replace those that failed during the first year and to continue the stream on the trajectory towards floodplain reconnection (e.g., added on top of BDAs buried by aggradation or to newly formed side channels). By 2012, 121 BDAs were functioning. Of the 236 total dams in Bridge Creek in 2013, nearly half (n = 115) were made by beavers. A total of 171 natural beaver dams and dams built on BDAs represents an 8-fold increase over the 2005–2008 pre-manipulation beaver dam average. The substantial increase in natural beaver dams occurred two years following the manipulation, primarily outside the treatment reaches (Fig. 4), suggesting the manipulation may have created a source of beavers for dispersal into unmanipulated areas. One control reach was subject to a high intensity flood event from an incoming tributary which greatly increased

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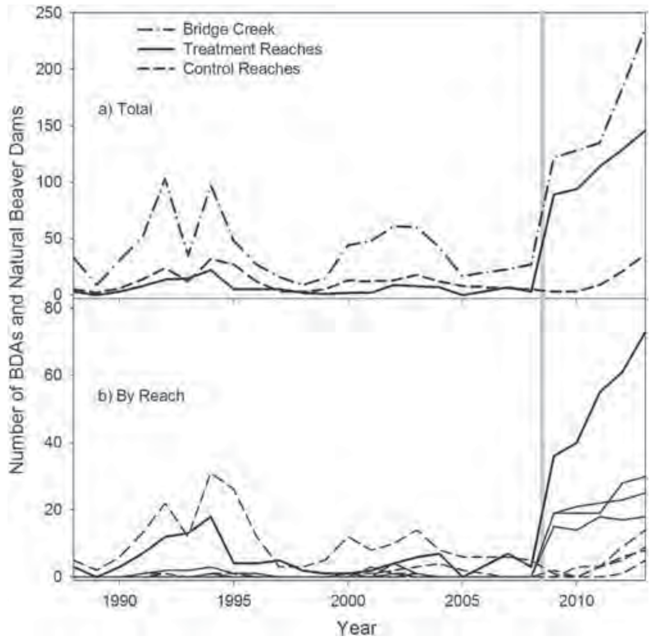

Figure 4. The number of dams (natural beaver dams and BDAs) through time. Upper panel represents the total number of dams for the Bridge Creek (dashed-dotted line), the sum of all treatment (solid line) and all control (dashed line) reaches. The lower panel is total number of dams for each of the four treatment (solid lines) and four control (dashed lines) reaches. Grey vertical line represents when BDAs were initially installed.

the number of new channels throughout the floodplain and was quickly occupied by beaver. With the exception of this reach, beaver dams in control reaches had a 10-fold higher failure rate than reinforced dams, similar to pre-manipulation conditions. No beaver dams were built in the four reference reaches during the study, however, occasionally dams were found in similarly incised channels elsewhere in Bridge Creek.

Habitat Response. Following the manipulation, habitat quantity and quality increased in treatment reaches and most control reaches with expanded beaver occupation relative to non-beaver-occupied reference reaches. BDAs and beaver ams both quickly raised the water, and created large upstream dam pools and downstream plunge pools. Relative to our reference reaches and Murderers Creek this resulted in a higher pool frequency (1.04 90% CI ± 1.01 pools/100 m, $p = 0.09$ and 1.43 90% CI ± 1.51 pools/100 m, $p = 0.11$, respectively; Supplementary Information Fig. 1) and deeper pools (0.10 90% CI ± 0.054 m, $p = 0.02$ and 0.162 90% CI ± 0.081 m, $p = 0.01$; respectively; Supplementary Information Fig. 2). Aggradation occurred rapidly, sometimes burying structures and channels, resulting in newly formed channels. From 2005 to 2013, inundation area of treatment reaches increased by 228%, considerably more than the control and reference reaches which increased 122% and 34%, respectively. New side channels were also formed as high flows were often forced onto inset floodplains. Area of side channels increased in treatment reaches by 1216%, but only by 479% in control reaches, with virtually no change in references reaches.

Information from groundwater wells demonstrated a raising of the water table in a treatment reach relative to a control reach. Water levels below the land surface over the low-flow period averaged −2.527 90% CI ± 0.052 m and −1.909 90% CI ± 0.077 m in a control reach (CR-4) and treatment reach (TR-4), pre-manipulation, and −2.402 90% CI ± 0.121 m and −1.531 90% CI ± 0.169, respectively, post- manipulation. This equates to a 0.25 m ($p < 0.001$) increase in groundwater levels following the manipulation in our treatment reach relative to our control reach that also had some beaver activity post-manipulation.

Temperature loggers placed at the top and bottom of reaches indicated that temperature either dropped or remained constant as water traversed reaches with extensive beaver dams; whereas, temperatures increased in reaches without beaver dams. Maximum temperatures were on average 1.47 °C (90% CI 1.34 to 1.72, $p < 0.001$) cooler in reaches that gained beaver dams after the manipulation (0 dams pre-manipulation to an average of 6.7 dams within 500 m upstream of the temperature loggers post-manipulation), than a reference reach that had no beaver dams within 500 m upstream over the study period.

For illustrative purposes regarding changes in channel planform, we compare water depth maps and longitudinal profiles of sites within the treatment reach (TR-4) and the closest upstream surveyed non-beaver-occupied reference reach (RR-4). Water depth maps and distributions depict greater variability in water depths, channel complexity, and an increase in the number of side channels in the treatment site (Fig. 5). Longitudinal profiles also emphasize differences in the variability of channel width and depths (Fig. 6a–d). We also compared day and night longitudinal temperature profiles for a site in TR-4 to a non-beaver-occupied site approximately 0.5 km upstream. During both day and night, the treatment site was cooler and contained considerably greater thermal heterogeneity (including cool refugia) than the unimpounded site which exhibited almost no longitudinal variability (Fig. 6e,f).

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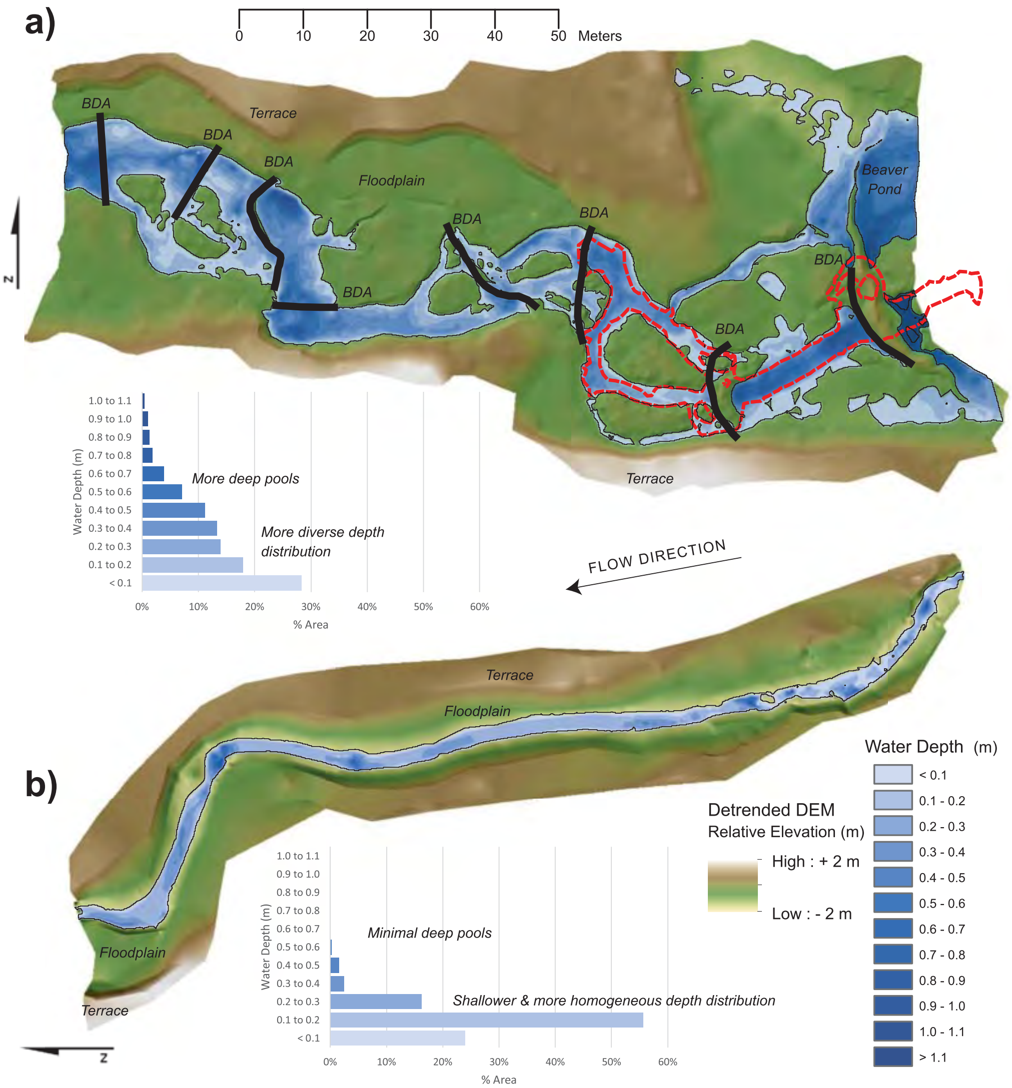

Figure 5. Water depth maps, relative topography and depth distributions for habitat sample site in treatment reach TR-4 (**a**) and a reference reach RR-4 (**b**). Digital elevation models (DEMs) were built from data collected from 2013 topographic surveys, with bottom elevations subtracted from water surface elevations to obtain water depths. Red outline in a) is the location of temperature survey information depicted in Fig. 6. Figure was created in ArcGIS 10.3 and Adobe Illustrator CS6.

Fish Population Response. We PIT tagged 35,867 juveniles from 2007 to 2013. When comparing a beaver pond to an adjacent upstream free-flowing site in three reaches on two dates, the linear and areal density of juveniles was on average 210 fish/100 m ($p = 0.007$) and 27 fish/100 m^2 ($p = 0.004$) greater in impounded than unimpounded reaches, suggesting a higher preference by juveniles for ponded areas. After the manipulation, fish density increased in Bridge Creek by 81 fish/100 m relative to our control watershed of Murderers Creek ($p = 0.01$; Fig. 7 and Supplementary Information Figs 3 and 4). In contrast, juvenile growth decreased after the manipulation by 6.1 grams per season in Bridge Creek relative to Murderers Creek ($p = 0.036$; Fig. 7 and Supplementary Information Fig. 5). Both Bridge and Murderers Creek exhibited density-dependent decreases in growth (growth $= -0.001$*density $+ 0.215$, $R^2 = 0.59$, $p < 0.0001$; growth $= -0.001$*density $+ 0.188$, $R^2 = 0.27$, $p = 0.02$, respectively). Following the manipulation, juvenile survival increased by 52% in Bridge Creek relative to Murderers Creek ($p = 0.004$; Fig. 7 and Supplementary Information Fig. 6). Production of juveniles, being the product of density, growth, and survival, is an informative quantitative indicator of population performance because it integrates multiple responses[24]. Just four years after the manipulation, there was an increase of 175% in juvenile production in Bridge Creek, relative to Murderers Creek ($p = 0.06$; Fig. 7 and Supplementary Information Fig. 7).

Despite the dramatic increase in beaver dams and BDAs, we observed no changes in upstream spawner migration success based on detections of PIT-tagged spawners at upstream arrays. Prior to the manipulation 57%, 18%, and 17% (92% total) of tagged spawners were detected above PIAs 2 through 4, respectively (the spawner trap is located at PIA1). After the manipulation, we observed, on average, 49%, 31%, 14% (93.5% total) of the

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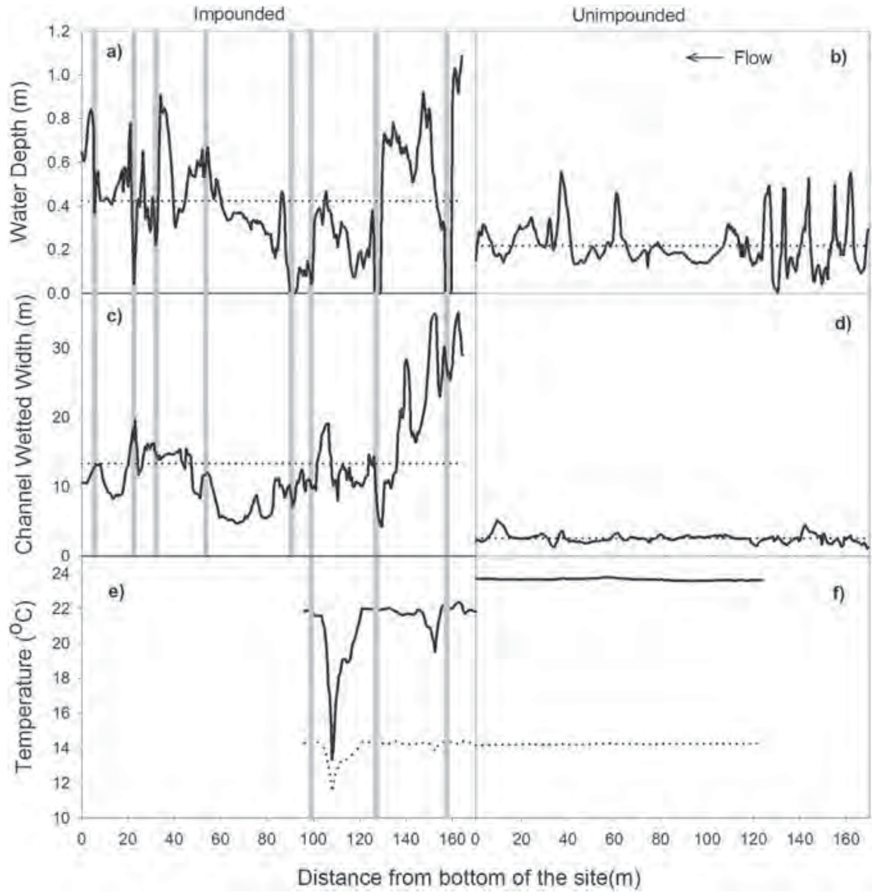

Figure 6. Longitudinal profile of stream characteristics. Water depth and channel width was determined from topographic survey information in 2013 in impounded TR-4 (panel a & c) and unimpounded RR-4 (panel b & d) sites, solid line is the metric value for each location, dotted line is the mean value for the reach. Longitudinal temperature profiles (panel e & f) were obtained from multiple temperature loggers in TR-4 (see Fig. 5) and an unimpounded reach just upstream (between TR-4 and CR-4). The solid line is maximum and dotted line is minimum temperatures. Grey vertical lines represent the locations of dams.

tagged spawners above these detection sites. Furthermore, several spawners were documented as having passed more than 200 dams and BDAs during their migrations. Likewise, more than 1000 PIT-tagged juveniles migrated downstream past the lower-most PIT tag array (PIA1) each year, the near expected amount given observed survival estimates and antenna efficiency. While upstream movement of juveniles is not common in Bridge Creek, we re-detected individuals in upstream reaches separated by more than 40 dams. Overall, mark-resight data indicate that neither beaver dams, nor BDAs, are barriers to spawner or juvenile movement.

Discussion

The addition of BDAs into Bridge Creek led to an immediate and rapid increase in the number of natural beaver dams, not only in our treatment areas but throughout much of Bridge Creek. Beavers build dams and dig canals to expand deep water to create refugia and to aid in the transport of the woody vegetation they harvest. We believe this increased activity throughout Bridge Creek was, in part, due to an increase in the population of beavers facilitated by BDAs. These structures provided stable places to build and expand natural beaver dam complexes that improved their habitat. Changes in the abundance of beavers are difficult to quantify because of their ability to quickly learn to avoid traps[25]. Thus, we cannot state with certainty that the beaver population actually increased following the installation of BDAs. Whether their dam-building activities increased because of a demographic or behavioral response is somewhat immaterial, because the modification of the stream ecosystem, rather than the beavers themselves, likely caused the fish population response.

BDAs and beaver dams led to large changes in both fish and beaver habitat, and the steelhead population response largely followed our hypothesized pathways (Fig. 1). We found compelling evidence that beavers increased the quantity of juvenile habitat. We observed higher linear and areal densities of juveniles in impounded sections of stream relative to unimpounded sections. To demonstrate the potential for beavers to alter stream salmonid production, we believe linear density is the most indicative numeric response variable because dams increase the area of fish habitat per length of stream. Areal densities normalize across streams of different widths; thus a fish response might not be detected even if the population increased simply by increasing the width of the same length of stream (i.e. areal densities stayed the same or even decreased). Studies reporting the influence of

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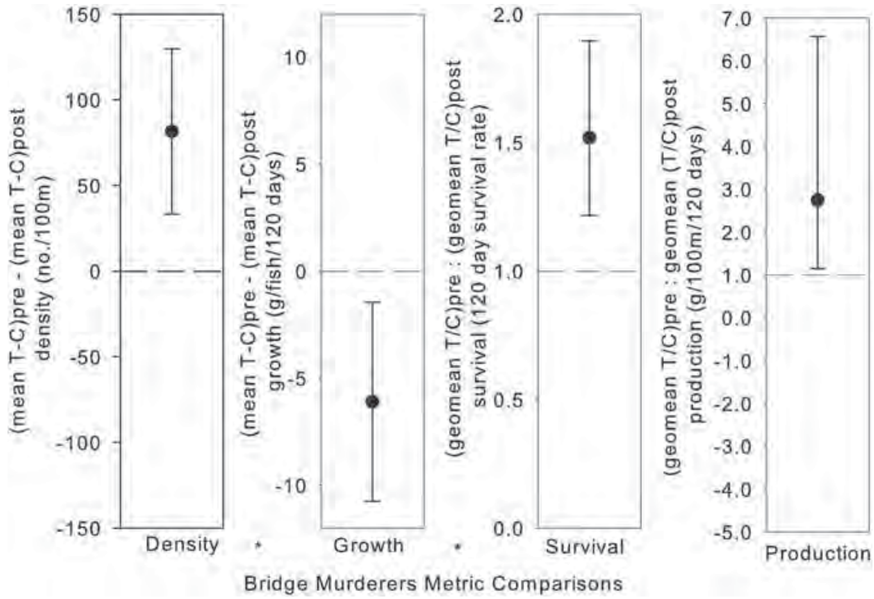

Figure 7. Summary of intervention analyses for juvenile steelhead responses. On every sampling occasion, the control (C) is subtracted (difference) or divided into (ratio) the treatment (T) value. Next, the average difference pre-manipulation is subtracted (difference) or divided into (ratio) the post-manipulation value. Confidence intervals (90%) not overlapping zero for difference and 1 for ratio indicates significance at $\alpha = 0.1$. Comparisons are made between Bridge Creek (treatment) and Murderers Creek (control), respectively. Results for difference in density and average growth, and ratio of survival and production (estimated as density* growth*survival) are displayed.

beaver ponds to produce more fish relative to other habitat types often use areal densities[26,27]. An areal density response metric may under-represent the contribution this habitat type has to the population, because one mechanism by which beaver dams increase fish abundance is by increasing the quantity of fish habitat, as we observed.

Natural beaver dams and BDAs increased the area of juvenile habitat in the treatment reaches in Bridge Creek because these reaches were in the building of the inset floodplain phase (early phase 3) of the successional cycle of an incised channel. The combination of increasing the dam crest height up to the inset floodplain and channel aggradation behind the dam, allowed surface waters to spill out onto inset floodplains greatly increasing the habitat area. The benefits of creating more fish habitat would be diminished in an incised trench, because small increases in surface water area occurs as surface water elevation increases. This condition is representative of our reference reaches. However, beaver dams and BDAs likely increase the rate at which phase 2, or channel widening occurs, thus accelerating the channel incision recovery process to benefit fish populations[14]. In fact, we most commonly observe breaches on the ends of beaver dams or BDAs. Such breaches create an acceleration of a flow jet at the outside bank of the incision trench and increases the rate of widening and the sinuosity of the channel.

The increase in groundwater elevation surrounding beaver ponds likely results in increased flow throughout the summer as water is slowly released[28,29]. We also found that water temperatures stayed the same or decreased throughout reaches with beaver ponds, and that diel fluctuation was dampened. Because dams slow water and often increase the area of solar input, a common assumption is that temperatures increase in impounded reaches[30]. However, quantitative evidence supporting[31,32] or refuting[33] this claim suggests that the complex interaction of solar input, and exchange with the hyporheic or groundwater call into question this simple generality[29]. In Bridge Creek, increased residence time and the slowed release of potentially cooler water after the construction of BDAs also increases habitat quantity during times of very low discharge observed during hot summer conditions.

Increasing habitat complexity may also partially explain the observed increase in total juvenile abundance, survival and productivity. In sections with natural and simulated beaver dams, we observed higher variability in water depth, channel width, and temperature from dam-building activities, all indicators of increased habitat complexity. Increased habitat complexity provides fish a greater selection of locations at which to forage, rest, and avoid predation and high flow events, while reducing migration distances required to conduct these activities for multiple life-stages[34]. Thus, we suspect that an increase in habitat complexity is partly responsible for the observed positive steelhead population responses.

This study provides further quantitative support to the proposal to reintroduce or expand beaver populations in their native range in North America and Eurasia to recover incised channels[8,14,35]. However, the impacts of beaver reintroductions on fish populations, summarized in a recent review[30], have been debated. Of note is the paucity of rigorous empirical studies backing conclusions of both positive and negative impacts. Unfortunately, many approaches to managing beaver populations for fisheries enhancement are also based on assumptions or results from weak study designs. In fact, policies to remove beavers/beaver dams as a means to improve salmonid populations, still exist in some U.S. states[36]. This does beg the question, how did both beavers and salmonids

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coexist in far greater numbers than occurs today without human intervention? While we observed many of the commonly reported positive impacts (habitat complexity), many of the claims of negative impacts of beaver dams on fish (e.g., fish passage barriers, temperature increases) are not supported by our findings to date.

The factors contributing to variability in fish and habitat responses across systems deserves further inquiry and will only be illuminated as additional studies are pursued in widely varying systems. For example, one large scale study found evidence suggestive of an increase in brook trout production after the removal of 200 beaver dams maintained for over two decades, in a low gradient stream network in Wisconsin, USA.[37]. In low-gradient systems with a reduced range of water velocities, beaver dams may not create the same heterogeneous environment as they do in relatively higher gradient systems like Bridge Creek. Multiple controlled experimental manipulations or comparative studies across a range of stream gradients would help establish whether salmonid and fish community responses to beaver-dominated systems are gradient dependent.

The use of BDAs to provide or enhance the benefits beavers have on stream ecosystems and salmonids could be a potential restoration strategy but requires additional rigorous assessments elsewhere. The use of BDAs as a restoration approach is certainly attractive from a cost perspective[38]. In a stream like Bridge Creek, installation of a BDA takes three people approximately 1–4 hours to install, requires a hydraulic post driver and 20–40 wood posts, (at ca. US$4 per post). The cost at a density of ~30 BDAs per km is less than $11,000. In contrast, conventional restoration techniques to achieve such objectives often involve massive grading operations with heavy equipment and major revegetation efforts that are extremely expensive and uncertain. Not only was our manipulation large in scale, but we benefited from the help of beaver to maintain, and likely improve, structures until self-maintaining processes (e.g. floodplain connection) were restored.

More important than the feasibility is our demonstration that such a restoration strategy actually results in benefits to the target population. Billions of dollars are spent annually on stream restoration in the U.S. alone[39]; however, very few studies have documented changes beyond localized increases in fish abundance following stream restoration[40]. Far fewer demonstrate increases in responses associated with fitness (i.e., survival, growth, and production). The few studies that have detected positive population-level changes due to restoration were likely able to do so because they were conducted at large spatial and temporal scales (many km and 10+ years), included extensive monitoring, and maximized contrasts (e.g., before-after-control-intervention experimental designs)[41,42]. Our ability to detect a fish response was, in part, due to the large signal created by adding BDAs to nearly 4 km of Bridge Creek, coupled with considerable localized changes caused by both BDAs and natural beaver dams. Although we tagged >35,000 juveniles, reach-level comparisons were difficult to make for responses requiring seasonal recaptures such as survival, growth, and production. We believe that large-scale experimental manipulations, rather than reach-level, opportunistic evaluations of small-scale habitat projects are necessary to increase our understanding of how fish respond to changes in their habitat or provide evidence of restoration benefits.

In order to improve our understanding of how organisms respond to their environment, ecosystem experiments that use restoration as a treatment and incorporate appropriate large-scale controls should be actively pursued. This approach is consistent with experimental and adaptive management and has recently been implemented to test the effects of stream restoration in several watersheds[19]. Effective implementation of this experimental restoration approach requires an investment in coordination, strong experimental designs, cost-effective yet extensive restoration strategies, and directed monitoring and research. However, the potential to implement more effective management and restoration actions while learning from such approaches readily justifies their cost.

Methods

Experimental and Survey Design. The manipulation was implemented in a hierarchical[22] experimental design where we compared four treatment and four control reaches in the early phase 3 stage within Bridge Creek (Fig. 2). We identified four additional reference reaches with minimal beaver influence. To address effects at different scales, issues of potential non-independence, and to protect against loss of control site information (i.e., create redundancy), we selected one control reach in each of two tributaries to Bridge Creek, and three reaches in a control watershed, Murderers Creek (Fig. 2). All experimental reaches were between 500 and 2000 m in stream length.

We monitored for three years pre-manipulation (2007–2009) and four years post-manipulation (2010–2013). Sample sites (i.e. segments within reaches) were used to characterize reaches. We monitored sites once a year for fish habitat. Aerial imagery from 2005 and 2013 was also used to quantify changes in channel morphology. We monitored sites for juveniles, which were collected and tagged with 12 mm full duplex Passive Integrated Transponder (PIT) tags each year in June, September and January. A habitat preference study to compare densities of juveniles in impounded and unimpounded portions of three reaches was conducted in the fall of 2013. We captured spawners during their upstream migration at a fish weir located near the mouth of Bridge Creek (Fig. 2). All fish PIT tagged were weighed and measured, and spawner sex was determined. Recapture of tagged fish provided information on movement, density, growth, and survival. We estimated production as the product of these responses. In general, we used intervention analyses to evaluate changes in fish response following the manipulation relative to controls[23].

Beaver Dam Surveys. Beaver dam census surveys were enumerated throughout the study area on Bridge Creek in late December during each year from 1988 to 2013[20]. During these surveys, beaver dams were recorded as being either intact (actively impounding water in pond to the maximum dam crest elevation), breached (partially impounding water) or blown out (not impounding water). When BDA structures were installed in 2009 they were surveyed in the same manner as natural beaver dams, and whether or not BDAs were being actively maintained by beavers was also recorded. These surveys were used to track the abundance and distribution of

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natural dams and BDA structures being maintained by beaver throughout the control, treatment, and reference reaches of Bridge and Murderers Creek (Fig. 4).

Habitat Surveys. Fish habitat surveys were conducted in November of each year at a single site within each of the reach types, as well as on rotating basis (every other year) at supplementary sites. In total 48 sites within Bridge Creek and 3 sites in Murderers Creek were sampled. Sites were 160 m in length (approximately 20 bankfull widths) and were surveyed using the methods developed by the Columbia Habitat Monitoring Program[43]. These surveys quantify a number of fish habitat attributes, and utilize survey-grade equipment to provide channel and floodplain topography and water surface extent and elevation. Topographic data were used to generate 10 cm resolution Digital Elevation Models (DEMs) of channel and water surface elevations that were differenced to create a third surface representing the water depths throughout each sub-site survey (Fig. 5). Longitudinal profiles of water depths and channel widths were extracted from water depth maps and wetted widths calculated at an interval of 0.5 m along the channel thalweg from the bottom to the top of the site (Fig. 6a–d).

Channel inundation area was calculated from high-resolution (15 cm) aerial imagery of Bridge Creek before and after the manipulation occurred and beaver dams proliferated. Aerial imagery was acquired on September 27, 2005 and a repeat acquisition was conducted on May 5, 2013 (Watershed Sciences, Corvallis, Oregon). Following acquisition, imagery was ortho-rectified and subject to rigorous quality assurance procedures to ensure spatial accuracy. Areas of inundation were extracted from the 2005 and 2013 aerial imagery by digitizing the extent of the wetted channel throughout each study site using ArcGIS.

Temperature loggers (Onset Tidbit V2, U22) were deployed at the top and bottom of all reaches, continuously recording temperature every 15 minutes. In addition, longitudinal stream temperature profiles were created from temperature monitoring in a portion of a site in a treatment and reference reach (Fig. 6e,f). Temperature loggers were fixed to the streambed for two weeks during the summer throughout the wetted channel at a density of approximately 0.04 m^2, and the location of each logger was surveyed using a Real Time Kinematic (RTK) GPS. Temperature information from each logger was used to construct digital temperature models depicting the spatial distribution of daily maximum and minimum temperature throughout the reach. The longitudinal profiles of stream temperatures presented in Fig. 6e,f, were created by extracting the maximum and minimum temperature on August 17, 2012 observed along the channel thalweg at an interval of 0.5 m from the bottom to the top of the surveyed reach.

Well fields were established adjacent to reaches TR-4 and CR-4 to compare groundwater elevational changes pre- and post-manipulation between a treatment and control reach. A line of 2 to 3 wells perpendicular to the channel extended back approximately 70 m on the terrace. Four and three lines of wells (lines were spaced 50–70 m apart parallel to the stream) produced 10 and 9 wells for the treatment and control reach, respectively. Groundwater elevation was obtained from wells drilled approximately 12 m deep and lined with 5 cm slotted PVC. In each well, water table elevation and groundwater temperature data were collected using HOBO Water Level Loggers (Onset Computer Corp., model U20-001-01) set to record data in one or two hour intervals over the duration of the study period.

Seasonal Juvenile Steelhead Surveys. Juvenile steelhead surveys were conducted in all reach types. Survey sites within these reaches ranged between 500–1000 m in stream length. On each juvenile steelhead survey occasion, two electrofishing passes were conducted, separated by a 24-hour period. During each pass juvenile steelhead were captured using a backpack electrofisher (SAMUS-725MP) and dip nets while fishing from the bottom to the top of the site. Captured salmonids $\geq$70 mm were anesthetized, measured (mm), weighed (g), and PIT tagged (Biomark HPT12, Boise, Idaho) in the abdominal cavity, then released back to their approximate capture location following recovery from the anesthetic. Methods of fish capture and handling were approved by the National Oceanic and Atmospheric Administration's Biological Opinion in accordance to their Federal Columbia River Power System Biological Opinion Letters of Determination 22-14-NWFSC100 and 23-14-NWFSC101 Scientific Research Permits.

Recapture information from each of the two electrofishing passes was used to estimate the population size of juvenile steelhead residing in each site during each seasonal sampling occasion using the Chapman equation[44]. In some cases, low steelhead densities prevented recapture of tagged individuals, and an estimate of capture efficiency (no. marked fish/no. of recaptures) calculated for each site from previous sampling occasions was used to expand the number of fish captured during the first pass into an estimate of population size.

Although the Cormack-Jolly-Seber (CJS) model has traditionally been used to estimate survival rates for tagged fish in the Columbia River Basin, it does not account for emigration thus producing estimates of apparent rather than true survival. Additionally, CJS cannot accommodate continuously collected data, such as the resightings from passive instream antenna (PIAs) that constitute a large portion of our resight data. Therefore, we used the Barker model[45] that uses recapture and continuous "resight" information to simultaneously estimate rates of emigration, immigration, and survival to produce estimates of true survival[46].

We generated encounter histories for each individual PIT-tagged fish from active tagging, mobile antenna surveys, and continuous detections from PIA arrays. We used Akaike's Information Criterion corrected for small sample size (AICc)[47,48] to determine the most parsimonious model for recapture/resight and movement parameters in the Barker model, while survival parameters were unconstrained (i.e., varied through time) in all models. Survival estimates and 95% credible intervals were computed using the Markov Chain Monte Carlo (MCMC) procedure in Program MARK[48,49]. Seasonal survival rates were standardized to 120 days.

Juvenile steelhead growth rates were calculated by direct measurement of the change in weight of PIT-tagged individuals recaptured from one season to the next (reported as g/fish/120 d). Seasonal production (g/100 m/120 d) of juvenile steelhead was calculated for each site as the product of the beginning of season density, seasonal growth rate, and seasonal survival.

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Analyses. We evaluated differences in pool frequency, residual pool depth, temperature, and groundwater elevation, as well as fish responses between treatments and controls using Before-After-Control-Impact paired (BACIP) design intervention analyses[50]. These comparisons were made at the reach or watershed scale depending on the response. Controls in this sense are used as covariates where effects common to both treatment and control reaches (e.g. weather) are filtered from the treatment time series of information by subtracting the control value from the treatment value for all observations. The average of this difference pre-manipulation is compared to the average of the value post-manipulation using a t-test. An $\alpha = 0.10$ was used to create 90% confidence intervals. Intervals encompassing zero were taken to indicate a lack of significant pre- versus post-manipulation difference for each response variable (Fig. 7 and Supplementary Information Fig. 3). In the case of survival and production, a natural log transformation was necessary to meet assumptions of normality (evaluated by inspecting quantile to quantile plots of residuals), which is equivalent to using treatment:control ratios for each observation event in the time series and conducting a ratio t-test. If the 90% confidence intervals surrounding the ratio crosses 1 then a significant difference was not observed.

These types of intervention analyses can bias p-values if assumptions of additivity and serial independence are violated[50,51]. To test the assumption of additivity, the presence of trends between the average versus the difference in paired treatment-control observations was evaluated for each response[50]. To test for auto-correlation, the difference between a treatment-control pair at time t was compared to the difference at $t+1$, for all observations[50]. A significant positive correlation between t and $t+1$ observations was taken as evidence for auto-correlation, suggesting that our p-values were negatively biased. In this case, we also noted whether a positive temporal trend in the difference between treatment-control pairs during the before period, as this violation of the additivity assumption is particularly egregious[52].

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Attachment B

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Author Contributions

N.B. performed analyses, N.B., N.W. and J.M.W. created figures and tables. All authors conceptualized the project, experimental and monitoring designs and contributed to the writing of the manuscript. C.E.J., M.M.P., W.C.S., I.A.T., C.V., J.M.W. reflect equal contributions to the manuscript.

Additional Information

Supplementary information accompanies this paper at http://www.nature.com/srep

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Final
Rocky Reach Habitat Conservation Plan
Coordinating Committees

Statement of Agreement

Closure of Rocky Reach Adult Fishway
Orifice Gates

(Approved July 26, 2016)

Agreement Statement

The Rocky Reach HCP Coordinating Committee (CC) agree to close orifice gates 1, 2, 3, 16, 18, and 20 of the Rocky Reach Adult Fishway in August 2016 to better achieve a one foot differential elevation at the Right Powerhouse Entrance (RPE). Upon the orifice gate closure, Chelan PUD Fishway Attendants will monitor in-ladder hydraulic conditions to ensure the fishway hydraulics are responding as expected to the gate closures. Chelan PUD Fishway Attendants will also conduct daily tailrace observation to see if adult fish are congregating in the immediate vicinity of the ladder entrances. Additionally, Chelan PUD will compile historical daily fish count data for comparison to current daily fish counts, and will distribute the data to the CC weekly through the end of the fish counting season. If results are observed in either fishway hydraulics or fish count data that are substantively inconsistent with historic or expected results, the CC will be notified within 24 hours to discuss the potential remedies, including reopening orifice gates in the Rocky Reach Adult Fishway. Absent any unexpected results that require consideration from the CC, the orifice gates will remain closed in subsequent fish passage seasons.

Background

In order to meet the 1 foot adult fishway differential target at the RPE under low tailwater elevations, one of three operational changes need to be implemented:1) restrict flow through the rotary gates at the RPE; 2) restrict flow to the Left Powerhouse Entrance (LPE) and middle spillway entrance (MSE) using wing gates located at the upstream end of the LPE channel and upstream end of the tunnel leading to the MSE; or 3) provide additional water through sluice gates in diffuser chambers along the collection channel. Option 1 is not applicable since operation of the rotary gates has been restricted. Options 2 and 3 can accomplish the desired goal, but hydraulic conditions in the trifurcation pool (option 2) or a decrease in water velocity through the collection channel (option 3) can result, both of which could effect adult passage in the Rocky Reach Adult Fishway. The closing of orifice gates 1, 2, 3, 16, 18, and 20 would result in the ability to provide adequate flow to the RPE entrance under decreased tailwater elevations without restricting flows at other entrances or reducing velocities inside the fishway.

From: Kristi Geris
To: Kristi Geris
Subject: RE: HCP-CC Methow Spring Chinook broodstock SOA redeux for approval
Date: Wednesday, July 27, 2016 1:18:52 PM

From: Tom Kahler [mailto:tomk@dcpud.org]
Sent: Friday, July 08, 2016 3:06 PM
To: Kristi Geris <kgeris@anchorqea.com>; Bob Rose (rosb@yakamafish-nsn.gov) <rosb@yakamafish-nsn.gov>; Jim Craig (jim_l_craig@fws.gov) <jim_l_craig@fws.gov>; John Ferguson <jferguson@anchorqea.com>; Keller, Lance <Lance.Keller@chelanpud.org>; Kirk Truscott <kirk.truscott@colvilletribes.com>; Korth, Jeff (DFW) (Jeff.Korth@dfw.wa.gov) <Jeff.Korth@dfw.wa.gov>; Scott Carlon <scott.carlon@noaa.gov>
Cc: Gale, William <william_gale@fws.gov>; Tracy Hillman <tracy.hillman@bioanalysts.net>; Sarah Montgomery <smontgomery@anchorqea.com>; (Carmen.andonaegui@dfw.wa.gov) <Carmen.andonaegui@dfw.wa.gov>; Justin Yeager <Justin.Yeager@noaa.gov>; Shane Bickford <ShaneB@dcpud.org>; Steve Hemstrom (steven.hemstrom@chelanpud.org) <steven.hemstrom@chelanpud.org>; Verhey, Patrick M (DFW) <Patrick.Verhey@dfw.wa.gov>; Karl Halupka <Karl_Halupka@fws.gov>; Stephen Lewis <stephen_lewis@fws.gov>; Jeff Krupka <Jeff_Krupka@fws.gov>
Subject: RE: HCP-CC Methow Spring Chinook broodstock SOA redeux for approval

Hi all,

…

Here's some clarification on the trapping provisions in the respective permits, and the origin of the timing constraints. Permits 1347 (summer Chinook) and 1395 (steelhead) constrain trapping to 16 hrs/day, 3 days/week and mandate no trapping at night to facilitate steelhead passage, while, as Jeff notes, Permit 1196 specifies conditions under which 100% of the spring Chinook run could be collected at Wells as a management measure in case of a real or perceived demographic emergency. However, the stated objective in 1196 is that when those conditions don't exist, adult retention "…shall be at levels that will meet maximum production objectives…." The 16 hrs/day, 3 days/week constraints that we've operated under for the last 15 years of spring Chinook collection come from the 2000 Wells Project Interim BiOp that states: "…FERC shall require the licensee to limit trap operations to a maximum of 16 hours per day for three days per week *or as approved by NMFS Hydro Program*, Portland, Oregon [emphasis supplied]. In addition, due to increased handling and delay, the FERC shall require the licensee to discontinue passive trapping operations prior to the 2001 adult fish passage season." Appendix A of the Wells HCP cites this BiOp condition, but omits the provision "…or as approved by NMFS Hydro Program," and thus we've operated without the flexibility included in that BiOp, and in 1196. The 2003 BiOp for the Section 10 ITP for operation of the Wells Project under the HCP deferred to that 2000 Wells Project Interim BiOp and the hatchery permits (1196, 1347, 1395) for trapping schedules. Ultimately, then, NMFS Hydro Program (or current, analogous org configuration) holds the trump card on trapping activities, and in the past, has exercised that through the CC in decisions on whether proposed actions will compromise the Federal Power Act standard of providing safe, timely, and effective passage for Plan Species at DPUD facilities.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	September 27, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the August 23, 2016, HCP Coordinating Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday August 23, 2016, from 9:30 to 11:30 a.m. Attendees are listed in Attachment A to these conference call minutes.

ACTION ITEM SUMMARY

- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).
- Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).
- Coordinating Committees representatives will submit edits and comments on the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) Statement of Agreement (SOA) to Lance Keller by September 15, 2016 (Item III-A).
- Chelan PUD will contact Scott Carlon regarding the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, which Chelan PUD will request approval on during the Coordinating Committees meeting on September 27, 2016 (Item III-A).
- Chelan PUD will provide a Draft 2016 Rocky Reach and Rock Island Spill Report, including a passive integrated transponder (PIT)-tag analysis, to Kristi Geris for

distribution to the Coordinating Committees prior to the Coordinating Committees meeting on September 27, 2016 (Item III-B).

- Chelan PUD will incorporate edits and comments received from the Colville Confederated Tribes (CCT), including a PIT-tag analysis, into the next weekly Rocky Reach Dam Fish Count Update related to the orifice gate (OG) closure (Item III-D). *(Note: Lance Keller provided this update, as described, to Kristi Geris on August 25, 2016, which Geris distributed to the Coordinating Committees on August 29, 2016.)*
- John Ferguson will contact Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) to: 1) notify the PRCC the Coordinating Committees meeting on September 27, 2016, will be held via conference call, as a courtesy for planning PRCC meeting logistics; 2) obtain access to the Grant PUD Wenatchee Office for the Coordinating Committees meeting on October 25, 2016; and 3) coordinate November and December 2016 meetings dates to further discuss with Tracy Hillman and the HCP Hatchery Committees (Item V-A). *(Note: Ferguson discussed these items with Rohr following the meeting on August 23, 2016, and Ferguson will provide an update during the next Coordinating Committees meeting on September 27, 2016.)*
- **The Coordinating Committees meeting on September 27, 2016, will be held via conference call (Item V-A).**

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

- Kristi Geris sent an email to the Coordinating Committees on August 10, 2016, notifying them that a Wells Project Land-use Permit Application (City of Pateros) was available for a 60-day review period, with comments due to Tom Kahler by Monday, October 10, 2016.

- Kristi Geris sent an email to the Coordinating Committees on August 15, 2016, notifying them that Amendment Requests to Remove Unconstructed Small Turbines from Licenses at Rocky Reach and Rock Island dams were available for review, with comments due to Lance Keller by September 15, 2016.
- Kristi Geris sent an email to the Coordinating Committees on August 22, 2016, notifying them that the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA is available for review; edits and comments are due to Lance Keller by September 15, 2016 (Item III-A).
- Kristi Geris sent an email to the Coordinating Committees on September 6, 2016, notifying them that a Wells Project Land-use Permit Application (Thomason) was available for a 60-day review period, with edits and comments due to Tom Kahler by Friday, November 4, 2016.

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

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

- Lance Keller added a discussion on fish count data associated with the Rocky Reach Dam OG closure.
- Tom Kahler added an update on ongoing studies and activities at Wells Dam.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft July 26, 2016, meeting minutes. Kristi Geris said a second revised version was distributed to the Coordinating Committees prior to the meeting on August 23, 2016, which included comments from Jeff Korth. Geris said four items remain to be discussed, as follows:

- Regarding the Decision Summary, Kirk Truscott clarified that the CCT's approval to end spill at Rocky Reach Dam at midnight on August 15, 2016, was not contingent upon discussing what can be done to minimize missing the 95% passage metric in the future; rather, additional discussion was only a request. Lance Keller said, based on discussions with Justin Yeager, the National Marine Fisheries Service's (NMFS's) approval was also not contingent upon additional discussion; rather, this was also just a request. The statement regarding contingencies to this approval will be struck from the record.

- Regarding the Agreement about trap operators at Wells Dam having the flexibility to trap spring Chinook salmon outside the protocols used to date in order to achieve broodstock collection targets as prescribed and in consultation with the annual Wells HCP Coordinating Committee-approved Broodstock Collection Protocols, the Coordinating Committees agreed to strike the statement, 'without first requiring approval from the Coordinating Committees' from the Agreement.
- Regarding the HCP Tributary Committees Update, Tracy Hillman clarified that the Okanagan Nation Alliance field trip is scheduled for October 12 and 13, 2016 (not October 13 and 14, 2016). The record will be revised as such.
- Regarding Chelan PUD's Rock Island Powerhouse 1 Maintenance Update, Lance Keller clarified the record should reflect that seven (not ten) units will be rehabilitated. The record will be revised as such.

Geris said all other comments and revisions received from members of the Committees were incorporated into the revised minutes. Coordinating Committees members present approved the July 26, 2016, meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on July 26, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on July 26, 2016):*

- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).*
  To be discussed during today's conference call and will also be carried forward.
- *Chelan PUD will provide a summary regarding the Rock Island Powerhouse 1 Units B1 to B4 modernization outage through 2020 and what effects this may have on*

spill and overall generation capacity at the project (Item I-C).
To be discussed during today's conference call.

- *Jeff Korth will inquire internally whether the Washington Department of Fish and Wildlife (WDFW) still has fixed radio telemetry sites installed at Rock Island or Rocky Reach dams (Item III-A).*
  Korth said fixed radio telemetry sites are currently installed for a steelhead study at Rock Island Dam, including three sites covering the forebay at the left bank, center adult ladder, right bank, and one site in the tailrace at the right bank. He said no fixed radio telemetry sites are currently installed at Rocky Reach Dam.
- *Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item III-B).*
  This action item will be carried forward.
- *Anchor QEA, LLC, will coordinate with Denny Rohr (PRCC Facilitator) to determine meeting logistics for future Coordinating Committees meetings to be held in Wenatchee, Washington, including logistics for the quarterly, joint HCP/PRCC sessions (Item VI-A).*
  Kristi Geris distributed an email to the Coordinating Committees and PRCC on August 8, 2016, indicating that future Coordinating Committees meetings and joint Coordinating Committees/PRCC sessions will be held at the Grant PUD office located at 11 Spokane Street (second floor), Wenatchee, Washington, beginning with the Coordinating Committees meeting on October 25, 2016.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the last HCP Hatchery Committees meeting on August 17, 2016.

- *U.S. Fish and Wildlife Service (USFWS) Bull Trout Consultation Update*: The Wenatchee Biological Opinion (BiOp) is currently being reviewed by applicants, and the Methow BiOp is undergoing internal review.
- *NMFS Consultation Update*: The Wenatchee Steelhead BiOp has been signed, and Section 10 permits will be issued soon. The draft Methow Spring Chinook Salmon BiOp is out for a two-week review by the applicants, and the Environmental Assessment is undergoing internal review. NMFS is working with WDFW on the Methow Steelhead Adult Management Plan.
- *Review Hatchery Monitoring & Evaluation (M&E) Plan Draft Appendices*: The HCP Hatchery Committees reviewed and approved Hatchery M&E Plan Appendix 3, which addresses proportionate natural influence, proportion of hatchery-origin spawner targets, and sliding scales. Hatchery M&E Plan Appendix 6, which addresses rearing targets, was edited, approved, and finalized. Hatchery M&E Plan Appendix 5, which addresses stray rates, was reviewed and edited, will be further reviewed, and will be finalized during the next meeting on September 21, 2016.
- *Population Structure of Upper Columbia River Summer and Fall Chinook Salmon*: The HCP Hatchery Committees reviewed the best available information on genetics and population structure of upper Columbia River summer and fall Chinook salmon and concluded the Upper Columbia River summer and fall Chinook salmon are one genetic population. Therefore, straying among subbasins (e.g., Wenatchee and Methow basins) will be considered a "within population genetic stray," and a 10% genetic stray rate applies. For example, Wenatchee summer Chinook salmon cannot make up more than 10% of the Methow summer Chinook salmon spawning escapement. Previously, a 5% genetic stray rate was applied because the Upper Columbia River summer and fall Chinook salmon populations were assumed to be independent populations. For management purposes, straying among subbasins will be considered a "management stray" and should not exceed 5%. Jeff Korth asked about the difference between genetic and management strays. Hillman explained that the HCP Hatchery Committees formerly followed stray rates outlined in the Interior Columbia River Basin Technical Recovery Team (TRT) Report and the Upper Columbia Spring Chinook and Steelhead Recovery Plan. The TRT and Recovery Plan identify stray rates based on population genetics, while management strays are based

on management goals. He said management stray rates are more rigorous. Kirk Truscott further explained that from a genetic perspective, spawning populations in the area are fairly homogenous, but a management stray level will allow differentiation to occur over time. Hillman agreed, adding that this will allow local adaptation to occur within each of the subbasins. John Ferguson asked, if the population is essentially the same genetically, how can a difference be detected between subpopulations. Hillman said this can be done based on tagging and marking of hatchery fish.

- *Spring Chinook Broodstock Collection at the Chiwawa Weir*: WDFW has been collecting natural-origin spring Chinook salmon broodstock at the Chiwawa Weir. By July 9, 2016, WDFW had collected 69 bull trout, which is the limit for bull trout encounters at the weir; therefore, WDFW had to terminate broodstock collection at the weir even though only 22 of the 80 natural-origin broodstock had been collected. WDFW and Chelan PUD requested from USFWS an increase in the allowance of bull trout encounters from 67 to 110 bull trout during spring Chinook salmon broodstock collection at the Chiwawa Weir. USFWS granted the increase, and to date, WDFW has collected 61 natural-origin broodstock and encountered 101 bull trout. Hillman noted that initially, obtaining so few spring Chinook salmon may seem upsetting; however, the positive aspect of the issue is the large increase in bull trout in the Chiwawa River Basin. He said more than 2,300 adult bull trout were estimated to inhabit the Chiwawa River last year, and this year the estimate is similar or slightly lower.
- *Pilot Study to Collect Summer Chinook Salmon Broodstock within the Chelan River for the Chelan Falls Program*: Chelan PUD conducted a pilot trapping effort at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station. Within a short period of time, the target of 100 summer Chinook salmon were collected. In fact, 60 summer Chinook salmon were collected in one day. These fish will be segregated from other Chelan Falls broodstock in order to evaluate egg viability.
- *Review of Upper Columbia Salmon Recovery Board (UCSRB) Draft Hatchery Report*: UCSRB asked if the HCP Hatchery Committees would review the Board's Draft Hatchery Report. UCSRB is preparing summary reports on Habitat, Hatcheries,

Harvest, and Hydropower ("four H's"). In general, these reports are intended to improve integrated decision-making, improve communication and outreach, identify key uncertainties and gaps in knowledge, and improve understanding of progress toward integrated recovery. UCSRB completed the Final Habitat Report a couple years ago and is currently finishing the Draft Hatchery Report. The HCP Hatchery Committees agreed to review the report. The draft report should be available for review within the next few weeks, and the final report should be available later this year. Bob Rose asked if these reports are mostly explanations or recommendations. Hillman said the reports include some recommendations, but are basically reviews of the four H's and what they contribute to recovery. He said he believes the reports also make some recommendations that may help in recovery efforts, which is a key reason why the HCP Hatchery Committees wanted to review these reports. Ferguson asked if the UCSRB is accepting of the performance of the HCPs, does this have any bearing on FERC or the respective licenses. Tom Kahler said there is no perfect connection, but if UCSRB has an issue with the way the HCPs are implemented, UCSRB would coordinate directly with FERC. Kahler said he understands the Board just wants a report card on the four H's—not a report card on the HCPs, but on hatcheries and their ability to achieve recovery. Hillman suggested reviewing the recent UCSRB Habitat Report (2014) because the layout is similar to the UCSRB Hatchery Report. *(Note: Hillman provided a web link to access the UCSRB Habitat Report to Kristi Geris following the meeting on August 23, 2016, which Geris distributed to the Coordinating Committees that same day.)*

- *2017 Rock Island and Rocky Reach Hatchery Monitoring and Evaluation (M&E) Implementation Plan*: The HCP Hatchery Committees reviewed and approved the plan.
- *HCP Administration:* The HCP Hatchery Committees and PRCC Hatchery Subcommittee agreed to convene their respective meetings back-to-back (on the same day) when agendas are brief. During back-to-back meetings, the HCP Hatchery Committees agreed to hold their meetings at Grant PUD's conference room in Wenatchee, Washington. The HCP Hatchery Committees also agreed to start their meetings at 9:00 a.m., rather than 9:30 a.m.

- *Next Steps*: The next meeting of the HCP Hatchery Committees will be on September 21, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the last HCP Tributary Committees conference call on August 11, 2016.

- *Review of Middle Entiat 80% Restoration Plans*: The HCP Tributary Committees received a request from Chelan-Douglas Land Trust (CDLT) and the Bureau of Reclamation (Reclamation) to review the 80% Middle Entiat River Restoration Plans. Recall in January 2016, the HCP Tributary Committees reviewed the 60% designs and concluded they were appropriate, but Reclamation made modifications to the 60% designs and would like feedback from the HCP Tributary Committees. The HCP Tributary Committees did not have time this month to review the designs, and requested to conduct the review in September 2016. The HCP Tributary Committees will provide comments to CDLT and Reclamation in September 2016.
- *Rock Island and Rocky Reach Plan Species Account Audit*: Cordell, Neher & Company completed their audit of the Rock Island and Rocky Reach Plan Species Accounts. They reviewed and tested the deposits into the Plan Species Accounts and reviewed a sample of project financial reports. They found that deposits were made in accordance with the HCP Agreements and all projects reviewed were approved in accordance with project budgets. The next audit of the Rocky Reach and Rock Island Plan Species Accounts will be in 5 years. Recall, the Wells Plan Species Account is audited annually.
- *General Salmon Habitat Program Application*: Recall in May 2016, the HCP Tributary Committees reviewed an application from Trout Unlimited titled Leavenworth Diversion Screening Project, involving installation of a NMFS-compliant fish screen on the City of Leavenworth Icicle Creek Diversion to prevent salmonid entrainment. The diversion is located at river mile 5.7 on Icicle Creek, which is upstream from the Boulder Field. In May 2016, the sponsor requested funding from HCP Tributary Funds, but at that time, the HCP Tributary Committees were unable to reach a funding decision and asked the City of Leavenworth to contribute up to about 25% of the total cost. In July 2016, the HCP Tributary Committees received a letter from the project sponsor indicating that the City of Leavenworth is unwilling to support the

project financially. The City of Leavenworth had previously indicated to others that they would not support fish passage at the Boulder Field unless the funding entities screen the Leavenworth Diversion. The HCP Tributary Committees were displeased with the City for effectively holding the Boulder Field project hostage, since the City's screening responsibility remains in effect, regardless of whether or not the Boulder Field project proceeds. After much discussion, the HCP Tributary Committees elected not to fund this project. Jim Craig asked how important the support of the City is to fish passage at the Boulder Field. Hillman said not that critical and added that the Salmon Recovery Funding Board (SRFB) is contributing a lot to this project. He said he understands the SRFB has a contract with the project sponsor, which will make it difficult for the City to interfere with the fish passage project. Ferguson asked if the Boulder Field is moving forward with SRFB and if the diversion screening is moving forward with regulatory agencies, and Hillman said that is what the HCP Tributary Committees understand.

- *Next Steps*: The next meeting of the HCP Tributary Committees will be on September 8, 2016.

III. Chelan PUD

A. Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA (Lance Keller)

Lance Keller said the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA (Attachment B) was distributed to the Coordinating Committees by Kristi Geris on August 22, 2016. Keller said Chelan PUD will not request approval of the draft SOA during today's meeting; rather, he just wants to present it to the Coordinating Committees at this time. He said this draft SOA is similar to the SOA that recently expired in June 2016, and he read aloud the Agreement Statement in Attachment B. He said while drafting the Agreement Statement, Chelan PUD was conscious that the Coordinating Committees want to continue ongoing discussions about subyearling Chinook salmon. He said this SOA does not stop those discussions from moving forward, and Chelan PUD looks forward to these and the quarterly joint discussions with Grant PUD, as well. Keller said Chelan PUD will request approval of this draft SOA during the Coordinating Committees meeting on September 27, 2016. John Ferguson added that if the

Coordinating Committees are ready to approve the SOA, the vote can also take place today. Keller agreed, but said a vote is not required today.

Kirk Truscott requested additional time to review the draft SOA prior to voting. He said the CCT will likely have no issues, but may have comments on the background language. He suggested, for example, the CCT might recommend incorporating a statement about assessing methods or strategies to evaluate life history. He said he does not believe that subyearlings' life history will change to any significant degree in the next 3 years; therefore, the Coordinating Committees need to reconsider the methods or strategies needed to evaluate these life histories in a survival study. Keller agreed that additional consideration needs to be given as to how the statistical model will address subyearling life history diversity.

Coordinating Committees representatives will submit edits and comments on the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA to Lance Keller by September 15, 2016. Chelan PUD will contact Scott Carlon regarding the draft SOA since he was not able to attend today's meeting, and Chelan PUD will request approval during the Coordinating Committees meeting on September 27, 2016.

B. Rocky Reach and Rock Island Summer Spill Update (Lance Keller)

Lance Keller reviewed summer spill updates, as follows:

Rock Island Dam

Keller said summer spill (20% of the daily average river flow) at Rock Island Dam started on May 29, 2016. He said that spill shutdown criteria were achieved, and summer spill was shut off on August 11, 2016. He recalled the criteria to shutdown summer spill includes: 1) Data Access in Real Time (DART) must have estimated that 95% of the juvenile subyearling Chinook salmon run has passed the project; and 2) daily subyearling Chinook salmon index counts at the juvenile bypass system must be 0.3% or less of the cumulative subyearling index total for any 3 out of 5 consecutive-day period. Keller said, as of today, DART estimates that 99.7% of the juvenile Chinook salmon outmigration had passed Rock Island Dam. He said that DART back calculated that 99.17% of the juvenile Chinook salmon outmigration had passed Rock Island Dam on August 11, 2016, when spill was shut off.

Keller said, while seeking approval to shutdown spill at Rock Island Dam, Kirk Truscott provided questions about shutting off spill at Rock Island Dam prior to Rocky Reach Dam, as distributed to the Coordinating Committees on August 10, 2016. Keller explained, as distributed to the Coordinating Committees on August 11, 2016, that the Rock Island and Rocky Reach HCPs are independent agreements, including spill. He attributed this to the different runs of subyearling Chinook salmon assessed at Rock Island Dam versus Rocky Reach Dam. He added that, historically, criteria have been met on different days at Rock Island and Rocky Reach dams. He said Thad Mosey (Chelan PUD Fish Biologist) will begin drafting the end-of-year spill analysis, which is a report on total passage percentage and overall spill volume for the season.

Rocky Reach Dam

Keller said shutdown criteria were achieved, and summer spill was shut off at Rocky Reach Dam on August 15, 2016. He said this year was unique compared to past years, and explained that, typically, summer spill is initiated soon after Wells and Chief Joseph hatcheries start their juvenile subyearling releases. He said, this year, Chief Joseph Hatchery released early, and he noted that Truscott notified Chelan PUD of these plans. Keller said, in a typical year, there is a slow trickle of fish counted, then a sharp increase, spill is turned on, the rest of the hatchery migration is captured, counts fall off, and then natural-origin passage occurs from mid-June to August. He said, this year, spill was initiated on May 29, 2016, based on data obtained on May 28, 2016. He said, on May 28, 2016, DART estimated that 3.3% of the juvenile subyearling run had passed Rocky Reach Dam, and based on those data, it seemed the 95 percentile would be met. He explained that DART continues to refine and recalculate run-timing estimates on a daily basis as daily index count data are added to the database. He said, once spill was turned on, counts dropped off. He said counts at Rocky Reach Dam included: May 29 = 114; May 30 = 11; May 31 = 7; June 1 = 10; June 2 = 80; June 3 = 69; and June 4 = 128. He said the previous estimate of 3.3% is now 7.99%, which means Chelan PUD is unable to spill for 95% of the juvenile subyearling outmigration at Rocky Reach Dam. He said, currently, DART is estimating 99.8% of the juvenile subyearling Chinook salmon outmigration had passed Rocky Reach Dam as of August 22, 2016.

Keller said he discussed the 2016 spill season with Truscott and Justin Yeager. He said Chelan PUD wants to determine how much of an outlier 2016 was, and whether PIT-tag data can provide guidance to meet the 95 percentile moving forward. He said he will review the past few years of PIT-tag data for Wells and Chief Joseph hatcheries releases to determine travel times. He will also incorporate daily average river flows and review river temperatures to determine the correlation between flow and travel times. He said Chelan PUD will provide a Draft 2016 Rocky Reach and Rock Island Spill Report, including a PIT-tag analysis, to Kristi Geris for distribution to the Coordinating Committees prior to the Coordinating Committees meeting on September 27, 2016.

Keller said Chelan PUD is also working on improving spill initiation and shutdown communication in the future. Jeff Korth asked how difficult initiating or ending spill is. Keller said initiating and ending spill is not too hard; however, internal spill coordination is quite involved. He said that Thad Mosey distributes spill memorandums 2 to 5 days in advance, which go to the PUD's power operators. Keller said there is also quite a bit of downstream coordination regarding flow and total dissolved gas (TDG). He said movement of spill gates at Rocky Reach Dam is simple, but is more labor intensive at Rock Island Dam where a crew needs to be mobilized to open and close gates, which requires scheduling ahead of time.

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

Lance Keller recalled that during the last Coordinating Committees meeting on July 26, 2016, Chelan PUD provided a comprehensive update on proposed changes to Rock Island Powerhouse 1 Units B1 to B4. He said there are no further updates on the rehabilitation at this time. He said he does have an update regarding Chelan PUD's action item to provide a summary about what effects the rehabilitation (outage) may have on spill and overall generation capacity at the project. He said generation at Rock Island Dam is 216,000 cubic feet per second (216 kcfs). He said the unit capacity of Units B1 to B4 is 6.75 kcfs each (27 kcfs total). He said with Units B1 to B4 out of service, generation at Rock Island Dam is reduced to 189 kcfs. He said Rock Island Dam has been operating in this configuration since results came back from the blade test. He said he spoke to Marcie Steinmetz (Chelan PUD

Water Resource Specialist) who indicated there were two TDG exceedances at Rock Island Dam during the month of June 2016. Keller said the water quality standard during bypass season is 115% TDG, which is measured in the Wanapum Dam forebay. He said, on June 5 and 6, 2016, two exceedances were attributed to higher flows than forecasted and were weather-dependent. He explained that as water travels from Rock Island Dam to Wanapum Dam, it typically degasses; however, warm water paired with windy conditions decreases degassing. He said, on June 5, 2016, TDG in the Rock Island Dam tailrace was 115.7%, which translated to 116.0% in the Wanapum Dam forebay. He said, on June 6, 2016, TDG in the Rock Island Dam tailrace was 117.1%, which translated to 116.5% in the Wanapum Dam forebay. He said it is worth noting, however, that on June 7, 2016, TDG in the Rock Island Dam tailrace was 117.0%, which translated to 114.0% in the Wanapum Dam forebay. He said Steinmetz believes this was attributed to an increase in air temperature and an increase in wind. Keller said, based on experiencing only these two brief exceedances, Chelan PUD does not believe the rehabilitation (outage) will have a negative effect on TDG at the project.

D. Fish Count Data associated with the Rocky Reach Dam OG Closure (Lance Keller)

Lance Keller recalled that last Thursday, August 18, 2016, he provided fish count data that Chelan PUD will be distributing every Thursday until mid-November 2016 to evaluate the closure of the OGs in the adult fishway at Rocky Reach Dam. He said comments were received from Kirk Truscott on August 19, 2016, as follows:

1. *How relevant is the 10-year average in your table? Seems that with the inclusion of 2016 and the previous 5-years that the 5-year average would be more appropriate, and the previous 5-year returns (total return by date) are more consistent with 2016 than the previous 10-years (based on a cursory look at the previous 5-years).*
2. *May want to consider adding passage graphs from Fish Passage Center (comparison graph -2016, 2015 and 10-year average) for Rocky Reach and Rock Island dams. This may better put into context the daily 2016 counts at Rocky Reach Dam.*

Keller said he agrees with Truscott's first comment, and Thad Mosey will make this change, as suggested. John Ferguson asked how the 5-year average is better. Truscott explained that run sizes during the last 5 years are more in line with abundance of summer Chinook salmon than the 10-year average. Keller said he also agrees with Truscott's second comment, and Mosey will make this change, as suggested. Ferguson asked about the best travel times to use, and Keller said this is difficult to narrow in on because daily counts of all species are being evaluated and travel times differ by species. Keller said he believes it is more important to verify that the general trending of lines are aligning (Rocky Reach Dam counts compared to Rock Island Dam are not drastically lower). Keller recalled Truscott's suggestion while discussing this SOA to review PIT-tag data, which Keller said he did and will include in the next weekly update.

Chelan PUD will incorporate edits and comments received from the CCT, including a PIT-tag analysis, into the next weekly Rocky Reach Dam Fish Count Update related to the OG closure. *(Note: Keller provided this update, as described, to Kristi Geris on August 25, 2016, which Geris distributed to the Coordinating Committees on August 29, 2016.)*

IV. Douglas PUD

A. Ongoing Studies and Activities at Wells Dam (Tom Kahler)

Pacific Lamprey

Tom Kahler said 51 Pacific lamprey were tagged and released just upstream of Rocky Reach Dam, which complements additional fish tagged and released by Chelan and Grant PUDs. He said so far only one Pacific lamprey has been detected passing Wells Dam this year, which occurred in May 2016. He said one fish was detected passing back and forth through the fish counting window area of the ladder last week; however, the fish was last observed passing downstream through the count window. He said, since the beginning of the 2016 Douglas PUD Pacific lamprey studies, a total of 16 orphan tags have been detected passing Wells Dam, and he hopes some of those are lamprey. He said detections have been directional and sequential through the coils and in an upstream direction. He said he is not sure about the overall proportion of the total Pacific lamprey run that is tagged; however, he believes it is small. He said no Pacific lamprey have used the lamprey boxes installed last year. He said two orphan-tagged fish switched ladders while passing the dam, and all other fish have passed the dam via the east ladder. Kahler will investigate to determine the species of those tagged fish currently classified as orphans, as they could be steelhead or summer

Chinook instead of lamprey. John Ferguson said it seems Pacific lamprey passage is still an issue at Wells Dam; however, Kahler said it is an enumeration issue, rather than passage, as those lamprey observed passing the count windows do so easily.

Bypass Operations

Kahler said bypass operations at Wells Dam were turned off at midnight last Friday, August 19, 2016. He said crews will begin pulling barriers this week starting on the east side of the dam, which will coincide with biannual maintenance on Unit 9.

Bypass Bay 2

Kahler said Biomark will be on site to witness the removal of the bypass structures that contain the PIT-tag system installed in Bypass Bay 2. He said there is interest in how well the system survived being submerged, because Douglas PUD is considering expanding the system to other bypass bays. He recalled that 4 antennas were installed in the top two rows of the bypass. He said the top two rows represent the upper 8 feet of the forebay. He said no Chinook salmon were detected, and only steelhead and Coho salmon were detected. He said Chinook salmon may have been detected, had the system been installed earlier in the season. He said the Bypass Bay 2 detection system detected 46 fish this year, including 18 Coho salmon (3 wild), 26 steelhead (4 wild), and two "unknown." He said Okanogan Basin steelhead detected included: one hatchery-origin from Loup Loup Creek, four hatchery-origin from Omak Creek, and two hatchery-origin from Salmon Creek. He said 70% of the fish were detected in the bottom row. He said there were also periods when the forebay elevation was below the antennas or debris was clogging the antennas. He said, based on fyke net data, Chinook salmon in general, including subyearlings tend to migrate deeper in the water column. He said Douglas PUD asked Biomark to inspect the system and obtain measurements of the lower sections for consideration of installing additional antennas. He said logistical details also need to be discussed.

Ferguson asked what might occur next year in terms of expanding the detection capacity of the PIT-tag detection system installed in Bypass Bay 2. Kahler said the plan is to expand the system, and Douglas PUD is now evaluating how best to do that. He said there are currently four readers connected to one master controller (capacity 12 readers), and if the entire top two rows are filled, this will increase to eight antennas. He said, based on fyke net data, fish tend to pass via the center of the bypass more than the edge. He said expansion may focus on the center two columns and expand down to the next barrier with three rows of two antennas. He said the system may also expand down to the next barrier as well, which would require another master controller, for which the conduit has already been installed in case Douglas PUD wants to expands the system farther. He said this is still a pilot investigation, and no decisions are final. He questioned whether it is better to run a single vertical row of detectors and go deeper, noting the logistical challenges which may result. He said Douglas PUD is interested in detecting Chinook salmon, particularly subyearlings. He added that he still plans to review additional fyke net data. He said, even without an expansion, the system will be up and running for the entire bypass season next year (unlike this year). He said the goal would be to have any expansion of the system ready and operational at the start of the bypass season.

V. HCP Administration

A. Next Meetings

The next scheduled Coordinating Committees meeting is on September 27, 2016, to be held by conference call. The October 25, 2016, meeting will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

John Ferguson will contact Denny Rohr to: 1) notify the PRCC the Coordinating Committees meeting on September 27, 2016, will be held via conference call, as a courtesy for planning PRCC meeting logistics; 2) obtain access to the Grant PUD Wenatchee Office for the Coordinating Committees meeting on October 25, 2016; and 3) coordinate November and December 2016 meetings dates to further discuss with Tracy Hillman and the HCP Hatchery Committees. *(Note: Ferguson discussed these items with Rohr following the meeting on August 23, 2016, and Ferguson will provide an update during the next Coordinating Committees meeting on September 27, 2016.)*

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Bob Rose*	Yakama Nation

Notes:

* Denotes Coordinating Committees member or alternate

† Joined for the HCP Tributary and Hatchery Committees Update

Draft
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 xxx, 2016)

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 on June 21, 2016, and agree that 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 2019) at Rock Island and Rocky Reach and to continue to monitor study design, tag technology, and life history information to evaluate survival study feasibility by 2019.

Background

In June, 2016, the HCP CCs were presented key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history since 2013.

Statistical survival models cannot calculate project survival as they are currently unable to differentiate between active and non-active migrants. Acoustic tag technology remains insufficient to conduct project survival studies required by the HCPs. Tag miniaturization resulting in smaller batteries and reduced battery life are insufficient for full project survival estimations, with tags still too large for small run of river subyearling Chinook originating from the Mid-Columbia. These factors, in combination with yet unknown proportions of migrant vs. non-migrant juvenile fish in the population remain impediments to project survival estimations for subyearling Chinook.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	October 25, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the September 27, 2016, HCP Coordinating Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday September 27, 2016, from 9:30 to 11:15 a.m. Attendees are listed in Attachment A to these conference call minutes.

ACTION ITEM SUMMARY

- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).
- Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).
- Chelan PUD will: 1) add details explaining subyearling Chinook salmon cumulative passage at Rocky Reach Dam in the Draft 2016 Rocky Reach and Rock Island Spill Report; 2) provide a revised draft for review and comment; and 3) request approval of the report during the Coordinating Committees meeting on October 25, 2016 (Item III-A). *(Note: Lance Keller provided a revised draft report for approval to Kristi Geris on October 24, 2016, which Geris distributed to the Coordinating Committees that same day.)*
- Chelan PUD will incorporate edits received from the Yakama Nation (YN) and the Colville Confederated Tribes (CCT) into the Rocky Reach and Rock Island

Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) Statement of Agreement (SOA), will distribute the revised SOA, and request email approval by Friday, September 30, 2016 (Item III-B). *(Note: Lance Keller provided a revised SOA, as discussed, to Kristi Geris on September 28, 2016, which Geris distributed to the Coordinating Committees for approval that same day.)*

- Bob Rose will discuss data and calculations used to derive new coho salmon phase designations during the Coordinating Committees meeting on November 15, 2016 (Item III-C).
- Chelan PUD will request approval during the Coordinating Committees meeting on October 25, 2016, to begin the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early; rather than beginning January 2, 2017, the new start would be December 12, 2016 to allow more time to complete an overhaul of one (of three) auxiliary water supply (AWS) pumps (Item III-E).
- Jim Craig will ask Greg Fraser (U.S. Fish and Wildlife Service [USFWS]) if he is available to share his presentation on Entiat River History and Impacts to Chinook Salmon during the Coordinating Committees in-person meeting on October 25, 2016 (Item IV-B). *(Note: Craig contacted Fraser following the meeting on September 27, 2016, and Fraser indicated he can present during the meeting on October 25, 2016.)*
- **The Coordinating Committees meeting on October 25, 2016, will be held in-person at the Grant PUD office in Wenatchee, Washington (Item IV-B).**

DECISION SUMMARY

- Rocky Reach and Rock Island HCP Coordinating Committees representatives approved the Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, as revised, via email, on September 29, 2016 (Item III-B).

AGREEMENTS

- There were no agreements discussed during today's conference call.

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on August 10, 2016, notifying them that a Wells Project Land-use Permit Application (City of Pateros) was available for a 60-day review period, with comments due to Tom Kahler by Monday, October 10, 2016.
- Kristi Geris sent an email to the Coordinating Committees on September 6, 2016, notifying them that a Wells Project Land-use Permit Application (Thomason) was available for a 60-day review period, with edits and comments due to Tom Kahler by Friday, November 4, 2016.
- Kristi Geris sent an email to the Coordinating Committees on October 6, 2016, notifying them that the Draft Wells Post-Season Bypass Report and Passage-Dates Analysis was available for a 60-day review period, with edits and comments due to Tom Kahler by Monday, December 5, 2016.

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the Coordinating Committees and asked for any additions or changes to the agenda. Tom Kahler added a debrief on the review of the HCP Coordinating Committees' Chairperson.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft August 23, 2016, meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Coordinating Committees members present approved the August 23, 2016, meeting minutes, as revised. The National Marine Fisheries Service (NMFS) abstained, because a NMFS representative was not present during the August 23, 2016, conference call.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on August 23, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on August 23, 2016):*

- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).*
  This will be discussed during today's conference call, and will also be carried forward.
- *Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).*
  Lance Keller said this item is outstanding, and explained that the table and written explanation will ultimately be included in the final submittal to FERC. He said Chelan PUD expects to complete this item in a couple of months and requested to carry the action item forward.
- *Coordinating Committees representatives will submit edits and comments on the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) Statement of Agreement (SOA) to Lance Keller by September 15, 2016 (Item III-A).*
  This will be discussed during today's conference call.
- *Chelan PUD will contact Scott Carlon regarding the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, which Chelan PUD will request approval on during the Coordinating Committees meeting on September 27, 2016 (Item III-A).*
  Lance Keller said he discussed this with Carlon yesterday, on September 26, 2016. This will be discussed further during today's conference call.
- *Chelan PUD will provide a Draft 2016 Rocky Reach and Rock Island Spill Report, including a passive integrated transponder (PIT)-tag analysis, to Kristi Geris for distribution to the Coordinating Committees prior to the Coordinating Committees meeting on September 27, 2016 (Item III-B).*
  Lance Keller provided the draft report and PIT-tag analysis to Geris on

September 26, 2016, which Geris distributed to the Coordinating Committees that same day. This will be discussed further during today's conference call.

- *Chelan PUD will incorporate edits and comments received from the CCT, including a PIT-tag analysis, into the next weekly Rocky Reach Dam Fish Count Update related to the orifice gate (OG) closure (Item III-D).*
  Lance Keller provided this update, as described, to Kristi Geris on August 25, 2016, which Geris distributed to the Coordinating Committees on August 29, 2016.
- *John Ferguson will contact Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) to: 1) notify the PRCC the Coordinating Committees meeting on September 27, 2016, will be held via conference call, as a courtesy for planning PRCC meeting logistics; 2) obtain access to the Grant PUD Wenatchee Office for the Coordinating Committees meeting on October 25, 2016; and 3) coordinate November and December 2016 meetings dates to further discuss with Tracy Hillman and the HCP Hatchery Committees (Item V-A).*
  Ferguson discussed these items with Rohr following the meeting on August 23, 2016. Ferguson said Rohr will provide him with the key to the Grant PUD office for the October 25, 2016, meeting. Ferguson also said, to accommodate the holidays, the Coordinating Committees November and December meetings will be held on November 15 and December 13, 2016, respectively. He said the meeting on October 25, 2016, will start at 9:30 a.m., per usual. He suggested the Coordinating Committees discuss at a later date possibly changing to an earlier start time to accommodate PRCC meetings in the afternoon of the same day.

II. HCP Tributary and Hatchery Committees Update

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

Tracy Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees conference call on September 21, 2016.

- *USFWS Bull Trout Consultation Update*: USFWS distributed a draft of the Biological Opinion (BiOp) covering hatchery programs in the Wenatchee Basin to the applicants for a 3-week review, with comments due on September 29, 2016. Some members requested additional time for review, so those members were asked to coordinate with USFWS to extend the review deadline. The draft memo regarding the Methow Spring Chinook Salmon BiOp is under internal review and will be distributed to applicants for review.

- *NMFS Consultation Update*: The Wenatchee Steelhead BiOp was issued to applicants; however, the Section 10 permit has not been issued and is pending completion of the Section 7 consultation with USFWS. Regarding the Methow Spring Chinook Salmon Consultation, a draft Environmental Assessment has been distributed to the applicants, which is part of the National Environmental Policy Act process, which is part of the BiOp. Regarding the draft Methow Steelhead Adult Management Plan, NMFS and Washington Department of Fish and Wildlife (WDFW) are working to develop gene flow guidelines; after these have been developed, members will receive a draft for review. NMFS expects to complete the Okanogan Steelhead Tribal Resource Management Plan by the end of 2016.
- *Review Hatchery Monitoring & Evaluation (M&E) Plan Draft Appendices*: The final appendix to the Hatchery M&E Plan was further discussed (Stray Rate Objectives). Recall, the HCP Hatchery Committees have been discussing management strays and genetic out-of-population and within-population strays. After a long discussion on how to define management strays, most representatives present generally concurred with setting a minimum acceptable level of 90% of the spawning escapement homing back to the stream in which they were released as juveniles, unless the HCP Hatchery Committees adjust that level based on stock-specific percent hatchery-origin spawners and proportionate natural influence. Therefore, a maximum of 10% of the spawning escapement may spawn in non-target streams. Grant PUD and the CCT requested additional time for internal review of these metrics. The genetic out-of-population and within-population strays follow the Interior Columbia River Basin Technical Recovery Team criteria from 2007.
- *Embryonic Imprinting*: Recall the HCP Hatchery Committees discussing earlier this year possibly testing embryonic imprinting or sequential imprinting to increase homing to particular areas (e.g., Chewuch River adults returning to the Chewuch River instead of the Methow River). Some representatives visited the Issaquah Hatchery, the location of an ongoing embryonic imprinting study. Due to other time-sensitive discussions, the HCP Hatchery Committees had not yet fully

addressed this topic, and representatives agreed to restart these discussions in October 2016. Roger Tabor (USFWS), a participant in the Issaquah Hatchery study, may attend the HCP Hatchery Committees meeting on October 19, 2016, to help address stray management. John Ferguson asked if Issaquah Hatchery is the only location testing these imprinting techniques. Hillman said Issaquah Hatchery is conducting embryonic testing, and hatcheries in the Yakima River Basin may be conducting sequential imprinting; however, he is unsure if there are other hatcheries conducting embryonic imprinting studies. He said the HCP Hatchery Committees will likely learn more after discussing this topic with Tabor.

- *Next Steps*: The next meeting of the HCP Hatchery Committees will be on October 19, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the last HCP Tributary Committees meeting on September 8, 2016.

- *Review of Middle Entiat 80% Restoration Plans*: The Chelan-Douglas Land Trust asked the HCP Tributary Committees to review the 80% Middle Entiat River Restoration Plans. In January 2016, the HCP Tributary Committees reviewed the 60% designs and concluded they were appropriate. The Bureau of Reclamation has since revised the designs; therefore, additional feedback was requested. The HCP Tributary Committees reviewed and approved the 80% designs (only reviewed two parcels).
- *General Salmon Habitat Program Application*: The Okanagan Nation Alliance submitted an application titled, Fish Passage at Ellis Creek Sediment Basin. The purpose of the project is to provide fish passage at the lower end of Ellis Creek, which would open 2.5 miles of stream to salmonids. The total cost of the project is $185,638, and the sponsor requested $39,784 from HCP Tributary Funds. After a long discussion, the HCP Tributary Committees declined to fund the project. They believe this project has limited biological benefit compared to other projects, and because Ellis Creek is an urban stream, it has limited spawning and rearing habitat compared to the cost. The HCP Tributary Committees recommended the sponsor focus on enhancement of other areas.

- *Monitoring Beaver Reintroductions*: In July 2016, the Rock Island HCP Tributary Committee agreed to fund the Beaver Fever Project submitted by Trout Unlimited. The purpose of this project was to reestablish beavers and install beaver dam analogs (BDAs) in tributaries of the Wenatchee River Basin. In September 2016, the HCP Tributary Committees discussed the lack of information available about the effects of beaver relocation activities on salmonids, and asked Trout Unlimited to submit a monitoring proposal. Trout Unlimited indicated they would think about it, and if they could not conduct all phases of monitoring themselves, they would team with an appropriate entity. Bob Rose said he thought this type of research has been ongoing for a while (via the Salmon Recovery Board and Regional Fisheries Enhancement Group). Hillman said the HCP Tributary Committees discussed this, and as he understands, the CCT were a major funder of the monitoring work in the Methow Basin. He said the CCT are not obtaining data on responses of salmonids; rather, the monitoring entities are reporting effects of beavers on temperature and other habitat parameters. Rose said he believes the Regional Fisheries Enhancement Group have been monitoring effects on fish in the Yakima River Basin for more than 5 years, and added that he will look further into this. Jeff Korth said this project has been ongoing in the Methow River Basin since about 2008, and is supervised by WDFW. He said one reason the monitoring has not been working as planned is because once beavers are translocated, they either leave or die. He added that beavers will populate an area if they want to. He said the project is still funded by the Methow Salmon Recovery Foundation and will continue until at least the end of June 2017. He said the evaluation part has not yet materialized. Ferguson asked if the John Day Basin monitoring data are applicable to the Upper Columbia Basin, or are the systems are too different. Hillman said the latter. He added that the HCP Tributary Committees understand the results from beaver reintroduction work in the John Day Basin (specifically Bridge Creek); however, those are incised, desert-type streams versus more forested areas in the Methow River Basin. He also noted that the Rock Island HCP Tributary Committee will only fund the BDA portion of the Beaver Fever Project, and not the relocation of beavers; therefore, the monitoring proposal will only be for BDA effects on salmon, not on the effects of beavers on salmon.

- *Next Steps*: The next meeting of the HCP Tributary Committees will be on November 10, 2016. The HCP Tributary Committees will tour projects on the Okanagan River on October 12 and 13, 2016. Hillman asked if any CC members are planning to attend.

III. Chelan PUD

A. Draft 2016 Rocky Reach and Rock Island Spill Report (Thad Mosey)

The Draft 2016 Rocky Reach and Rock Island Spill Report (Attachment B) and Subyearling PIT-Tag Analysis to Rocky Reach Dam (Attachment C) were distributed to the Coordinating Committees by Kristi Geris on September 26, 2016. Lance Keller said Thad Mosey (Chelan PUD Fish Biologist) will first review the draft spill report, and then Keller will briefly review the PIT-tag analysis.

Mosey reviewed Attachment B. John Ferguson asked about the subyearling Chinook salmon cumulative passage of 91.4%, listed under summer spill at Rocky Reach Dam during 2016. Keller recalled that the Columbia River Data Access in Real Time (DART) database continually adjusts and recalculates run-timing estimates on a daily basis as daily index count data are added to the database. He said, based on initial DART estimates, it seemed spill operations at Rocky Reach Dam would meet the 95% passage criteria by initiating spill at 0000 hours on May 29, 2016, as the current passage estimate was 3.30%. He said, however, the adjusted estimate indicated a larger portion of the juvenile subyearling Chinook salmon run passed Rocky Reach Dam earlier in the season, resulting in spill being initiated after 7.99% of the subyearling run had passed, and a total cumulative passage of only 91.4%. He said essentially, the 95% passage target was missed by 1 day due to the DART estimate increasing 5.71% from May 27 to May 28, 2016 (i.e., would have been met had spill been initiated 1 day earlier). Kirk Truscott suggested including, in the spill report, an explanation similar to what Keller provided regarding subyearling Chinook salmon cumulative passage at Rocky Reach Dam.

Keller reviewed Attachment C, recalling that the purpose of this exercise was to determine whether travel-time data can be used to help guide when to initiate spill and meet the passage standard. He said Scott Hopkins (Chelan PUD Biologist) analyzed mean travel times of hatchery summer Chinook salmon released upstream of Rocky Reach Dam. Keller recalled that hatchery releases upstream of Rocky Reach Dam determine when spill is initiated. He said hatchery counts decrease, then an unmarked population follows, and arrival timing at the dam for the wild component is assumed with high confidence. He said water temperature graphs were also developed (see bottom of Attachment C), which he said revealed nothing particular to note. He said, in summary, he did not see anything standing out in PIT-tag travel-time data in the last 2 to 5 years that gives indication of when fish may arrive at Rocky Reach Dam. He said the strategy at Rock Island Dam, after missing passage targets for sockeye salmon, was to use caution going forward and initiate spill earlier than normal, if needed. He said Chelan PUD plans to implement the same caution at Rocky Reach Dam.

Keller said Chelan PUD will: 1) add details explaining subyearling Chinook salmon cumulative passage at Rocky Reach Dam in the Draft 2016 Rocky Reach and Rock Island Spill Report; 2) provide a revised draft for review and comment; and 3) request approval of the report during the Coordinating Committees meeting on October 25, 2016. *(Note: Keller provided a revised draft report for approval to Geris on October 24, 2016, which Geris distributed to the Coordinating Committees that same day.)*

B. DECISION: Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA (Lance Keller)

Lance Keller said Kristi Geris sent an email to the Coordinating Committees on August 22, 2016, notifying them that the Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA was available for review. Edits and comments were due to Keller by September 15, 2016. The CCT provided edits (Attachment D) prior to the meeting on September 27, 2016. Kirk Truscott said his edits are intended to clarify his expectations for activities between now and 2019. He said, rather than just modifying a study design, he would like the survival model to address the life history of subyearlings. Keller agreed with the CCT's edits, and noted that this draft SOA is written as such that these efforts will be undertaken by the entire Coordinating Committees. He added that convening periodic check-ins with the HCP and PRCC provides a good opportunity to accomplish the intention of the CCT's edits.

John Ferguson asked if the Coordinating Committees plan to track what John Skalski (Columbia Basin Research) is doing with the survival model, or plan to more proactively coordinate with Skalski about additional studies needed to inform the statistical models. Bob Rose said this is a great question, and noted that the same question was discussed in the Grant PUD forum. Rose also suggested another edit to the draft SOA (Attachment E), which was distributed to the Coordinating Committees by Geris following the meeting on September 27, 2016. Rose and Truscott agreed the intent of their respective edits was the same and would be supportive of including either version of their edits in the draft SOA for approval.

Chelan PUD will incorporate edits received from the YN and the CCT into the Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, and will distribute the revised SOA, requesting email approval by Friday, September 30, 2016. *(Note: Keller provided a revised SOA, as discussed, to Geris on September 28, 2016, which Geris distributed to the Coordinating Committees for approval that same day.)*

Rocky Reach and Rock Island HCP Coordinating Committees representatives approved the Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA, as revised (Attachment F), via email, on September 29, 2016.

C. Rocky Reach and Rock Island Coho Phase Designation (Steve Hemstrom and Alene Underwood)

Steve Hemstrom said a Draft Estimation of Juvenile Coho Survival for Rocky Reach and Rock Island Projects (Attachment G) was distributed to the Coordinating Committees by Kristi Geris on September 22, 2016. Hemstrom said Attachment G is based on methods and data used by John Skalski and Rich Townsend (Columbia Basin Research) to estimate reach survival of PIT-tagged juvenile coho salmon, spring Chinook salmon, and steelhead released from Winthrop National Fish Hatchery to the Lower Columbia River. Hemstrom reviewed Table 1 in Attachment G, noting that the Rocky Reach and Rock Island Project coho salmon survival rates (94.56% and 94.95%, respectively) were calculated as the intermediate value between the combined multiyear-average survival rate for spring Chinook salmon and steelhead.

Bob Rose said Skalski and Townsend's methods and data are also being discussed in the Grant PUD hatchery forum, and there are data that may not be used. Rose added that Keely Murdoch (YN HCP Hatchery Committees Alternate) has been more involved in these discussions than he has. Rose suggested discussing this with respective HCP Hatchery Committees representatives to gain a full understanding about this information.
John Ferguson asked about a timeline for those discussions with Grant PUD, because Attachment G is preceding a draft SOA from Chelan PUD. Rose said he is unsure of a timeline. Hemstrom asked if Rose knows which data are in question. Rose said yes; however, that information is not currently available. He said there is quite a bit. He said he is willing to further discuss this at another time, and his comment was not intended to slow progress down for Chelan PUD. Ferguson asked about a deadline for Chelan PUD.
Alene Underwood (Chelan PUD HCP Hatchery Committees Representative) said there is no hard deadline at this time. She said, in the interim, Chelan PUD will coordinate with Rose and others to obtain a better understanding of data that need further discussion. Underwood said the SOA is the first step in a larger process, and then Chelan PUD will discuss within the HCP Hatchery Committees what this means for Chelan PUD's No-Net-Impact mitigation. She said she hoped this discussion would be ready for the HCP Hatchery Committees by the end of 2016 or beginning of 2017.

Rose said he will discuss this further with Murdoch to determine a recommendation to move forward. Ferguson asked if this discussion will continue within the PRCC soon, and Rose said the YN are just now developing some principles with Grant PUD on how to move forward. Rose said he will discuss data and calculations used to derive new coho salmon phase designations during the Coordinating Committees meeting on November 15, 2016.

Underwood asked if other Coordinating Committees representatives have questions or comments at this time. Jeff Korth said WDFW has a few editorial suggestions, and he will send those to Hemstrom. Korth also asked why Attachment G requires Coordinating Committees approval prior to the HCP Hatchery Committees. Underwood explained that Chelan PUD first needs to understand the survival estimate and what numbers are passing through the projects to determine what the hatchery compensation would be.

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

Lance Keller said the design is still moving forward, and he has nothing new to report at this time.

E. 2016/2017 Rocky Reach Adult Ladder Winter Maintenance Outage (Lance Keller)

Lance Keller said there are extensive maintenance items planned for this year. He said one item is continuing maintenance on the adult AWS. He recalled the AWS is a gravity system where water from the forebay is used to drive three pumps that pump AWS water from the tailrace into the collection system to maintain proper head differentials on the ladder entrances. He said preventative maintenance was conducted 5 years ago, and now Chelan PUD plans to begin an overhaul on the first of three AWS pumps. He recalled the unanticipated delays last year with the Rock Island Dam right fish ladder sluice gate, RO4, and said, as a cautionary measure, Chelan PUD would like to request an earlier outage than normal for work on the AWS. He said the typical outage is January 1 through February 28, but this year, Chelan PUD is asking to take the ladder offline on December 12, 2016, to allow an early start on the AWS pump teardown, as well as other maintenance items. He said the contractor repairing the AWS pump is located in Spokane, Washington. He said there is a little cushion built into this year's winter outage schedule in case unanticipated delays are encountered. He said, if everything is completed ahead of time, the ladder may be brought back online earlier than the end of February 2017. He said there may also be time to repair two AWS pumps during the 2017/2018 outage, which would avoid an early outage for a third year in a row. He said Chelan PUD Planners are fairly confident that could happen.

John Ferguson asked how reliable the contractor in Spokane is, and Keller said Chelan PUD uses this contractor quite often. Keller said Chelan PUD has a higher level of confidence in this contractor solely because the work will be conducted in Washington State, opposed to across the country (as was the contractor for the RO4 gate).

Chelan PUD will request approval during the Coordinating Committees meeting on October 25, 2016, to begin the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early. Rather than beginning January 2, 2017, the new start would be December 12, 2016, to allow more time to complete an overhaul of one (of three) AWS pumps.

IV. HCP Administration

A. Review of the HCP Coordinating Committees' Chairperson (Tom Kahler)

Tom Kahler said there is a requirement in the HCPs to review the performance of the Chairperson every 3 years. He said August 2016 was the deadline to conduct the review again. He said the HCP Committees conduct an informal review requesting representatives' input on the performance of the Chairperson. He said this year's review was conducted via email. He said all parties are pleased with John Ferguson's and Kristi Geris' performance and would like to continue their Chairperson and support terms for another 3 years. Kahler said there are parallel processes for the HCP Tributary and Hatchery Committees. He said he is not sure if the HCP Hatchery Committees Chairperson review is complete, and said he will follow-up with Greg Mackey (Douglas PUD HCP Hatchery Committees Representative). Kahler said the HCP Tributary Committees reviewed and extended Tracy Hillman's role as Chairperson. Ferguson thanked Kahler for the update, and asked if any action was needed by Anchor QEA, LLC, to memorialize this review. Kahler said documenting this discussion in the meeting minutes should suffice for the administrative record.

B. Next Meetings

The next scheduled Coordinating Committees meeting is on October 25, 2016, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. Jim Craig will ask Greg Fraser if he is available to share his presentation on Entiat River History and Impacts to Chinook Salmon, during the Coordinating Committees in-person meeting on October 25, 2016. *(Note: Craig contacted Fraser following the meeting on September 27, 2016, and Fraser indicated he can present during the meeting on October 25, 2016.)*

The November 15 and December 13, 2016, 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

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft 2016 Rocky Reach and Rock Island Spill Report
Attachment C	Subyearling PIT-Tag Analysis to Rocky Reach Dam
Attachment D	Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA – CCT edits
Attachment E	Draft Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA – YN edits
Attachment F	Final Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) SOA
Attachment G	Draft Estimation of Juvenile Coho Survival for Rocky Reach and Rock Island Projects

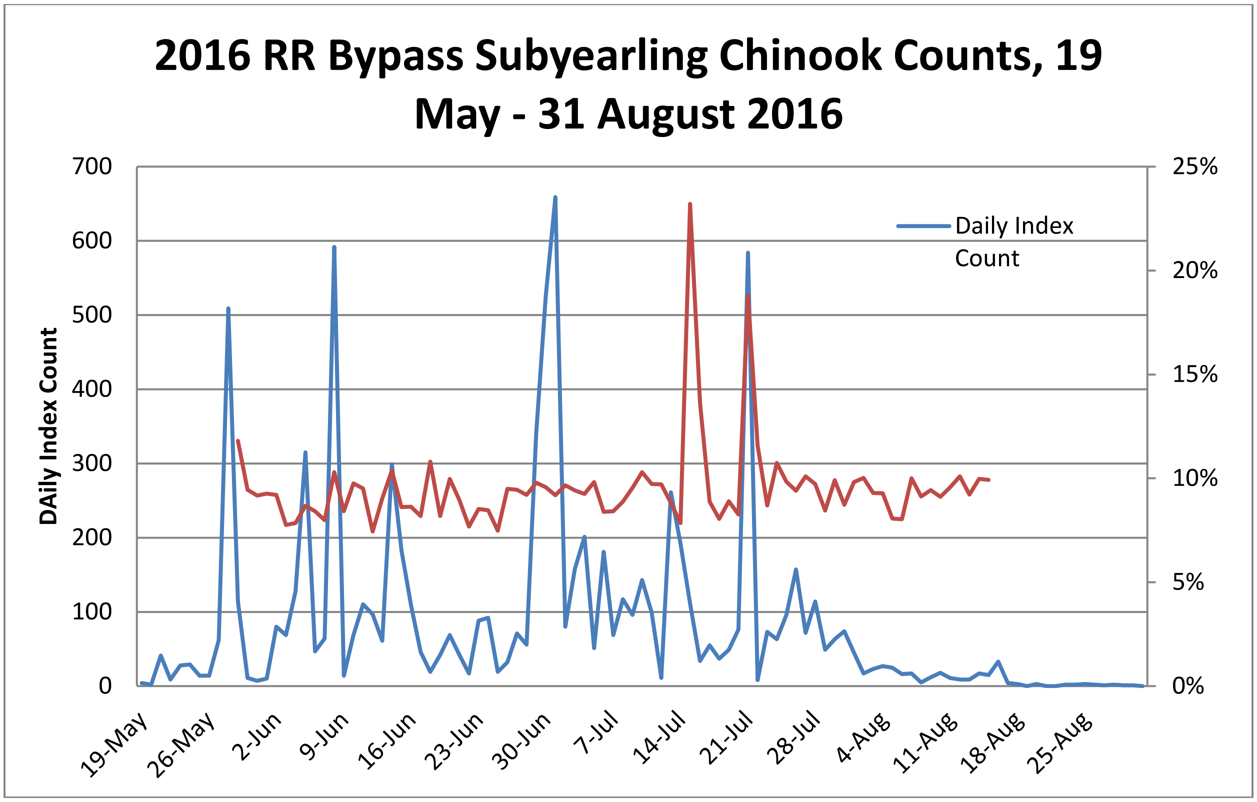
Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood††	Chelan PUD
Steve Hemstrom*††	Chelan PUD
Thad Mosey†††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Jeff Korth*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Bob Rose*	Yakama Nation

Notes:
* Denotes Coordinating Committees member or alternate
† Joined for the HCP Tributary and Hatchery Committees Update
†† Joined for the Rocky Reach and Rock Island Coho Phase Designation discussion
††† Joined for the Draft 2016 Rocky Reach and Rock Island Spill Report discussion

Chelan PUD
Rocky Reach and Rock Island HCPs
Draft 2016 Fish Spill Report

2016 ROCKY REACH
Summer Spill

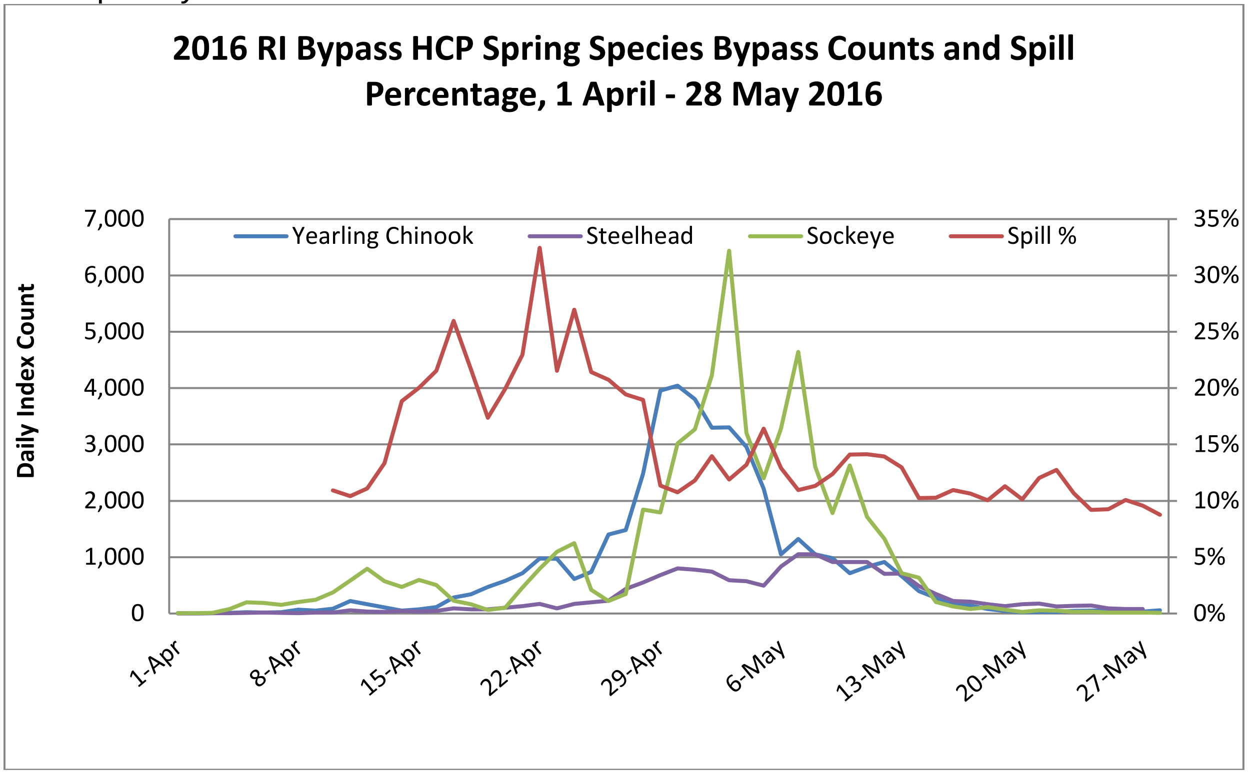
Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	29 May, 0001 hrs
Spill stop date:	15 August, 2400 hrs
95% Est. passage date:	30 July
Percent of run with spill:	91.4% on 15 August (estimated as of 31 August)
Cumulative index count:	8,905 subyearling Chinook (as of 31 August)
Summer spill percentage:	9.49% (9.00% fish spill, plus 0.49% forced spill)
Avg river flow at RR:	115,590 cfs (29 May - 15 August)
Avg spill rate at RR:	10,971 cfs (29 May - 15 August)
Total spill days:	79



<u>2016 ROCK ISLAND</u>

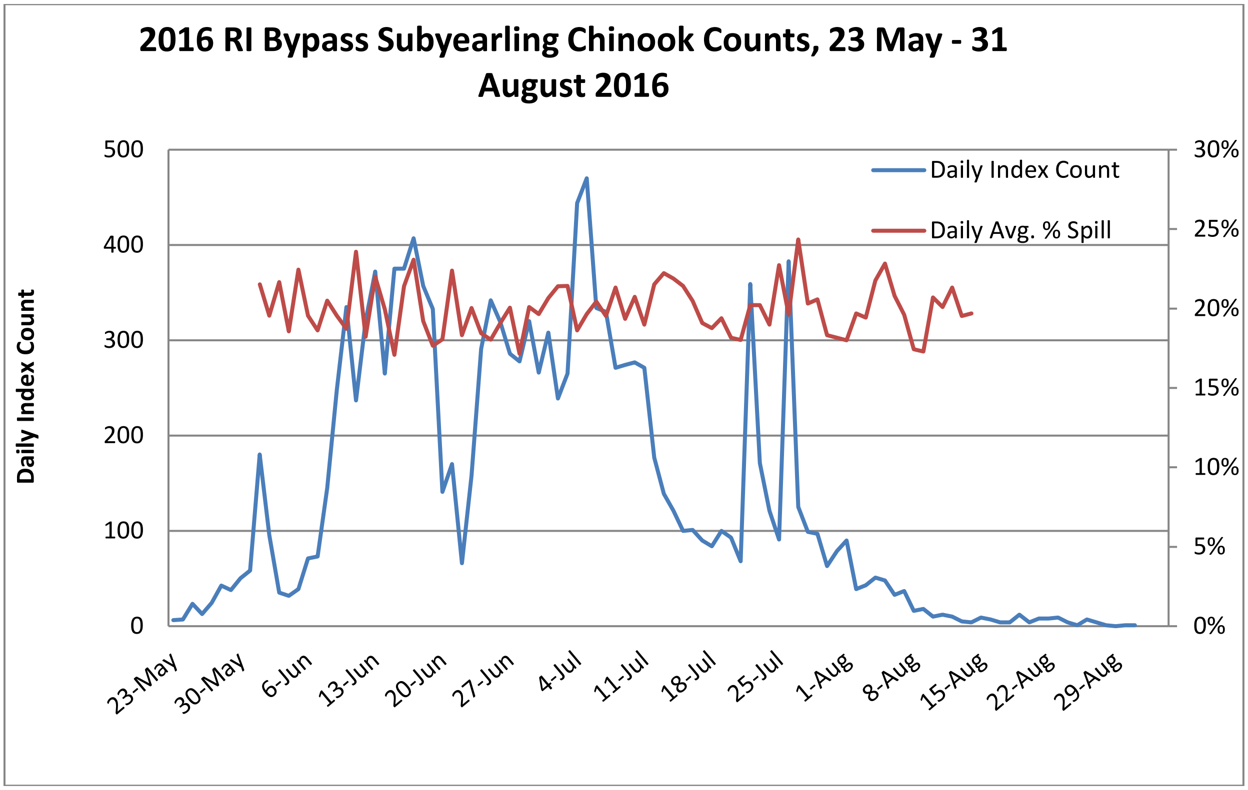
Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	10 April, 0001 hrs
Spill stop date:	28 May, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	Yearling Chinook - 99.3%; steelhead - 95.7%; sockeye – 97.9%
Cumulative index count:	44,784 yearling Chinook**;** 17,663 steelhead**;** 56,638 sockeye
Spring spill percentage:	15.59% (9.95% fish spill, plus 5.64% forced spill)
Avg river flow at RI:	160,343 cfs (10 April – 28 May)
Avg spill flow at RI:	25,005 cfs (10 April – 28 May)
Total spill days:	49



Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	29 May, 0001 hrs
Spill stop date:	11 August, 2400 hrs
95% Est. passage date:	26 July
Percent of run with spill:	99.3% (estimated as of 31 August)
Cumulative index count:	13,270 subyearling Chinook (as of 31 August)
Summer spill percentage**:**	19.90% (19.87% fish spill, plus 0.03% forced spill)
Avg river flow at RI:	120,671 cfs (29 May - 11 August)
Avg spill flow at RI:	24,012 cfs (29 May - 11 August)
Total spill days:	75



Juvenile Index Counts 2006-2016 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, 2006-2016

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015	2016
Sockeye	239,185	169,937	136,206	40,758	724,394	67,879	384,224	199,497	553,645	53,575	**1,374,418**
Steelhead	4,329	4,532	8,721	6,309	4,931	5,683	4,902	2,528	5,270	4,157	**1,478**
Yearling Chinook	23,461	18,080	38,394	18,946	33,840	24,400	95,207	29,018	15,871	32,220	**41,676**
Subyearling Chinook	19,996	13,496	11,820	11,944	59,751	17,246	5,774	22,073	22,327	37,104	**8,905**

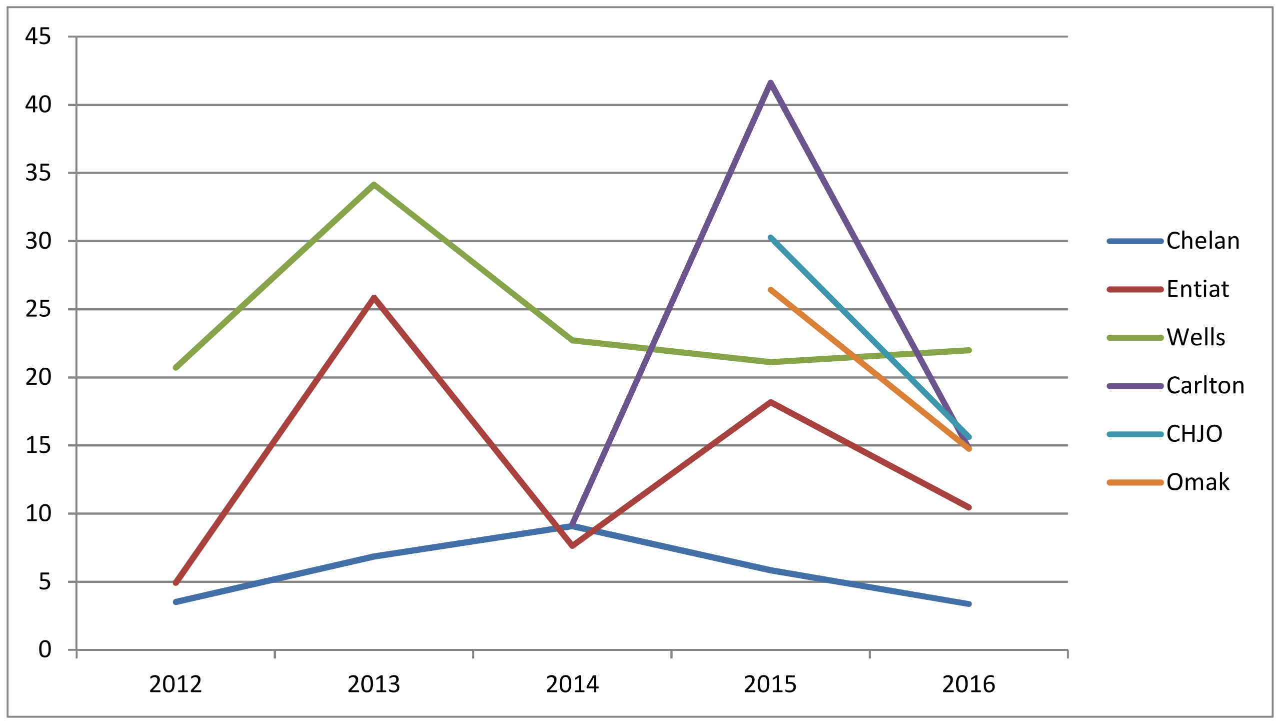
Table 2. Rock Island Smolt Monitoring Program index sample counts, 2006-2016

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015	2016
Sockeye	34,604	16,410	38,965	4,926	37,404	18,697	46,788	25,111	38,596	4,128	**56,638**
Steelhead	26,930	18,482	22,780	17,636	17,194	28,408	16,957	15,099	28,299	12,549	**17,663**
Yearling Chinook	37,267	23,714	22,562	9,225	11,802	26,407	25,759	28,324	26,429	16,762	**44,784**
Subyearling Chinook	27,106	15,686	15,940	8,189	23,205	27,397	27,298	17,170	34,527	15,349	**13,270**

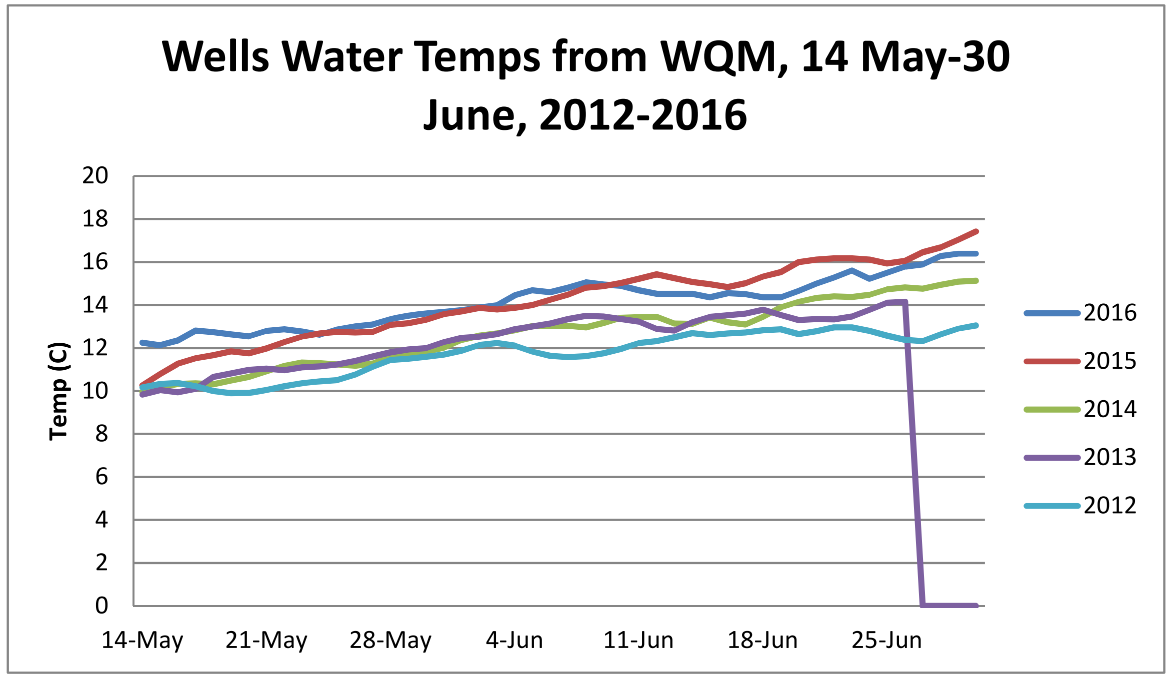
***** In 2014, as directed by the HCP, Chelan PUD conducted bypass operations outside of the normal operating period of 1 April to 31 August to assess achievement of bypass operations for 95% of the subyearling Chinook outmigration. The Rocky Reach juvenile fish bypass operated from 1 April through 15 September, and the Rock Island bypass facility at powerhouse 2 operated from 1 April through 15 September.

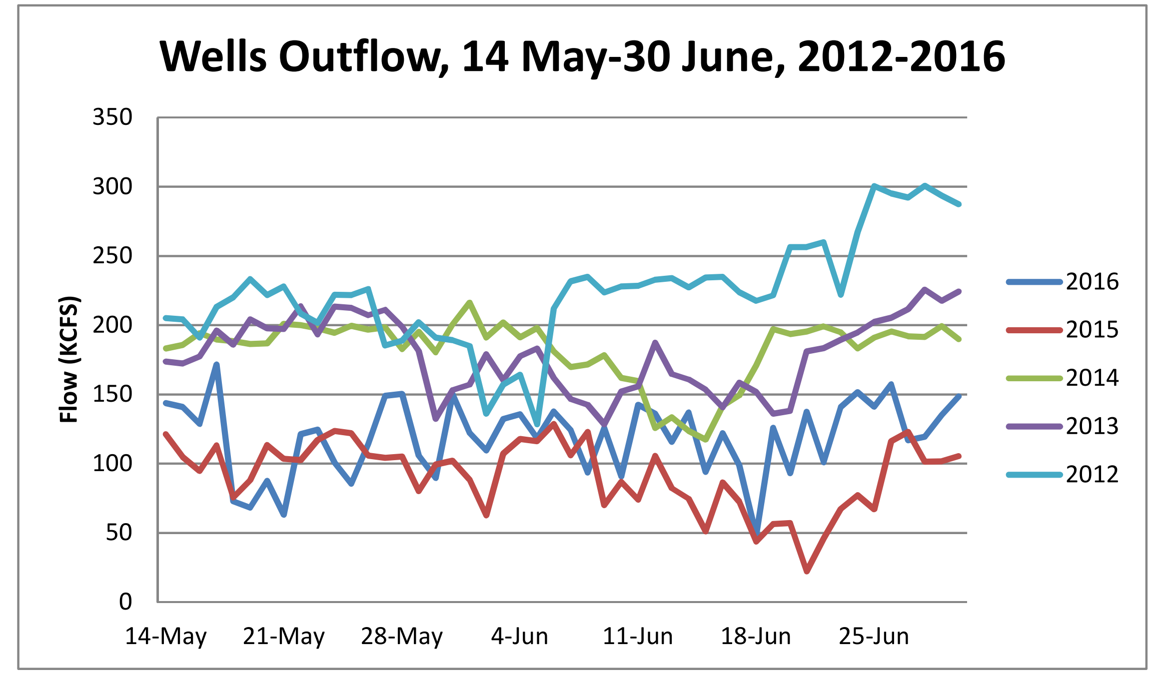
	Mean Travel Times of Summer Chinook from Release to RR Surface Collector (days)									
	2012		2013		2014		2015		2016	
	MTT	SE	MTT	SE	MTT	SE	MTT	SE	MTT	SE
Carlton					9.23	0.15	41.62	0.1	14.81	0.32
CHJO							30.26	0.24	15.62	0.2
Omak							26.43	0.64	14.76	0.25
Chelan	3.52	0.21	6.86	0.41	9.09	0.17	5.85	0.12	3.37	0.09
Entiat	4.92	0.17	25.85	0.3	7.62	0.22	18.18	0.27	10.46	0.13
Wells	20.71	0.93	34.15	0.71	22.71	0.44	21.12	0.3	22	0.33
Similkameen			31.81	0.3						

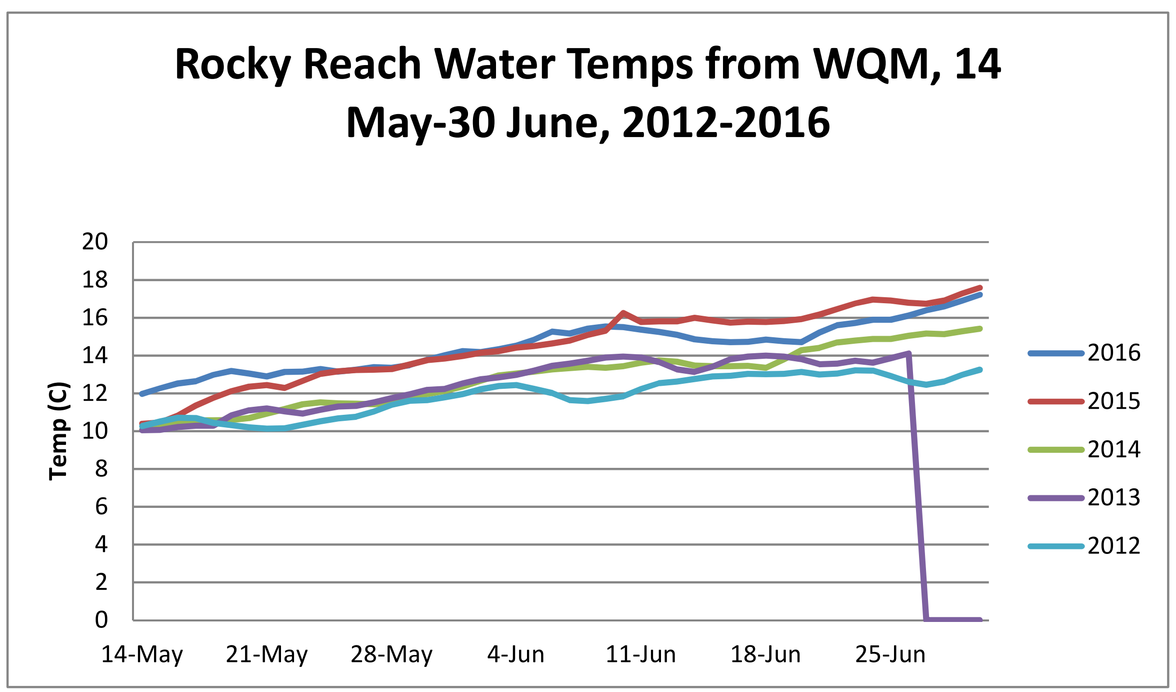
2011
2012
2013
2014
2015
2016



	Mean Travel Times of Summer Chinook from Release to RR Surface Collector, detected at RRJ in May (days)				
	2012	2013	2014	2015	2016
Carlton			8.9		
CHJO				11.7	11.6
Entiat		30.0			
Wells	7.2	8.3	9.5	8.8	13.0


Wells Water Temps from WQM, 14 May-30 June, 2012-2016
Temp (C)
20
18
16
14
12
10
8
6
4
2
0
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2016
2015
2014
2013
2012


Wells Outflow, 14 May-30 June, 2012-2016
Flow (KCFS)
350
300
250
200
150
100
50
0
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2016
2015
2014
2013
2012


Rocky Reach Water Temps from WQM, 14 May-30 June, 2012-2016
Temp (C)
20
18
16
14
12
10
8
6
4
2
0
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
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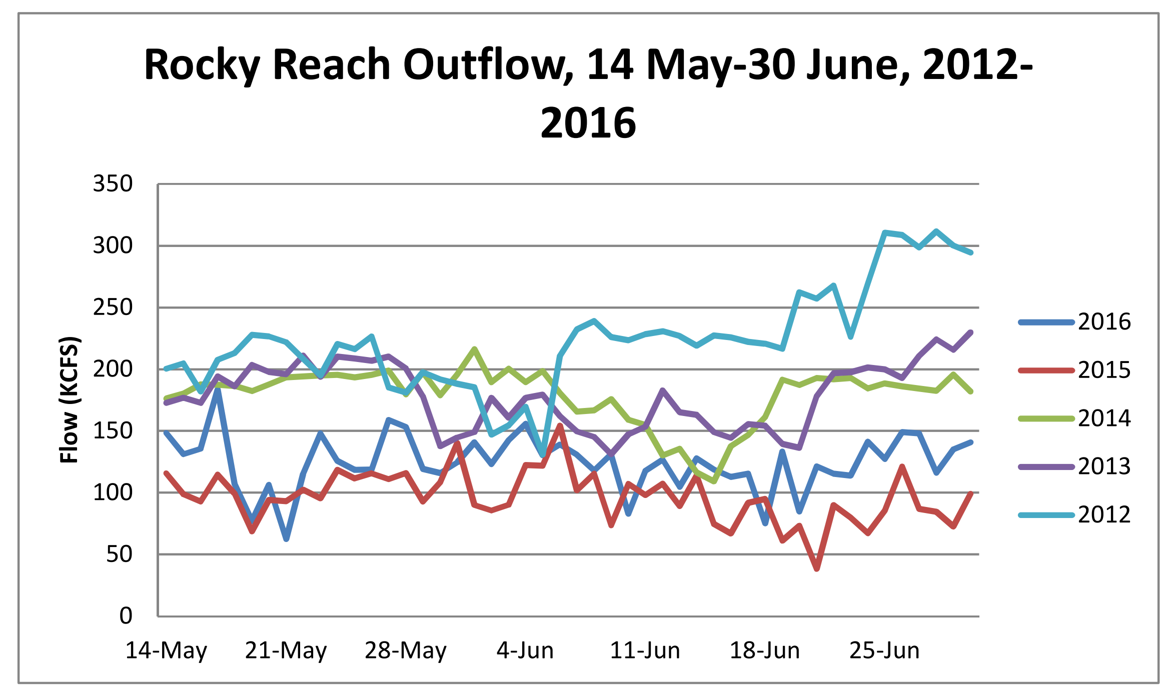
2014
2013
2012


Rocky Reach Outflow, 14 May-30 June, 2012-2016
Flow (KCFS)
350
300
250
200
150
100
50
0
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2016
2015
2014
2013
2012

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 27, 2016)

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 on June 21, 2016, and agree that 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 2019) at Rock Island and Rocky Reach and ~~to~~ to assess potential statistical survival model modifications to address sub-yearling life histories and continue to monitor ~~study design,~~ tag technology, and life history information to evaluate survival study feasibility by 2019.

Background

In June, 2016, the HCP CCs were presented key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history since 2013.

Current ~~S~~statistical survival models cannot calculate project survival as they are currently unable to address~~differentiate between~~ active and non-active migrants. 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 yet unknown proportions of migrant vs. non-migrant juvenile fish in the population remain impediments to project survival estimations for subyearling Chinook.

Final
Rock Island and Rocky Reach Habitat Conservation Plans
Coordinating Committees

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Maintain Rock Island and Rocky Reach Subyearling Chinook in Phase III (Additional Juvenile Studies) for up to three years

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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 on June 21, 2016, and agree that 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 2019) at Rock Island and Rocky Reach and to continue to evaluate or monitor study design, tag technology, and life history information to better understand future survival study feasibility by 2019.

Background

In June, 2016, the HCP CCs were presented key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history since 2013.

Statistical survival models cannot calculate project survival as they are currently unable to differentiate between active and non-active migrants. 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 yet unknown proportions of migrant vs. non-migrant juvenile fish in the population remain impediments to project survival estimations for subyearling Chinook.

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Rock Island and Rocky Reach Habitat Conservation Plans
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(Approved September 29, 2016)

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 on June 21, 2016, and agree that 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 2019) at Rock Island and Rocky Reach and to continue to evaluate or monitor study design, tag technology, and life history information to better understand future survival study feasibility by 2019.

Background

In June, 2016, the HCP CCs were presented key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history since 2013.

Current statistical survival models cannot calculate project survival as they are currently unable to address active and non-active migrants. 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 yet unknown proportions of migrant vs. non-migrant juvenile fish in the population remain impediments to project survival estimations for subyearling Chinook.

Estimation of Juvenile Coho Survival for Rocky Reach and Rock Island Projects using Combined Multiyear-Average Spring Chinook and Steelhead Survival Rates

This background paper summarizes the Rocky Reach and Rock Island HCP survival rates for spring Chinook and steelhead to estimate juvenile coho passage survival through the Projects. We review methods and data used by John Skalski and Rich Townsend (2015) to estimate juvenile coho passage survival through the hydro system. Skalski and Townsend calculated and compared annual survival rates of PIT tagged juvenile coho, spring Chinook, and steelhead released from Winthrop National Fish Hatchery over five years, 2010-2014. Subsequently, the HCP Coordinating Committee (HCP CC) established a new coho survival rate through the Wells Project and designated juvenile coho in HCP Phase III Standards Achieved (SOA, October 2015). Chelan PUD has evaluated the applicability of the Skalski and Townsend methods to estimate survival of juvenile coho through its Rocky Reach and Rock Island Projects. Chelan PUD is providing an analysis of survival data for Rocky Reach and Rock Island and will seek HCP CC review and approval of a SOA to designate juvenile coho in HCP Phase III Standards Achieved.

Skalski and Townsend (2015) estimated annual PIT tag survival for multiple releases of juvenile coho, spring Chinook and steelhead from the Winthrop National Fish Hatchery (WNFH) 2010 through 2014. Skalski and Townsend reported Cormack-Jolly-Seber (CJS) mark-recapture PIT tag survival estimates for the three species in two independent but contiguous river reaches that contain PIT detection. The two river reaches analyzed contain multiple dams and reservoirs. The annual reach survivals evaluated were: (1) Rocky Reach Dam to McNary Dam (359 km reach) and (2) McNary Dam to John Day Dam (123 km reach). This enabled direct comparison of passage survival rates of the three species in the same hydrosystem reaches.

The three species' PIT detection results for the five years analyzed demonstrated that coho survival was generally "intermediate" between steelhead and spring Chinook. That is, PIT tagged coho released from WNFH survived hydro system passage in-between that of PIT tagged Chinook and PIT tagged steelhead. The HCP CC reviewed and approved methods to estimate coho survival using a combined multiyear-average steelhead and Chinook survival through the Wells Project.

Coho Survival Estimates Based on Mean Steelhead and Chinook Survival at RRH and RIS

Table 1 contains HCP estimates of spring Chinook and steelhead survival at the Rocky Reach and Rock Island Projects and the resulting multiyear-average survival used to estimate coho survival.

Table 1. Rocky Reach and Rock Island HCP Project survival estimates for spring Chinook and steelhead, and their combined survival rate used to estimate coho survival through the Projects.

	Rocky Reach		Rock Island	
Year	Spring Chinook $\hat{S}$	Steelhead $\hat{S}$	Spring Chinook $\hat{S}$	Steelhead $\hat{S}$
2004		98.33%		
2005		93.03%		
2006		95.98%		
2007			97.25%	
2008			89.72%	96.99%
2010	92.50%		94.28%	96.52%
2011	92.94%			
Mean $\hat{S}$	**92.72%**	**95.78%**	**93.75%**	**96.76%**
Calculated Coho $\hat{S}$	**94.56%**		**94.95%**	

Chelan PUD completed five HCP juvenile passage survival studies at Rocky Reach and five at Rock Island for spring Chinook and steelhead (total of 10 studies). Those passage survival rates were used to estimate Project passage survival for juvenile coho at Rocky Reach and at Rock Island (Table 1).

The Rocky Reach HCP multiyear-average Project survival rate for steelhead passage in years 2004, 2005, and 2006 is **95.78%** (Table 1). The multiyear-average survival for spring Chinook passage in years 2010 and 2011 is **92.72%.** Using methods approved by the HCP CC to calculate coho survival for the Wells Project using combined multiyear-average survival rate for spring Chinook and steelhead, the Rocky Reach Project coho survival is **94.56%**.

The Rock Island HCP multiyear-average Project survival estimate for steelhead passage in years 2008 and 2010 is **96.76%** (Table 1). For spring Chinook, the HCP multiyear-average survival estimate for years 2007, 2008 and 2010 is **93.75%.** Using methods approved by the HCP CC to estimate coho survival using the combined multiyear-average survival rate for spring Chinook and steelhead, the Rock Island Project HCP coho survival is **94.95%**.

Skalski, J. R. and R.L. Townsend. 2015. Memo to Douglas PUD. Corrected comparison of juvenile survivals of spring Chinook, Coho, and steelhead released from Winthrop National Fish Hatchery. June 2015.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	November 18, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the October 25, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at Douglas PUD Headquarters in East Wenatchee, Washington, on Tuesday October 25, 2016, from 9:30 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).
- Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to the Federal Energy Regulatory Commission (FERC) for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).
- Bob Rose will discuss data and calculations used to derive new Coho salmon phase designations during the Coordinating Committees meeting on November 15, 2016 (Item I-C).
- **The Coordinating Committees meeting on November 15, 2016, will be held at 10:00 a.m., in-person at the Grant PUD office in Wenatchee, Washington (Item IV-B).**

DECISION SUMMARY

- Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island Spill Report, as revised (Item V-C).

(Note: Jeff Korth provided Washington Department of Fish and Wildlife's [WDFW's] approval of the report via email on November 3, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)

AGREEMENTS

- Rocky Reach HCP Coordinating Committee representatives present agreed to Chelan PUD beginning the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early. Rather than beginning January 2, 2017, the new start would be December 12, 2016, to allow more time to complete an overhaul of one or two (of three) auxiliary water supply (AWS) pumps (Item V-B). *(Note: Jeff Korth provided WDFW's approval of the early outage via email on November 3, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)*
- Coordinating Committees representatives present agreed that Coordinating Committees approval will be required to add non-HCP representatives and alternates to HCP email distribution lists, similar to approving Extranet access (the latter discussed February 25, 2014; Item VI-A).
- Coordinating Committees representatives present agreed to add Michael Humling (U.S. Fish and Wildlife Service [USFWS]) to the HCP Hatchery Committees email distribution list (Item VI-A).
- Coordinating Committees representatives present agreed to move the start time of the monthly Coordinating Committees from 9:30 to 10:00 a.m., to accommodate travel arrangements for attendees (Item VI-B).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on September 6, 2016, notifying them a Wells Project Land-use Permit Application (Thomason) was available for a 60-day review period, with edits and comments due to Tom Kahler by Friday, November 4, 2016.
- Kristi Geris sent an email to the Coordinating Committees on October 6, 2016, notifying them the Draft Wells Post-Season Bypass Report and Passage-Dates Analysis was available for a 60-day review period, with edits and comments due to

Tom Kahler by Monday, December 5, 2016 (Item IV-A).

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

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

- Lance Keller postponed the Rocky Reach and Rock Island Coho Salmon Phase Designation discussion until the Coordinating Committees meeting on November 15, 2016, and added a decision on the 2016/2017 Rocky Reach Adult Ladder Winter Maintenance Outage.
- Ferguson added a discussion on HCP email distribution lists protocol.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft September 27, 2016, conference call minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Coordinating Committees members present approved the September 27, 2016, conference call minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on September 27, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on September 27, 2016):*

- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).*
  This will be discussed during today's meeting, and will also be carried forward.
- *Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to FERC for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).*

This action item will be carried forward.

- *Chelan PUD will: 1) add details explaining subyearling Chinook salmon cumulative passage at Rocky Reach Dam in the Draft 2016 Rocky Reach and Rock Island Spill Report; 2) provide a revised draft for review and comment; and 3) request approval of the report during the Coordinating Committees meeting on October 25, 2016 (Item III-A).*

  Lance Keller provided a revised draft report for approval to Kristi Geris on October 24, 2016, which Geris distributed to the Coordinating Committees that same day.
- *Chelan PUD will incorporate edits received from the Yakama Nation (YN) and the Colville Confederated Tribes (CCT) into the Rocky Reach and Rock Island Subyearling Chinook Salmon Phase III Designation (Additional Juvenile Studies) Statement of Agreement (SOA), will distribute the revised SOA, and request email approval by Friday, September 30, 2016 (Item III-B).*

  Lance Keller provided a revised SOA, as discussed, to Kristi Geris on September 28, 2016, which Geris distributed to the Coordinating Committees for approval that same day.
- *Bob Rose will discuss data and calculations used to derive new Coho salmon phase designations during the Coordinating Committees meeting on November 15, 2016 (Item III-C).*

  This action item will be carried forward.
- *Chelan PUD will request approval during the Coordinating Committees meeting on October 25, 2016, to begin the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early; rather than beginning January 2, 2017, the new start would be December 12, 2016 to allow more time to complete an overhaul of one (of three) auxiliary water supply (AWS) pumps (Item III-E).*

  This will be discussed during today's meeting.
- *Jim Craig will ask Greg Fraser (U.S. Fish and Wildlife Service [USFWS]) if he is available to share his presentation on Entiat River History and Impacts to Chinook Salmon during the Coordinating Committees in-person meeting on October 25, 2016 (Item IV-B).*

  Craig contacted Fraser following the meeting on September 27, 2016, and Fraser indicated he can present during the meeting on October 25, 2016.

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 convene a meeting in October 2016; rather, some members of the Committees met to tour projects on the Okanagan River in Canada on October 12 and 13, 2016. Jeff Korth also participated in the tour. The tour included Conservancy Island, where Chris Fisher (CCT) explained current restoration efforts and results from monitoring and evaluation (M&E) studies conducted in side channels around the island. The HCP Tributary Committees also met with the Okanagan Nation Alliance (ONA), who provided an overview and results of past projects funded by the HCP Tributary Committees and the Priest Rapids Coordinating Committee Habitat Subcommittee. The tour also included viewing and discussing restoration activities and opportunities for streams that discharge into the Okanagan River, and viewing constructed spawning beds and side-channel reconnection options in the Penticton Channel. On the second day, the HCP Tributary Committees toured some major tributaries to Okanagan Lake, and ONA discussed limiting factors and plans to address them. The next meeting of the HCP Tributary Committees will be on November 10, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on October 19, 2016.

- *USFWS Bull Trout Consultation Update*: Bill Gale (USFWS HCP Hatchery Committees Representative and Coordinating Committees Alternate) reported that no update was available. He also stated that he was directed by USFWS regional staff to shift focus to other projects. Therefore, Matt Cooper will now become the USFWS HCP Hatchery Committees Representative, and Gale will become the Alternate (Gale will also remain the Coordinating Committees Alternate). This change may only be in effect for 6 months. Jim Craig provided a USFWS HCP Representation Designation Letter to Kristi Geris on October 21, 2016, which Geris distributed to the Coordinating Committees that same day (Attachment B). USFWS also requested to add Michael Humling to the HCP Hatchery Committees email distribution list, which will be further discussed during today's meeting.

- *National Marine Fisheries Service (NMFS) Consultation Update*: NMFS is reviewing comments received from the applicants on the Methow Spring Chinook Salmon Draft Environmental Assessment.
- *Embryonic Imprinting*: The HCP Hatchery Committees are revisiting discussions regarding homing of Chewuch spring Chinook salmon. A subgroup is preparing a study plan to evaluate the use of adult outplanting in the Chewuch River. The Committees believe this approach will provide more useful information for future studies and is less costly than conducting an embryonic imprinting study. Pending the results of the ouplanting study, the HCP Hatchery Committees may consider the more expensive embryonic or sequential imprinting study.
- *Genetic Sampling for HCP Program Species Timeline*: WDFW proposed conducting genetic analyses of HCP Program Species every 10 years. WDFW also discussed whether a power analysis should be run to verify how often genetic analyses are needed. This discussion is a part of Hatchery M&E Plan Objective 7. WDFW received comments from the HCP Hatchery Committees and will resubmit the proposal for approval.
- *Review Hatchery M&E Plan Draft Appendices*: The HCP Hatchery Committees further discussed Appendix 5 (stray rate objectives), in order to reach agreement on a definition for genetic and management strays. The Committees reviewed the language in the Hatchery M&E Plan and, once re-evaluated, decided it was not necessary to have an appendix because stray rates are adequately defined in the plan. Next month, the Committees will discuss possibly revising stray rates targets in the Hatchery M&E Plan. Tom Kahler explained, the idea is that hatchery stray rates should not be required to be lower than natural populations. Hillman said a paper by Mike Ford (NMFS) and others indicates a natural stray rate of up to 17.5% for Chinook salmon.[1] Hillman said currently the Hatchery M&E Plan calls for a stray rate of 10% within the basin, so the Committees may consider increasing the in-basin stray rate based on Ford's paper.

[1] Ford, M., A. Murdoch, M. Hughes, 2015. Using parentage analysis to estimate rates of straying and homing in Chinook salmon (*Oncorhynchus tshawytcha*). *Molecular Ecology* 24:1109-1121.

- *Draft Summary of Hatchery M&E Report Review:* The HCP Hatchery Committees want to document that responsibilities have been fulfilled with regard to review of the Hatchery M&E Report, as required by the HCP Hatchery Committees SOA "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-Year Report 2006-2010" (approved March 27, 2015). Therefore, Chelan PUD drafted a document summarizing these efforts and will also include an executive summary, as recommended by the HCP Hatchery Committees, for Committees' review.
- *Methow Steelhead Gene Flow*: Douglas PUD and USFWS are evaluating proportionate natural influence (PNI) and percent hatchery-origin spawners (pHOS) objectives using a four-population gene flow model developed by NMFS. All scenario results indicate that in order to reach the proposed pHOS and PNI objectives, adult removal rates would need to be 70% or greater. At this point, it appears NMFS will recommend a pHOS of 0.5 (rather than 0.3) for Methow steelhead. Hillman noted this seems appropriate, considering this is the same target used for the spring Chinook salmon population.
- *3-Year Hatchery Committees Chair Review Results*: The HCP Hatchery Committees elected to retain the Chairperson and support personnel for three more years.
- *Draft Methow M&E Implementation Plan 2017*: Douglas PUD submitted a draft plan to the HCP Hatchery Committees to review. The Committees agreed to a 30-day review instead of the normal 60-day review. Comments are due November 8, 2016, which will help facilitate contracting requirements before the end of 2016.
- *Next Steps*: The next meeting of the HCP Hatchery Committees will be on November 16, 2016, which means the HCP Hatchery Committee Chairperson will not provide an update of this meeting to the Coordinating Committees until the December 2016 meeting.

III. USFWS

A. PRESENTATION: Entiat River History and Impacts to Chinook Salmon (Greg Fraser)

Jim Craig introduced Greg Fraser, USFWS Fish Biologist. Craig said Fraser focuses most of his time on evaluation efforts associated with the Entiat National Fish Hatchery (NFH). Fraser said he will be presenting a talk titled "Entiat River History and Impacts to Chinook Salmon" (Attachment C), which was distributed to the Coordinating Committees by

Kristi Geris on September 28, 2016. The presentation included a brief history about the Entiat River and Entiat NFH, review of Entiat River survey data and results, and population trends from 1995 to 2015.

Presentation

Historically, three dams blocked anadromous fish access to the Entiat River, extirpating any endemic fish runs. In 1948, a flood destroyed the dams and reopened the river to anadromous fish. Following 1948, a natural barrier, located in the lower Entiat River, still existed during low-flow conditions (summer and fall runs); however, it did not present a barrier to fish passage during high-flow conditions (spring run). In 1961, construction of Rocky Reach Dam inundated the natural barrier, and it is now passable to all Chinook salmon runs.

In 1941, Entiat NFH was constructed and initially used for research. In 1961, the hatchery was converted into a production facility and was reconstructed in 1979. Historically, the hatchery has produced spring and summer Chinook salmon, sockeye and coho salmon, and rainbow trout, sourced from multiple stocks. From 2009 to present day, Entiat NFH rears summer Chinook salmon only.

Fish surveys are conducted in the upper and lower Entiat River basin. Surveys are not conducted in the middle basin because of the steeper gradient, larger substrate, and overall poor spawning habitat. Based on spawning ground surveys conducted from 1995 to 2015, abundance trends include peaks and valleys each year for spring and summer Chinook salmon, but overall are generally increasing. Survey data indicate spatial and temporal separation between spring and summer Chinook salmon (springers tend to spawn in upper reaches, and summers spawn in lower reaches); however, the data also indicate some overlap. These data suggest some superimposition of summer Chinook salmon on spring Chinook salmon redds (as high as 60% at times), which has been a concern in the Entiat River. Genetic spatial distribution and carcass recovery data indicate the proportion of hatchery-origin fish is greater in the lower reaches of the river, and natural-origin fish proportions are greater in the upper reaches of the river. In some years, most hatchery-origin returns came from out-of-basin hatcheries (strays). This is especially true for spring Chinook salmon, starting in 2010, and for summer Chinook salmon prior to 2014.

Questions

Craig asked about the increase in spring Chinook salmon abundance in 2015 and asked if it may be due to a temperature affect (warmer water in 2015, especially in the Snake River). Fraser said this may be so in 2015; however, he has not reviewed those data in prior years. Craig said the increase could be due to hatchery or environmental effects.

John Ferguson asked what the programmatic driver was behind the shift from springers to summers. Craig said it was a USFWS reform action to move away from Endangered Species Act-listed spring Chinook salmon. He said it was an easy change to rear a non-ESA-listed stock. Fraser added, these fish are produced for harvest.

Kirk Truscott asked about the proportion of strays compared to the overall spawning population. He cautioned this does not translate to fewer fish. He said, from a genetic integration standpoint, in order to evaluate the success of the Mid-Columbia Programs, the number of strays also needs to be considered, along with the proportion. Fraser said some fish return later, which seem to be a collection of hatchery fish from different areas. He said, among natural-origin returns, he is uncertain whether these are all from the Entiat River or whether they are strays from other systems. Truscott asked about detections of passive integrated transponder (PIT)-tagged natural-origin recruits in the Entiat River, and Fraser said most of those detected are from the Entiat River. Craig noted that PIT-tag array efficiency is low during the spring. Tom Kahler asked whether Entiat NFH releases are returning, and Fraser said yes.

Ferguson asked if the focus of the habitat restoration efforts in the basin is on springers, summers, or both. Fraser said the focus is on juvenile rearing. He added that USFWS is focusing on enhancing rearing habitat. Ferguson said it seems that all the effort is pushing toward summers. Kahler said the work is to benefit ESA-listed springers and steelhead, since most of the restoration money comes from federal programs intended to recover those species, and benefits to summers are incidental.

Truscott asked, based on scale samples during carcass-recovery efforts, whether the preponderance of natural-origin recruits of summer Chinook salmon were from true subyearlings, and Fraser said yes.

IV. Douglas PUD

A. Draft Wells Post-Season Bypass Report and Passage-Dates Analysis (Tom Kahler)

Tom Kahler said Kristi Geris sent an email to the Coordinating Committees on October 6, 2016, notifying them the Draft Wells Post-Season Bypass Report and Passage-Dates Analysis (Attachment D) was available for a 60-day review period, with edits and comments due to Kahler by Monday, December 5, 2016. Kahler said he has received one comment to date, from Jim Craig. Kahler said Craig asked, considering the Coordinating Committees accepted that yearling Chinook salmon survival is a reasonable surrogate for yearling coho salmon survival, why in Table 1 of Attachment D are the estimated travel time for yearling coho salmon shown as being 2 days when it is 5 days (based on data) for yearling Chinook salmon. Kahler said he believes Craig is correct, that travel time for yearling coho salmon should be 5 days, similar to yearling Chinook salmon, and the adjustment will be made prior to finalizing the report. Kahler welcomed additional comments prior to the review deadline.

V. Chelan PUD

A. Rock Island Powerhouse 1 Maintenance Update (Lance Keller and Brett Bickford)

Lance Keller introduced Brett Bickford, Chelan PUD Engineering and Project Management Director. Bickford handed out a summary on the Rock Island Powerhouse 1 Units B1 to B4 Maintenance Project, 2017 to 2020 (Attachment E), which was electronically distributed to the Coordinating Committees by Kristi Geris on October 26, 2016. Bickford recalled that surface cracks were identified on the blades of Rock Island Powerhouse 1 Units B1 through B4. He said, following several months of blade repairs and continued cracking, Chelan PUD conducted a comprehensive review to determine whether to modernize or retire the turbine units. He said, based on this review, Chelan PUD decided there was an overall value to keeping the units and discussed with manufacturers options for replacing the blades only. He said the head covers are cast iron; if they crack, there is no easy way to fix them. So Chelan PUD decided the repairs will include up to the head covers. He said the hydraulic capacity and generation output will not change, and the proposed improvements will incorporate fish-friendly features, as described in Attachment E.

Bickford reviewed the rest of Attachment E, and noted the schedule is fairly aggressive. He said, typically, Chelan PUD would prefer to address one unit at a time. However, he believes it will be valuable to complete all repairs prior to the HCP check-in in 2020. Keller reminded the Coordinating Committees that these repairs are considered as maintenance by FERC. Alene Underwood (Chelan PUD Fish and Wildlife Program Manager) said the next step for Chelan PUD, in concert with Bickford's process, is to draft a letter to FERC outlining the planned maintenance for the Rock Island Dam Powerhouse 1 units, and provide that draft letter to the Coordinating Committees for review. Underwood said Chelan PUD will request a 30-day review, and target submitting the final letter to FERC by December 31, 2016. John Ferguson suggested providing the draft letter for review by the Coordinating Committees prior to the next meeting on November 15, 2016.

B. DECISION: 2016/2017 Rocky Reach Adult Ladder Winter Maintenance Outage (Lance Keller)

Lance Keller recalled that Chelan PUD is requesting to begin the upcoming 2016/2017 annual adult fish ladder winter maintenance period at Rocky Reach Dam 3 weeks early to complete needed work, including an overhaul of one (of three) AWS pumps. Keller said Thad Mosey (Chelan PUD Fish Biologist) reminded him that a past Coordinating Committees concern regarded which fish are migrating past the project during the month of December. Keller said, to address this concern, Chelan PUD monitored count window passage using video from November 16 to December 31, 2012, which he used to review passage data from December 12 to 31, 2014 (the proposed early outage period). He said that, based on these data, fish passage during that time period included: zero Chinook salmon, seven natural-origin steelhead, ten hatchery-origin steelhead, four adult bull trout, three subadult bull trout, and one coho salmon. He said, this year, the steelhead run is even lower, but overall, he expects these numbers to be largely representative for 2016.

Keller reminded the Coordinating Committees that if the work is completed early, the ladders will be brought back online early. He also clarified that this request is for this year only, and next year's maintenance period will be based on the results of this year's efforts.

Rocky Reach HCP Coordinating Committee representatives present agreed to Chelan PUD beginning the 2016/2017 adult fish ladder winter maintenance work period at Rocky Reach Dam 3 weeks early. Rather than beginning on January 2, 2017, the new start would be December 12, 2016, to allow more time to complete an overhaul of one or two (of three) AWS pumps. *(Note: Jeff Korth provided WDFW's approval of the early outage via email on November 3, 2016, which Kristi Geris distributed to the Coordinating Committees that same day.)*

C. DECISION: 2016 Rocky Reach and Rock Island Spill Report (Lance Keller)

Lance Keller said a Revised Draft 2016 Rocky Reach and Rock Island Spill Report was distributed to the Coordinating Committees by Kristi Geris on October 24, 2016. Keller offered to postpone approval of the report, if needed, due to the late distribution of the revised report. He said revisions included: 1) corrected percent of run that passed under Rock Island spring spill for each species; and 2) added explanation under Rocky Reach summer spill describing how the 95% passage target was missed for subyearling Chinook salmon. John Ferguson asked if the added language will suffice for FERC reporting purposes, since missing the 95% objective will have to be described, and Keller said that combined with the meeting minutes, he believes it will.

Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2016 Rocky Reach and Rock Island Spill Report, as revised. *(Note: Jeff Korth provided WDFW's approval of the report via email on November 3, 2016, which Geris distributed to the Coordinating Committees that same day.)*

VI. HCP Administration

A. HCP Email Distribution Lists Protocol (John Ferguson and Kristi Geris)

Kristi Geris recalled the Coordinating Committees revisiting the HCP email distribution lists in 2014, and discussing how to manage the lists so they remain meaningful and somewhat exclusive. She said this discussion was prompted because the lists had become large and included an assortment of members, including several retired staff. She also recalled Mike Schiewe's (former HCP Chairman, retired) interest in encouraging interagency coordination, as opposed to copying everyone on every email. *(Note: after the meeting, Geris* *recalled that the HCP email distribution lists were then reduced to representatives only, and the carbon copy list included alternates and select staff, as discussed and agreed upon with the PUDs.)*

Geris said there was an agreement to require Coordinating Committees approval for non-HCP representatives and alternates for HCP Extranet access; however, a process was not specified for modifying the email distribution lists. She said, based on review of HCP Hatchery and Coordinating Committees minutes, people have been added to the email distribution lists with and without Coordinating Committees approval. Geris asked the Coordinating Committees what they prefer regarding protocol for modifying email lists. John Ferguson also noted that Michael Humling was recently added to the HCP Hatchery Committees email distribution list, and Ferguson wanted to verify the Coordinating Committees approved, if applicable. Tom Kahler explained that Humling is USFWS's point of contact for hatchery coordination in the Methow, much like Charlie Snow (WDFW) is for Douglas and Chelan PUDs, so being added to the email distribution seems reasonable.

Coordinating Committees representatives present agreed that Coordinating Committees approval will be required to add non-HCP representatives and alternates to HCP email distribution lists, similar to approving Extranet access (the latter discussed February 25, 2014). Coordinating Committees representatives present agreed to add Humling to the HCP Hatchery Committees email distribution list.

B. Next Meetings

The next scheduled Coordinating Committees meeting is on November 15, 2016, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. Tom Kahler said a room at Douglas PUD is typically available, if needed (similar to this month). Scott Carlon proposed moving the meeting start time to 10:00 a.m. to accommodate travel arrangements. Coordinating Committees representatives present agreed to move the start time of the monthly Coordinating Committees from 9:30 to 10:00 a.m., to accommodate travel arrangements for attendees.

The December 13, 2016, and January 24, 2017, 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	USFWS HCP Representation Designation Letter
Attachment C	Entiat River History and Impacts to Chinook Salmon
Attachment D	Draft Wells Post-Season Bypass Report and Passage-Dates Analysis
Attachment E	Rock Island Powerhouse 1 Units B1 to B4 Maintenance Project, 2017 to 2020

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood†††	Chelan PUD
Brett Bickford†††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Greg Fraser††	U.S. Fish and Wildlife Service
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Coordinating Committees member or alternate
† Joined by phone for the HCP Tributary and Hatchery Committees Update
†† Joined for USFWS presentation
††† Joined for the Rock Island Powerhouse 1 Maintenance Update

United States Department of the Interior
U.S. Fish and Wildlife Service
Mid-Columbia Fish and Wildlife Conservation Office
7501 Icicle Road
Leavenworth, Washington 98826

10/21/16

To: Tracy Hillman, Chair, Rock Island, Rocky Reach, and Wells HCP Hatchery Committees

From: Jim Craig, Project Leader

Subject: US Fish and Wildlife Service Hatchery Committee representation

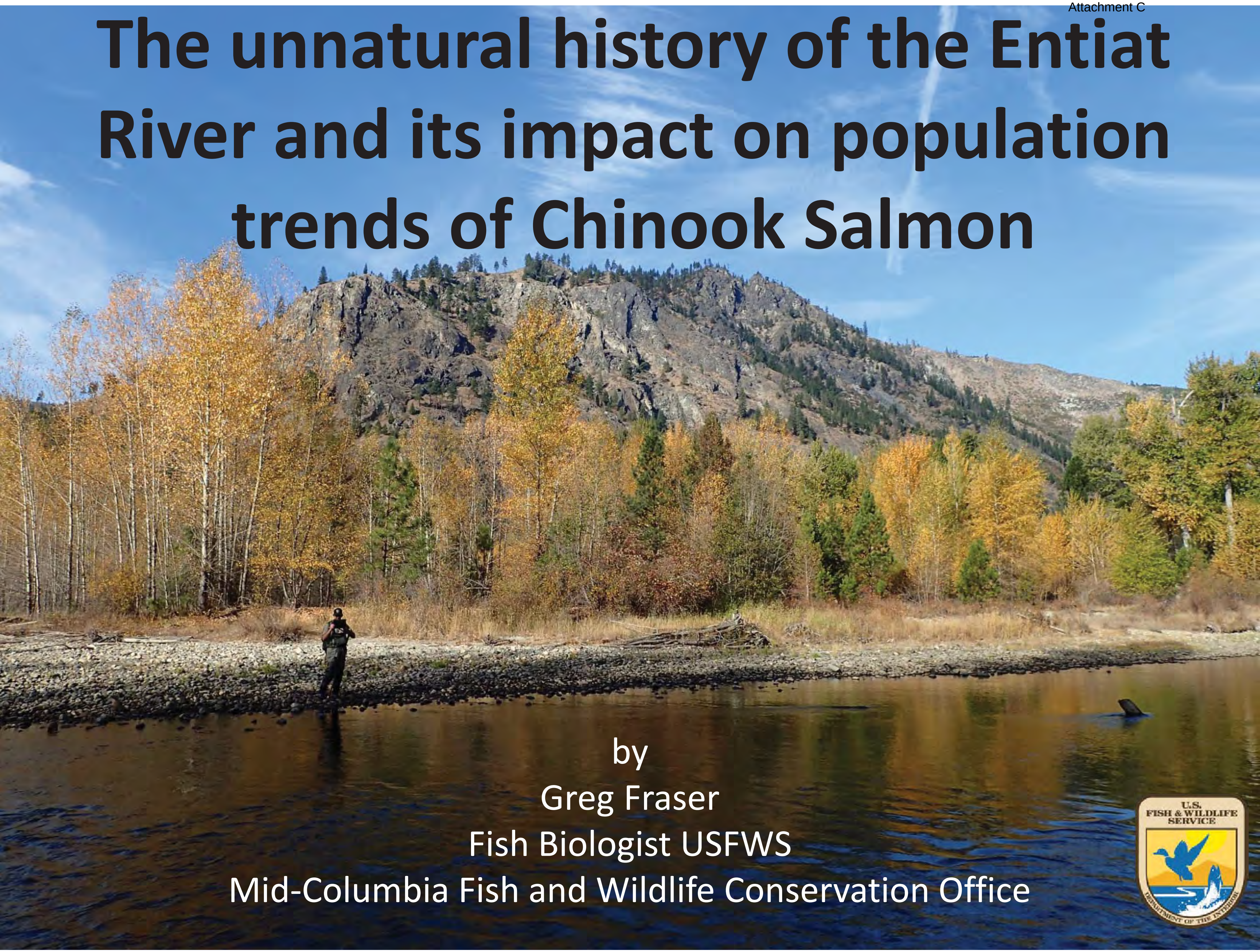
This Memorandum provides notification of a change in US Fish and Wildlife Service representation on the Rock Island, Rocky Reach, and Wells HCP Hatchery Committees. To better address current work loads Mathew Cooper will become the lead representative while William Gale will serve as the alternate Service representative to these committees.

Sincerely,

Jim Craig
Project Leader

Attachment C

The unnatural history of the Entiat River and its impact on population trends of Chinook Salmon



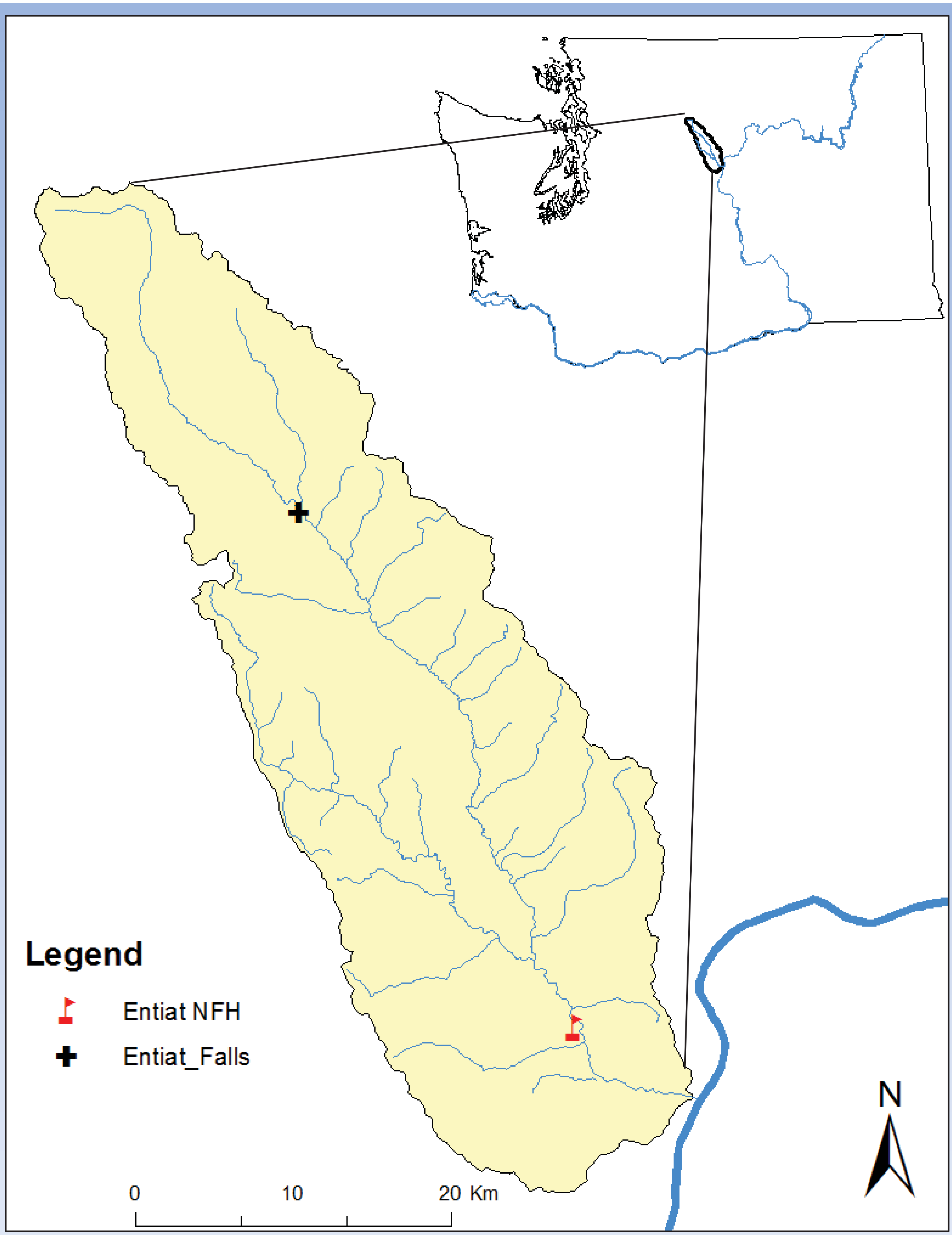
by
Greg Fraser
Fish Biologist USFWS
Mid-Columbia Fish and Wildlife Conservation Office

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Outline

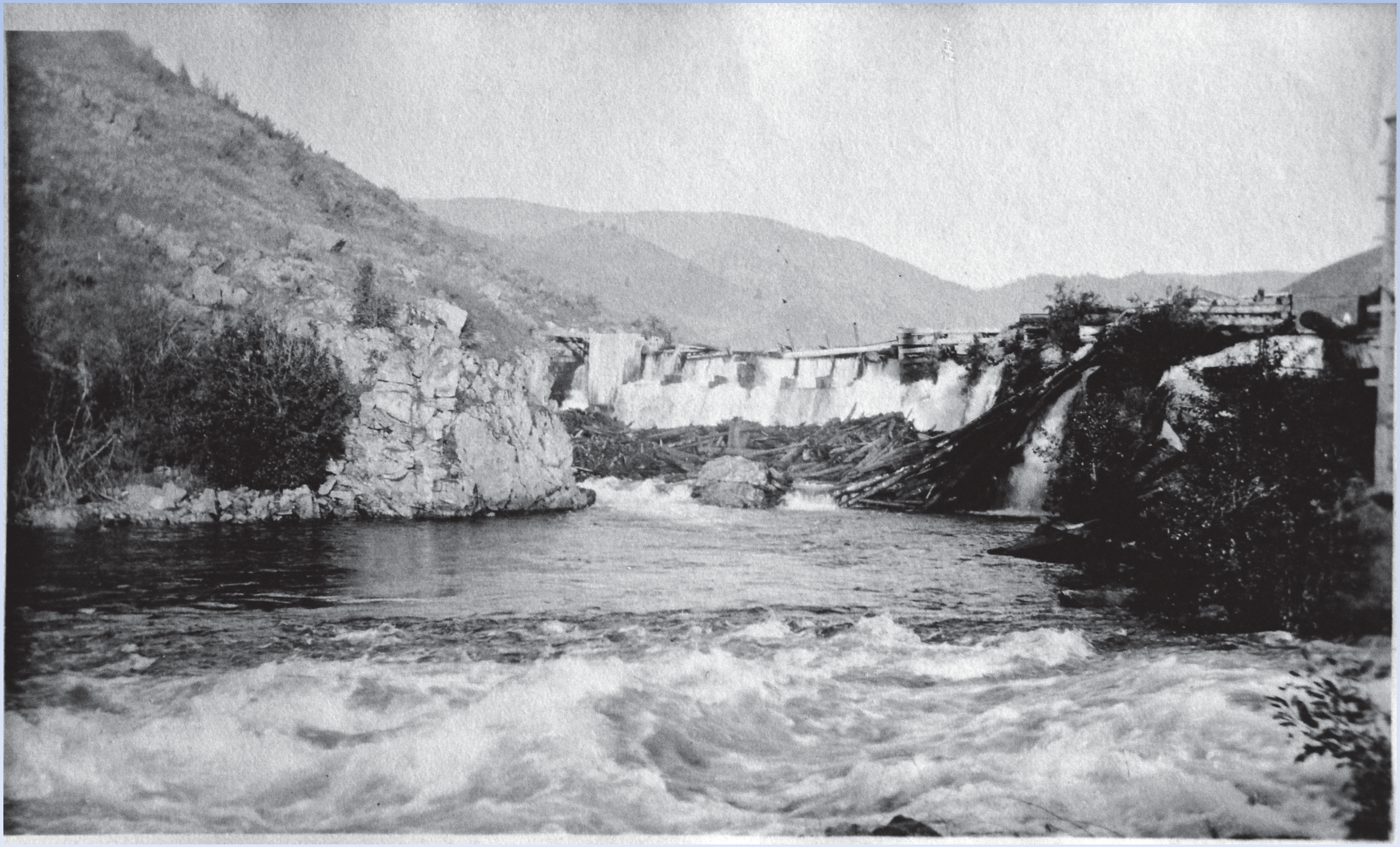
- Entiat River History
- Data collection
- 2015 Results
- Population trends 2002-2015

Attachment C

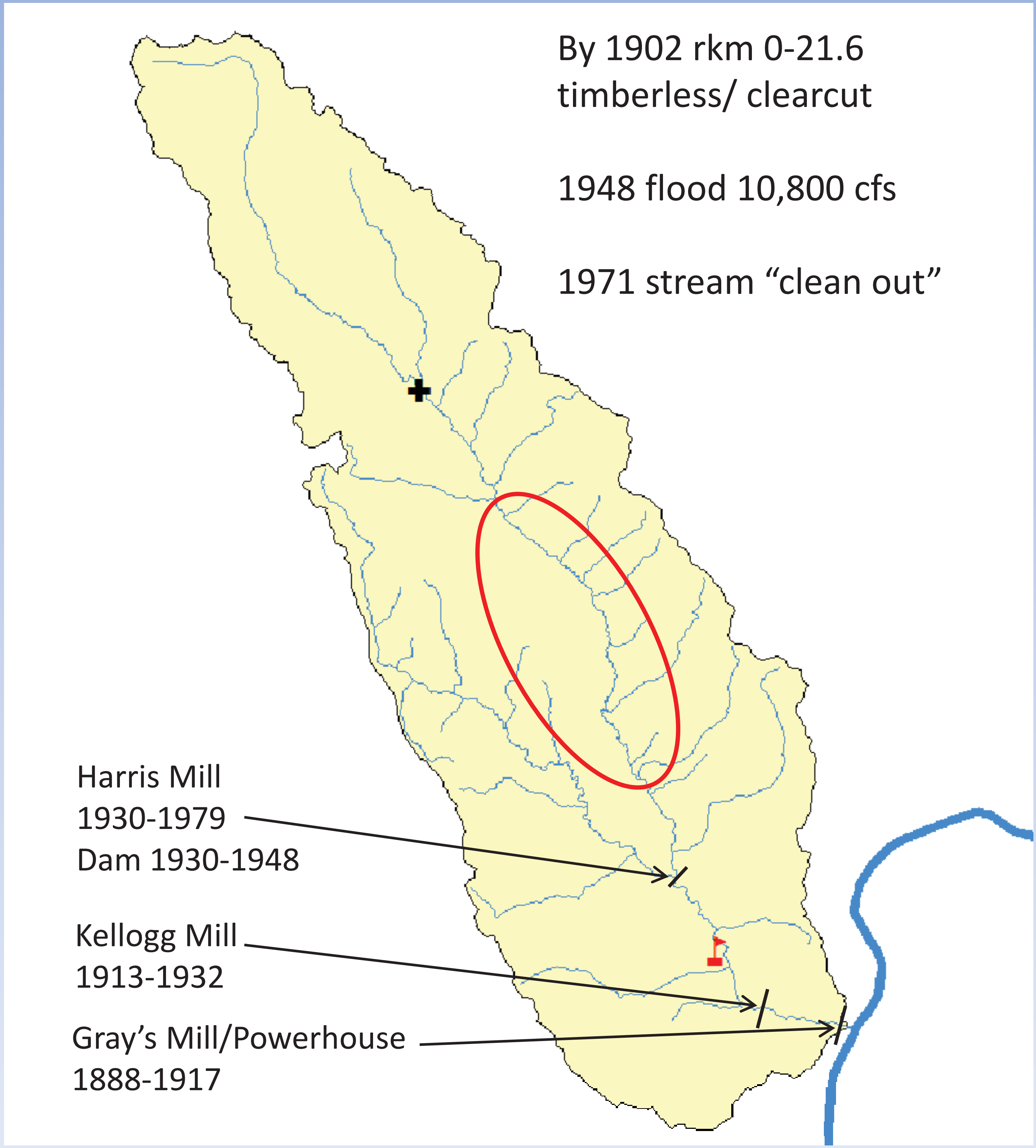

Legend
Entiat NFH
Entiat_Falls
0
10
20 Km
N

Entiat River History: Dams

- 1800's multiple dams extirpated salmon runs

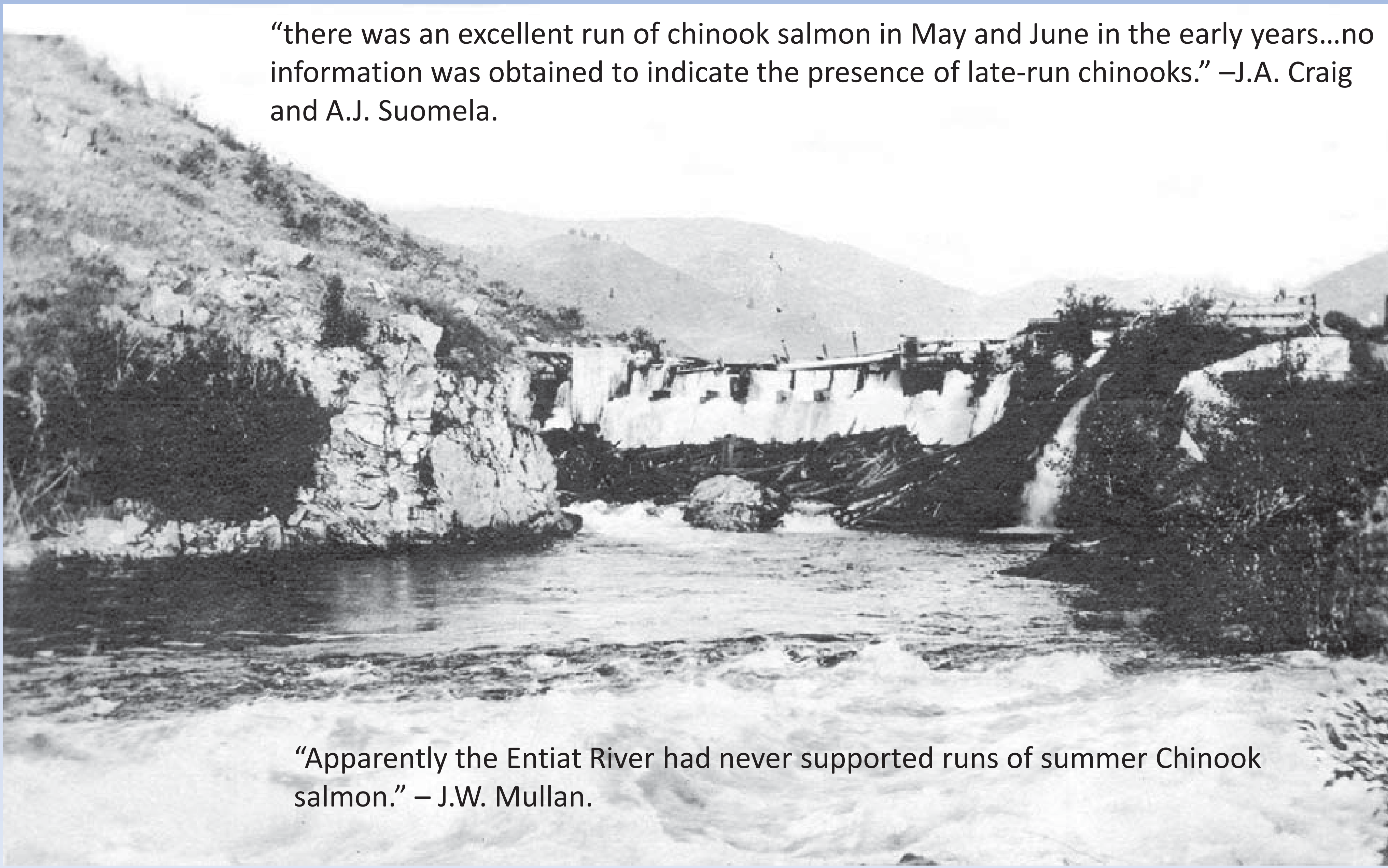


Attachment C



Entiat River History: Springers

“there was an excellent run of chinook salmon in May and June in the early years…no information was obtained to indicate the presence of late-run chinooks.” –J.A. Craig and A.J. Suomela.



“Apparently the Entiat River had never supported runs of summer Chinook salmon.” – J.W. Mullan.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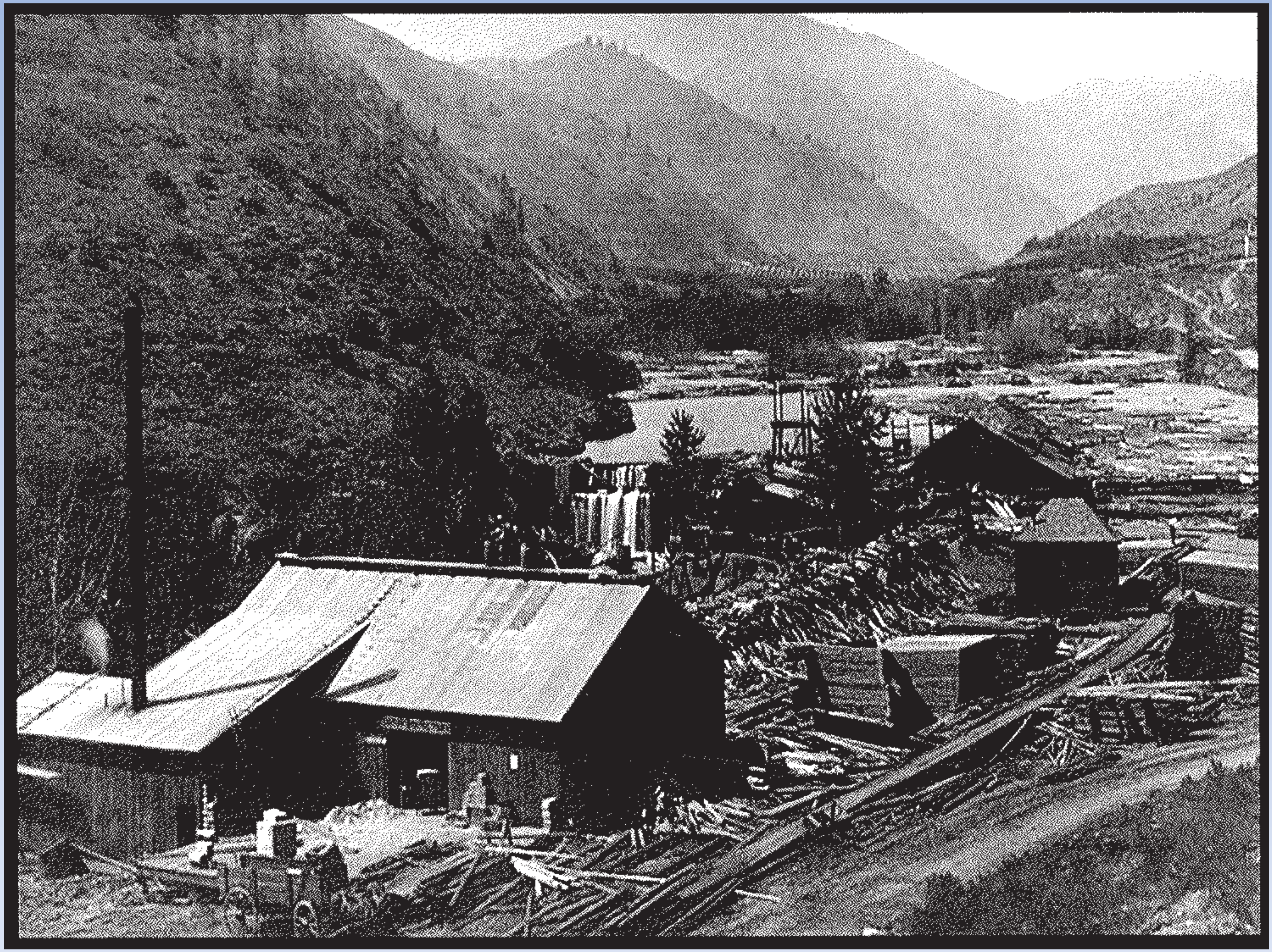
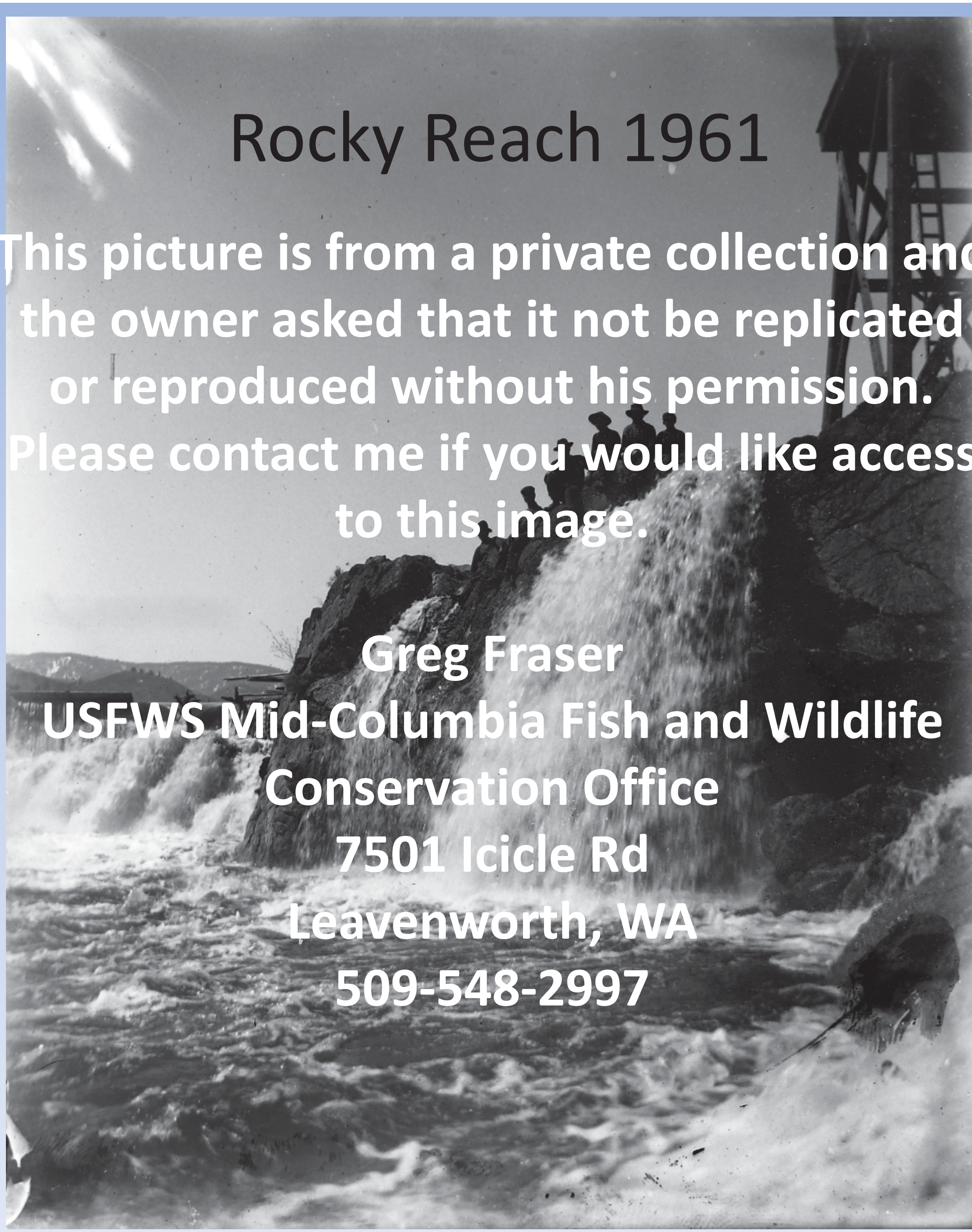
the owner asked that it not be replicated
or reproduced without his permission.
Please contact me if you would like access
to this image.
Greg Fraser
USFWS Mid-Columbia Fish and Wildlife
Conservation Office
7501 Icicle Rd
Leavenworth, WA
509-548-2997
Spring flows circa 1900



Attachment C



Rocky Reach 1961

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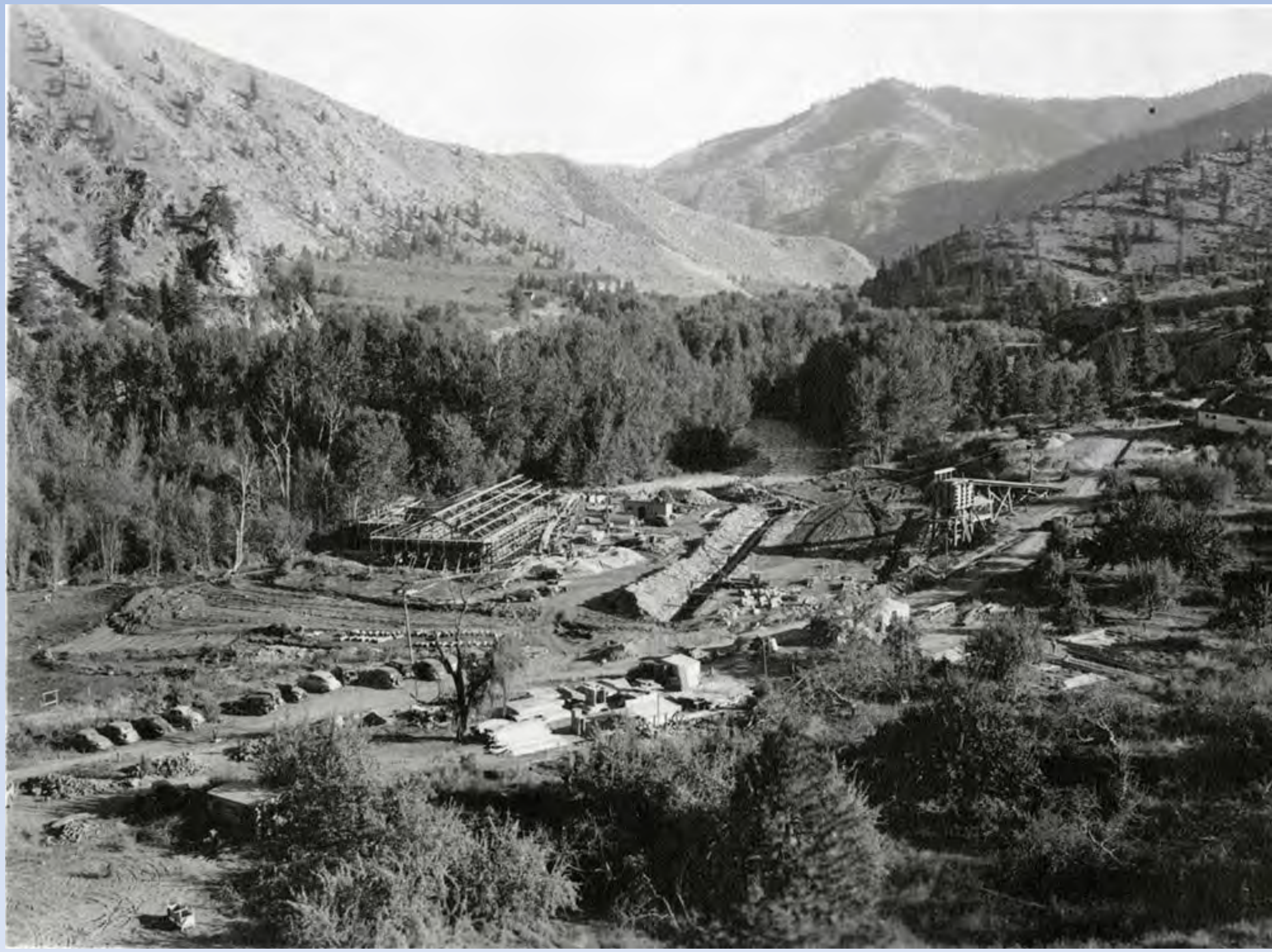
Greg Fraser
USFWS Mid-Columbia Fish and Wildlife Conservation Office
7501 Icicle Rd
Leavenworth, WA
509-548-2997

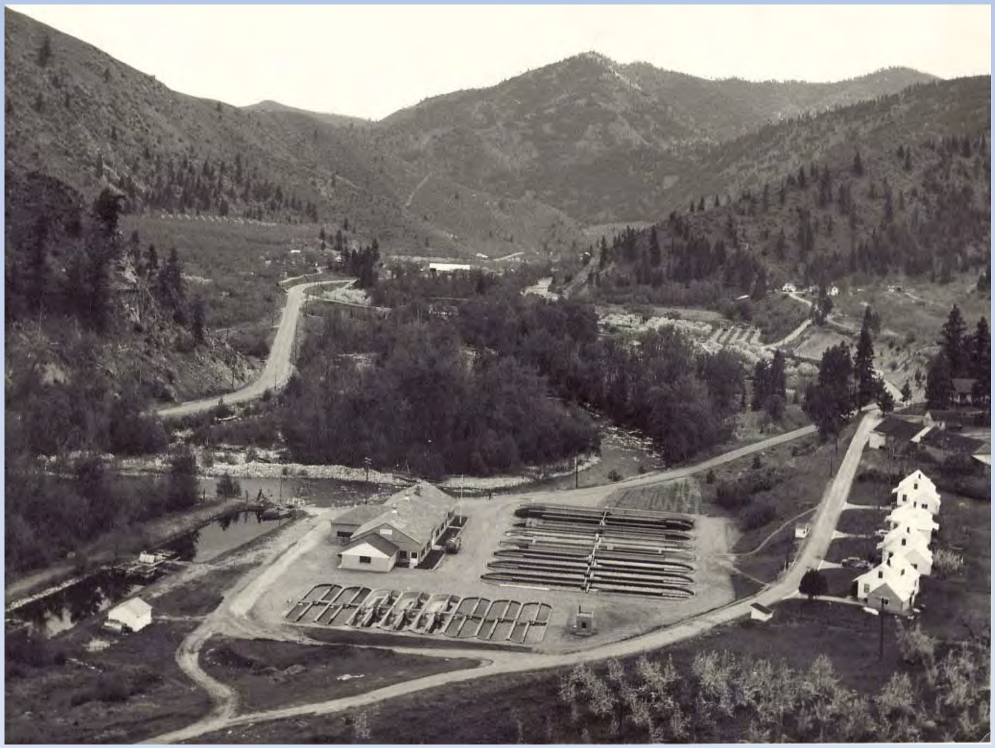
Entiat River History: Entiat NFH

- 1941 constructed
- 1951 research
- 1961 production



Entiat River History: Entiat NFH

- 1979 Entiat NFH reconstructed



Entiat NFH Release Information (1945-1974)

Year	Species	Number	
1945	Summer Chinook	65957	
	Coho	99485	
	Steelhead	16473	Entiat River
	Sockeye	35226	
1946	Summer Chinook	751447	
	Steelhead	7190 EE	Eyed eggs shipped to Leavenworth - no Entiat release
	Spring Chinook	176589 EE	
1947	Summer Chinook	251438	
	Steelhead	22276	Entiat River
1948	Summer Chinook	396744	
	Steelhead	109502	- Transferred as fingerlings to Chelan State Fish Hatchery
	Sockeye	0	
1949	Summer Chinook	375591	
	Steelhead	0	- Only one female spawned due to new adult pond construction
	Sockeye	9930	
1950	Summer Chinook	526520	
	Steelhead	23570	Released Dec. 11 1950 15 miles above hatchery
	Sockeye	45800	
1951	Summer Chinook	625358	
	Steelhead	7474	Released as fry into Entiat River
	Sockeye	27775	
1952	Summer Chinook	321727	
	Steelhead	0	
	Sockeye	154148	
1953	Summer Chinook	659076	
	Steelhead	0	
	Sockeye	458642	
1954	Summer Chinook	498323	
	Steelhead	0	
	Sockeye	260727	Eggs to Leav.
1955	Summer Chinook	463393	
	Steelhead	0	
	Sockeye	488953	
1956	Summer Chinook	250472	
	Steelhead		
	Sockeye	240452	Eggs to Leav.
1957	Summer Chinook	309380	
	Steelhead	0	
	Sockeye	396794	
1958	Summer Chinook	522504	
	Steelhead		
	Sockeye	726970	
1959	Summer Chinook	143847	
	Steelhead		
	Sockeye	396128	
1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

* Entiat NFH became "Salmon Cultural Laboratory" in 1951 and Steelhead were no longer a species of interest for the station. Due to a WDFW policy that stated fingerlings must be reared for 18 months or longer prior to release, the steelhead program was discontinued.

Entiat NFH Release Information (1945-1974)

Year	Species	Number	
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	Steelhead	16473	Enti
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	Steelhead	22276	Ent
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	Steelhead	109502	- Trans
	Sockeye	0	
1949	Summer Chinook	375591	
	Steelhead	0	- Only
	Sockeye	9930	
1950	Summer Chinook	526520	
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	Sockeye	45800	
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	Steelhead	7474	Releas
	Sockeye	27775	
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	Steelhead	0	
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	Steelhead	0	
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1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

Year	Species	Number	
	Rainbow Trout	80315	
1962	Summer Chinook	229828	
	Steelhead	54,334 eggs	- Taken from adults trapped at Rocky Reach Dam
	Sockeye	None	
	Rainbow Trout	182783	
	Cutthroat Trout	eggs	
1963	Summer Chinook	230593	
	Steelhead	377591	- Eyed eggs shipped to Winthrop NFH and Chelan SFH
	Sockeye	0	
	Cutthroat Trout	8106	
	Coho	eggs	
1964	Summer Chinook	2100 to Leav	
	Steelhead	36101	- Fingerlings transferred to "Washington State Game" for distribution - unknown sites
	Sockeye	0	
	Rainbow Trout	95496	
	Cutthroat Trout	0	
	Coho	0	
1965	Summer Chinook	990898	
	Steelhead	22503	- No record of release site.
	Sockeye	0	
	Rainbow Trout	716482	
	Coho	473882	
1966	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	252475	
	Coho	275000	
1967	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	1053364	
	Coho	299855	
1968	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	304380	
	Coho	2805816	
1969	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	510148	
	Coho	452929	
1970	Summer Chinook	0	
	Coho	588745	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	456549	
	Cutthroat Trout	0	
	Brook Trout	0	
1971	Summer Chinook	0	
	Coho	0	
	Steelhead	0	

Attachment C

Entiat NFH Release Information (1945-1974)

Year	Species	Number	
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	Sockeye	396128	
1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

	Rainbow Trout	80315	
1962	Summer Chinook	229828	
	Steelhead	54,334 eggs	– Taken from adults trapped at Rocky Reach Dam
	Sockeye	None	
	Rainbow Trout	182783	
	Cutthroat Trout	eggs	
1963	Summer Chinook	230593	
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	Sockeye	0	
	Rainbow Trout	95496	
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	Steelhead	22503	– No record of release site.
	Sockeye	0	
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	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	252475	
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	Steelhead	0	
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	Coho	2805816	
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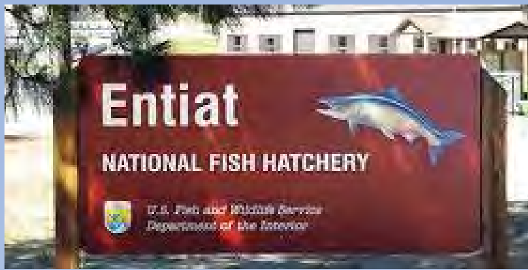
	Coho	588745	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	456549	
	Cutthroat Trout	0	
	Brook Trout	0	
1971	Summer Chinook	0	
	Coho	0	
	Steelhead	0	

	Sockeye	0
	Rainbow Trout	761456
	Cutthroat Trout	3230
	Brook Trout	11410
1972	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	754523
	Cutthroat Trout	0
	Brook Trout	26000
1973	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	764802
	Cutthroat Trout	0
	Brook Trout	19768
1974	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	317207
	Brook Trout	24921

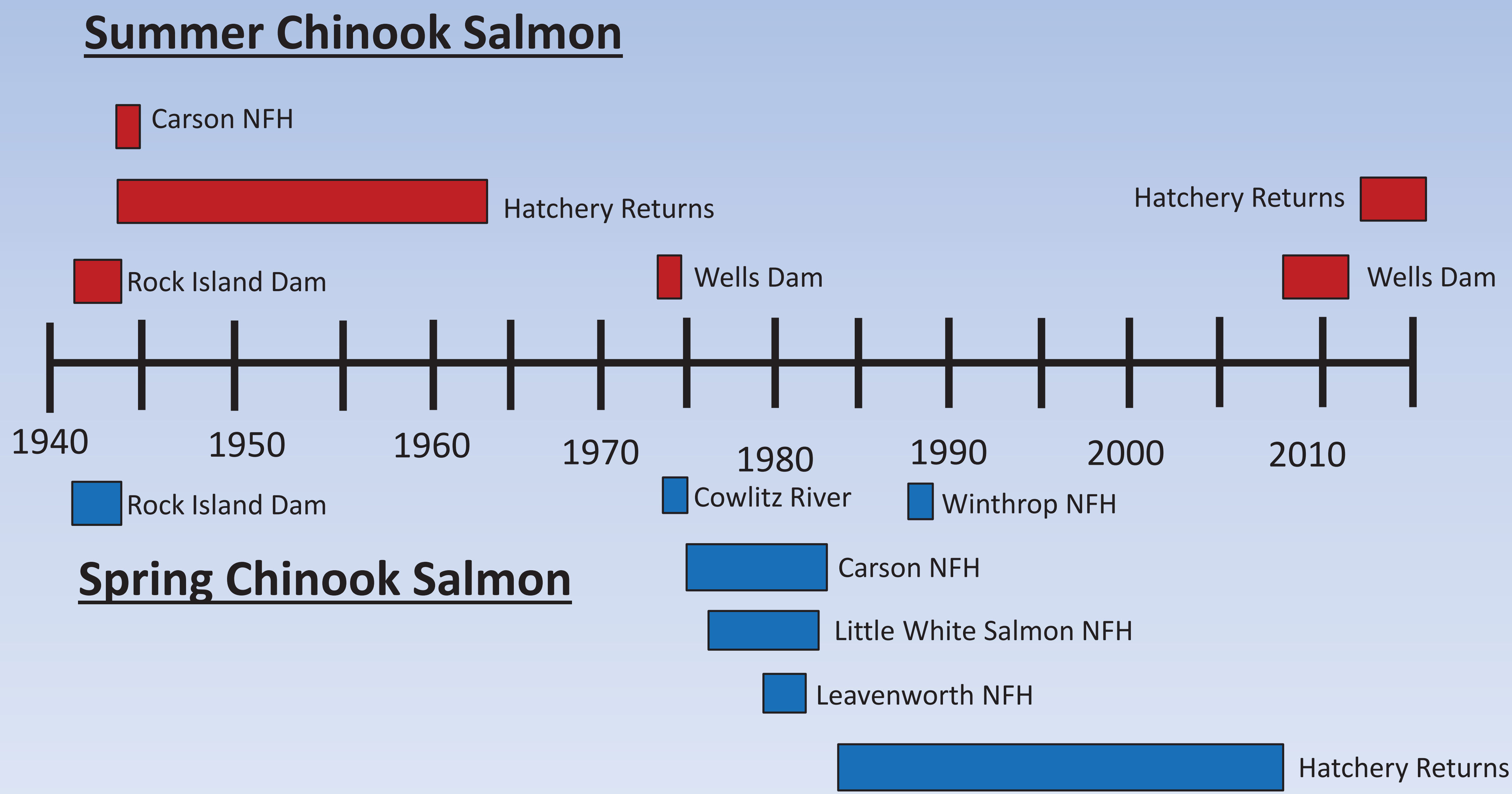
1943 "Spring" steelhead 7,974 into Entiat River at hatchery in May.
"Land Locked" steelhead 21,667 into Entiat River at hatchery in July.
"Spring" steelhead 619,245 fry into Entiat River at hatchery in September.
"Fall" steelhead 599,778 fry into Entiat River at hatchery in September.

Entiat River History: Entiat NFH

- 1939-1940 Summer Chinook placed in river
- 1942-1944 Spring Chinook
- 1945-1961 Sockeye
- 1941-1965 Summer Chinook
- 1966-1973 Coho and Rainbow Trout
- 1974-2007 Spring Chinook
- 2009-present Summer Chinook



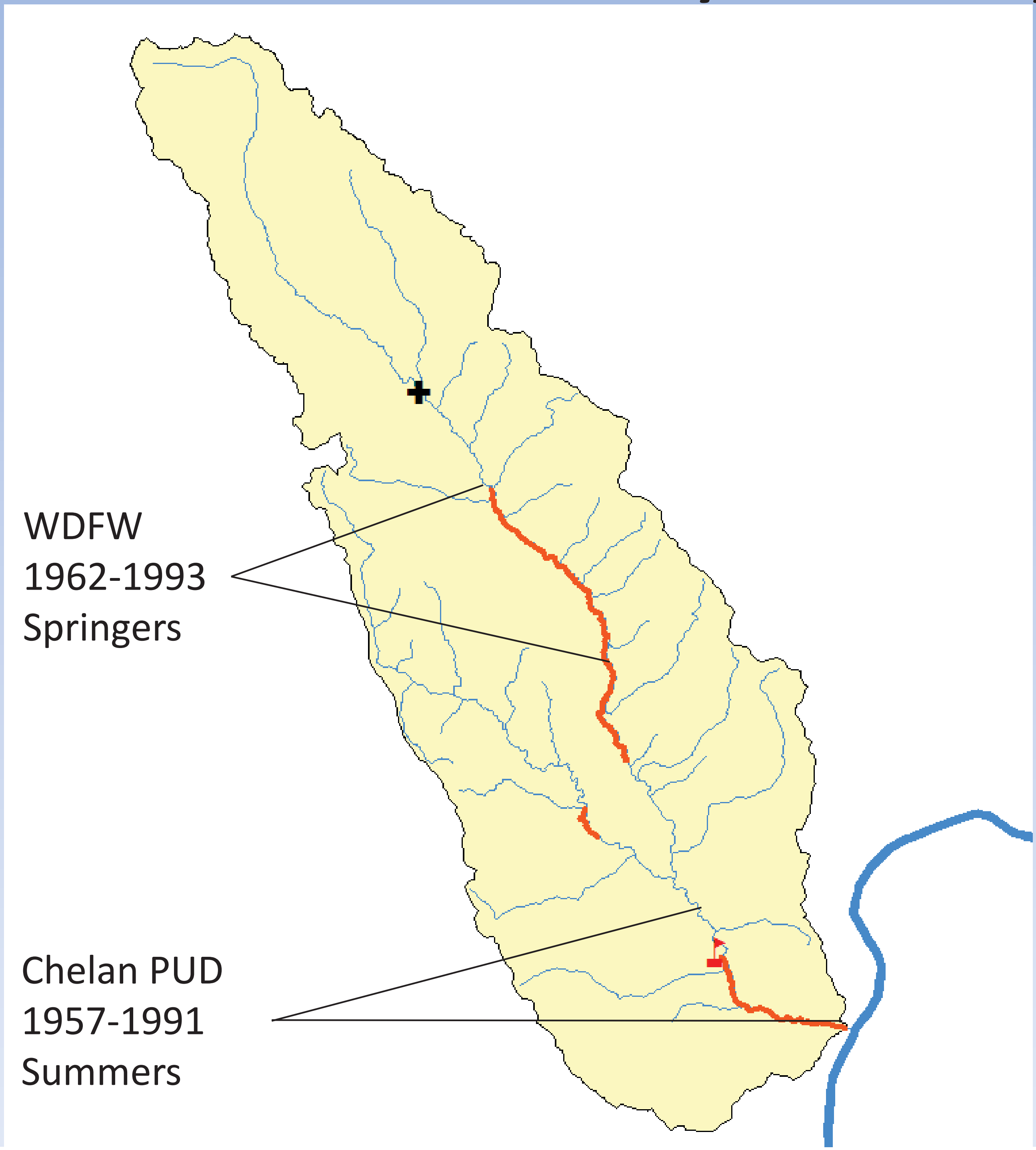
Broodstock History



Entiat River History

- 1974-2007 Entiat NFH raised spring Chinook
  - Last spring Chinook release 2007, last return 2010
- 2009-present raise summer Chinook
  - First release 2011
  - First full production release 2013

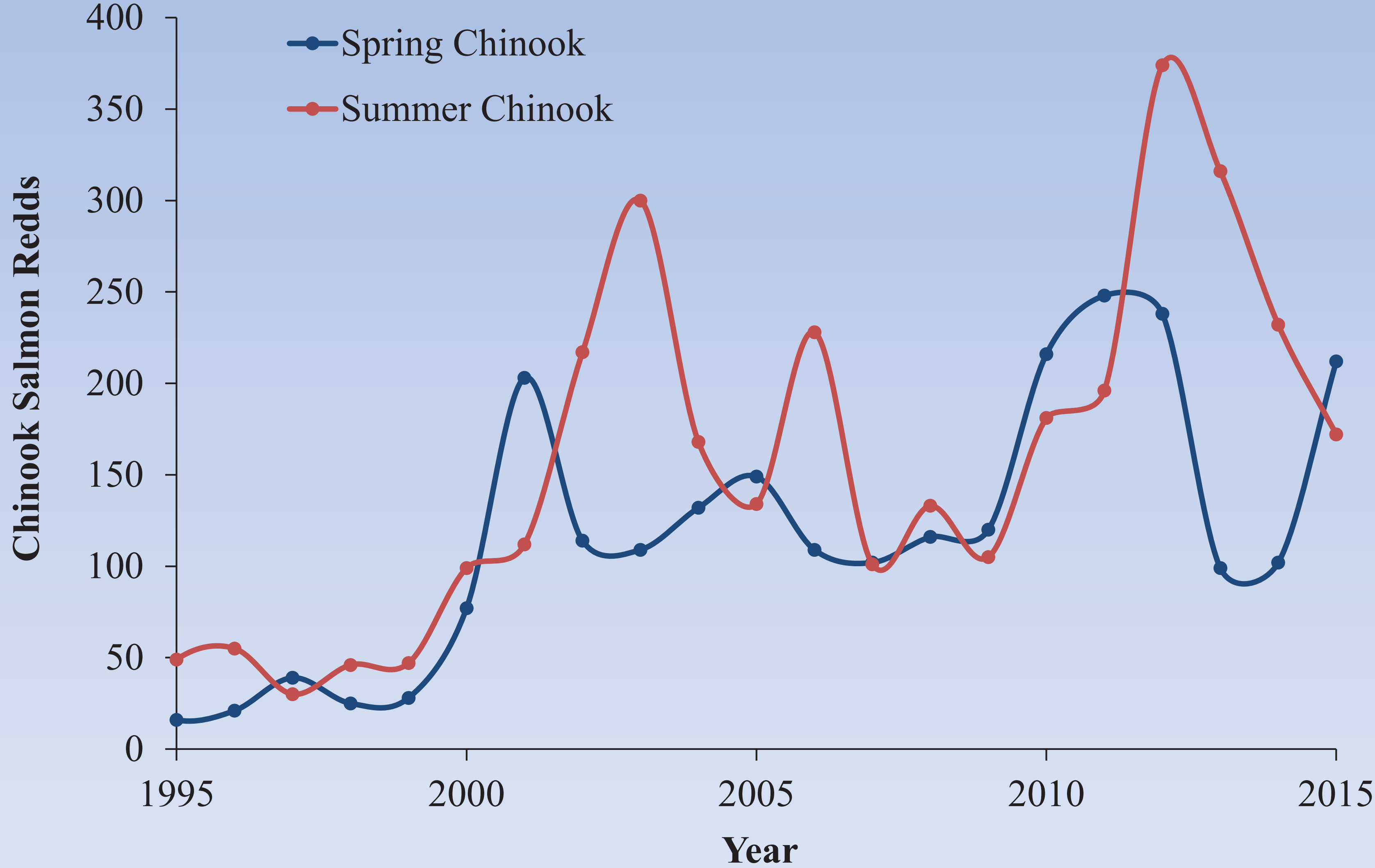
Entiat River History: Surveys



Spawning Ground Surveys

- Groups of 2-4 observers per survey
- One observer per bank minimum
- Weekly surveys began late-July
- Redd Data: spatial, temporal, abundance
- Carcass Data: age, sex, origin

Abundance Trends



Attachment C

Total

0

Spring

0

0

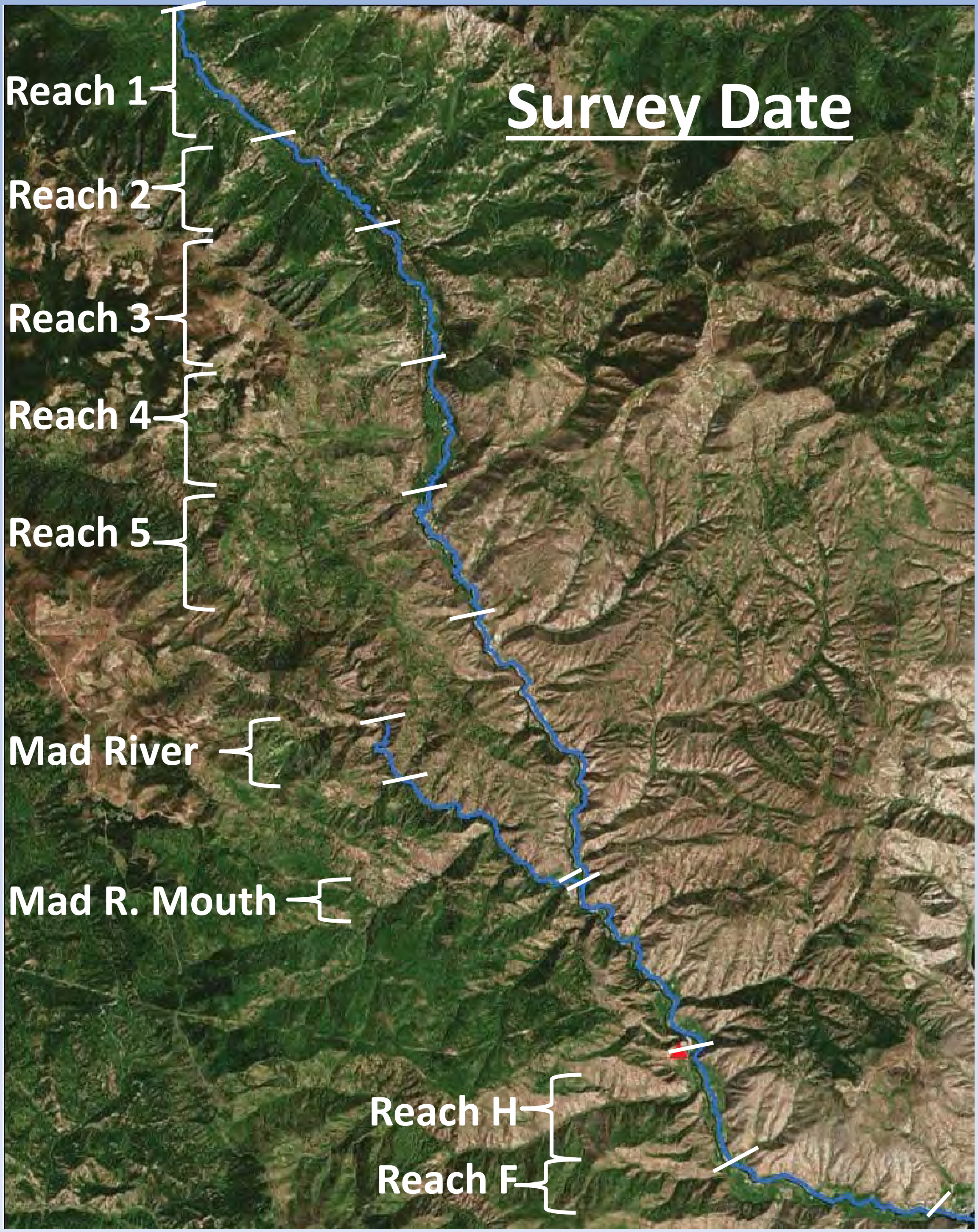
0

0

0

0

0



Summer

0

0

0

0

0

0

0

0

0

Total

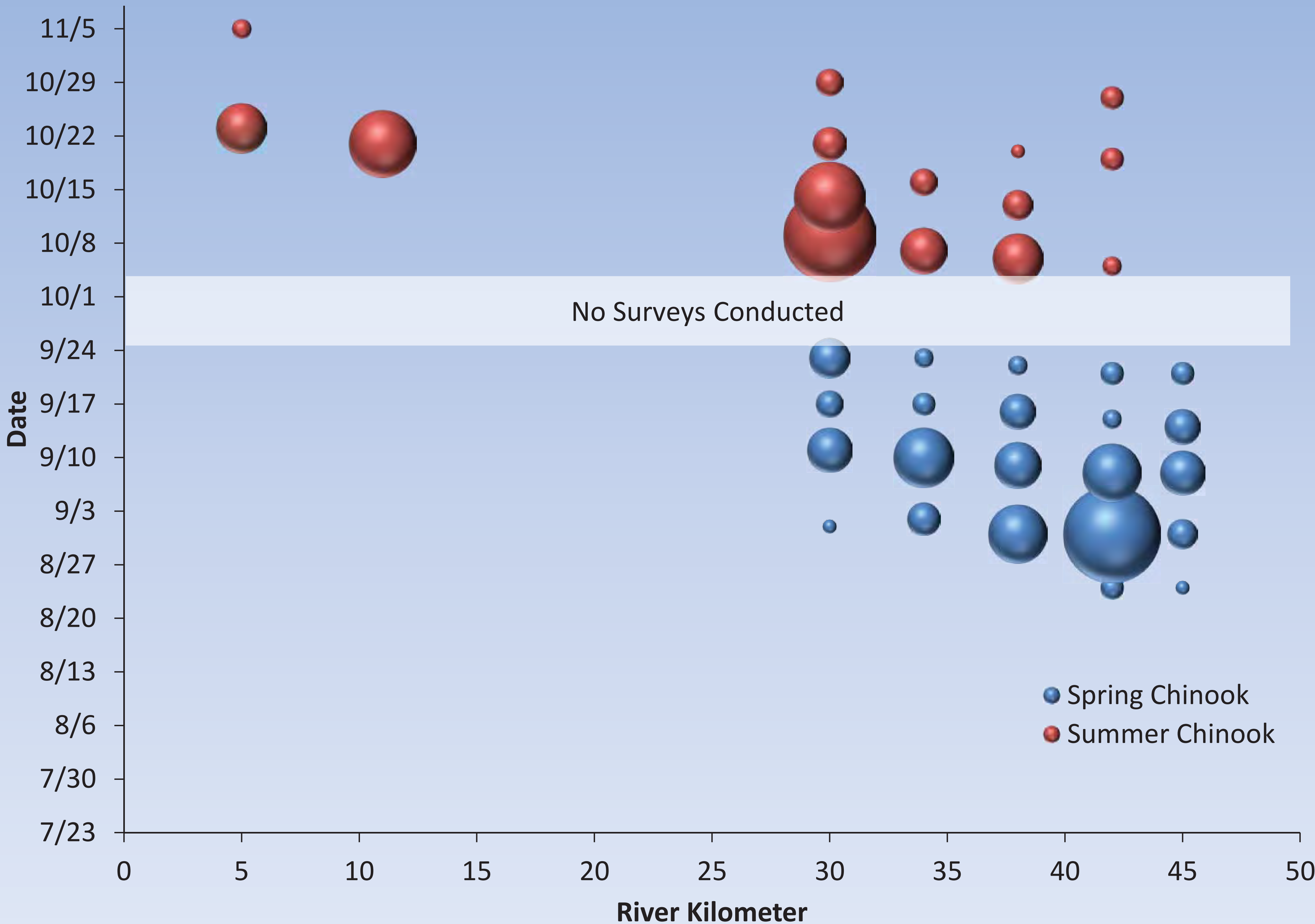
0

Attachment C

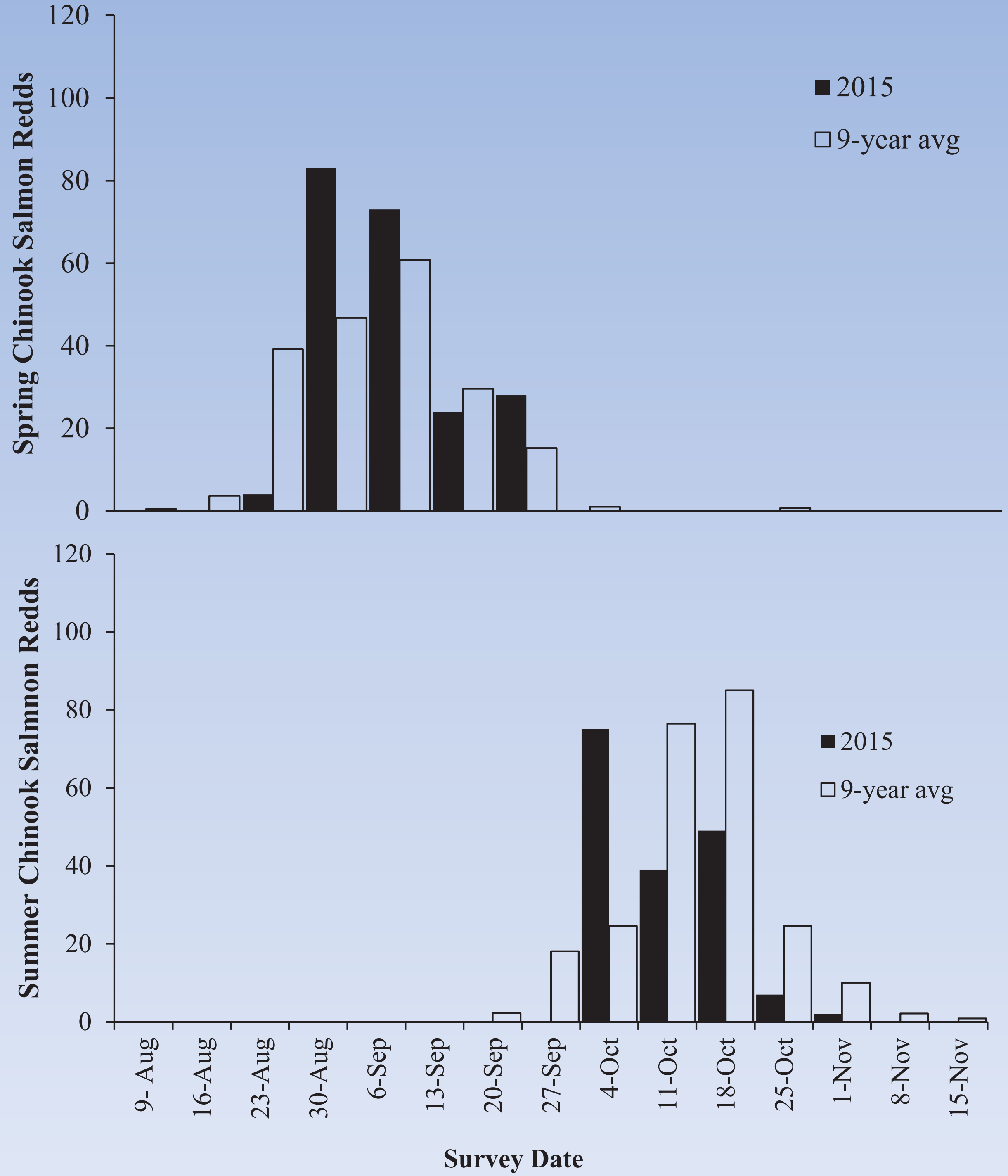
Spring	Summer
27	0
79	8
40	20
31	16
25	85
10	0
0	2
	25
	16

Total 212 (Spring)

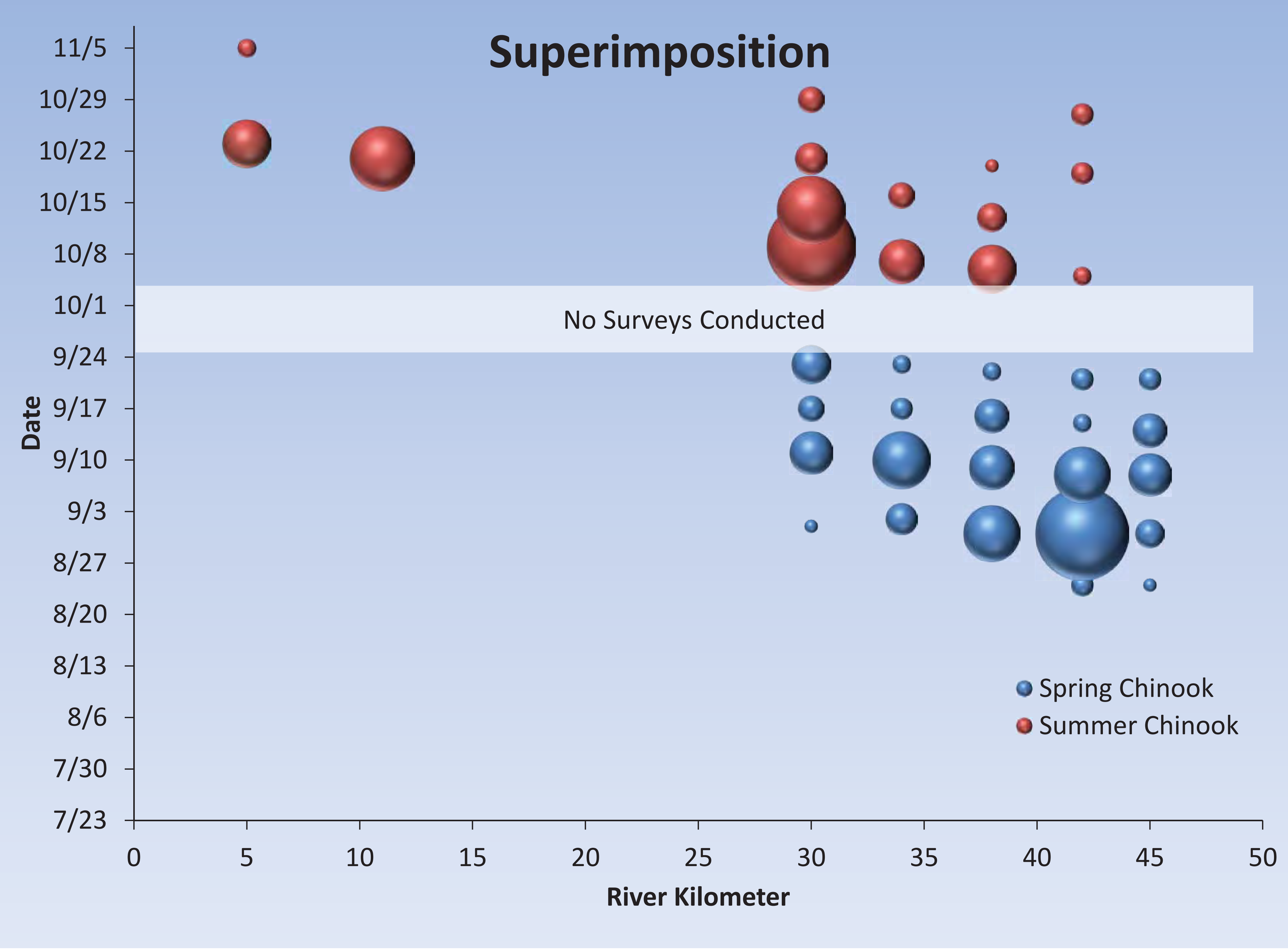
Total 172 (Summer)



Date
11/5
10/29
10/22
10/15
10/8
10/1
9/24
9/17
9/10
9/3
8/27
8/20
8/13
8/6
7/30
7/23
No Surveys Conducted
Spring Chinook
Summer Chinook
0
5
10
15
20
25
30
35
40
45
50
River Kilometer

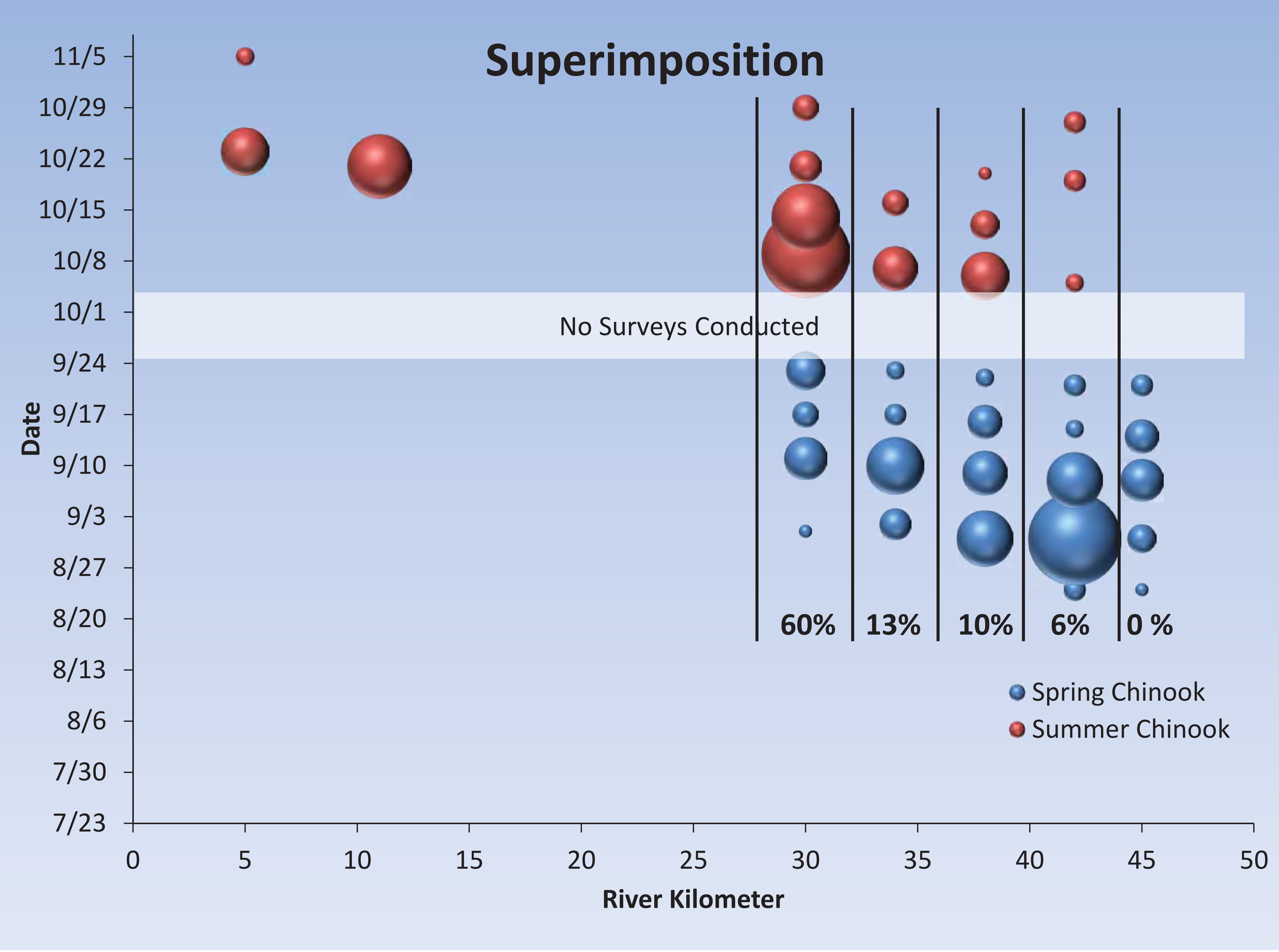


Spring Chinook Salmon Redds
120
100
80
60
40
20
0
2015
9-year avg
Summer Chinook Salmnon Redds
120
100
80
60
40
20
0
2015
9-year avg
9- Aug
16-Aug
23-Aug
30-Aug
6-Sep
13-Sep
20-Sep
27-Sep
4-Oct
11-Oct
18-Oct
25-Oct
1-Nov
8-Nov
15-Nov
Survey Date



Superimposition
Date
11/5
10/29
10/22
10/15
10/8
10/1
9/24
9/17
9/10
9/3
8/27
8/20
8/13
8/6
7/30
7/23
No Surveys Conducted
Spring Chinook
Summer Chinook
0
5
10
15
20
25
30
35
40
45
50
River Kilometer

Attachment C



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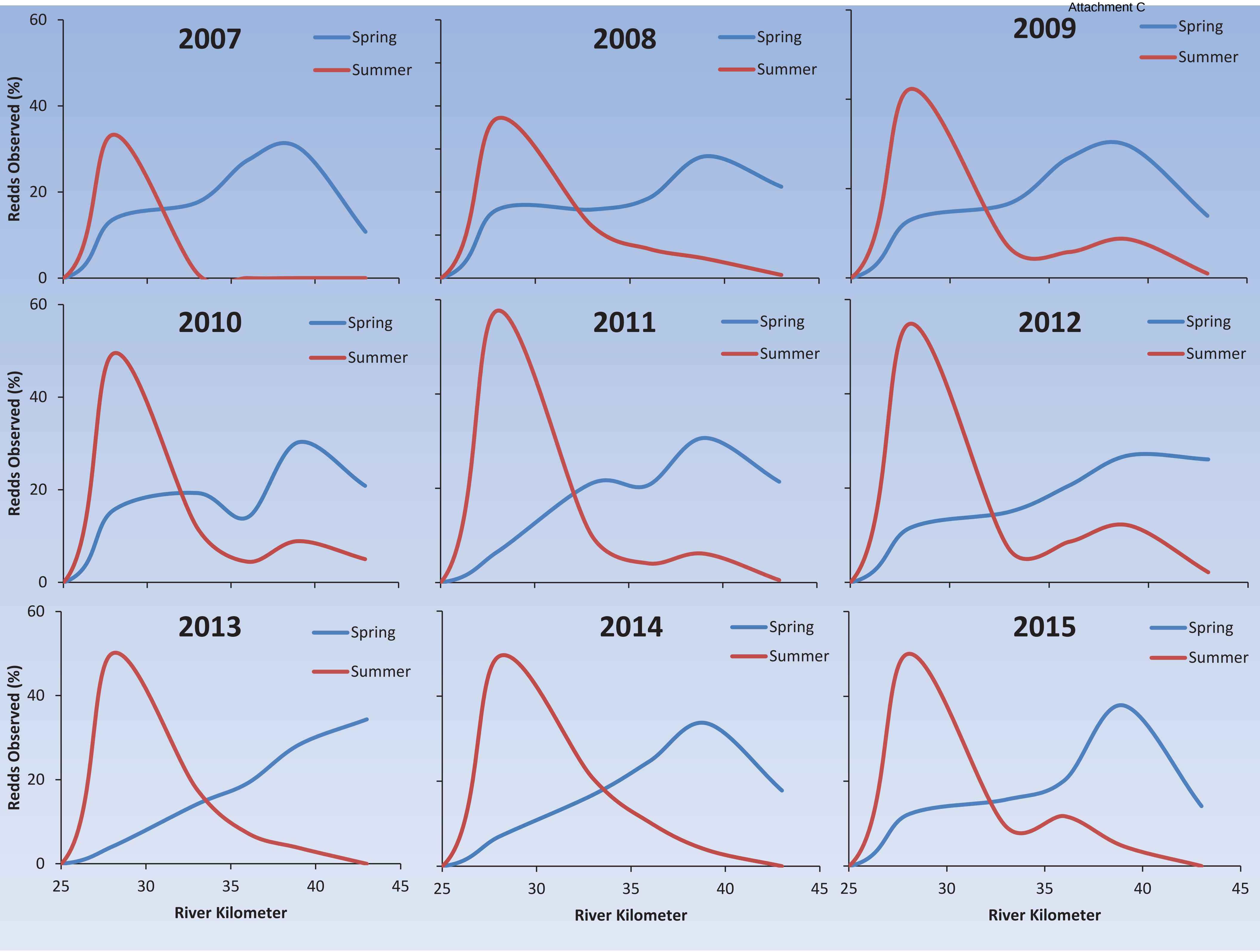
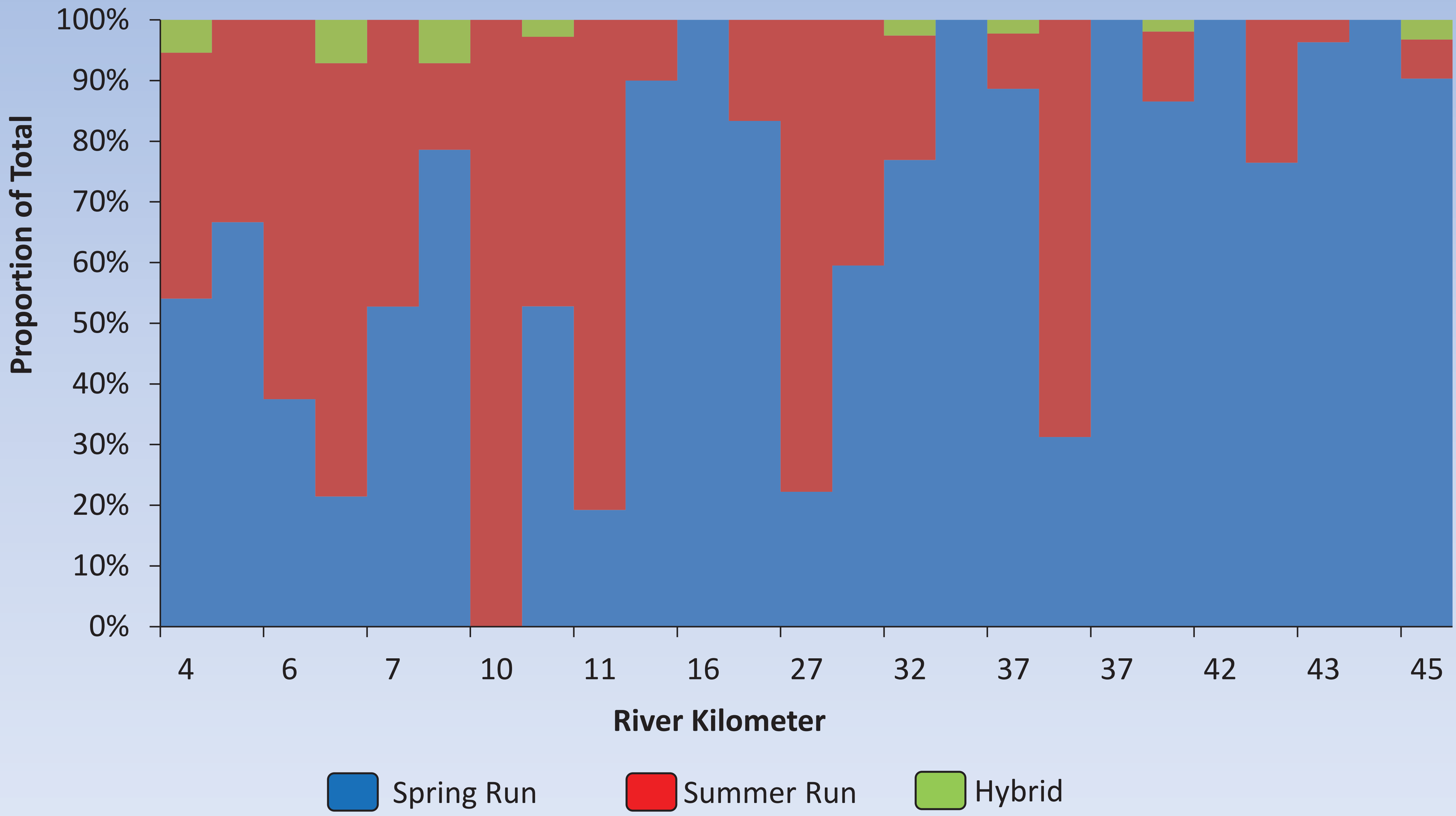


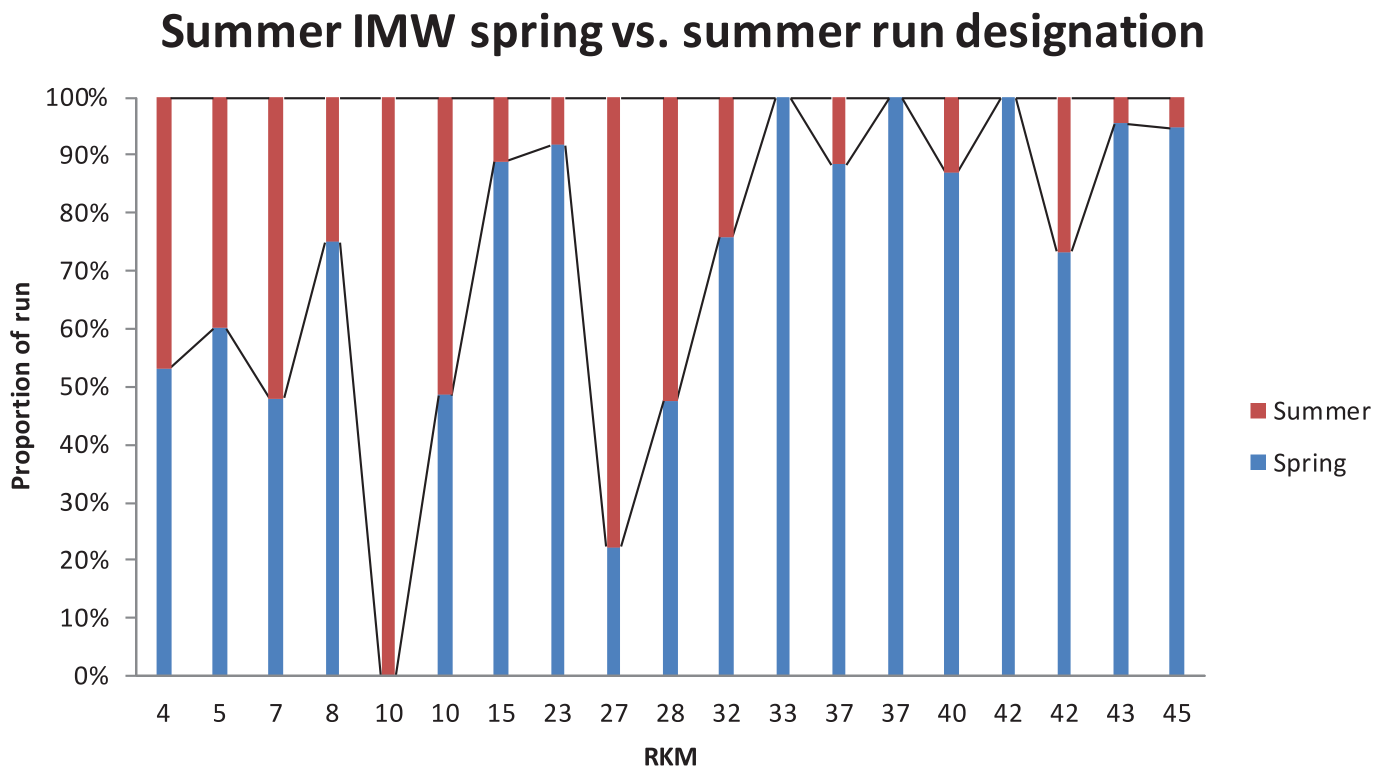

2007
2008
2009
2010
2011
2012
2013
2014
2015
Summer
Spring
Redd Abundance
0
50
100
150
200
250
River Kilometer
30
34
38
42
45

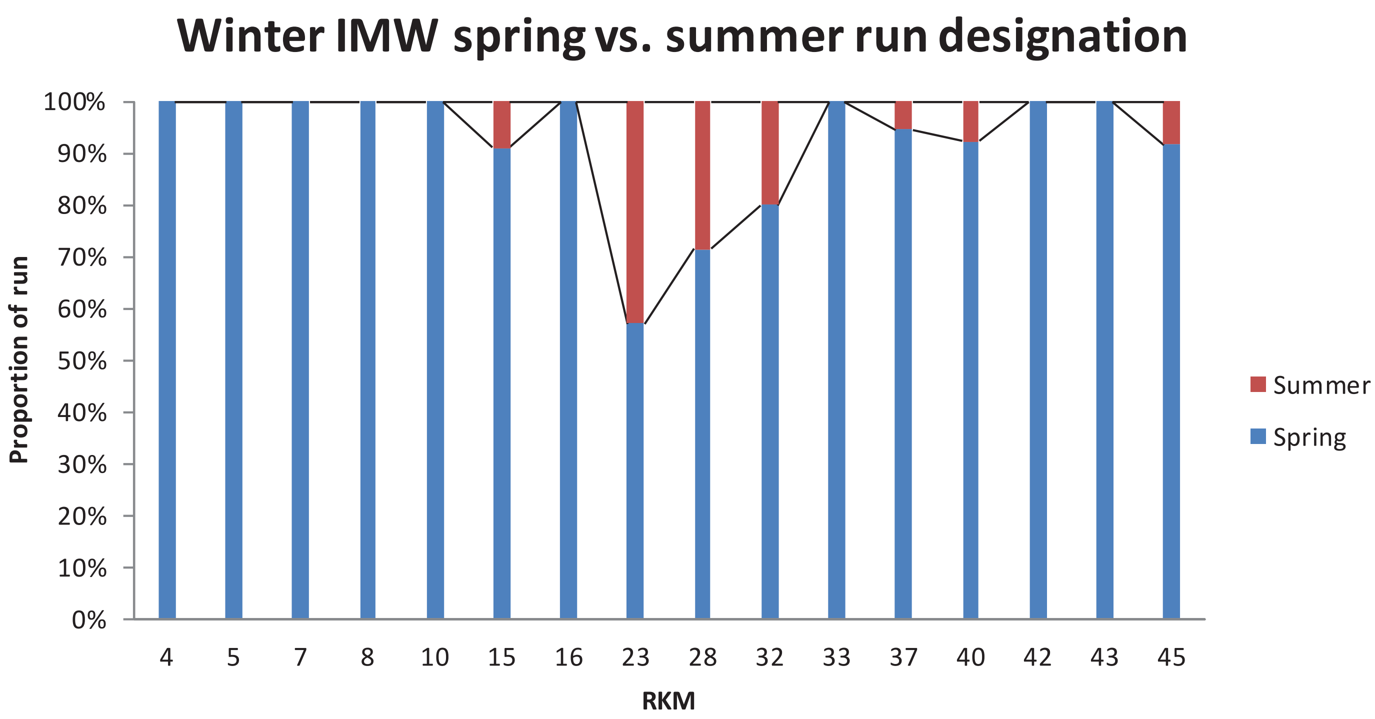
Genetic Spatial Distribution



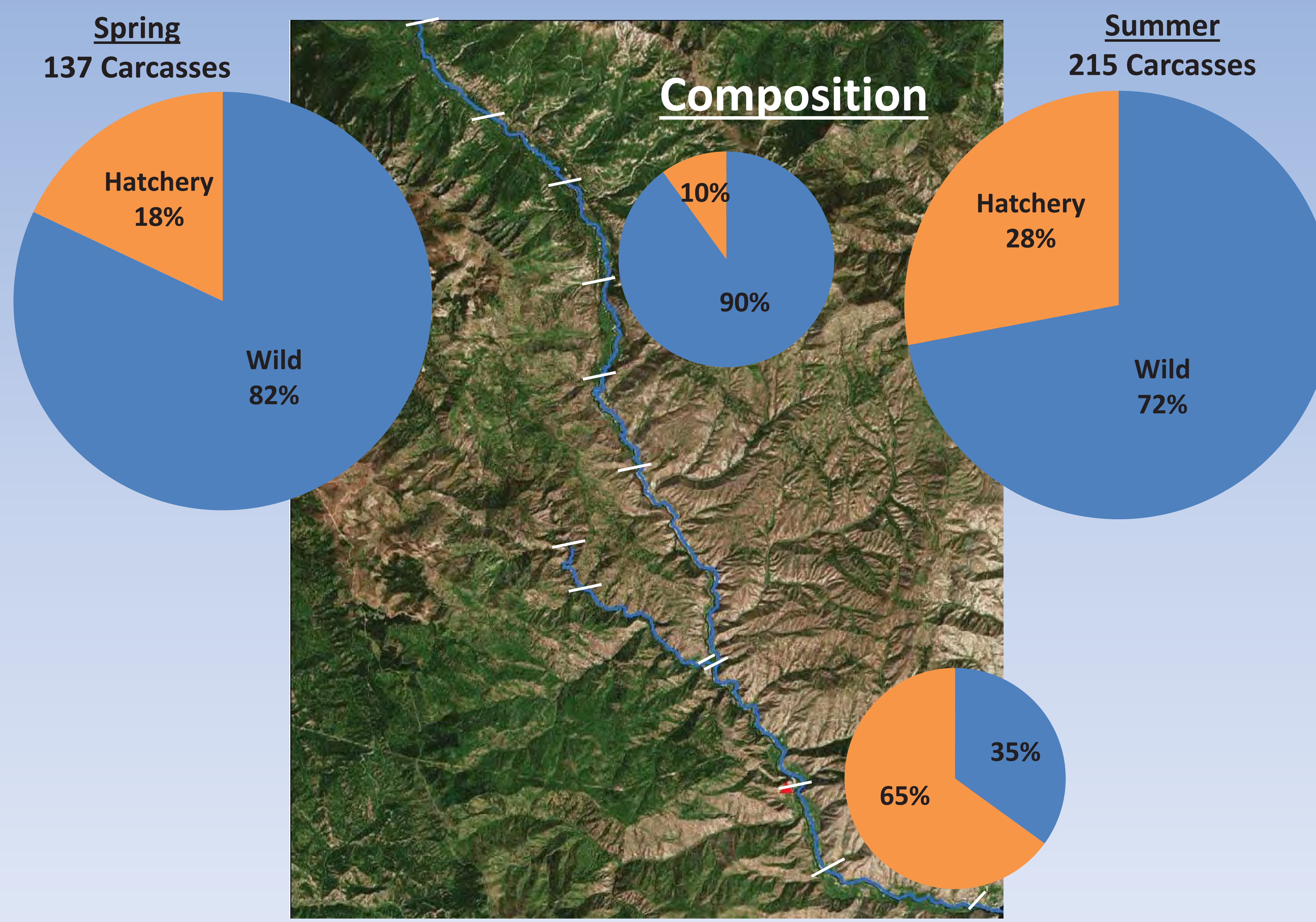
Chinook Life Histories

- Spring Chinook migrate as yearlings
- Summer Chinook migrate as sub-yearlings


Summer IMW spring vs. summer run designation
Proportion of run
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4 5 7 8 10 10 15 23 27 28 32 33 37 37 40 42 42 43 45
RKM
Summer
Spring


Winter IMW spring vs. summer run designation
Proportion of run
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4 5 7 8 10 15 16 23 28 32 33 37 40 42 43 45
RKM
Summer
Spring

Attachment C



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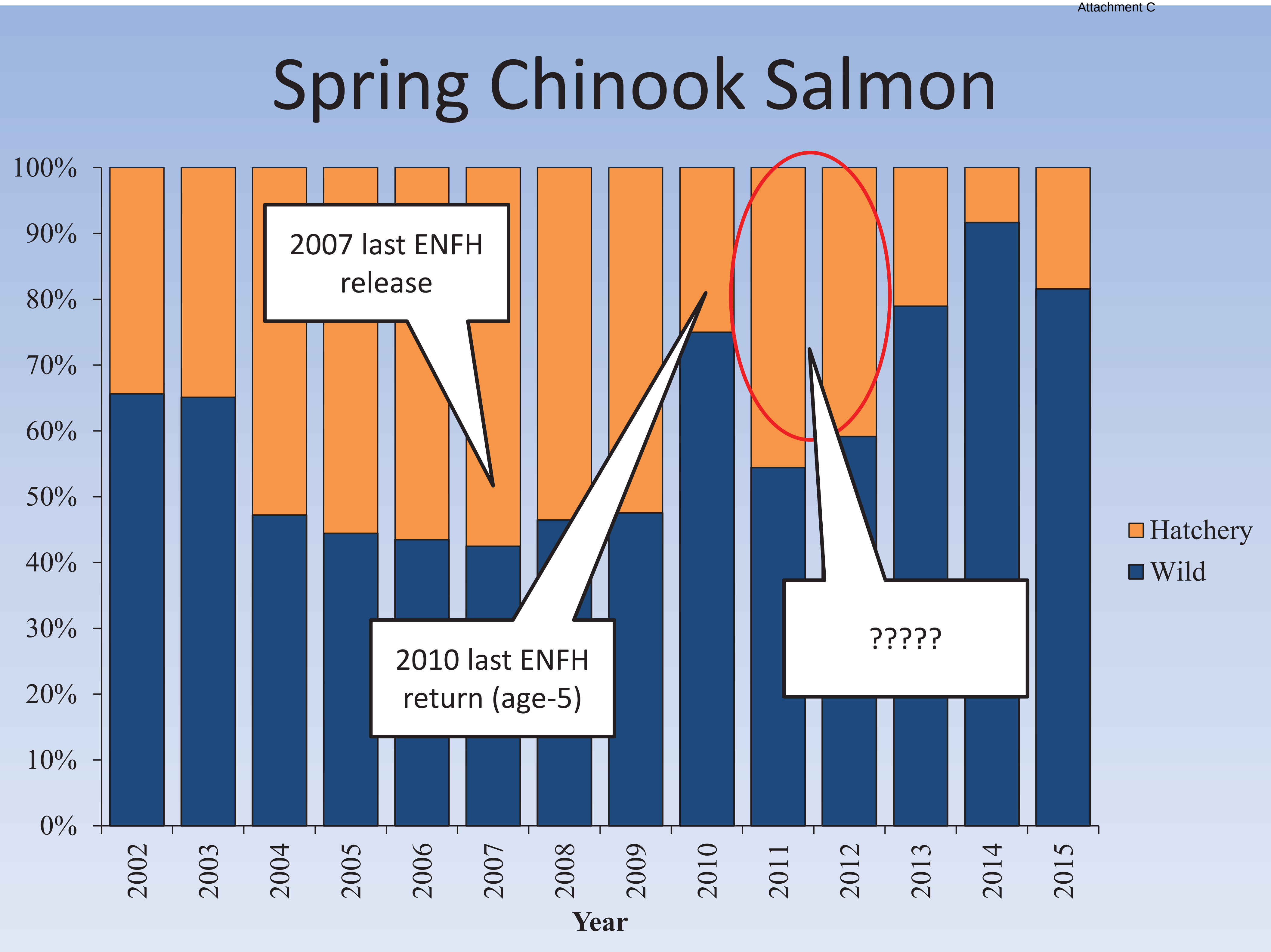
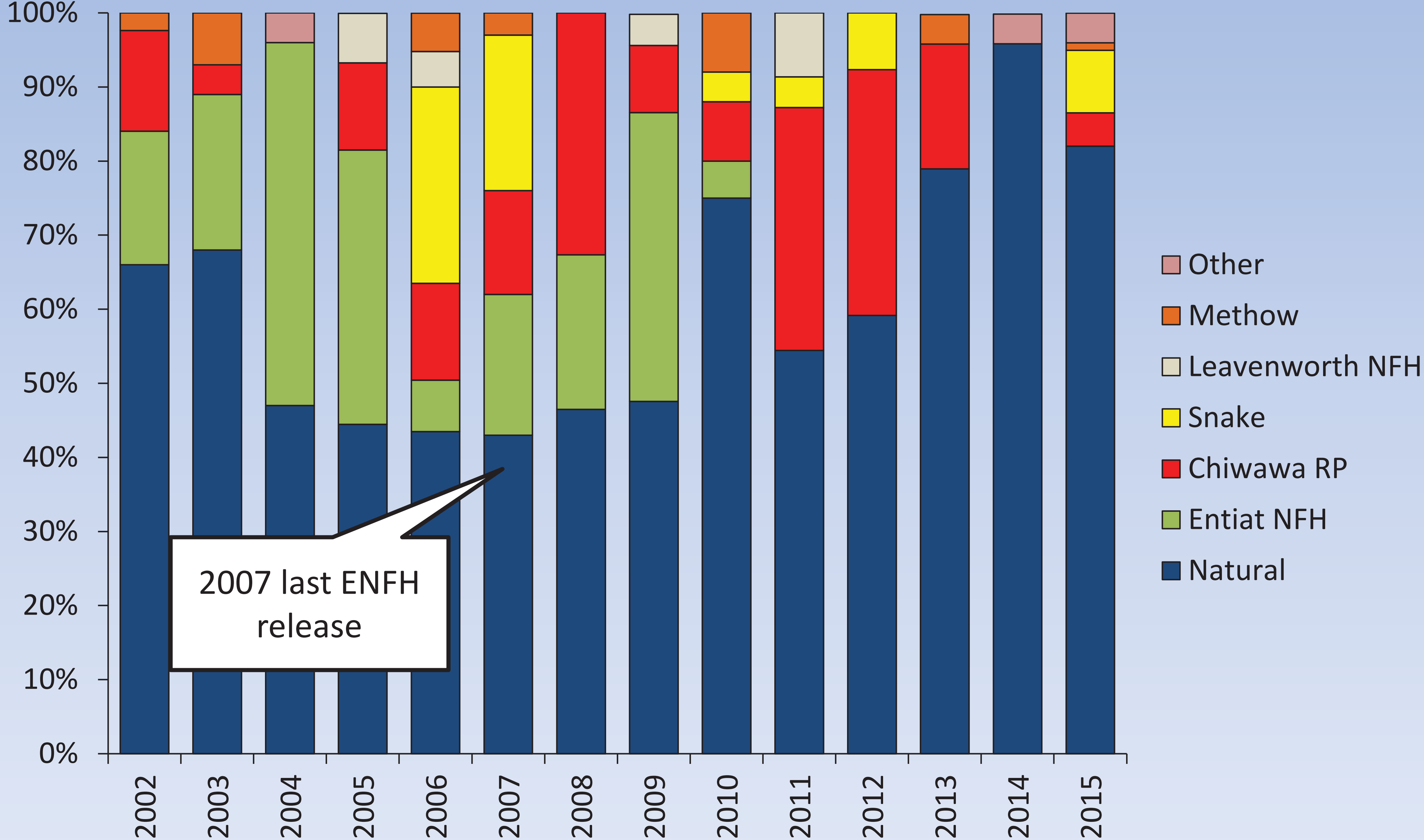
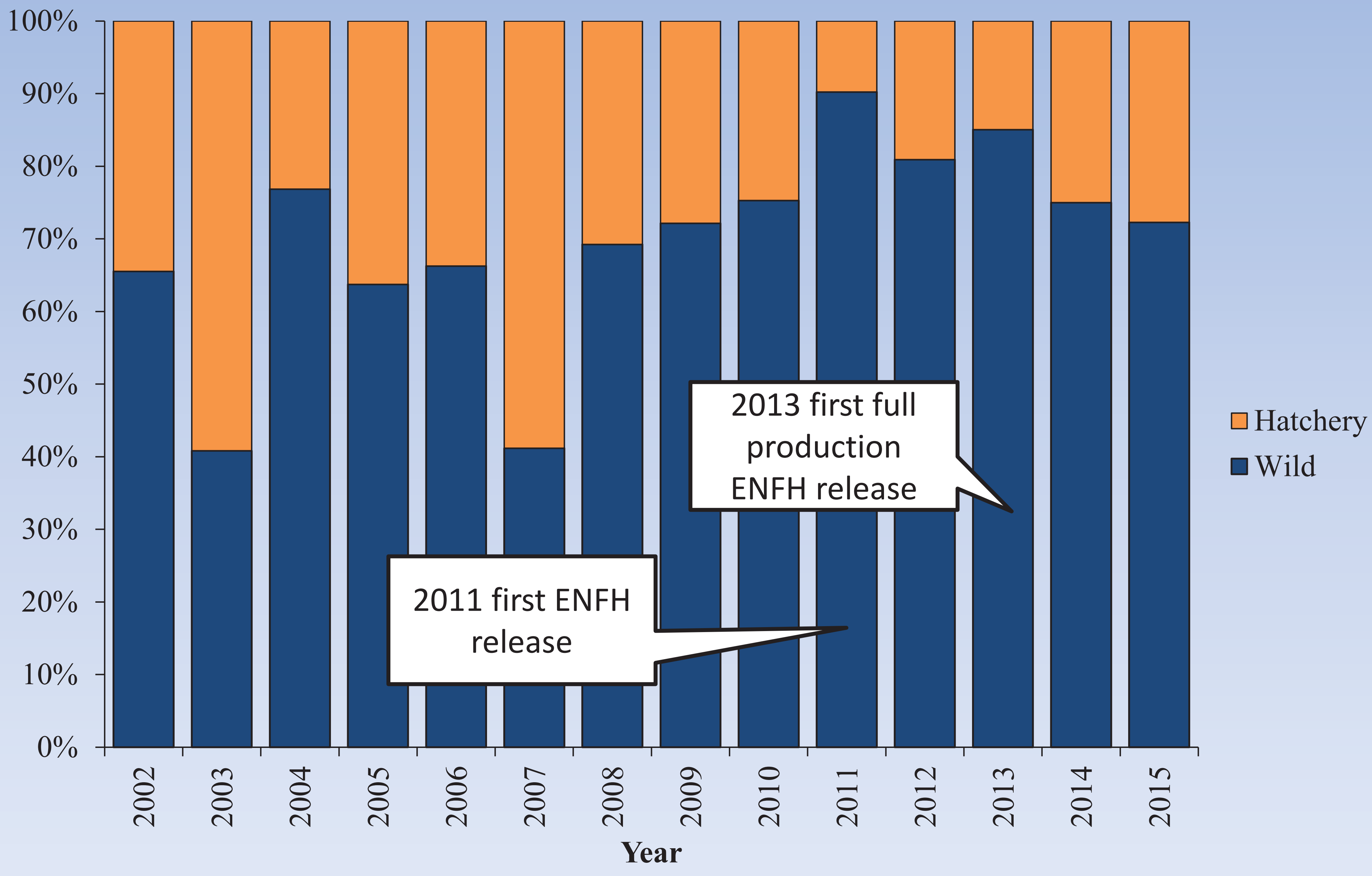
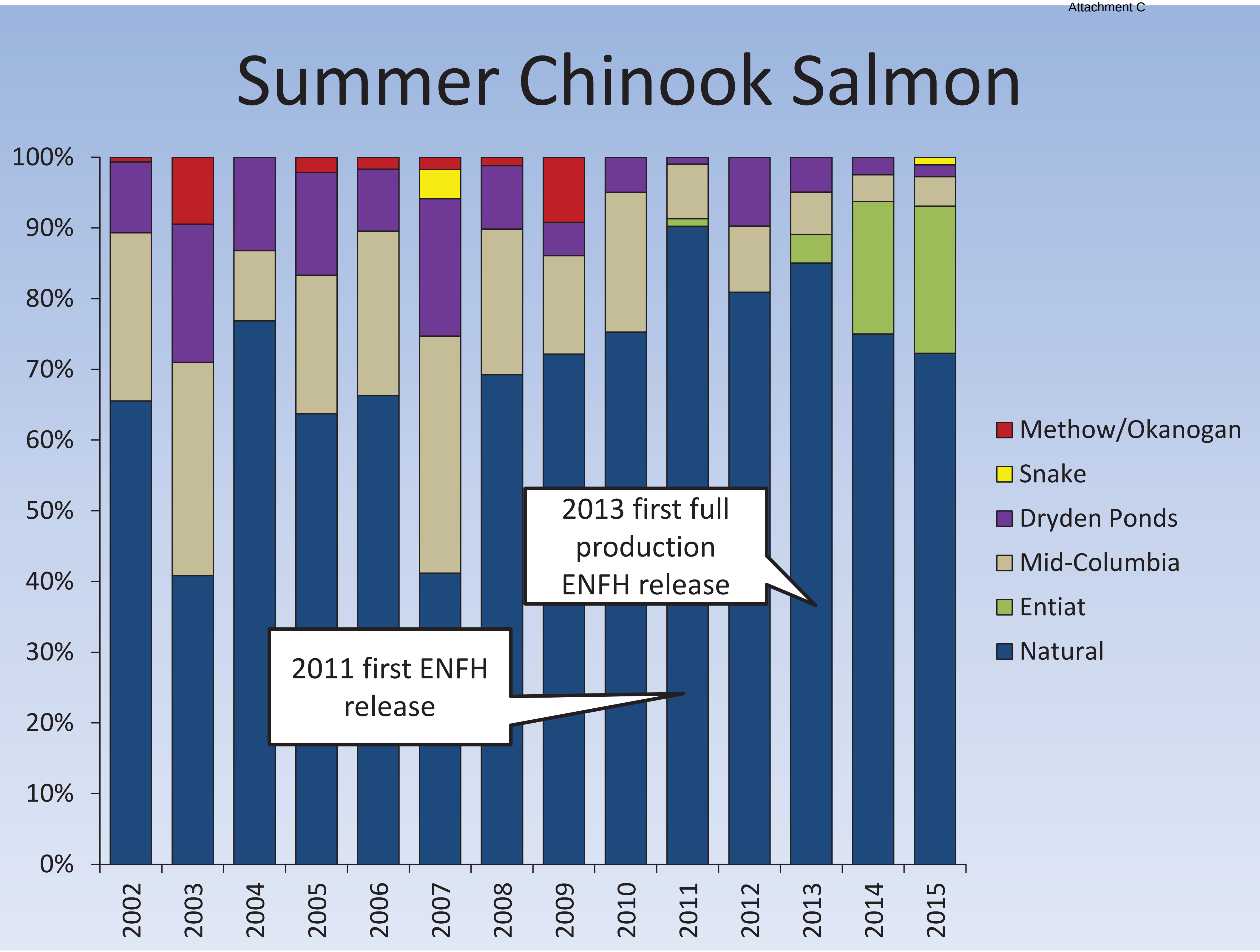


Spring Chinook Salmon

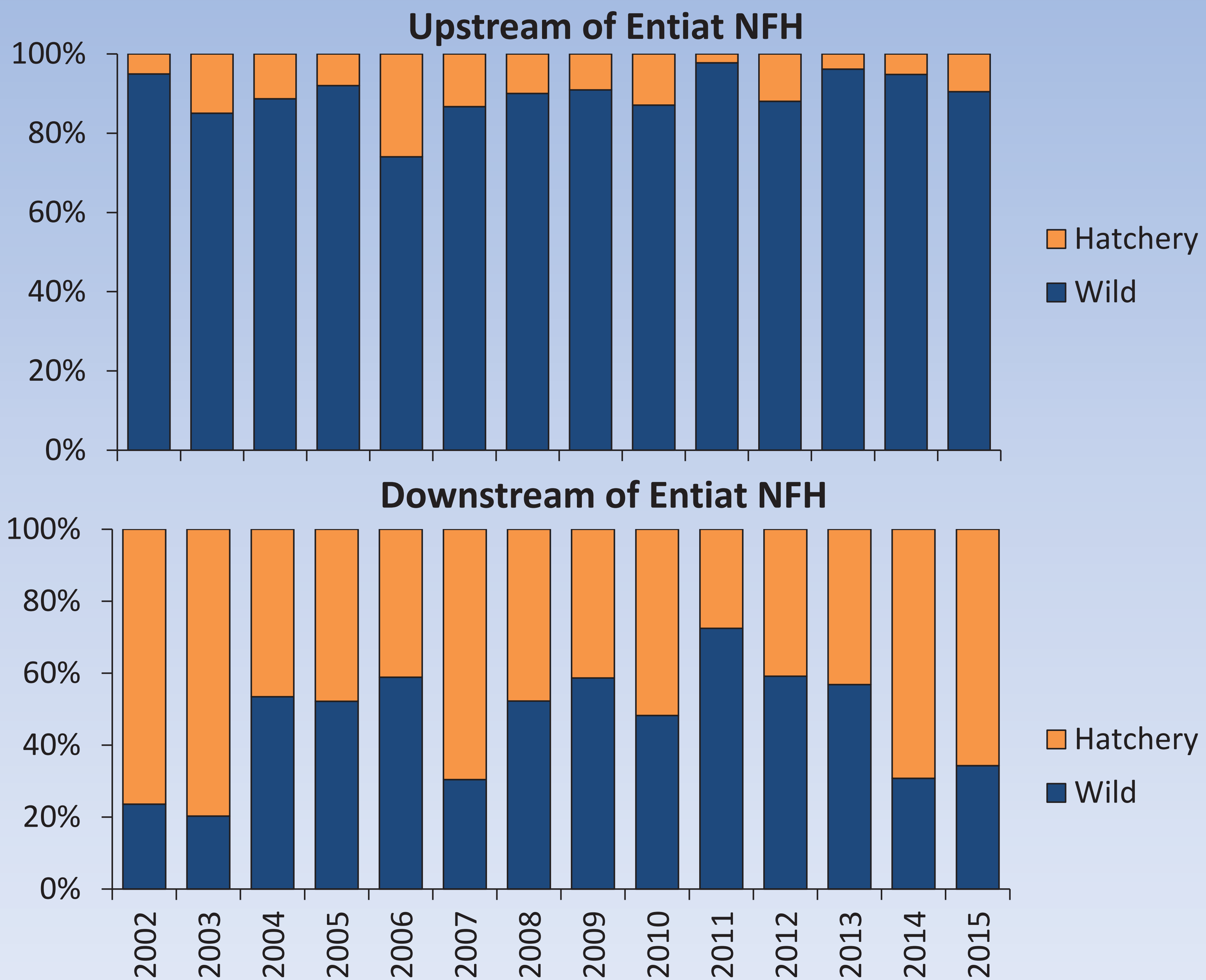


Summer Chinook Salmon




Summer Chinook Salmon
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Methow/Okanogan
Snake
Dryden Ponds
Mid-Columbia
Entiat
Natural
2013 first full production ENFH release
2011 first ENFH release

Spatial Distribution of Summer Chinook Origin



The Future

- Monitor spatial distribution of both runs
- Evaluate the impact of Entiat NFH summer Chinook releases: superimposition and composition
- Habitat improvements to the Entiat River may alter distribution and abundance
- Relate to genetic work
- Climate change impacts?

Conclusion

- Summers may not be endemic to Entiat River
- Dams extirpated all endemic runs
- Hatchery and strays colonized the Entiat River
- Spatial and temporal difference in spawning
- Production change altered run compositions
- Composition of runs differs annually
- Reliable stray component to both runs

Acknowledgements

Supervisor:

Matt Cooper

Geneticist:

Pat DeHaan

Technicians:

Charles Hamstreet

Katy Pfannenstein

Jakub Bednarek

Entiat Historians:

Phyllis Griffith

L. Wayne Long

Jim and Barbara Small

Conard Peterson


Questions?

Draft Summary of 2016 Juvenile Fish Bypass Operations at Wells Hydroelectric Project
October 06, 2016

Douglas PUD operated the Wells bypass system in 2016 as guided by the Wells HCP Coordinating Committee-approved *2016 Bypass Operating Plan.* The plan was intended to provide non-turbine passage during 95 percent of the juvenile Plan Species migration passing Wells Dam. Bypass operations were initiated on April 9 at 00:00 hours, and operated continuously until terminated at 24:00 hours on August 19, for a total of 133 days.

The *2016 Bypass Operating Plan* included measures for complying with Federal Energy Regulatory Commission (FERC) requirements for maintaining minimum automatic-gate-opening capacity under the *Wells Project Emergency Action Plan* (EAP) and Washington Department of Ecology requirements for compliance with total dissolved gas (TDG) standards as directed by the FERC-approved *Total Dissolved Gas Abatement Plan* (GAP) for the Wells Project. Compliance with the requirements of both of these plans is typically achieved by systematic removal of bypass barriers under increasing discharge, including the concentration of spill through adjacent spillways at the center of Wells Dam and spilling over the discharge from active turbine units, as described in the *2016 Bypass Operating Plan*. Because of moderate flows during the period of bypass operations in 2016, Douglas PUD did not need to remove bypass barriers to maintain compliance with the EAP or GAP.

Based on analysis conducted by Drs. John Skalski and Richard Townsend of Columbia Basin Research (Appendix A), Douglas PUD achieved the HCP requirement to provide bypass operations during 95 percent of the juvenile salmon and steelhead migration passing Wells Dam by providing bypass passage during 99.72 percent of the yearling Chinook migration, 99.77 percent of the steelhead migration, 100 percent of the Sockeye migration, 99.89 percent of the Coho migration, and 99.84 percent of the sub-yearling Chinook migration passing Wells Dam in 2016.

Appendix A

Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam in 2016

DRAFT

Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam in 2016

Prepared for:

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802 - 4497

Prepared by:

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28 September 2016

Introduction

Outmigration has been monitored at the juvenile sampling facility at Rocky Reach Dam for four stocks of salmonids (yearling and subyearling Chinook salmon, steelhead, and sockeye salmon) from 2005 onward. Coho salmon were added in 2013, using the detections at Rocky Reach Bypass of PIT-tagged fish. The proportions of each stock covered by the bypass operations at Wells Dam can be estimated using daily counts at Rocky Reach Dam, adjusting for the travel time from Wells to Rocky Reach dams. Table 1 has the average travel times based on Douglas PUD's 2010 PIT-tag study for yearling Chinook salmon, and acoustic-tag studies for steelhead and sockeye salmon. Due to a dearth of PIT-tag or acoustic-tag studies performed with subyearling Chinook and coho salmon, travel time was assumed to be 2 days.

Table 1: Average travel times from Wells tailrace to Rocky Reach Dam, based on PIT-tag release studies conducted in 2010.

Stock	Travel time
Yearling Chinook salmon	5 days
Subyearling Chinook salmon	2 days
Steelhead	2 days
Sockeye salmon	2 days
Coho salmon	2 days

Plots of the annual cumulative proportion of the outmigration for spring migrants (yearling Chinook, steelhead, sockeye, and coho), and subyearling Chinook in the summer had fairly consistent start and end dates at Rocky Reach (Figure 1). The timing of bypass operations for the spring outmigration at Wells from 2004 through 2011 was from 00:01 April 12th through 24:00 June 13th of each year for the "spring" spill season, and from 00:01 June 14th through 24:00 August 26th for the "summer" spill season. For 2012 and beyond, the Wells Habitat Conservation Plan (HCP) Coordinating Committee approved the modification of the timing of bypass operations at Wells Dam as follows: bypass operations commenced at 00:01 on April 9th and continued through 24:00 on August 19th. This current timing of bypass operations will continue annually, unless modified as a result of future investigations that demonstrate an inadequacy of these dates at providing bypass passage for 95% of the migrations of both spring- and summer-migrating Plan Species at Wells Dam.

Results

The proportions of passage during the Wells bypass operations in 2016 were 99.72% for yearling Chinook salmon, 99.77% for steelhead, 100% for sockeye salmon, 99.89% for coho salmon, and 99.84% for subyearling Chinook salmon. The 2016 results for all monitored species were all consistent with historical trends, 2007–2015 (Table 2).

To assess the effectiveness of the selected start date for bypass operations, Table 3 compares the start date for bypass operations each year with the date on which the 5th percentile of the cumulative yearling Chinook salmon outmigration passed Wells Dam that year. For yearling Chinook salmon in 2016, the start date for bypass operations was 3 days earlier than necessary to achieve the HCP standard of providing bypass passage for ≥95% of the migration.

Similarly, Table 4 compares the actual termination date for bypass operations with the date on which bypass operations covered 95% of the subyearling Chinook salmon outmigration. In each year, an earlier termination of bypass operations would have been possible without jeopardizing the achievement of the HCP standard of providing a bypass route for ≥95% of outmigrating subyearling Chinook salmon. For subyearling Chinook salmon in 2016, the termination of bypass operations at midnight on August 19 was 22 days later than required to achieve the HCP standard of providing bypass passage for ≥95% of the migration.

Table 2. Total proportion of each stock's migration affected by bypass operations (spring, summer) at Wells Dam, based on travel times from Wells Dam to Rocky Reach Dam, the cumulative proportion of the annual migration of each stock at Rocky Reach, and the start and stop dates of Wells bypass operations, 2005-2016.

	Proportion passed	**Annual migration proportion**					
Spring Outmigration	**Yearling Chinook Salmon**	2005	2006	2007	2008	2009	2010
	prior to spring Bypass Ops period	0.0528	0.0259	0.0551	0.0025	0.0116	0.0067
	during spring Bypass Ops period	0.9455	0.9559	0.9154	0.9972	0.9827	0.9917
	during summer Bypass Ops period	0.0017	0.0182	0.0296	0.0002	0.0056	0.0016
	after Bypass Ops period	0	0	0	0	0	0
	Total Covered by Bypass Ops	**0.9472**	**0.9741**	**0.9449**	**0.9975**	**0.9884**	**0.9933**
		2011	2012	2013	2014	2015	**2016**
	prior to spring Bypass Ops period	0.0085	0.0004	0.0171	0.0169	0.0012	**0.0028**
	during spring Bypass Ops period	0.9910	0.9996	0.9823	0.9829	0.9983	**0.9929**
	during summer Bypass Ops period	0.0005	0.0001	0.0006	0.0003	0.0004	**0.0043**
	after Bypass Ops period	0	0	0	0	0	**0**
	Total Covered by Bypass Ops	**0.9915**	**0.9996***	**0.9829**	**0.9831+**	**0.9988**	**0.9972+**
	Steelhead	2005	2006	2007	2008	2009	2010
	prior to spring Bypass Ops period	0.0015	0.0101	0.0066	0.0009	0.0019	0.0045
	during spring Bypass Ops period	0.9903	0.9762	0.9887	0.9901	0.9965	0.9763
	during summer Bypass Ops period	0.0081	0.0137	0.0042	0.0089	0.0016	0.0188
	after Bypass Ops period	0	0	0.0004	0.0001	0	0.0004
	Total Covered by Bypass Ops	**0.9985**	**0.9899**	**0.9930**	**0.9990**	**0.9981**	**0.9951**
		2011	2012	2013	2014	2015	**2016**
	prior to spring Bypass Ops period	0.0190	0.0014	0.0079	0.0021	0.0029	**0.0022**
	during spring Bypass Ops period	0.9513	0.9885	0.9847	0.9817	0.9602	**0.9892**
	during summer Bypass Ops period	0.0297	0.0101	0.0074	0.0158	0.0367	**0.0085**
	after Bypass Ops period	0	0	0	0.0004	0.0002	**0.0001**
	Total Covered by Bypass Ops	**0.9810**	**0.9986**	**0.9921**	**0.9975**	**0.9969**	**0.9977**
	Sockeye Salmon	2005	2006	2007	2008	2009	2010
	prior to spring Bypass Ops period	0	0	0	0	0	0
	during spring Bypass Ops period	0.9983	0.9984	0.9998	0.9972	0.9957	0.9992
	during summer Bypass Ops period	0.0017	0.0016	0.0001	0.0028	0.0043	0.0008
	after Bypass Ops period	0	0	0	0	0	0
	Total Covered by Bypass Ops	**1.0000**	**1.0000**	**0.9999**	**1.0000**	**1.0000**	**1.0000**
		2011	2012	2013	2014	2015	**2016**
	prior to spring Bypass Ops period	0	0	0	0	0	**0**
	during spring Bypass Ops period	0.9923	0.9995	0.9990	0.9999	0.9994	**1.0000**
	during summer Bypass Ops period	0.0077	0.0005	0.0009	0.0001	0.0006	**0**
	after Bypass Ops period	0	0	0.0001	0	0.0001	**0**
	Total Covered by Bypass Ops	**1.0000**	**1.0000**	**0.9999**	**1.0000**	**0.9999***	**1.0000**

***Proportions not summing to 1 are due to round-off error. +Proportion estimated using only releases above Wells Dam.**

Table 2. (continued).

	Proportion passed	Annual migration proportion					
Spring Outmigration	**Coho Salmon**			2013	2014	2015	**2016**
	prior to spring Bypass Ops period			0	0.0001	0.0004	**0.0012**
	during spring Bypass Ops period			0.9910	0.9984	0.9872	**0.9969**
	during summer Bypass Ops period			0.0090	0.0015	0.0125	**0.0018**
	after Bypass Ops period			0	0	0	**0**
	Total Covered by Bypass Ops			**1.0000**	**0.9999**	**0.9996**	**0.9989**
Summer Outmigration	**Subyearling Chinook Salmon**	2005	2006	2007	2008	2009	2010
	prior to spring Bypass Ops period	0	0	0	0	0	0
	during spring Bypass Ops period	0.1937	0.1894	0.2136	0.1266	0.1029	0.5212
	during summer Bypass Ops period	0.8022	0.8077	0.7847	0.8620	0.8882	0.4723
	after Bypass Ops period	0.0041	0.0029	0.0017	0.0113	0.0089	0.0064
	Total Covered by Bypass Ops	**0.9959**	**0.9971**	**0.9983**	**0.9887**	**0.9911**	**0.9936**
		2011	2012	2013	2014	2015	**2016**
	prior to spring Bypass Ops period	0	0	0	0	0	**0**
	during spring Bypass Ops period	0.5628	0.5871	0.1670	0.3529	0.0745	**0.3349**
	during summer Bypass Ops period	0.4331	0.4059	0.8263	0.6151	0.9252	**0.6636**
	after Bypass Ops period	0.0041	0.0070	0.0067	0.0320	0.0003	**0.0016**
	Total Covered by Bypass Ops	**0.9959**	**0.9930**	**0.9933**	**0.9680**	**0.9997**	**0.9984**

Table 3. A comparison of the actual start date for bypass operations at Wells Dam for the last ten years versus the date on which the 5th percentile of the yearling Chinook salmon migration passed Wells Dam that year, 2007-2016. Operations begin at 00:01 for the date listed in column 2. "Proportion bypass ops would have covered" indicates the proportion of the migration that would have been provided a bypass passage route had bypass operations started at 00:01 on the date that the 5th percentile of the migration passed Wells Dam (column 5). "Bypass start date timing" (column 8) indicates whether the bypass start date was earlier or later than the date on which the 5th percentile of the yearling Chinook migration passed Wells Dam, and by how many days.

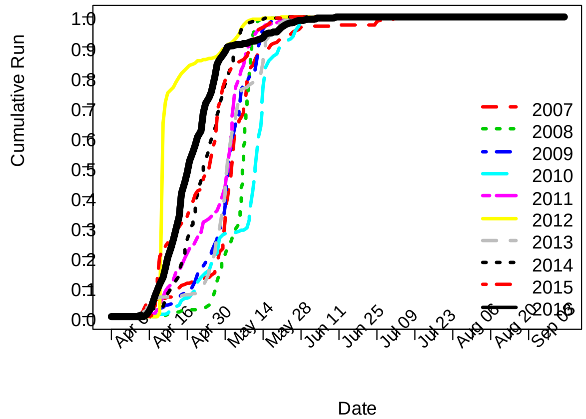
Migration Year	Actual bypass start date	Cumulative proportion passed before 00:01	Proportion Covered by Bypass Ops	Date on which the 5th percentile passed	Cumulative proportion passed before 00:01	Proportion bypass ops would have covered	Bypass start date timing
2007	April 12	0.0551	0.9449	April 9	0.0243	0.9757	3 days late
2008	April 12	0.0025	0.9975	May 3	0.0406	0.9594	21 days early
2009	April 12	0.0116	0.9884	April 19	0.0436	0.9564	7 days early
2010	April 12	0.0067	0.9933	April 22	0.0410	0.9590	10 days early
2011	April 12	0.0085	0.9915	April 15	0.0446	0.9554	3 days early
2012	April 9	0.0004	0.9996	April 15	0.0115	0.9885	6 days early
2013	April 9	0.0171	0.9829	April 10	0.0240	0.9760	1 days early
2014	April 9	0.0169	0.9831	April 16	0.0386	0.9614	7 days early
2015	April 9	0.0012	0.9988	April 13	0.0210	0.9790	4 days early
2016	April 9	0.0028	0.9972	April 12	0.0380	0.9620	3 days early

Table 4. A comparison of the actual stop date for bypass operations at Wells Dam for the last ten years, versus the stop date necessary to have covered at least 95% of the subyearling Chinook salmon outmigration that year. Operations are assumed to end at 24:00 for the date listed..

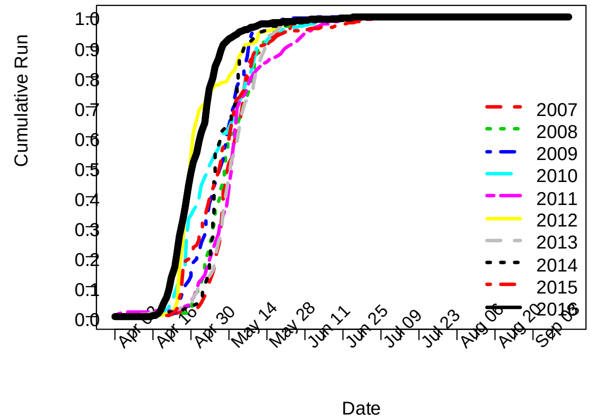
Migration Year	Actual bypass stop date	Cumulative proportion passed by 24:00 of actual stop date	Date on which the 95% standard was achieved	Cumulative proportion passed by 24:00 of the date on which the 95% standard was achieved	Bypass ended this many days after the 95% standard was achieved
2007	August 26	0.9983	August 11	0.9538	15
2008	August 26	0.9887	August 19	0.9502	7
2009	August 26	0.9911	August 22	0.9709	4
2010	August 26	0.9936	August 10	0.9537	16
2011	August 26	0.9959	July 25	0.9528	32
2012	August 19	0.9930	July 29	0.9502	22
2013	August 19	0.9933	August 7	0.9592	12
2014	August 19	0.9696	August 15	0.9524	4
2015	August 19	0.9997	July 19	0.9559	31
2016	August 19	0.9984	July 28	0.9554	22

Figure 1. Passage dates at Rocky Reach Dam for spring and summer migrating stocks, 2007-2016. Cumulative proportions are based on the expanded counts obtained from sampling daily from 1 April – 31 August (or through 4 September in 2008 and 15 September in 2014).

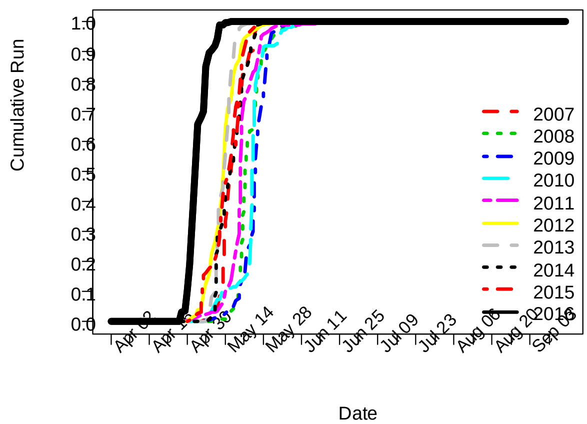
a. Yearling Chinook Salmon



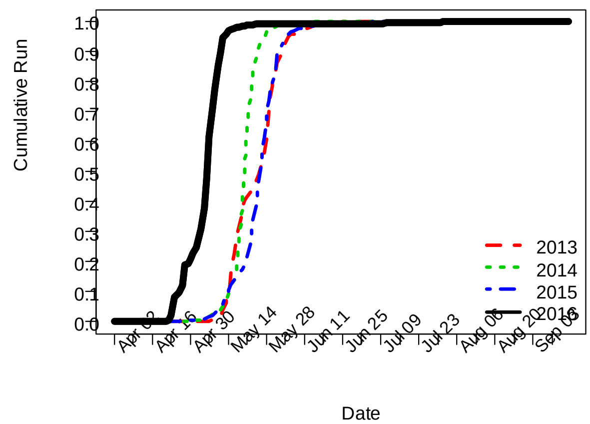
b. Steelhead



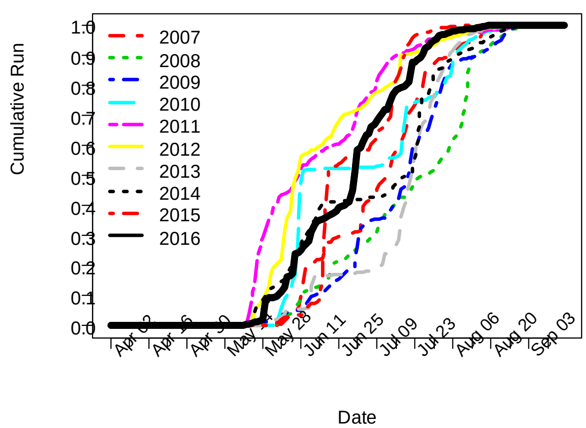
c. Sockeye Salmon



d. Coho Salmon



e. Subyearling Chinook Salmon



Appendix

This year marks the availability of PIT-tag detections at Wells Dam (WEJ). Unfortunately, starting late in the season, there were only 46 unique tag codes identified. These comprised 18 Coho Salmon, 26 Steelhead, and 2 orphaned tags (no release information in PTAGIS). As these numbers are too few to estimate any credible survival estimates, Table A1 summarizes the number of detections and estimated travel times between Wells and Rocky Reach Dam. It is hoped that future runs will be captured at higher numbers to enable a more detailed correction to the outmigration distribution estimated for Wells Dam.

Table A1. Travel Time summary for detected PIT-tagged fish at both Wells and Rocky Reach PIT-tag detectors in 2016.

			Travel Time (days)	
Species	Detected at Wells Dam	Detected at Rocky Reach Dam	Mean (SE)	Range
Coho	18	7	6.8 (1.2)	2.8 - 12.0
Steelhead	26	10	2.9 (0.6)	1.2 - 7.6

Rock Island Powerhouse 1
Units B1-B4 Maintenance Project 2017 to 2020

Scope

New fixed blade turbine runners, head covers and turbine shaft.
New rotor spider and rim.
New governor hydraulic system with digital controls and new excitation.
Other components to be inspected and any necessary repairs made to extend life for another 50 years.

Proposed Fish Friendly Improvements

1. Expect new runner to have 4 blades instead of 6 with current design.
2. Fixed blade pitch can eliminate gaps at hub.
3. Partially spherical discharge liner and reducing blade tip clearance from 3/8" to 1/8".
4. Vertical blade tip extensions to minimize pressure changes.
5. Reduced turbulence via efficiency improvement expected to be 5 to 7%.
6. No oil in hub.
7. Greaseless wicket gates, gate ring and turbine guide bearing.

What isn't changing:

1. No change to generator nameplate or authorized project hydraulic capacity.
2. No change to authorized generating capacity (23 MVA).
3. No increase in the size of the discharge ring.
4. No change to the size of the intake, distributor or draft tube structures.

Estimated Schedule

1. Bid solicitation until Dec. 6, 2016.
2. Award by January 2017.
3. Design - January through July 2017.
4. Manufacturing 1st Unit - August 2017 to July 2018
5. First Unit construction - August 2018 to January 2019.
6. All four units complete by April 2020.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	January 25, 2017
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Minutes of the November 15, 2016, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday November 15, 2016, from 10:00 to 11:15 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Lance Keller will confirm the appropriate title for Alene Underwood (Chelan PUD), for the administrative record, regarding her participation in the Coordinating Committees meeting on October 25, 2016 (Item I-B). *(Note: Keller confirmed Underwood's title, Chelan PUD Fish and Wildlife Program Manager, on November 18, 2016.)*
- Bob Rose will provide a list of Yakama Nation (YN) concerns regarding datasets used for estimating coho salmon survival, which will be used in future discussions of the Rocky Reach and Rock Island Coho Salmon Phase Designation, prior to the Coordinating Committees meeting on December 13, 2016 (Item III-A).
- Chelan PUD and the YN will convene to discuss concerns regarding datasets used for estimating coho salmon survival, prior to the Coordinating Committees meeting on December 13, 2016 (Item III-A).
- Rocky Reach and Rock Island Coho Salmon Phase Designation will be discussed during the Coordinating Committees meeting on December 13, 2016 (Item III-A).
- Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the Coordinating Committees meeting on December 13, 2016, including discussing

the Draft Federal Energy Regulatory Commission (FERC) Notification Letter for Rock Island B1-B4 Maintenance (Item III-B).

- John Ferguson will coordinate with Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) regarding scheduling a joint HCP/PRCC meeting soon to discuss estimating the survival of subyearling Chinook salmon passing Mid-Columbia dams (Item V-A).
- **The Coordinating Committees meeting on December 13, 2016, will be held at 10:00 a.m., in-person at the Grant PUD office in Wenatchee, Washington (Item V-B).** *(Note: the Coordinating Committees meeting on December 13, 2016, was canceled due to lack of agenda items and available attendees.)*

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

- Kristi Geris sent an email to the Coordinating Committees on October 6, 2016, notifying them the Draft Wells Post-Season Bypass Report and Passage-Dates Analysis was available for a 60-day review period, with edits and comments due to Tom Kahler by Monday, December 5, 2016.
- Kristi Geris sent an email to the Coordinating Committees on November 15, 2016, notifying them the Draft FERC Letter for Rock Island B1-B4 Maintenance was available for review. The draft letter is available for a 30-day review period with edits and comments due to Lance Keller by Thursday, December 15, 2016.
- Kristi Geris sent an email to the Coordinating Committees on December 15, 2016, notifying them the Draft 2015 Pikeminnow Program Annual Report was available for a 60-day review period, with edits and comments due to Tom Kahler by Monday, February 13, 2017.
- Kristi Geris sent an email to the Coordinating Committees on January 5, 2017, notifying them the Draft 2017 Wells Dam Gas Abatement Plan and Bypass Operating

Plan (GAP and BOP) was available for a 30-day review period, with edits and comments due to Tom Kahler by Monday, February 6, 2017.

FINALIZED DOCUMENTS

- The Wells Post-Season Bypass Report and Passage-Dates Analysis was finalized following a 60-day review period, which ended on December 5, 2016, and was distributed to the Coordinating Committees by Kristi Geris on December 28, 2016. As noted in the email, the edits discussed and requested by the Coordinating Committees were incorporated into the final passage-dates analysis, and the post-season bypass report was updated accordingly.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the Coordinating Committees and asked for any additions or changes to the agenda. Tom Kahler added an update on the 2016/2017 Wells Dam fish ladder winter maintenance period.

B. Meeting Minutes Approval (John Ferguson)

The Coordinating Committees reviewed the revised draft October 25, 2016, meeting minutes. Kristi Geris said there is one item remaining to be discussed regarding the appropriate title to note for Alene Underwood. Geris said Underwood is currently noted in the minutes as the Chelan PUD HCP Hatchery Committees Representative; however, Tom Kahler made a good point that Underwood is also the Chelan PUD Fish and Wildlife Program Manager, which is more the reason for her participation in the meeting. Geris asked Lance Keller if 'Chelan PUD Fish and Wildlife Program Manager' would be the appropriate title to reflect in the minutes for Underwood. Keller said he will confirm the appropriate title for Underwood, for the administrative record. Geris said all other comments and revisions received from members of the Committees were incorporated into the revised minutes. Coordinating Committees members present approved the October 25, 2016, meeting minutes, as revised. *(Note: Kirk Truscott provided the Colville Confederated Tribes' [CCT's] approval of the revised minutes via email prior to the* *meeting on November 15, 2016. Keller confirmed Underwood's title, Chelan PUD Fish and Wildlife Program Manager, on November 18, 2016.)*

C. Last Meeting Action Items (John Ferguson)

Action items from the Coordinating Committees meeting on October 25, 2016, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on October 25, 2016):*

- *Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the next Coordinating Committees meeting (Item I-C).*
  This will be discussed during today's meeting.
- *Chelan PUD will provide a table and written explanation of the maintenance (upgrades) being proposed to FERC for Rock Island Powerhouse 1 Units B1 to B4, including how the upgrades differ from current conditions, to Kristi Geris for distribution to the Coordinating Committees (Item I-C).*
  This will be discussed during today's meeting.
- *Bob Rose will discuss data and calculations used to derive new coho salmon phase designations during the Coordinating Committees meeting on November 15, 2016 (Item I-C).*
  This 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 said the HCP Hatchery Committees were scheduled to convene tomorrow, November 16, 2016; however, due to lack of agenda items, the meeting was canceled. The next meeting of the HCP Hatchery Committees will be on December 21, 2016.

Hillman updated the Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on November 10, 2016.

- *Acquisitions in Canada*: The HCP Tributary Committees received a General Salmon Habitat Program (GSHP) application from the Okanagan Nation Alliance (ONA) titled, "Ecommunity Place Locatee Lands Land Acquisition for Off-Channel Salmon Habitat." The purpose of this project is to acquire and protect 7.96 acres of floodplain/riparian habitat adjacent to the Penticton Channel (Channel). The total cost of the acquisition is $456,514 (Canadian dollars [CAD]), and ONA requested $59,676 CAD from Tributary Funds. The HCP Tributary Committees agree Tributary Funds can be used by project sponsors to purchase acquisitions and conservation easements in Canada; however, they do not currently have an approved appraiser in Canada. Therefore, they will research and select an approved appraiser in Canada and, once that is complete, the HCP Tributary Committees will evaluate the application from ONA and make a funding decision in December 2016. Hillman explained that ONA has built spawning platforms in the channel adjacent to the wetland that are heavily used by sockeye salmon and Kokanee in the Penticton Channel, which is adjacent to the wetland. He said the southern portion of the wetland is what they are trying to acquire, so they will own the entire wetland/floodplain and can then reconnect it with the Penticton Channel, which should have a large fish benefit. Bob Rose asked if this project is focused primarily on sockeye salmon or other species as well. Hillman said spring Chinook salmon and steelhead will also benefit, and the project would create off-channel habitat for other Plan species. John Ferguson asked how far into Canada the project is located, and Tom Kahler estimated in the range of 50 kilometers. *(Note: the actual distance is about 65 kilometers into Canada.)*

- *Clear Creek Fish Passage Budget Amendment*: The Rocky Reach HCP Tributary Committee received a budget amendment request from Trout Unlimited for the "Clear Creek Fish Passage and Instream Flow Enhancement Project." The sponsor requested to move $3,000 from "Contract Labor" to "Project Materials." The Rocky Reach HCP Tributary Committee approved the budget amendment. This amendment will not change the total budget amount.
- *Methow Valley Irrigation District (MVID) Budget Amendment and Time Extension*: The HCP Tributary Committees received a time extension request from Trout Unlimited for the "MVID Instream Flow Improvement Project." The sponsor needs additional time to complete items, including hooking up a surface irrigation well and testing groundwater levels in the Poorman Creek area. The sponsor requested to extend the period of the project to March 31, 2017, and the HCP Tributary Committees approved the time extension. The sponsor also asked the

Rock Island HCP Tributary Committee to approve moving the remaining budget for "Sponsor Salaries and Benefits" and "Indirect/Administration" to "Contract Labor," and they asked the Wells HCP Tributary Committee to approve moving funds from "Cultural Resources," "Project Materials," and "Indirect/Administration/Overhead" to "Contract Labor." The Rock Island and Wells HCP Tributary Committees approved the budget amendments. These amendments will not change the total budget amounts.

- *GSHP Draft Proposal*: Section 3.4 of the Tributary Committees Policies and Procedures for Funding Projects document states, "The Committees require a draft proposal application process to give Project Sponsors an early indication of the appropriateness of a project concept…" When GSHP proposals are submitted outside the Salmon Recovery Funding Board (SRFB) process, the HCP Tributary Committees have not required sponsors to use the draft application process. Members agreed that it is not necessary to use the GSHP draft application process and directed Hillman to revise the language in the Policies and Procedures document accordingly.
- *Barkley Irrigation Company – Under Pressure Project Discussion with Trout Unlimited:* Guest speaker, Aaron Penvose (Trout Unlimited) discussed the status of the Barkley Irrigation Company project. The purpose of the project was to eliminate mortality of Endangered Species Act (ESA)-listed fish species, improve stream flows (by adding up to 26 cubic feet per second) within 8 miles of the Methow River, eliminate fish stranding within the upper half mile of the diversion side channel, and reconnect Bear Creek with the Methow River. This would be accomplished by building a pressurized irrigation system located downstream from the existing diversion. The Barkley Irrigation Company hired a firm to evaluate operations and maintenance (O&M) costs, which were ultimately too high. Trout Unlimited tried resolving the cost issue with no success. Trout Unlimited is working on an alternative, which includes using the MVID headworks to serve Barkley Irrigation Company users. The larger pump station would not be constructed; although, they would use the smaller pump stations. The revised system will not be pressurized; rather, it will be totally gravity fed. The alternative would still produce benefits described in the original proposal. At this time, Barkley Irrigation Company and MVID are supportive of the alternative. Once Trout Unlimited has more information

on O&M costs associated with the alternative, Trout Unlimited will likely come back to the HCP Tributary Committees to determine how to move forward.

- *Review of HCP Tributary Committees Chairperson*: The HCP Tributary Committees agreed unanimously to retain Hillman as the Chairperson for the next 3-year period (2017 through 2019). Hillman accepted the appointment.
- *Bonneville Power Administration (BPA) and Chelan-Douglas Land Trust (CDLT)*: BPA removed most of their funding for restoration work in the Middle Entiat Basin because they were unable to come to an agreement with CDLT on liability (CDLT is now requiring compensation for liability insurance for restoration projects implemented on their lands). BPA is redirecting those funds to improve habitat in the Wenatchee and Methow River basins. Restoration may still occur in the Entiat Basin on parcels not owned by CDLT; however, the National Environmental Policy Act processes have stopped because there is no certainty on what actions will be implemented given that BPA has reprogrammed their funding. This is not consistent with the HCP Tributary Committees' desire to support acquisitions and conservation easements where restoration work is needed. In the past, the HCP Tributary Committees have provided funds to CDLT for acquisitions because the HCP Tributary Committees understood that CDLT would allow restoration to take place on those parcels. The HCP Tributary Committees are now reevaluating their support of protection projects within the Upper Columbia River Region. Rose asked how much land the CDLT owns in the Middle Entiat Basin, and Hillman said he does not know, but he thinks it is a lot. Kahler said it seems CDLT owns most areas where BPA is proposing actions. Hillman questioned what this means for the intensively monitored watershed evaluations being conducted in the basin, which were funded under the assumption that a large amount of restoration would occur, and the resultant change in productivity would likely be large enough to measure through the evaluations. Rose said it seems the restoration can still be accomplished, just with different landowners. Kahler added it would need to be through a different funding source. Rose asked if BPA may reconsider, and Kahler recommended discussing this with Lee Carlson (YN) and Brandon Rogers (YN), as they are on top of this issue. Rose asked if any Entiat Basin actions were a part of the Accords funds. Hillman said they are all BPA funding and not a part of the Accords process.

- *Next Steps*: The next meeting of the HCP Tributary Committees will be on December 8, 2016.

III. Chelan PUD

A. Rocky Reach and Rock Island Coho Phase Designation (Steve Hemstrom)

Steve Hemstrom recalled that a Draft Estimation of Juvenile Coho Survival for Rocky Reach and Rock Island Projects was distributed to the Coordinating Committees by Kristi Geris on September 22, 2016. He said this was a summary of hydrosystem survival estimates for juvenile coho salmon, steelhead, and yearling spring Chinook salmon based on passive integrated transponder (PIT)-tag estimates, compiled by John Skalski and Rich Townsend (Columbia Basin Research). Hemstrom said Chelan PUD received updated data from Skalski and Townsend for tagged juveniles released from Winthrop National Fish Hatchery (WNFH). He said the updated data included additional PIT-tag statistics from the corner collector at Bonneville Dam, as well as an additional year of data for all analyses. He said analyses are still ongoing. He said the goal is to ultimately come up with a solid mathematical, statistically rigorous estimate for coho salmon survival through the Rocky Reach and Rock Island reservoirs based on comparisons of the species' hydrosystem survival. He said, within about 3 weeks, Skalski will provide a revised summary report for Coordinating Committees review. Hemstrom said Chelan PUD desires to achieve Phase III (Standards Achieved) in a representative way for juvenile coho salmon through this analysis.

Bob Rose recalled concerns expressed by Keely Murdoch (YN HCP Hatchery Committees Alternate) in the Grant PUD hatchery forum, regarding what data are included in these analyses. Rose said he is being vague so as to not misrepresent something; however, emphasized the importance of fully understanding all the data. He added that there are a number of things to be aware of when interpreting the data, for example, hatchery versus run-of-the-river data. John Ferguson asked, regarding the summary by Skalski and Townsend that Chelan PUD provided in September 2016, if Rose is suggesting there are other datasets to consider, and Rose said that is correct. Ferguson said Chelan PUD plans to discuss an updated summary in December 2016, but if there are other data available for discussion, those should be distributed for review. Hemstrom said WNFH is used for its common year releases for all three species (coho salmon, spring Chinook salmon, and steelhead). He added that the representativeness for survival for all species from the common location (WNFH) is the strongest dataset available. He said he would be interested in reviewing the data Rose and Murdoch are referring to. Rose said he will provide a list of YN concerns regarding datasets used for estimating coho salmon survival, which will be used in future discussions of the Rocky Reach and Rock Island Coho Salmon Phase Designation, prior to the Coordinating Committees meeting on December 13, 2016. Chelan PUD and the YN will also convene to discuss concerns regarding datasets used for estimating coho salmon survival, prior to the Coordinating Committees meeting on December 13, 2016.

Ferguson asked about optimal timing for Chelan PUD for a decision on phase designation. Alene Underwood said Chelan PUD would like to take time to ensure questions and concerns are adequately addresses. She said the current designation for coho salmon is Phase III (Additional Juvenile Studies). She said the limiting factor is on the HCP Hatchery Committees side. She said, once the Coordinating Committees agree on a plan forward, the discussion moves to the HCP Hatchery Committees to make sure Chelan PUD meets its No-Net-Impact targets. Underwood recalled that Chelan PUD originally wanted to reach agreement in the Coordinating Committees by the end of 2016; however, due to unanticipated internal delays, the new goal is to reach resolution in the beginning of 2017.

Rocky Reach and Rock Island Coho Salmon Phase Designation will be discussed during the Coordinating Committees meeting on December 13, 2016.

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

Lance Keller handed out hard copies of a Draft FERC Letter for Rock Island B1-B4 Maintenance (Attachment B), which was distributed to the Coordinating Committees by Kristi Geris prior to the meeting on November 15, 2016. Keller requested that the letter be available for a 30-day review period, with edits and comments due to him by Thursday, December 15, 2016. He said this is an informal notification letter to FERC, as described by Brett Bickford (Chelan PUD Engineering and Project Management Director) during the last Coordinating Committees meeting on October 25, 2016. Keller recalled a revolving action item to produce a table to accompany this letter; however, he has since learned that FERC does not favor tables included with letters of this sort. He said the information Chelan PUD would have included in a table is included in the letter. He also noted that the last page of the letter is a placeholder to insert consultation with the Coordinating Committees. Ferguson asked if Chelan PUD plans to request approval of the letter during the Coordinating Committees meeting on December 13, 2016. Keller said, if the Coordinating Committees are ready to vote at that time, Chelan PUD would accept approval of the letter; however, Chelan PUD would also like to provide the 30-day review, if needed.

Chelan PUD will provide a Rock Island Powerhouse 1 Maintenance Update during the Coordinating Committees meeting on December 13, 2016, including discussing the Draft FERC Notification Letter for Rock Island B1-B4 Maintenance.

IV. Douglas PUD

A. 2016/2017 Wells Dam Winter Maintenance Period (Tom Kahler)

Tom Kahler said annual fish ladder winter maintenance at Wells Dam is tentatively scheduled to start with the east fish ladder on November 29 or 30, 2016. He said winter maintenance typically begins during the first week of December; however, this year, December 1 lands in the middle of the week. He said the dewatering process takes several days, so crews prefer not to start midweek, which is why the maintenance was scheduled slightly earlier. John Ferguson asked about the duration of the outage. Kahler said the east ladder will likely be back online by late December 2016; however, it may push over into the first week of January 2017. He said maintenance on the west fish ladder will follow the next full week after the east ladder is back in service. Ferguson asked if the Pacific lamprey entrance boxes will remain installed, and Kahler said yes. Kahler also noted that there has been only one detection of a juvenile Chinook salmon at that location. Ferguson asked about plans for Bypass Bay 2, and Kahler said a full height installation is planned. He recalled that last year, two PIT-tag antennas were installed in the middle two (of four) columns of the top-two rows of the 70-by-16-foot slot. He said the goal is to better understand current vertical distribution through the area, because available fyke net data is decades old. He said six master controllers would be needed to wire the entire slot; however, it is only feasible to install two. He said the plan is to fill one vertical column with PIT-tag detection capability.

V. HCP Administration

A. Subyearling Chinook Salmon Update (John Ferguson)

John Ferguson recalled holding a Subyearling Chinook Salmon workshop on June 21, 2016, and the subsequent agreement to convene quarterly, joint HCP/PRCC sessions to continue discussions regarding subyearling Chinook salmon passage studies. Ferguson said he will coordinate with Denny Rohr regarding scheduling a joint HCP/PRCC meeting soon, to discuss estimating the survival of subyearling Chinook salmon passing Mid-Columbia dams.

B. Next Meetings

The next scheduled Coordinating Committees meeting is on December 13, 2016, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. *(Note: the Coordinating Committees meeting on December 13, 2016, was canceled due to lack of agenda items and available attendees.)*

The January 24, February 28, and March 27, 2017, 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	Draft FERC Letter for Rock Island B1-B4 Maintenance

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Steve Hemstrom*	Chelan PUD
Alene Underwood††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Bob Rose*	Yakama Nation

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

Attachment B



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

(Draft 11/15/2016 – for HCP Coordinating Committee 30-day Review)

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Rock Island Hydroelectric Project, FERC No. 943
Continuation of Rehabilitation Work (Units B1-B4)

Dear Secretary Bose:

As the Federal Energy Regulatory Commission (Commission or FERC) is aware, the Public Utility District No. 1 of Chelan County, Washington (Chelan PUD) has been engaged in a long-standing effort to rehabilitate the units in the First Powerhouse (PH1) at its Rock Island Hydroelectric Project, FERC No. 943 (Project). This effort began with the rehabilitation of Unit B10, which Chelan PUD completed in 2008,[1] followed by the completion of rehabilitation work for Unit B9 in 2012.[2] Chelan PUD originally advised the Commission of its planned rehabilitation of these units, together with Units B5, B6, and B7, in 2003.[3]

The purpose of this letter is to advise the Commission of its intent to continue its rehabilitation effort at the Project's PH1 by rehabilitating the turbine-generators for Units B1-B4. A detailed description of Chelan PUD's plans for Units B1-B4 appears below.

Consistent with how this rehabilitation program has progressed to date, and pursuant to Chelan PUD's consultation with Commission staff on April 29, 2016, prior Commission approval of the rehabilitation work for Units B1-B4 will not be required for this work. The rehabilitation of Units B1-B4 will not involve any change to the maximum hydraulic capacity of 220,000 cubic

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1 *Pub. Util. Dist. No. 1 of Chelan County*, 135 FERC ¶ 62,207 (2011) (acknowledging the completion of the Unit B10 rehabilitation and adjusting annual charges for the unit).

2 *See Pub. Util. Dist. No. 1 of Chelan County*, 146 FERC ¶ 62,055 (2014) (acknowledging the completion of the Unit B9 rehabilitation and adjusting annual charges for the unit).

3 *See* Letter from Charles J. Hosken, Public Utility District No. 1 of Chelan County, to Magalie R. Salas, Federal Energy Regulatory Commission, Project No. 943-000 (filed Oct. 29, 2003). As noted in Attachment A herein, Chelan PUD anticipates completing the rehabilitation for Units B5, B6 and B7 in the 2016-22 timeframe.

feet per second currently authorized under the Project's license, nor will it result in any increase in the Project's authorized installed capacity, which for each of these units is 20,700 kilowatts.[4] Moreover, because Chelan PUD will only be replacing equipment that is reaching the end of its useful life with comparable equipment, the rehabilitation of Units B1-B4 will not involve a "substantial change" or "substantial alteration" to the approved Project works under Standard Articles 2 and 3 of the Project license.[5]

Although no prior Commission approvals are required for this next phase of the rehabilitation program, Chelan PUD will continue to provide the Commission updates of its progress. After each turbine-generator unit is rehabilitated, Chelan PUD will notify the Commission of the date on which the rehabilitated unit went on line and its capacity in order to confirm whether there will be a need to revise the authorized installed capacity or annual charges for the Project. After rehabilitation work is completed, Chelan PUD will file "as-built" exhibits with the Commission.

In addition, as detailed below and in Attachment B, Chelan PUD has consulted with the Habitat Conservation Plan (HCP) Coordinating Committee, comprised of federal and state resource agencies and Tribes, regarding potential environmental effects of the rehabilitation work.

<u>Proposed Rock Island Rehabilitation</u>

Chelan PUD intends to rehabilitate the 20.7 MW Kaplan turbine-generators in the Rock Island PH1. These units have been in service since the early1930s. The proposed rehabilitation work will begin in 2018 and continue through 2020. The following outlines the proposed work, schedule and environmental considerations. Attachment A provides Chelan PUD's estimated rehabilitation schedule for PH1.

The rehabilitation will not result in a change to generator nameplate or authorized project hydraulic capacity (220,000 cubic feet per second (cfs) or authorized capacity, 20,700 kilowatt (kW). No civil works will be necessary, including no changes to the diameter of the intake or draft tube discharge structures, height of wicket gates, or stator core. The units will continue to operate with fixed blades, the same conditions that met the Habitat Conservation Plan's no-net impact.

The rehabilitation will change the turbine horsepower (HP) from 32,000 HP to about 30,000 HP. The head for PH1 units will be updated to 39.7 feet to be consistent with other updated PH1 rehabilitated units and PH2. A smaller oil-free hub with no gaps will be installed, along with new fixed propeller runners optimized for the current operating head and flow. Currently, the units contain manually adjustable Nagler-type propeller turbines. The units will have more efficient four-blade turbines instead of six-blades. Governor controls will be replaced.

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4 *See* 18 C.F.R. § 4.201(b)

5 *See Pub. Util. Dist. No. 1 of Chelan County*, 46 FERC ¶ 61,033, at p. 61,208 (1989) (Ordering Paragraph (E), adopting Form L-5 into the license); *see also* 16 U.S.C. § 803(b) (prohibiting "substantial alteration or addition not in conformity with the approved plans . . . without the prior approval of the Commission"); *e.g., International Falls Power Co.*, 66 FERC ¶ 61,086 at p. 61,114-17 (1994).

Upon installation and testing, revised best gate capacities for the units will be submitted to the Commission.

Estimated Schedule – Powerhouse 1

1. Unit B1 – 2020
2. Unit B2 – 2019
3. Unit B3 – 2019
4. Unit B4 – 2018

Environmental Considerations

The rehabilitation work will not adversely affect aquatic resources or Chelan PUD's obligations under the HCP. Modern turbine design with tighter operating tolerances and fixed blade angle positioned for optimum flow conditions supporting efficient power generation will benefit fish passage survival. Additionally, laminar flow conditions associated with peak generating capability equate to providing fish the best possible flow conditions for turbine route passage. In 2013, the HCP Coordinating Committee approved Chelan PUD's 2013 Comprehensive Progress Report that concluded Chelan PUD had reached no net impact at Rock Island with respect to all planned species.[6] Chelan PUD's achievement of no net impact in 2013 was successfully achieved while operating the vintage 1933 units. The proposed rehabilitation work will not alter the HCP Coordinating Committee's 2013 finding of no net impact and in fact, Chelan PUD anticipates that the new modern design of present day turbines will offer additional survival benefit of fish passing through the rehabbed B1-4 units. A project survival standard check-in study is scheduled for 2020 (post B1-4 rehab) to verify continued achievement of the juvenile survival standard. The schedule has all PH1 units in operation by April 2020 providing the best chance for success during the 2020 HCP check-in.

Consultation

Chelan PUD has kept the HCP Coordinating Committee apprised of maintenance work occurring at the Rock Island Project. On October 25, Chelan PUD Director of Engineering and Project Management, Brett Bickford provided the HCP Coordinating Committee an overview of maintenance work planned on Units B1-B4. On November 15, Chelan PUD provided a draft of this letter to the HCP Coordinating Committee for the agencies' and committee's comments. Documentation, including comments received and Chelan PUD responses are included in Attachment B.

Conclusion

Chelan PUD appreciates the support of Commission staff and federal and state resource agencies as it continues with this important rehabilitation program for the Rock Island Hydroelectric Project. Should you have any questions regarding this matter, please contact me.

[6] Statement of Agreement, Approval of Rock Island and Rocky Reach HCPs 2013 Comprehensive Progress Report (Approved February 26, 2013).

Regards,

Jeffrey G. Osborn
License Compliance Supervisor
Public Utility District No. 1 of Chelan County
jeff.osborn@chelanpud.org
(509) 661-4176

cc: FERC DHAC Director
FERC D2SI Director
FERC D2SI Regional Engineer

Attachment A: Table of Proposed Authorized Capacities
Attachment B: Consultation Documentation

ATTACHMENT A

ESTIMATED MAINTENANCE SCHEDULES AND CAPACITIES

Modified November 2016 by Chelan PUD to reflect estimated maintenance schedules and anticipated capacities for PH1 Units B1-4.

	License Issued 01/18/1989	**Amendment Issued 03/14/2002**	**Amendment Issued 09/22/2004**	**Amendment Issued 06/09/2011**	**Amendment Issued 01/24/2014**	**B1-B4 Rehab 2018-2020**	**Maintenance Schedule**
Units	Authorized Capacity kW	Authorized Capacity kW	Authorized Capacity kW	Authorized Capacity kW	Authorized Capacity kW	Authorized Capacity kW	
B1	15,000	15,000	20,700	20,700	20,700	20,700	2020
B2	20,700	20,700	20,700	20,700	20,700	20,700	2019
B3	20,700	20,700	15,000	20,700	20,700	20,700	2019
B4	20,700	20,700	20,700	20,700	20,700	20,700	2018
B5	22,500	22,500	18,000	22,500	22,500		2020/2021
B6	22,500	22,500	18,000	22,500	22,500		2017
B7	22,500	22,500	18,000	22,500	22,500		2017/18
B8	22,500	22,500	18,000	18,000	18,000		2021/2022
B9	22,500	22,500	18,000	15,312	14,355		Completed in 2012
B10	22,500	22,500	18,000	14,100	14,100		Completed in 2008
U1	51,300	51,300	27,975	27,975	27,975		2022
U2	51,300	51,300	27,975	27,975	27,975		2023
U3	51,300	51,300	27,975	27,975	27,975		2024
U4	51,300	51,300	27,975	27,975	27,975		2025
U5	51,300	51,300	27,975	27,975	27,975		2026
U6	51,300	51,300	27,975	27,975	27,975		2027
U7	51,300	51,300	27,975	27,975	27,975		2028
U8	51,300	51,300	27,975	27,975	27,975		2029
AW		700	700	700	700		Application to Remove from License filed 9/27/2016
	622,500	623,200	409,600	422,212	421,255		

ATTACHMENT B

CONSULTATION DOCUMENTATION

APPENDIX B
HABITAT CONSERVATION PLAN
HATCHERY COMMITTEES
2016 MEETING MINUTES AND
CONFERENCE CALL MINUTES

720 Olive Way, Suite 1900
Seattle, Washington 98101
Phone 206.287.9130
Fax 206.287.9131
www.anchorqea.com

FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	February 18, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the January 20, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD headquarters in East Wenatchee, Washington, on Wednesday, January 20, 2016, from 9:30 a.m. to 3:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Mike Tonseth will add contingencies for overages to the Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth and Andrew Murdoch (WDFW) will keep the Hatchery Committees updated on the WDFW moratorium on hexacopter use (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will distribute meeting materials to the Hatchery Committees and the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC; Item I-A). *(Note: Montgomery distributed six documents on January 21, 2016, including: 1) Chelan PUD's TMDL Compliance at Dryden Acclimation Facility presentation; 2) Chelan PUD's Size-at-Release Target Summary presentation; 3) Chelan PUD's Draft 2016 Rocky Reach and Rock Island HCP Action Plan; 4) Tracy Hillman's HRR Targets spreadsheet; 5) Chelan PUD's Draft SOA for Wenatchee Summer Chinook salmon; and 6) Douglas PUD's Draft 2016 Wells HCP Action Plan.)*

- Hatchery Committees members will send Tom Kahler questions or topics for Andrew Dittman to discuss at the February 17, 2016, Hatchery Committees meeting by February 3, 2016 (Item I-A).
- Rob Jones (National Oceanic and Atmospheric Administration [NOAA]) will send a letter to the HCP Coordinating Committees regarding changes in NOAA representation on the Hatchery Committees (Item II-A). *(Note: Dale Brambrick sent a letter regarding changes in NOAA representation on the Hatchery Committees to Tracy Hillman on February 11, 2016, which Kristi Geris forwarded to the Hatchery Committees and HCP Coordinating Committees that same day.)*
- Tracy Hillman will calculate 40th percentile hatchery replacement rate (HRR) targets that include harvest (Item II-B). *(Note: Hillman provided the updated spreadsheet to Sarah Montgomery on January 22, 2016, which she distributed to the Hatchery Committees that same day.)*
- Grant PUD will discuss internally approving the use of the 40th percentile approach that includes harvest for calculating HRR targets (Item II-B). *(Note: Todd Pearsons sent a document titled, "HRR Target Proposal" regarding this topic to Sarah Montgomery on February 9, 2016, which she distributed to the Hatchery Committees that same day.)*
- Keely Murdoch will develop her outline, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a draft (Item II-D). *(Note: Murdoch sent the draft to Sarah Montgomery on January 26, 2016, which she distributed to the Hatchery Committees and HETT that same day.)*
- The Hatchery Committees will discuss Keely Murdoch's draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," with Andrew Dittman (NOAA) at the February 17, 2016, Hatchery Committees meeting (Item II-D).
- Hatchery Evaluation Technical Team (HETT) members will update the Draft Hatchery Monitoring and Evaluation (M&E) Plan Appendices 2 to 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-D). *(Note: Sarah Montgomery forwarded Appendices 5 and 6 to the Hatchery Committees on February*

5, 2016, and Appendix 4 on February 9, 2016.)

- Kirk Truscott will discuss internally the acclimation of Methow spring Chinook salmon at Chewuch Acclimation Facility (AF) under the operation of the Yakama Nation (YN) and the 2013 Final Chewuch Acclimation Statement of Agreement (SOA) by Friday, January 22, 2016 (Item IV-B). *(Note: Truscott sent an email to Tracy Hillman saying this item is ongoing on January 22, 2016, which Sarah Montgomery forwarded to the Hatchery Committees that same day. On January 27, 2016, Truscott sent a second email detailing CCT's preferences regarding the acclimation of Methow spring Chinook salmon at Chewuch AF, which Montgomery forwarded to the Hatchery Committees that same day.)*
- WDFW will pursue the feasibility of staffing Chewuch AF for the potential acclimation and release of Methow spring Chinook salmon (Item IV-B). *(Note: Jeff Korth sent an email on February 12, 2016 to Tracy Hillman and Sarah Montgomery stating that WDFW did not successfully recruit qualified candidates for staffing the Chewuch AF, which Montgomery forwarded to the Hatchery Committees that same day.)*
- Keely Murdoch will send the 2013 Final Chewuch Acclimation SOA to Kirk Truscott (Item IV-B).
- Keely Murdoch will discuss internally the status of facility improvements at Chewuch AF (Item IV-B).
- Sarah Montgomery will add brood year 2014 spring Chinook salmon acclimation in the Methow Basin to the February 17, 2016, Hatchery Committees meeting agenda (Item IV-B). *(Note: Montgomery distributed the Hatchery Committees February 17, 2016 meeting agenda, including this item, on February 5, 2016.)*
- Bill Gale will ask Ann Gannam (USFWS) about the results of a phosphorus study she presented at the American Fisheries Society 2015 conference (Item IV-C).
- Hatchery Committees members will provide comments on the Chelan PUD draft SOA titled, "Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook," to Alene Underwood by Monday, February 1, 2016 (Item IV-C).
- Alene Underwood will finalize the draft Wenatchee summer Chinook salmon SOA by Wednesday, February 3, 2016, so that it can be a decision item at the February 17, 2016, Hatchery Committees meeting (Item IV-C). *(Note: Underwood*

sent the SOA to Sarah Montgomery on February 3, 2016, which Montgomery forwarded to the Hatchery Committees that same day.)

DECISION SUMMARY

- The Wells Hatchery Committee representatives present approved Douglas PUD's 2016 Wells Action Plan as follows: Douglas PUD, U.S. Fish and Wildlife Service (USFWS), WDFW, National Marine Fisheries Service (NMFS), YN, and Colville Confederated Tribes (CCT) approved on January 20, 2016 (Item III-A).

AGREEMENTS

- The Hatchery Committees representatives present agreed to revise the method (now, 40th percentile, including harvest) for calculating HRR targets (Item II-B).
- The Hatchery Committees representatives present decided to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly (Item II-B).

REVIEW ITEMS

- Sarah Montgomery sent the Rocky Reach and Rock Island Hatchery Committees SOA, "Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook" to the Hatchery Committees on February 3, 2016 for discussion at the February 17, 2016 Hatchery Committees meeting.
- Sarah Montgomery sent the revised Hatchery M&E Appendices 5 and 6 to the Hatchery Committees on February 5, 2016, and Appendix 4 on February 9, 2016, for discussion at the Hatchery Committees February 17, 2016 meeting.

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on February 17, 2016, notifying them that the Final 2016 Douglas PUD Wells HCP Action Plan (approved by the HCP Coordinating Committees on January 26, 2016) is now available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the December 16, 2015, Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. One revision was requested:

- Bill Gale removed the USFWS consultation update.

The Hatchery Committees reviewed the revised draft December 16, 2015, meeting minutes. Sarah Montgomery said there are several outstanding comments to be discussed. The Hatchery Committees discussed the outstanding comments and made revisions.

Hatchery Committees members present approved the draft December 16, 2015, meeting minutes, as revised.

Action items from the Hatchery Committees meeting on December 16, 2015, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on December 16, 2015)*:

- *Mike Tonseth will add contingencies for overages to the Broodstock Collection Protocols (Item I-A).*
  This item is ongoing.
- *Tonseth and Andrew Murdoch will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item is ongoing. Mike Tonseth said McLain Johnson is working on the timeline, and there has been a change in genetic sampling collection methods.
- *Andrew Murdoch will keep the Hatchery Committees updated on the WDFW moratorium on hexacopter use (Item I-A).*
  This item is ongoing.
- *WDFW, Chelan PUD, and NMFS will provide comments or written feedback regarding the Draft Wenatchee River Basin BiOp to Karl Halupka before December 25, 2015 (Item II-A).*
  This item is complete. Alene Underwood and Mike Tonseth said Chelan PUD and WDFW completed this item. Craig Busack said Amilee Wilson (NOAA) completed

this item on January 14, 2016.

- *The Hatchery Evaluation Technical Team (HETT) will review potential methods for increasing homing fidelity of spring Chinook salmon in the Methow Basin (Item II-A).*
  This item is ongoing and was discussed at the HETT January 7, 2016, meeting.
- *Todd Pearsons will discuss internally whether Grant PUD approves using the new method for calculating hatchery replacement rate (HRR) targets (Item II-A).*
  Pearsons provided Grant PUD agreement to using this methodology on December 17, 2015.
- *Tracy Hillman will ask Craig Busack if NMFS approves the new method for calculating HRR targets (Item II-A).*
  Hillman asked Busack who provided agreement to using this methodology on December 22, 2015.
- *Sarah Montgomery will distribute meeting materials related to the methods for calculating HRR targets to the Hatchery Committees and the Priest Rapids Coordinating Committee's Hatchery Sub-Committee (PRCC HSC; Item II-A).*
  Montgomery distributed three documents on December 17, 2015: 1) Hatchery Replacement Rate Targets Methodology; 2) Chiwawa Spring Chinook HRRs and Natural Replacement Rates (NRRs); and 3) Smolt-to-adult HRR Update.
- *Tom Kahler will request that Andrew Dittman (National Oceanic and Atmospheric Administration [NOAA]) attend the Hatchery Committees February 17, 2016, meeting (Item II-A).*
  Kahler said Andrew Dittman can attend the Hatchery Committees February 17, 2016, meeting, but would prefer to attend a meeting in March.
- *Keely Murdoch will outline study plan options to address homing fidelity of spring Chinook salmon in the Methow Basin for discussion at the January 7, 2016, HETT meeting (Item II-A).*
  Keely Murdoch provided the outline to Sarah Montgomery, which she distributed to the HETT on January 6, 2016.
- *Catherine Willard will summarize the available data on size-at-release targets for spring Chinook salmon in the Chiwawa River, and will coordinate with Douglas PUD, Grant PUD, and WDFW to summarize available size at release data for*

Nason Creek and Methow River spring Chinook salmon (Item II-A).
This will be discussed during today's meeting.

- *Tracy Hillman and Sarah Montgomery will add Objective 1 of the 5-Year Monitoring and Evaluation (M&E) Report to the list of objectives flagged for further discussion, and will develop a strategy to ensure all flagged objectives are discussed before the 1-year review timeline ends on March 31, 2016 (Item II-A).*
  This will be discussed during today's meeting. Hillman said all flagged objectives are on agenda for discussion before March 31, 2016, but that does not guarantee the end of the review process.
- *Tracy Hillman will ask Craig Busack if NMFS approves Douglas PUD's Means of Satisfying No Net Impact (NNI) for Methow River Coho Statement of Agreement (SOA; Item III-A).*
  Hillman asked Busack who provided NMFS approval of the SOA on December 22, 2015.
- *Alene Underwood will provide an update on the future acclimation of Chelan PUD's approximately 60,000 spring Chinook salmon in the Methow Basin at the next Hatchery Committees meeting on January 20, 2016 (Item IV-A).*
  This will be discussed during today's meeting.
- *Sarah Montgomery will add the update on Chelan PUD's spring Chinook salmon acclimation in the Methow Basin to the Hatchery Committees' January 20, 2016, meeting agenda (Item IV-A).*
  Montgomery distributed the January 20, 2016, Hatchery Committees meeting agenda, including this item, on January 9, 2016.
- *Tracy Hillman will request that the HCP Coordinating Committees approve email distribution and Extranet access to Deanne Pavlik-Kunkel (Grant PUD) regarding items related to joint HCP-HC/PRCC HSC discussions (Item V-A).*
  Hillman sent a request to John Ferguson (HCP Coordinating Committees Chairman; Anchor QEA, LLC) on December 28, 2015, which Kristi Geris (Anchor QEA) distributed to the Coordinating Committees that same day.

II. Joint HCP-HC/PRCC HSC

A. NMFS Consultation Update (Craig Busack)

Craig Busack said many career transitions are occurring at NMFS. He said Will Stelle (Regional Administrator) is taking a different position, Bob Turner (Assistant Regional Administrator) is retiring, and Gary Sims (Tribal Relations Coordinator) is also retiring. He said Justin Yeager will be the NMFS representative on the Hatchery Committees, and he (Busack) will become the alternate. He said NMFS has hired two, new term positions in order to help with the workload resulting from consultations, and continues to recruit for two more positions. He said Rob Jones (NOAA) will send a letter to the Coordinating Committees regarding the changes in Hatchery Committees representation.

Busack said, on January 13, 2016, Wild Fish Conservancy filed a 60-day notice of intent to sue NMFS and the Department of Commerce for funding hatchery programs under the Mitchell Act without Endangered Species Act (ESA) coverage. He said some of the hatchery programs have explicit ESA coverage, but the suit regards the lack of coverage in the funding of the programs, not the programs themselves. He said NMFS is also busy completing an environmental impact statement (EIS) for Puget Sound steelhead programs, and its timeliness in finishing the EIS will affect releases of steelhead from hatcheries into Puget Sound. He said Charlene Hurst is working on the Methow spring Chinook salmon consultation and assuming bull trout consultation with USFWS is completed on time, the NMFS consultation should be complete by May. He said he has no update on the Wenatchee Basin steelhead consultation.

Todd Pearsons asked what the implications are of the potential Mitchell Act suit and if Wild Fish Conservancy had any novel biological information. Busack replied that in regard to the Mitchell Act, NMFS has two responsibilities—to fund and license the hatchery programs. The Wild Fish Conservancy claims that NMFS does not meet the funding obligation. He said NMFS will likely have to complete a National Environmental Policy Act analysis and a concept Biological Opinion to address the effects of funding the hatchery programs. He said Wild Fish Conservancy could then sue NMFS for individual programs lacking ESA coverage, because ESA coverage of the funding of a program does not apply to the actual operation of that program. Pearsons asked if this suit would apply to any hatcheries in the mid- to upper Columbia basin. Busack replied that Mitchell Act funds are used for all state hatcheries downstream of Bonneville Dam in Oregon and in Washington, and some of the funds are also used in the mid- to upper Columbia basin. Keely Murdoch said coho salmon rearing is partially funded by the Mitchell Act. Bill Gale said most of the federal facilities in the Columbia River gorge are funded by the Mitchell Act. Busack said this suit would affect all or part of 51 hatchery programs, 11 of which have ESA authorization. Gale said USFWS was named in the notice of intent only when referencing bull trout consultations, and asked why a notice of intent was also sent to USFWS. Busack said Wild Fish Conservancy understands that USFWS consultation on bull trout is needed for full ESA coverage, so USFWS will need to consult with NMFS in order to continue the funding of the hatchery programs.

B. 5-Year Hatchery M&E Review Planning—Review Timeline; Objectives 4, 6, and 2 (All)

Review Timeline

Tracy Hillman said that he and Sarah Montgomery developed a timeline ensuring all flagged objectives are discussed before the March 31, 2016 deadline; however, discussion of each objective may also continue past the deadline. He said today's agenda includes objectives 4, 6, and 2, and the agenda for the Hatchery Committees February 17, 2016 meeting includes objectives 5, 7, and 1. At the Hatchery Committees March 16, 2016 meeting, a write-up of the review process and any ongoing items can be discussed.

Objective 4

Tracy Hillman said the HETT met on January 7, 2016 and discussed Objective 4, hatchery replacement rates (HRRs). Hillman shared a spreadsheet titled "HRRs and Targets (Hillman revisions 1-13-16)" (Attachment B). (*Note: Hillman provided a revised version of the spreadsheet to Sarah Montgomery on January 22, 2016, which she distributed to the Hatchery Committees that same day [Attachment C].)* He said he revised the spreadsheet to reflect recommended changes from the HETT (to include harvest) and added data from additional programs (Okanogan and Omak steelhead). He said the HETT did not pick a representative target program for each basin, but used the example that in the Okanogan basin, all Okanogan steelhead programs should assess HRR compared to the Okanogan steelhead HRR, because the Okanogan steelhead program performs better than the Omak steelhead program.

Kirk Truscott said it is not suitable to set a target less than the mean; therefore, the 20th percentile should not be used. He said if HRRs greater than the 20th percentile are met in all 5 years, the resulting 5-year mean could be less than the previous 5-year mean. He said the mean or something greater than the mean should be used as the HRR target. Hillman replied that the 20th percentile method was developed in order to set a target that is 80% of the time achievable, always greater than one, and can be used as a tool in assessing hatchery performance. He said high targets are often not met and the Hatchery Committees have not acted when these targets were not met. Truscott said his understanding was that the HRR target would be the 80th percentile, and expressed concern that if programs achieve low targets, they will provide fewer returning adults than the dataset that was used for calculating the target. He said meeting a target less than the mean can decrease the target over time. Hillman said using the 50th percentile would mean that on average, two to three years in a five-year period would not achieve the target if the programs perform as well as they did during 2000 to present. Truscott said at least the median of past performance should be used as the target.

Bill Gale asked if a range about the median could be used as the HRR target, for example, within 10 percent of the median would be green, 10 to 20 percent could be yellow, and outside of that could be red. Tom Kahler responded that the stoplight approach is based on the number of years, not the variance within 1 year. Gale said the 5-year median should be used as the HRR target. Mike Tonseth said the approaches could be combined. For example, within 10 percent of the median value in 1 year would be considered meeting the target. He said sensitivity should be built into HRR assessments so that potential problems can be identified, and it can be used as a monitoring indicator. Hillman asked if not meeting a 20th percentile target in 2 out of 5 years would have the same reaction as not meeting the median target in 2 out of 5 years. Truscott replied that the recommendation to the program might be the same, but urgency would be greater if a 20th percentile target is not being met. Hillman said the HETT sought a target at a reasonable level to denote a red flag, requiring action. He said the higher the target is set, the less concern there is for not meeting that target. For example, he asked if the Committees would have the same reaction if a program fell just below a 50% target of 5.2 versus falling below a 20% target of 1.2. Truscott said his concern is that there would not be a red flag for values between the 20th and 50th percentiles, which could result in slow program performance decline, and the Hatchery Committees cannot condone an underperforming program.

Alene Underwood said the Hatchery Committees are continuing to discuss a target that does not hold much relevancy based on past Hatchery Committees actions. Keely Murdoch said the 20th percentile was agreed upon as a target, and it was also agreed to set a target for each species per basin. She said if one program is underperforming, the 20th percentile target of a better program would be used to assess the underperforming program. Underwood said, for example, the median HRR for Methow summer Chinook salmon is 3.8. Hillman said that if the program performed in the future as it did in the recent past, the target would not be met in 2 or 3 years out of a 5-year period and asked the Hatchery Committees if they would consider that program underperforming because it did not meet the median target value. Keely Murdoch said the Okanogan summer Chinook salmon program outperformed the Methow summer Chinook salmon program and explained an above-Wells Dam standard could be used as the 20th percentile target because the fish from both programs have similar migrations.

Gale asked if the Hatchery Committees are more concerned about HRR trends over time or depending on year-to-year values. He said HRRs could be assessed on a 5-year cycle, and the target could be achieving or exceeding the median in 3 out of 5 years. Kahler and Pearsons suggested reconsidering the linkage of HRR targets to NRRs. Hillman said the original proposal from the HETT was to link the HRRs to NRRs; however, the approach did not find favor with the Hatchery Committees. Hillman said any percentile can be chosen as the target, but if it is too high, not meeting the target might trigger unnecessary actions. Relating back to a suggestion from Gale to include a range about the median, Hillman suggested the 40th percentile as a target. Truscott said the easiest way to achieve a target is to set a low target, and he is not willing to set a target that could result in hatchery programs not meeting past performance. Pearsons said Grant PUD will need to discuss internally the implications of changing the HRR targets. Peter Graf suggested changing the stoplight approach for flagging low performance instead of the target itself. Hillman said the HETT also discussed the sequence of not meeting targets; that is, whether it is worse if a program misses its target in consecutive years. Tonseth said HRRs are calculated based on brood year effects, which will factor into whether or not the HRR target is met. He said either hatchery effects or longstanding environmental conditions would result in missing targets in sequential years.

The Hatchery Committees representatives present agreed to revise the method (now 40th percentile, including harvest) for calculating HRR targets. Hillman said he will calculate 40th percentile HRR targets that include harvest.

Catherine Willard said conversations in HETT and Hatchery Committees meetings are often similar or repetitive, and improvements should be made in communication between the HETT and the Hatchery Committees. She said the Hatchery Committees should keep this in mind when assigning tasks to the HETT.

Objective 6

Willard shared a presentation titled, "Juvenile Spring Chinook Size at Release Summary," (Attachment D), which Montgomery distributed to the Hatchery Committees on January 21, 2016.

Summary

Willard said she summarized size-at-release data to date by coordinating with WDFW, Douglas PUD, and Grant PUD. Pearsons said size-at-release targets were initially set from a biological basis, but there are mutually exclusive tradeoffs in optimizing different variables. He said reducing precocity needs to be balanced with trying to get many females and older males onto spawning grounds. He said it is currently understood that growth occurring before February affects the chance of precocity. For example, in the White River program, growth is kept low during fall and winter because that is thought to be the key period for precocious maturation. After February, growth is maximized in order to reduce predation based mortality and increase survival. He said due to cold water temperature, it is difficult to reduce precocious maturation and still produce large fish. Willard shared a quote from Brian Beckman (NOAA), "There is no best size at release that optimizes across all management goals; therefore, size-at-release targets represent a compromise across a series of management values." Results, questions, and comments were discussed:

Size at Release (Slide 3)

Methow composite and Chiwawa spring Chinook salmon were smaller than the size-at-release target on average. Twisp salmon were, on average, close to the target.

Growth Profiles (Slide 7)

Willard said Chiwawa River and Methow River composite spring Chinook salmon had similar growth profiles, and the Nason Creek growth profile differed, which could be attributed to different water temperatures or winter feeding regimes.

Mini-jack Rates (Slides 8 and 9)

Based on the brood year 2013 results from a size target study conducted with NOAA-Fisheries on the Chiwawa, Nason and White River stocks, Willard said mini-jack rates were measured by examining gonads during lethal sampling. Nason Creek spring Chinook salmon had the lowest mini-jack rates, which could be attributed to size at release, growth profiles and/or circular tank rearing. Pearsons said Grant PUD and Douglas PUD evaluated mini-jack rates and precocious male maturation for Brood Year 2012 Methow spring Chinook in April 2014 using gonadosomatic index (GSI) measurements and visual observation. Mature fish were larger than immature fish, and all fish with a fork length of greater than 160 millimeters were mature (n=300).

Outmigration Performance (Slide 10)

Willard said Chiwawa River spring Chinook salmon had higher survival and less travel time to McNary Dam than Nason Creek fish, which could be attributed to method of release. Graf said some fish, which were not volitionally released, had higher survival. Kahler asked if the date of travel was analyzed, and noted that survival through the hydroelectric system varies widely over time. Graf said, even when date of travel was similar for different groups of fish, their survival varied.

Proportion of Age Classes by Group (Slide 11)

Willard said, based on the fork lengths during fall PIT-tagging of Chiwawa spring Chinook salmon (BY 2009-2011), the larger half of the smolt groups released returned a greater proportion of mini-jacks and jacks. However, it must also be considered that releasing smaller fish may result in fewer returns. She said growth profiles should be considered, as well, because how the size at release is reached may be just as important as the size of the fish released.

Questions and Comments

Tonseth asked if mini-jack rates were only representative of sampled males and what the size distribution of females compared to males was in the Methow spring Chinook salmon evaluation. Pearsons said mini-jack rates were only calculated using males, and the length distribution rates of females had not been calculated.

Hillman asked if maximizing smolt-to-adult return is a management goal. Tonseth said more than 1 year of data is needed in order to make broad-scale program changes. Truscott asked if the graph of mini-jacks included females. Kahler said no, but those data are available. Gale said early maturation could be considered its own objective so that it is duly addressed. Underwood said that would imply a target should be set for maturation, and asked if that was really the best plan forward. Kahler said maturation is a fundamental part of the size-at-release objective, so targets would be set for growth rates or size, but not maturation itself. Gale asked if a plan should be drafted for how to obtain size-at-release targets and if programs should be evaluated based on their ability to reach a size-at-release target a certain way.

Willard summarized that the same size-at-release target can be reached in different ways (for example, Nason Creek and Chiwawa River), and the existing standards should not be changed until more data are available. The Hatchery Committees and PRCC HSC representatives present decided to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly.

Objective 2

Keely Murdoch said Objective 2 was flagged for further discussion because there are issues with the spawning distribution of hatchery and wild fish; however, the Hatchery Committees already approved a study design to determine if spawner distribution in the Methow Basin can be improved with short-term acclimation (the Goat Wall proposal and SOA).

C. Spring Chinook Early Maturation Sampling (Todd Pearsons)

Todd Pearsons said an additional year of sampling for precocious males should be completed. He said there is a strong basis for using visual sampling because visual exams of gonads are highly correlated with ketotestosterone and GSI sampling. He said plans for sampling in 2016 would include 300 fish from each of the following populations: 1) Nason spring Chinook salmon; 2) Chiwawa spring Chinook salmon; 3) Methow spring Chinook salmon; 4) Methow/Okanogan summer Chinook salmon; and, 5) Wenatchee summer Chinook salmon.

D. HETT Update (Sarah Montgomery)

Sarah Montgomery said HETT members will update Draft Hatchery M&E Plan Appendices 2 to 6 and send revised versions to her by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review. Keely Murdoch said she will develop her outline, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a draft, which the Hatchery Committees will discuss with Andrew Dittman (NOAA) at the February 17, 2016, Hatchery Committees meeting.

III. Douglas PUD

A. DECISION: Approve Douglas PUD Wells HCP Action Plan (Tom Kahler)

Tom Kahler shared a document titled, "2016 Wells HCP Action Plan," (Attachment E), which Sarah Montgomery distributed to the Hatchery Committees on December 21, 2015. Kahler said one addition to the plan is that he added dates to the Hatchery and Genetic Management Plan permits, and the ongoing review of the 5-Year Hatchery M&E Plan has also been added. He said the Action Plan is in no way a binding document.

Kahler said Douglas PUD funded the development of the Okanogan Sockeye Fish/Water Management Tool, which went into full operation for Okanogan sockeye salmon for water year 2004 to 2005. He said, due to the age of the software and hardware, and identified improvements like the hydraulic model and fish parameters, a modernization process began in November 2014 to update the tool. He said the update includes three phases: 1) meet with stakeholders to identify and prioritize upgrades, and update the user interface and sub-model inputs and algorithms; 2) re-code sub-models and modernize software and hardware; and 3) document the updated tool and training materials. He said the updated tool will run side by side with the existing model starting at the spring freshet in 2016, and will completely replace the old tool for the 2016-to-2017 water year.

The Hatchery Committees representatives present approved Douglas PUD's 2016 Wells Action Plan.

IV. Chelan PUD

A. 2016 Action Plan (Alene Underwood)

Alene Underwood shared a document titled, "Draft 2016 Rock Island and Rocky Reach HCP Action Plan," (Attachment F), which Sarah Montgomery distributed to the Hatchery Committees on January 21, 2016. Underwood said Chelan PUD intends to work with WDFW to compile the available science on minimizing issues related to potential residualism of Wenatchee hatchery steelhead releases. She said a draft steelhead residualism plan is included in the Action Plan for brood year 2017 in order to reduce residualism as much as possible. She said the 2016 Rock Island and Rocky Reach HCP Action Plan will be a decision item at the February 17, 2016, Hatchery Committees meeting.

B. BY 2014 Methow Spring Chinook Salmon Acclimation (Alene Underwood)

Alene Underwood said Chelan PUD does not currently have an operator for the final acclimation of brood year 2014 Methow spring Chinook salmon at Chewuch AF. She said YN has funding to operate the pond but does not have permission from CCT. Jayson Wahls said WDFW would need to propose a budget and discuss internally before agreeing to operate the facility. Underwood said issues outside of implementing the HCP are affecting Chelan PUD's ability to contract with a suitable operator and, therefore, are affecting its ability to implement the HCP. She summarized other options for acclimating and releasing the fish:

1. Release the fish directly into the Methow River from Methow Fish Hatchery (FH). Underwood said a contract is currently not in place with Douglas PUD for final acclimation, so the fish cannot stay at Methow FH past March 31, 2016, without a new or amended contract.
2. Truck plant the fish that are progeny from Chewuch River tangle netting as far upstream in the Chewuch River Basin as possible.
3. Final acclimate the fish at Carlton Pond. Underwood said Chelan PUD still maintains access to its acclimation pond, adjacent to the new Grant PUD facility, and could potentially cost-share WDFW staff with Grant PUD.

Keely Murdoch asked if Douglas PUD has rescinded YN permission to operate Chewuch AF due to CCT opposition to YN operating at Chewuch AF. Tom Kahler replied that Douglas PUD attempts to not worsen any issues between YN and CCT. Keely Murdoch said YN operating Chewuch AF in 2015 went well and Kahler and Wahls agreed. Mike Tonseth said the WDFW perspective on operating Chewuch AF is that it does not currently have enough staff, and hiring would be problematic due to the short duration of the assignment and limited candidate pool. He said YN operating the facility appeals to WDFW from a logistical and biological standpoint. WDFW staffing the Chewuch AF will be difficult, and the Hatchery Committees agreed to a Chewuch-acclimated biological component.

Keely Murdoch asked what rules apply to a member of the Hatchery Committees approving an SOA and later changing his or her mind. She said the 2013 SOA referred to acclimation in 2016. Kirk Truscott said he would discuss internally the implications of the 2013 Final Chewuch Acclimation SOA. Keely Murdoch said fish tangle netted in the Chewuch River should be released back to the Chewuch River no matter who operates the Chewuch AF. Craig Busack suggested looking into temporary positions that can be assigned from one agency to another in order to fill a gap. Tonseth said WDFW lacks time on this matter because the hiring process can be lengthy. Truscott said it would be doubtful that CCT could hire staff and execute a new contract to operate the facility timely enough to meet the scheduled arrival of fish at the Chewuch AF and that the WDFW option may similarly be constrained by staff hiring, but would likely only require an amended Task Authorization under WDFW's current contract with Chelan PUD, rather than a new contract. Further, Truscott noted that, notwithstanding the eventual outcome of the operator at the Chewuch AF for 2016, future facility operator at Chewuch AF will necessarily be WDFW or a third-party operator, consistent with Hatchery Committees' approval of the Coho NNI Hatchery-Compensation SOA on December 22, 2015 for the operation of the Twisp and Chewuch ponds.

Keely Murdoch said the Hatchery Committees would not have agreed to tangle netting in the Chewuch River if there was doubt about the release of their progeny into the Chewuch River. She said YN would not support releasing the fish directly from the Methow FH. Tonseth said truck planting would be difficult due to weather and road conditions. Tracy Hillman asked if WDFW could operate the facility beginning in 2017 and if this is just a 1-year issue. Underwood asked Truscott if a meeting with Chelan PUD executives would be helpful to discuss the intent of the HCP and implementing hatchery programs might help the CCT agree to YN operating Chewuch AF. Busack said the disruptions in the spring Chinook salmon program are troubling, and assurance that actions will occur on a regular basis is needed. He said it should not matter who is contracted to operate the facility, as long as they are competent fish culturists. Underwood said this is the first time that Chelan PUD is restricted in contracting with available and competent entities.

Hillman summarized that the primary option would be for YN, or secondly, WDFW, to operate the Chewuch AF. Tonseth said both of those options can be pursued simultaneously, but WDFW would prefer to have YN operate the facility in 2016. WDFW will pursue the feasibility of staffing Chewuch AF for the potential acclimation and release of Methow spring Chinook salmon.

Busack said truck planting fish in the Chewuch River might be the easiest option, but the fish would not be acclimated. He said releasing the fish from Methow FH would require an addendum to an agreement and is opposed by YN. Keely Murdoch and Tonseth said they do not support final acclimation at Carlton Pond. Hillman summarized the options for acclimating Methow spring Chinook salmon: 1) YN operate the Chewuch AF; 2) WDFW operate the Chewuch AF; 3) rear fish at Methow FH and truck plant in Chewuch River; or 4) final release at Methow FH or Carlton Pond.

Bill Gale asked if WDFW are contracted in future years for the acclimation of Methow spring Chinook salmon. Truscott said the SOA for coho salmon requires that WDFW or an approved third party operate facilities. Keely Murdoch said the 2013 Final Chewuch Acclimation SOA and 2015 Coho NNI Hatchery-Compensation SOA are in conflict. She said the 2013 SOA authorizes YN to use the pond and says that spring Chinook salmon can co-acclimate with coho salmon.

Truscott will discuss internally the acclimation of Methow spring Chinook salmon at Chewuch AF under the operation of the YN and the 2013 Final Chewuch Acclimation SOA by Friday, January 22, 2016. Keely Murdoch will send the 2013 Final Chewuch Acclimation SOA to Truscott.

Truscott said that changes, including the air-burst system on the divisions screen, the division of the pond, and others, were proposed to occur at Chewuch AF. He said there have been issues with sedimentation and the alarm call-out system. He said, now that the conservation program has decreased, there is more risk in holding approximately 60,000 spring Chinook salmon at Chewuch AF because their loss could have a much greater potential impact on returning adults to the Methow basin. Wahls said WDFW had met with YN to discuss infrastructure improvements at Chewuch AF. Truscott asked if it is worth the risk to continue to raise fish at Chewuch AF until the infrastructure improvements are made. He said he advocates for the release of spring Chinook salmon in the Chewuch River, but raising fish in a facility that increases risk during acclimation is not acceptable. Underwood said Chelan PUD has discussed the infrastructure improvements with YN and agreed to contribute funds for improvements. Keely Murdoch said she will discuss internally the status of facility improvements at Chewuch AF.

Sarah Montgomery will add brood year 2014 spring Chinook salmon acclimation in the Methow Basin to the February 17, 2016, Hatchery Committees meeting agenda.

C. Wenatchee Summer Chinook Draft SOA (Alene Underwood)

Alene Underwood shared a presentation titled, "Chelan County PUD Wenatchee River TMDL Compliance at Dryden Acclimation Facility," (Attachment G). She also distributed the draft SOA, "Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook," (Attachment H), which Sarah Montgomery sent to the Hatchery Committees on January 18, 2016. Underwood said the intent of the SOA is to design a chilled, partial water reuse aquaculture system at Eastbank Hatchery for Wenatchee summer Chinook salmon to enable Chelan PUD to meet phosphorus discharge requirements under the Wenatchee River Total Maximum Daily Load (TMDL) for dissolved oxygen and pH. A summary of the presentation and questions and comments are included in the following sections.

Background

Underwood said in March 2012, the Washington State Department of Ecology (Ecology) issued an addendum to Wenatchee River TMDL for dissolved oxygen and pH, giving a revised waste load allocation. In July 2012, Chelan PUD proposed to evaluate six actions to determine compliance with the TMDL:

1. Measure baseline phosphorus levels in the Wenatchee River and at Dryden facility before, during, and after fish on station in order to establish baseline levels, estimate variability, and determine the amount of phosphorus and flow that can be discharged.
2. Conduct low-phosphorus feed trials at Dryden facility in order to measure the water quality response in effluent to using regular and low-phosphorus feeds and determine the efficacy of future use.
3. Benchmark water quality of effluent from Chelan Falls and Leavenworth National Fish Hatchery (NFH) circular tanks in order to determine their efficacy with radial flow separators for removal of phosphorus.
4. Evaluate the size of smolts released and use physiological data and Passive Integrated Transponder tag data to empirically test different smolt sizes. The purpose of this action is to optimize smolt release size to decrease precocity, increase smolt-to-adult return rates, and reduce phosphorus input.
5. Evaluate the number of fish released and effects of phosphorus levels in order to examine the reduction in phosphorus discharge associated with decreased smolt production.

6. Evaluate Actions 1 to 5 and select the best options for the Dryden facility to meet the TMDL standard.

Results

- Action 1: Total phosphorus discharge in 2012 was higher than waste load allocation. Rapid increases in phosphorus occur during ponding and feeding, and the baselines in Dryden Canal and Wenatchee River also vary.
- Action 2: Using 0.8 percent phosphorus in feed resulted in a reduction in the phosphorus in effluent, and fish metrics were similar. A subsequent study by Ann Gannam tested 0.6 percent phosphorus in feed. The study suggests that 0.6 percent phosphorus can be used to fine tune effluents for short periods if other approaches are not sufficient. Guar gum was also tested in order to keep feces better contained, but resulted in a difference in fish metrics and is not recommended.
- Action 3: Infrastructure was not built at Leavenworth NFH and overlapping studies conducted at Chelan Falls confounded any infrastructure test results at that facility.
- Action 4: Based on a summer Chinook salmon size target study for brood years 2012 and 2013, overwinter temperature has an overwhelming effect on early maturation and the ability to rear fish to a smaller size at release.
- Action 5: Program changes are likely to reduce phosphorus levels.

Questions and Comments

- Action 1: Craig Busack asked if Ecology has a standard approach for sampling to meet TMDL. Underwood said Ecology does not have standard sampling protocols for a facility like Dryden, and Chelan PUD will have to be compliant by 2019, and is continuing to work with Ecology to determine what the sampling protocols may be. She also said Chelan PUD Wastewater department is working on a pipeline between the facilities in Peshastin and Dryden to consolidate treatment facilities to address their phosphorus discharge limits.
- Action 2: Bill Gale said he will ask Gannam about the results of a phosphorus study she presented at the American Fisheries Society 2015 conference. Underwood said she thinks Ecology expects that point sources will be the bulk of the reduction in phosphorus because they can be more easily regulated.

- Action 3: Busack asked if there are available data comparing circulars to raceways in regard to phosphorus. Underwood replied solids are more easily removed from a circular tank, which can reduce phosphorus if the solids are then immediately removed from the site and not allowed to resettle and mix in a waste abatement pond.
- Action 4: The findings from Action 4 indicate that efforts should be made to reduce winter temperatures at Eastbank and/or feeding in order to decrease early maturation rates.

Underwood identified the best solutions to meet the TMDL at Dryden: 1) modify feeding practices to reduce food waste as much as possible while not compromising CV values; and 2) rear Wenatchee summer Chinook salmon to a smaller size (estimated fish per pound [FPP] of approximately 18), which would require colder overwinter temperatures than Eastbank Hatchery can provide. She also suggested reusing water which would limit the volume of water for chilling and thus the related infrastructure sizing and cost.

Kirk Truscott asked if Eastbank Hatchery had warmer groundwater in 2015. Underwood replied yes, and that it was surprising considering the modeling Chelan PUD has undertaken with the aquifer and that while known that the Columbia River water temperatures influence the aquifer temperatures, the rate at which the temperature was affected in 2015 was quicker than expected.
Keely Murdoch said, if there is higher smolt survival when fish are on cold winter temperatures with fast spring growth, it could be beneficial to the program to have smaller smolts. Underwood said FPP targets can be changed in the future and Chelan PUD will work with the HC members to develop new targets.

Hatchery Committees members will provide comments on the Chelan PUD draft SOA titled, "Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook," to Underwood by Monday, February 1, 2016. Underwood will finalize the draft Wenatchee summer Chinook salmon SOA by Wednesday, February 3, 2016, so it can be a decision item at the February 17, 2016, Hatchery Committees meeting.

V. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees meetings are on February 17, 2016 (Chelan PUD), March 16, 2016 (Douglas PUD), and April 20, 2016 (Chelan PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	HRRs and Targets (Hillman revisions 1-13-16)
Attachment C	HRRs and Targets (Hillman revisions 1-22-16)
Attachment D	Juvenile Spring Chinook Size at Release Summary
Attachment E	Wells HCP Action Plan
Attachment F	Draft 2016 Rock Island and Rocky Reach HCP Action Plan
Attachment G	Chelan County PUD Wenatchee River TMDL Compliance at Dryden Acclimation Facility
Attachment H	Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons†	Grant PUD
Peter Graf†	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Craig Busack*†	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Charlie Snow†	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife
Brian Lyon	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone

Hatchery Replacement Rates
Without Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000					7.38	3.20	2.20		6.78	1.16	6.69
2001					4.73	3.80	1.20	4.30	1.31	1.38	0.32
2002					8.44	4.80	13.80	3.70	3.73	1.49	2.19
2003					5.94	1.10	2.70	0.60	2.89	0.59	4.88
2004					8.54	3.50	2.80	1.10	1.19	1.02	15.64
2005					4.90	2.70	1.90	1.80	2.72	1.83	1.92
2006			18.50	7.00	4.62	8.40	7.90	4.30	6.93	6.11	15.06
2007			21.60	7.30	5.22	5.70	0.90	8.10	0.30	0.65	4.54
2008			25.70	11.90	7.49	6.70	7.90	4.00			
2009			21.00	23.90							
Percentiles on Time Series 2000-2008											
20%			***18.5***	***7.0***	***4.7***	***2.7***	***1.2***	***1.0***	***1.0***	***0.6***	***1.6***
Old Target	19.20	19.60			5.80	4.50	4.50	4.50	5.30	5.30	5.30

Hatchery Replacement Rates
With Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000	2.60	6.30			7.85	3.34	2.70		28.89	3.43	20.34
2001	58.06	40.50			4.88	3.76	1.22	4.50	4.90	4.16	1.27
2002	11.76	15.90			9.29	5.45	13.99	4.14	9.26	4.04	5.95
2003	6.17	26.90			6.65	1.21	2.69	0.65	6.20	1.04	10.40
2004	11.70	17.90			10.15	3.90	3.12	1.18	2.93	2.23	39.86
2005	14.86	27.40			5.35	1.79	1.92	1.81	7.35	4.27	4.94
2006	7.31	31.90			6.57	9.42	8.93	4.84	21.95	16.07	38.74
2007	3.04	91.40			7.70	5.72	0.93	8.28	1.14	2.30	15.63
2008		26.30			11.73	8.80	10.37	7.92			
2009		30.40									
Percentiles on Time Series 2000-2008											
20%	***3.0***	***16.3***			***5.4***	***1.8***	***1.2***	***1.1***	***2.6***	***2.0***	***4.2***

Chiwawa Spring Chinook HRRs and NRRs

Brood year	Harvest not included			Harvest included		
	HRR	NRR	HRR/NRR	HRR	NRR	HRR/NRR
1989	6.43	0.27	23.81	7.29	0.40	18.23
1990	0.05	0.06	0.83	1.00	0.07	14.29
1991	1.00	0.01	100.00	1.09	0.01	109.00
1992	0.27	0.07	3.86	0.28	0.07	4.00
1993	2.82	0.68	4.15	2.86	0.70	4.09
1994	1.62	0.20	8.10	1.62	0.21	7.71
1995		2.00			2.09	
1996	4.28	4.40	0.97	4.39	4.81	0.91
1997	18.60	3.92	4.74	21.74	4.35	5.00
1998	20.65	3.84	5.38	24.71	4.09	6.04
1999		0.11			0.12	
2000	7.38	2.02	3.65	7.85	2.12	3.70
2001	4.73	0.18	26.28	4.88	0.18	27.11
2002	8.44	0.35	24.11	9.29	0.36	25.81
2003	5.94	0.40	14.85	6.65	0.43	15.47
2004	8.54	0.32	26.69	10.15	0.35	29.00
2005	4.90	0.66	7.42	5.35	0.69	7.75
2006	4.62	1.83	2.52	6.57	2.30	2.86
2007	5.22	0.37	14.11	7.70	0.44	17.50
2008	7.49	0.63	11.89	11.73	0.70	16.76
Statistics on Time Series 1989-2008						
Average	***6.28***	***1.12***	***15.74***	***7.51***	***1.22***	***17.51***
Lower SD	***0.75***	***-0.30***	***-7.11***	***0.90***	***-0.32***	***-6.99***
Statistics on Time Series 2000-2008						
Average	***6.36***	***0.75***	***14.61***	***7.80***	***0.84***	***16.22***
Lower SD	***4.75***	***0.07***	***5.27***	***5.54***	***0.05***	***6.32***
Percentiles on Time Series 1989-2008						
5%	***0.05***	***0.01***		***0.28***	***0.01***	
10%	***0.25***	***0.06***		***0.93***	***0.07***	
15%	***0.89***	***0.08***		***1.08***	***0.08***	
20%	***1.50***	***0.12***		***1.51***	***0.13***	
Percentiles on Time Series 2000-2008						
5%	***4.62***	***0.18***		***4.88***	***0.18***	
10%	***4.62***	***0.18***		***4.88***	***0.18***	
15%	***4.68***	***0.25***		***5.12***	***0.27***	
20%	***4.73***	***0.32***		***5.35***	***0.35***	

Chiwawa Spring Chinook HRRs and NRRs

Brood year	Harvest not included			Harvest included		
	HRR	NRR	HRR/NRR	HRR	NRR	HRR/NRR
1989	6.43	0.27	23.81	7.29	0.40	18.23
1990	0.05	0.06	0.83	1.00	0.07	14.29
1991	1.00	0.01	100.00	1.09	0.01	109.00
1992	0.27	0.07	3.86	0.28	0.07	4.00
1993	2.82	0.68	4.15	2.86	0.70	4.09
1994	1.62	0.20	8.10	1.62	0.21	7.71
1995		2.00			2.09	
1996	4.28	4.40	0.97	4.39	4.81	0.91
1997	18.60	3.92	4.74	21.74	4.35	5.00
1998	20.65	3.84	5.38	24.71	4.09	6.04
1999		0.11			0.12	
2000	7.38	2.02	3.65	7.85	2.12	3.70
2001	4.73	0.18	26.28	4.88	0.18	27.11
2002	8.44	0.35	24.11	9.29	0.36	25.81
2003	5.94	0.40	14.85	6.65	0.43	15.47
2004	8.54	0.32	26.69	10.15	0.35	29.00
2005	4.90	0.66	7.42	5.35	0.69	7.75
2006	4.62	1.83	2.52	6.57	2.30	2.86
2007	5.22	0.37	14.11	7.70	0.44	17.50
2008	7.49	0.63	11.89	11.73	0.70	16.76
Statistics on Time Series 1989-2008						
Geomean	***3.56***	***0.45***	***8.01***	***4.80***	***0.49***	***9.84***
Lower SD	***-0.77***	***-4.40***	***4.61***	***1.70***	***-4.43***	***6.82***
Statistics on Time Series 2000-2008						
Geomean	***6.18***	***0.55***	***11.25***	***7.51***	***0.60***	***12.52***
Lower SD	***4.29***	***-1.75***	***8.72***	***5.77***	***-1.78***	***10.06***

Hatchery Replacement Rate Targets:

Percentiles on Time Series 2000-2009

Stock	20%	30%	40%	50%
Wenatchee steelhead	3.0	5.2	6.9	9.5
Methow steelhead	16.3	20.4	26.5	27.2
Okanogan steelhead**	18.5	19.8	21.0	21.3
Omak steelhead**	7.0	7.2	7.3	9.6
Chiwawa spring Chinook	5.4	6.6	6.7	7.7
Methow spring Chinook	1.8	3.3	3.8	3.9
Twisp spring Chinook	1.2	1.9	2.7	2.7
Chewuch spring Chinook	1.1	1.6	3.2	4.3
Wenatchee summer Chinook	2.6	4.3	5.7	6.8
Methow summer Chinook	2.0	2.3	3.0	3.7
Okanogan summer Chinook	4.2	5.6	8.6	13.0

****Note, harvest is included in all percentiles except Okanogan and Omak Steelhead.**

Chiwawa Spring Chinook HRRs and NRRs

Brood year	Harvest not included			Harvest included		
	HRR	NRR	HRR/NRR	HRR	NRR	HRR/NRR
1989	6.43	0.27	23.81	7.29	0.40	18.23
1990	0.05	0.06	0.83	1.00	0.07	14.29
1991	1.00	0.01	100.00	1.09	0.01	109.00
1992	0.27	0.07	3.86	0.28	0.07	4.00
1993	2.82	0.68	4.15	2.86	0.70	4.09
1994	1.62	0.20	8.10	1.62	0.21	7.71
1995		2.00			2.09	
1996	4.28	4.40	0.97	4.39	4.81	0.91
1997	18.60	3.92	4.74	21.74	4.35	5.00
1998	20.65	3.84	5.38	24.71	4.09	6.04
1999		0.11			0.12	
2000	7.38	2.02	3.65	7.85	2.12	3.70
2001	4.73	0.18	26.28	4.88	0.18	27.11
2002	8.44	0.35	24.11	9.29	0.36	25.81
2003	5.94	0.40	14.85	6.65	0.43	15.47
2004	8.54	0.32	26.69	10.15	0.35	29.00
2005	4.90	0.66	7.42	5.35	0.69	7.75
2006	4.62	1.83	2.52	6.57	2.30	2.86
2007	5.22	0.37	14.11	7.70	0.44	17.50
2008	7.49	0.63	11.89	11.73	0.70	16.76
Statistics on Time Series 1989-2008						
Average	***6.28***	***1.12***	***15.74***	***7.51***	***1.22***	***17.51***
Lower SD	***0.75***	***-0.30***	***-7.11***	***0.90***	***-0.32***	***-6.99***
Statistics on Time Series 2000-2008						
Average	***6.36***	***0.75***	***14.61***	***7.80***	***0.84***	***16.22***
Lower SD	***4.75***	***0.07***	***5.27***	***5.54***	***0.05***	***6.32***
Percentiles on Time Series 1989-2008						
5%	***0.05***	***0.01***		***0.28***	***0.01***	
10%	***0.25***	***0.06***		***0.93***	***0.07***	
15%	***0.89***	***0.08***		***1.08***	***0.08***	
20%	***1.50***	***0.12***		***1.51***	***0.13***	
Percentiles on Time Series 2000-2008						
5%	***4.62***	***0.18***		***4.88***	***0.18***	
10%	***4.62***	***0.18***		***4.88***	***0.18***	
15%	***4.68***	***0.25***		***5.12***	***0.27***	
20%	***4.73***	***0.32***		***5.35***	***0.35***	

Chiwawa Spring Chinook HRRs and NRRs

Brood year	Harvest not included			Harvest included		
	HRR	NRR	HRR/NRR	HRR	NRR	HRR/NRR
1989	6.43	0.27	23.81	7.29	0.40	18.23
1990	0.05	0.06	0.83	1.00	0.07	14.29
1991	1.00	0.01	100.00	1.09	0.01	109.00
1992	0.27	0.07	3.86	0.28	0.07	4.00
1993	2.82	0.68	4.15	2.86	0.70	4.09
1994	1.62	0.20	8.10	1.62	0.21	7.71
1995		2.00			2.09	
1996	4.28	4.40	0.97	4.39	4.81	0.91
1997	18.60	3.92	4.74	21.74	4.35	5.00
1998	20.65	3.84	5.38	24.71	4.09	6.04
1999		0.11			0.12	
2000	7.38	2.02	3.65	7.85	2.12	3.70
2001	4.73	0.18	26.28	4.88	0.18	27.11
2002	8.44	0.35	24.11	9.29	0.36	25.81
2003	5.94	0.40	14.85	6.65	0.43	15.47
2004	8.54	0.32	26.69	10.15	0.35	29.00
2005	4.90	0.66	7.42	5.35	0.69	7.75
2006	4.62	1.83	2.52	6.57	2.30	2.86
2007	5.22	0.37	14.11	7.70	0.44	17.50
2008	7.49	0.63	11.89	11.73	0.70	16.76
Statistics on Time Series 1989-2008						
Geomean	***3.56***	***0.45***	***8.01***	***4.80***	***0.49***	***9.84***
Lower SD	***-0.77***	***-4.40***	***4.61***	***1.70***	***-4.43***	***6.82***
Statistics on Time Series 2000-2008						
Geomean	***6.18***	***0.55***	***11.25***	***7.51***	***0.60***	***12.52***
Lower SD	***4.29***	***-1.75***	***8.72***	***5.77***	***-1.78***	***10.06***

20% HRRs

Hatchery Replacement Rates
Without Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000					7.38	3.20	2.20		6.78	1.16	6.69
2001					4.73	3.80	1.20	4.30	1.31	1.38	0.32
2002					8.44	4.80	13.80	3.70	3.73	1.49	2.19
2003					5.94	1.10	2.70	0.60	2.89	0.59	4.88
2004					8.54	3.50	2.80	1.10	1.19	1.02	15.64
2005					4.90	2.70	1.90	1.80	2.72	1.83	1.92
2006			18.50	7.00	4.62	8.40	7.90	4.30	6.93	6.11	15.06
2007			21.60	7.30	5.22	5.70	0.90	8.10	0.30	0.65	4.54
2008			25.70	11.90	7.49	6.70	7.90	4.00			
2009			21.00	23.90							
Percentiles on Time Series BY 2000-2009											
20%			***18.5***	***7.0***	***4.7***	***2.7***	***1.2***	***1.0***	***1.0***	***0.6***	***1.6***
Old Target	19.20	19.60			5.80	4.50	4.50	4.50	5.30	5.30	5.30

Hatchery Replacement Rates
With Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000	2.60	6.30			7.85	3.34	2.70		28.89	3.43	20.34
2001	58.06	40.50			4.88	3.76	1.22	4.50	4.90	4.16	1.27
2002	11.76	15.90			9.29	5.45	13.99	4.14	9.26	4.04	5.95
2003	6.17	26.90			6.65	1.21	2.69	0.65	6.20	1.04	10.40
2004	11.70	17.90			10.15	3.90	3.12	1.18	2.93	2.23	39.86
2005	14.86	27.40			5.35	1.79	1.92	1.81	7.35	4.27	4.94
2006	7.31	31.90			6.57	9.42	8.93	4.84	21.95	16.07	38.74
2007	3.04	91.40			7.70	5.72	0.93	8.28	1.14	2.30	15.63
2008		26.30			11.73	8.80	10.37	7.92			
2009		30.40									
Percentiles on Time Series BY 2000-2009											
20%	***3.0***	***16.3***			***5.4***	***1.8***	***1.2***	***1.1***	***2.6***	***2.0***	***4.2***

30% HRRs

Hatchery Replacement Rates
Without Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000					7.38	3.20	2.20		6.78	1.16	6.69
2001					4.73	3.80	1.20	4.30	1.31	1.38	0.32
2002					8.44	4.80	13.80	3.70	3.73	1.49	2.19
2003					5.94	1.10	2.70	0.60	2.89	0.59	4.88
2004					8.54	3.50	2.80	1.10	1.19	1.02	15.64
2005					4.90	2.70	1.90	1.80	2.72	1.83	1.92
2006			18.50	7.00	4.62	8.40	7.90	4.30	6.93	6.11	15.06
2007			21.60	7.30	5.22	5.70	0.90	8.10	0.30	0.65	4.54
2008			25.70	11.90	7.49	6.70	7.90	4.00			
2009			21.00	23.90							
Percentiles on Time Series BY 2000-2009											
30%			***19.8***	***7.2***							
Old Target	19.20	19.60			5.80	4.50	4.50	4.50	5.30	5.30	5.30

Hatchery Replacement Rates
With Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000	2.60	6.30			7.85	3.34	2.70		28.89	3.43	20.34
2001	58.06	40.50			4.88	3.76	1.22	4.50	4.90	4.16	1.27
2002	11.76	15.90			9.29	5.45	13.99	4.14	9.26	4.04	5.95
2003	6.17	26.90			6.65	1.21	2.69	0.65	6.20	1.04	10.40
2004	11.70	17.90			10.15	3.90	3.12	1.18	2.93	2.23	39.86
2005	14.86	27.40			5.35	1.79	1.92	1.81	7.35	4.27	4.94
2006	7.31	31.90			6.57	9.42	8.93	4.84	21.95	16.07	38.74
2007	3.04	91.40			7.70	5.72	0.93	8.28	1.14	2.30	15.63
2008		26.30			11.73	8.80	10.37	7.92			
2009		30.40									
Percentiles on Time Series BY 2000-2009											
30%	***2.2***	***20.4***			***6.6***	***3.3***	***1.9***	***1.6***	***4.3***	***2.3***	***5.7***

40% HRRs

Hatchery Replacement Rates
Without Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000					7.38	3.20	2.20		6.78	1.16	6.69
2001					4.73	3.80	1.20	4.30	1.31	1.38	0.32
2002					8.44	4.80	13.80	3.70	3.73	1.49	2.19
2003					5.94	1.10	2.70	0.60	2.89	0.59	4.88
2004					8.54	3.50	2.80	1.10	1.19	1.02	15.64
2005					4.90	2.70	1.90	1.80	2.72	1.83	1.92
2006			18.50	7.00	4.62	8.40	7.90	4.30	6.93	6.11	15.06
2007			21.60	7.30	5.22	5.70	0.90	8.10	0.30	0.65	4.54
2008			25.70	11.90	7.49	6.70	7.90	4.00			
2009			21.00	23.90							
Percentiles on Time Series BY 2000-2009											
40%			***21.0***	***7.3***							
Old Target	19.20	19.60			5.80	4.50	4.50	4.50	5.30	5.30	5.30

Hatchery Replacement Rates
With Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000	2.60	6.30			7.85	3.34	2.70		28.89	3.43	20.34
2001	58.06	40.50			4.88	3.76	1.22	4.50	4.90	4.16	1.27
2002	11.76	15.90			9.29	5.45	13.99	4.14	9.26	4.04	5.95
2003	6.17	26.90			6.65	1.21	2.69	0.65	6.20	1.04	10.40
2004	11.70	17.90			10.15	3.90	3.12	1.18	2.93	2.23	39.86
2005	14.86	27.40			5.35	1.79	1.92	1.81	7.35	4.27	4.94
2006	7.31	31.90			6.57	9.42	8.93	4.84	21.95	16.07	38.74
2007	3.04	91.40			7.70	5.72	0.93	8.28	1.14	2.30	15.63
2008		26.30			11.73	8.80	10.37	7.92			
2009		30.40									
Percentiles on Time Series BY 2000-2009											
40%	***6.9***	***26.5***			***6.7***	***3.8***	***2.7***	***3.2***	***5.7***	***3.0***	***8.6***

50% HRRs

Hatchery Replacement Rates
Without Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000					7.38	3.20	2.20		6.78	1.16	6.69
2001					4.73	3.80	1.20	4.30	1.31	1.38	0.32
2002					8.44	4.80	13.80	3.70	3.73	1.49	2.19
2003					5.94	1.10	2.70	0.60	2.89	0.59	4.88
2004					8.54	3.50	2.80	1.10	1.19	1.02	15.64
2005					4.90	2.70	1.90	1.80	2.72	1.83	1.92
2006			18.50	7.00	4.62	8.40	7.90	4.30	6.93	6.11	15.06
2007			21.60	7.30	5.22	5.70	0.90	8.10	0.30	0.65	4.54
2008			25.70	11.90	7.49	6.70	7.90	4.00			
2009			21.00	23.90							
Percentiles on Time Series BY 2000-2009											
50%			***21.3***	***9.6***							
Old Target	19.20	19.60			5.80	4.50	4.50	4.50	5.30	5.30	5.30

Hatchery Replacement Rates
With Harvest

Brood year	Wenatchee steelhead	Methow steelhead	Okanogan steelhead	Omak steelhead	Chiwawa spring Chinook	Methow spring Chinook	Twisp spring Chinook	Chewuch spring Chinook	Wenatchee summer Chinook	Methow summer Chinook	Okanogan summer Chinook
2000	2.60	6.30			7.85	3.34	2.70		28.89	3.43	20.34
2001	58.06	40.50			4.88	3.76	1.22	4.50	4.90	4.16	1.27
2002	11.76	15.90			9.29	5.45	13.99	4.14	9.26	4.04	5.95
2003	6.17	26.90			6.65	1.21	2.69	0.65	6.20	1.04	10.40
2004	11.70	17.90			10.15	3.90	3.12	1.18	2.93	2.23	39.86
2005	14.86	27.40			5.35	1.79	1.92	1.81	7.35	4.27	4.94
2006	7.31	31.90			6.57	9.42	8.93	4.84	21.95	16.07	38.74
2007	3.04	91.40			7.70	5.72	0.93	8.28	1.14	2.30	15.63
2008		26.30			11.73	8.80	10.37	7.92			
2009		30.40									
Percentiles on Time Series BY 2000-2009											
50%	***9.5***	***27.2***			***7.7***	***3.9***	***2.7***	***4.3***	***6.8***	***3.7***	***13.0***

Attachment D

Juvenile Spring Chinook Size at Release Summary

January 18, 2016
Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees
and
Priest Rapids Hatchery Sub-Committee

Trade-offs

“There is no best size at release that optimizes across all management goals; therefore, size at release targets represent a compromise across a series of management values”.

(Brian Beckman-NOAA)

- Precocious maturation (males)
- Later maturation (anadromous males/females, abundance, age composition)

Size at Release

Methow Comp spring Chinook

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2008	2010	125.9	9.7	24.0	18.9
2009	2011	124.2	12.9	22.9	19.8
2010	2012	128.8	10.7	26.9	16.9
2011	2013	142.8	11.3	33.6	14.4
2012	2014	132.2	8.3	27.2	17.1
Targets		***137***	***9.0***	***30.3***	***15***

Twisp spring Chinook

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2008	2010	128.7	9.2	26.8	16.8
2009	2011	144.6	11.1	37.2	12.2
2010	2012	130.4	13.3	27.7	16.4
2011	2013	135.6	6.4	31.1	14.6
2012	2014	135.5	8.6	29.3	15.5
Targets		***135***	***9.0***	***30.2***	***15***

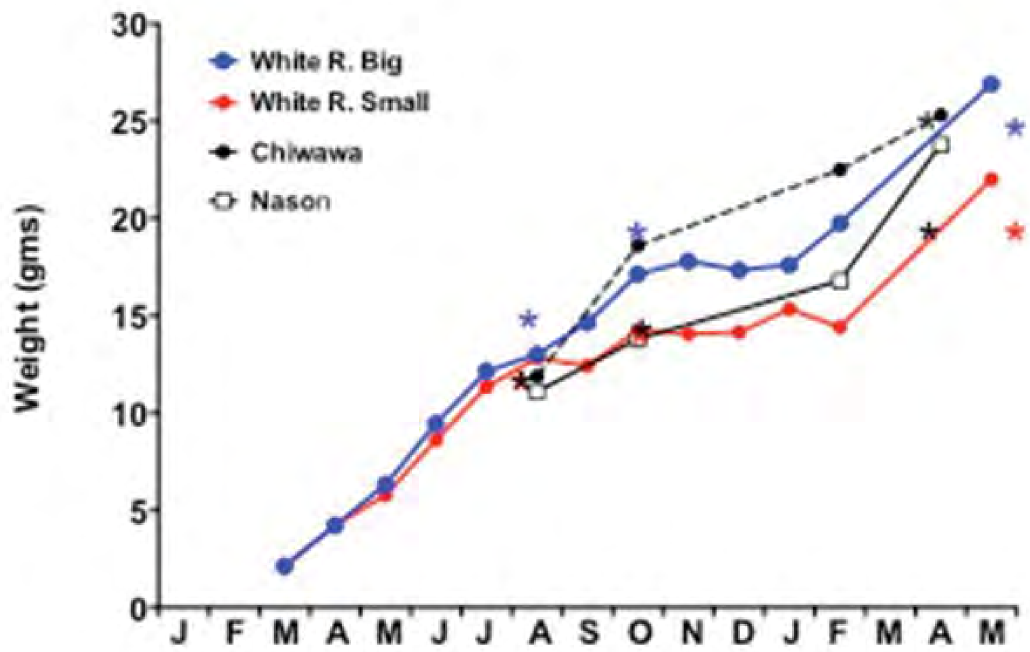
Chiwawa spring Chinook

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
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
Targets		***155***	***9.0***	***37.8***	***18***

FPP Target=12 for BY2008-BY2011

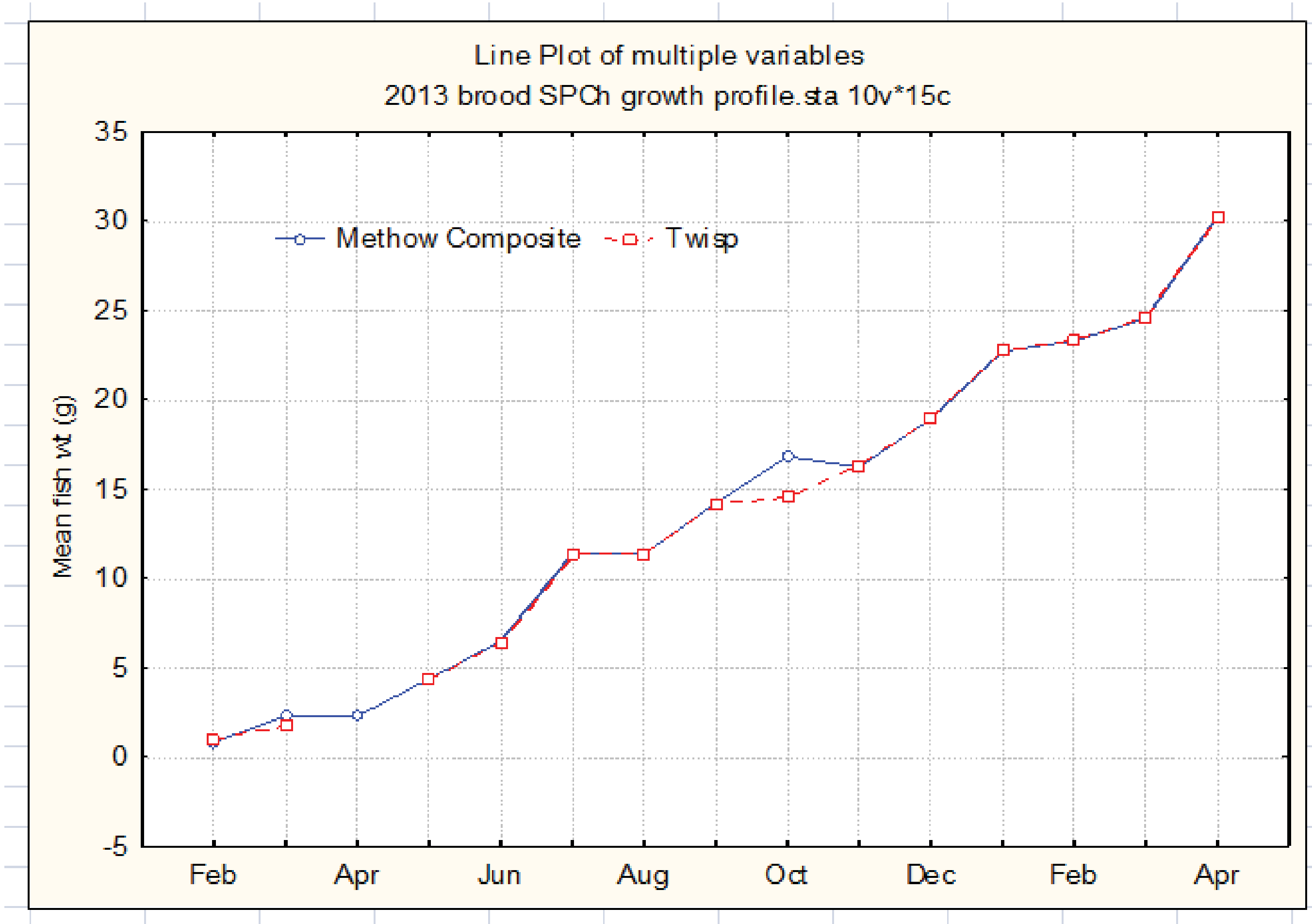
- The Effect of Diet and Ration on Smolting and Early Maturation in White River Spring Chinook Salmon
  - White River BY2011-2013
  - Included BY2013 Nason and Chiwawa

Growth Profiles



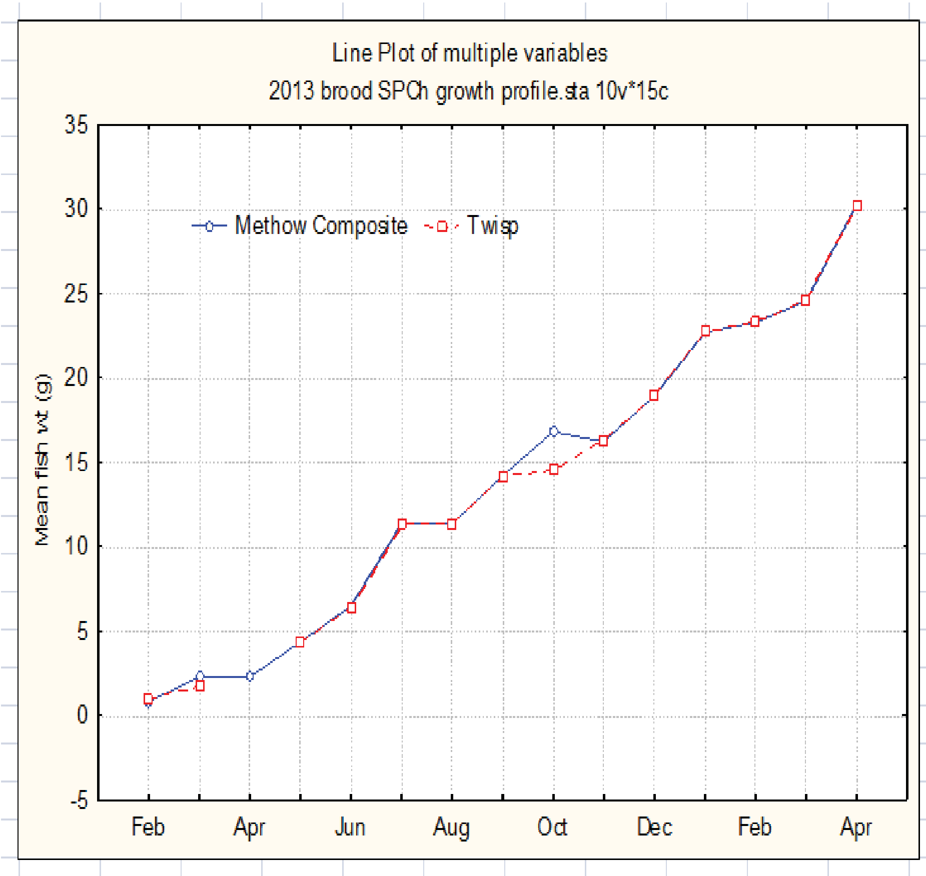
Group *	Aug FPP (gm)	Oct FPP (gm)	Feb FPP (gm)	Release FPP (gm)
White R. 18 fpp	30 (15 gm)	24 (19gm)	22 (21gm)	18 (25)
White R. 24 fpp	38 (12 gm)	32(14 gm)	30 (15gm)	24 (19)
Chiwawa	Standard	Standard	Standard	18 (25)
Nason	38 (12 gm)	32 (14 gm)	30 (15gm)	24 (19)

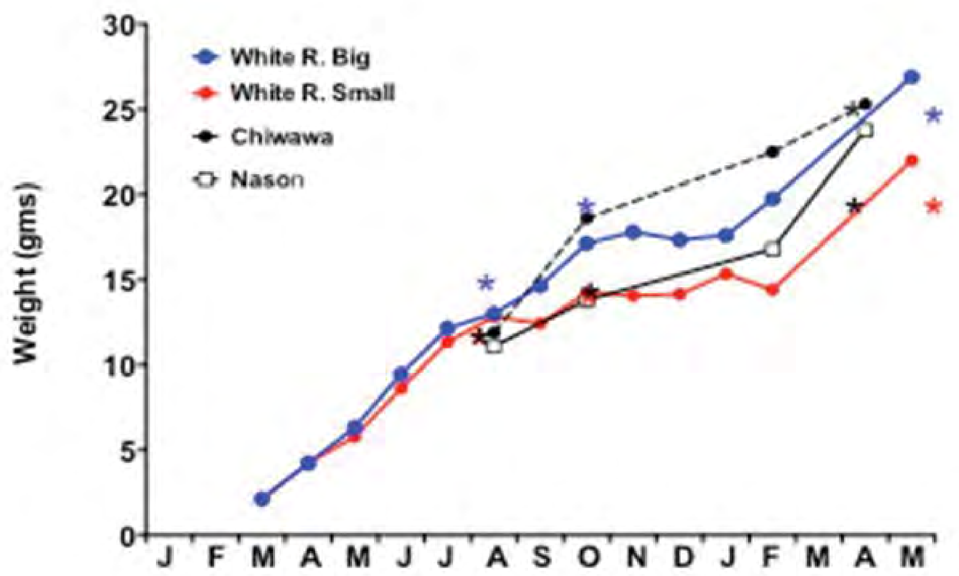
Growth Profiles



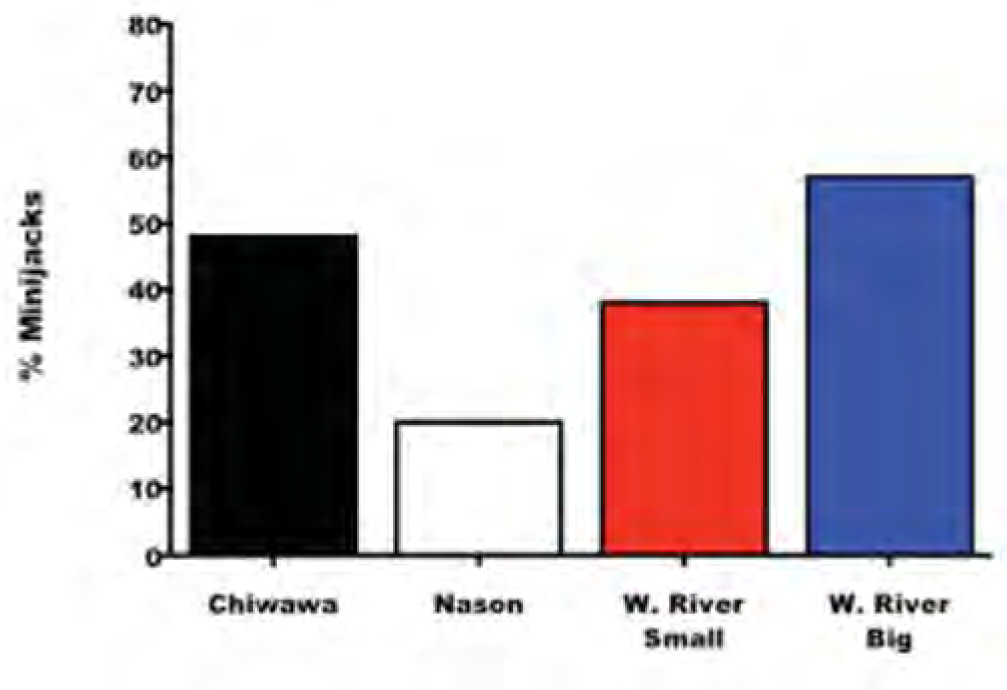
	Fork Length		Weight	
Stock	**Mean (mm)**	**CV**	**Mean (g)**	**FPP**
Methow River spring Chinook	137	9	30.2	15
Twisp River spring Chinook	135	9	30.2	15

Growth Profiles





Mini-Jack Rates



Mini-Jack Rates

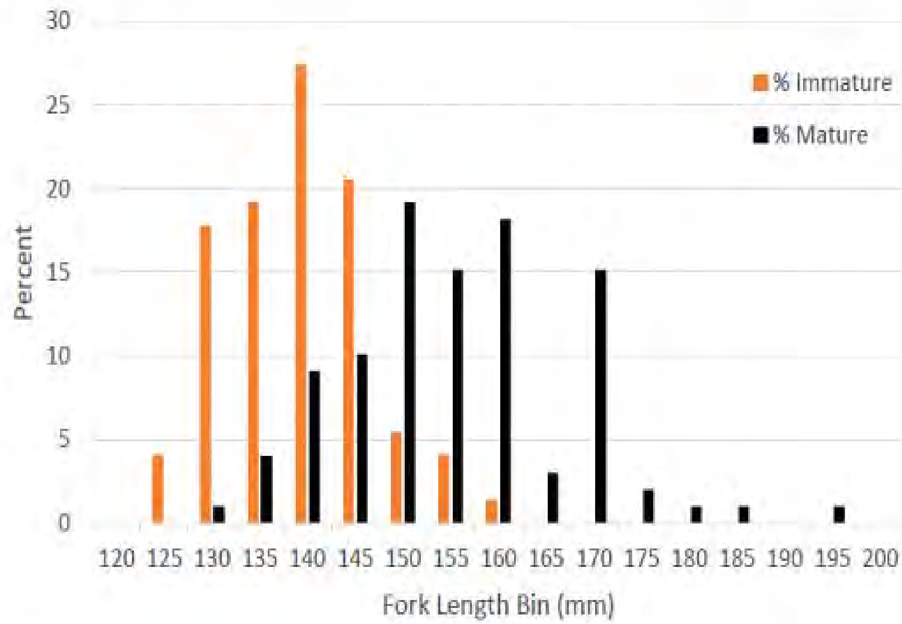
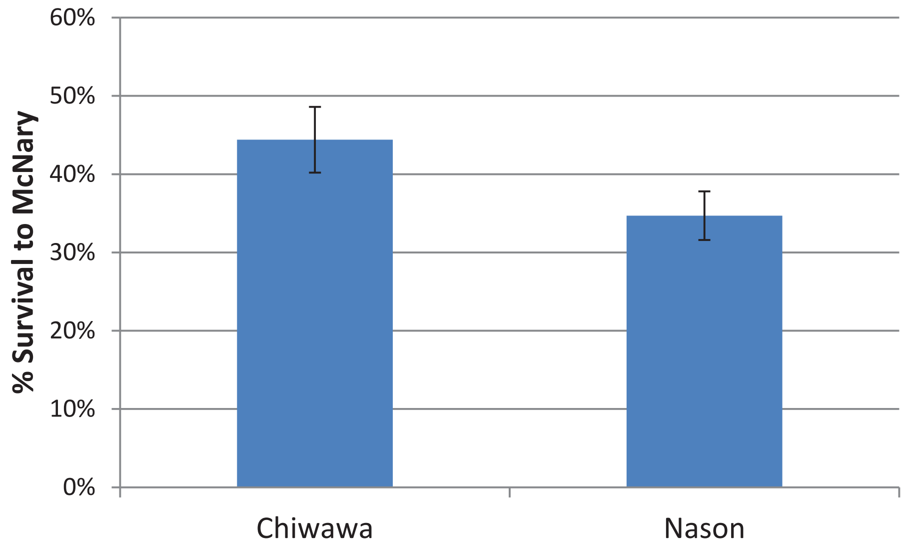


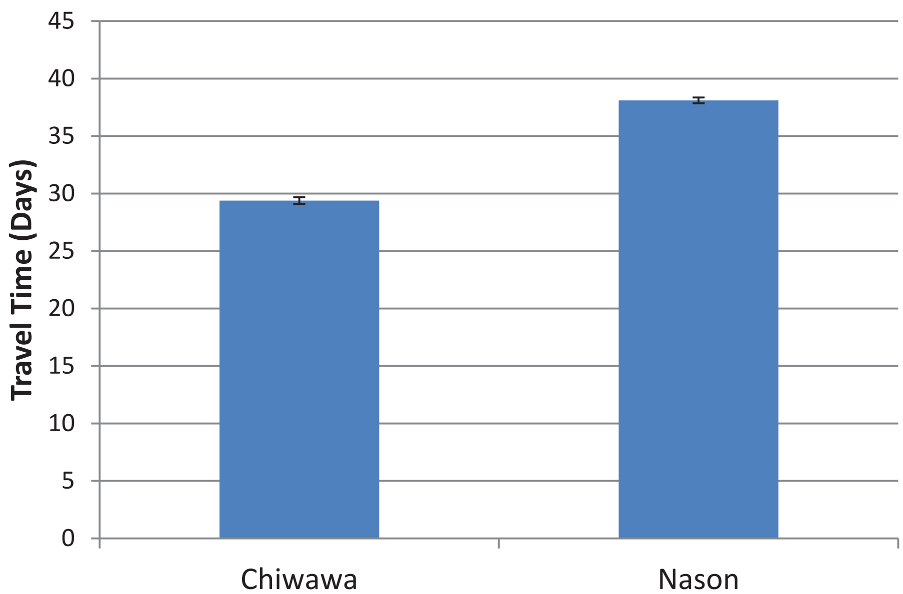
Figure 2. Percent of immature and mature fish in each size bin. Bins are expressed as the 5 mm bin less than each numerical value expressed in the figure (e.g., 125 is 120.1-125.0).

Sex	n	Immature	Mature	% Mature
Males	172	73	99	57.6
Females	128	128	0	100
Total	300	201	99	

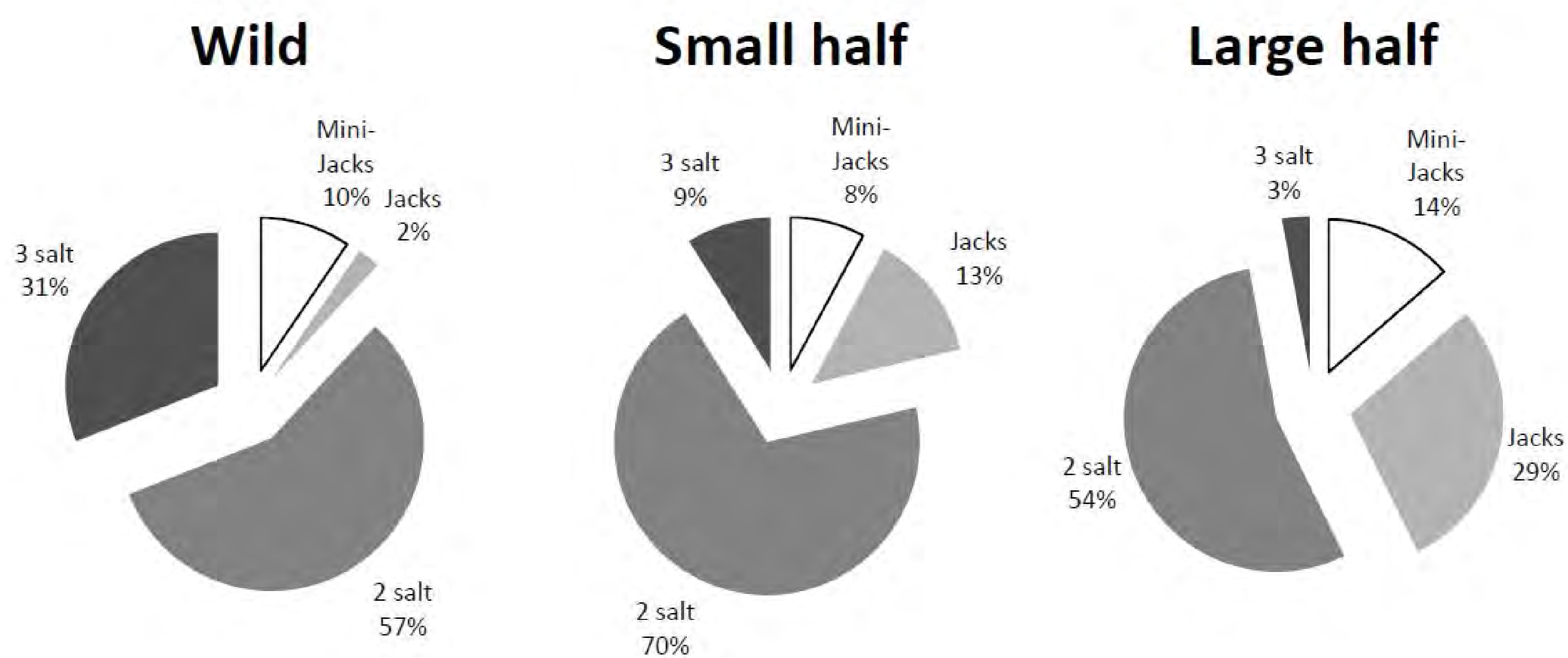
Note: Mean weight of the immature fish = 29 (g) and mature fish = 42 (g). Release target is 30 (g).

Outmigration Performance BY2013





Proportion of age classes by group



Distribution of returns from wild and hatchery origin spring Chinook smolts released in the Chiwawa River 2007-2009. Hatchery smolts were separated by median fork length at time of tagging and returns from 2009 do not yet include 3-salt fish.

How size of release is reached may be just as important as the size of release!

DRAFT 2016 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. **Juvenile Fish Bypass**
   a. Draft Bypass Operating Plan (BOP) to Coordinating Committee (CC)...mid-January 2016
   b. CC comments on draft BOP to DCPUD..mid-February 2016
   c. Submit final BOP to FERC for approval .... February 24, 2015
   d. Draft post-season report to CC ....November 2016
   e. Final report...December 2016

2. **Pikeminnow Control Program**
   a. Draft 2015 pikeminnow report to HCP CC ....January 2016
   b. Final 2015 pikeminnow report integrated into HCP Annual Report .... March 2016
   c. Pikeminnow removal – Wells Project...March-November 2016

3. **Sub-yearling Chinook Life-history Study**
   a. Monitor fish tagged in 2011-2013 study years through adult returns.......... December 2018
   b. 2011-13 draft juvenile life-history report and presentation to CC................ February 2016
   c. 2011-13 final juvenile life-history report.. June 2016

4. **Annual Monitoring of Juvenile Migration Run Timing and Bypass Operations**
   a. 2016 Skalski analysis of index and PIT-tag data from RR......................... September 2016
   b. 2016 draft of Skalski's report to DCPUD and CC..October 2016
   c. 2016 CC approval of final report ....December 2016

5. **Fish Passage and Count-station Maintenance**
   a. Plug gaps around count station in the west ladder................ December 2015-January 2016
   b. Plug gaps around count station in the east ladder................................ January-March 2016
   c. Install temporary "lamprey box" in east low-level entrance .... January-March 2016
   d. Install PIT-tag detection in lamprey boxes .... January-March 2016
   e. Install temporary lamprey enumeration structures .... December 2015-March 2016

6. **Fishway Outage Schedule for Fishway Inspection, Maintenance, and Fishway Projects**
   a. West Fishway.. December 1, 2015-January 2016
   b. East Fishway .... February-March, 2016

7. **2016 Lamprey Passage and Enumeration Study**
   a. Study implementation ....July-October 2016
   b. Data analysis ....October 2016-June 2017

8. **Bull Trout Passage Study**
    a. Study plan development.. December 2015-January 2016
    b. Study plan to CC for review of passage effects... February 2016
    c. CC approval of trapping plan... March 2016
    d. Bull trout trapping and tagging (radio and PIT tags).................................... May-July 2016
    e. Monitoring tagged fish... June 2016-August 2017
    f. Aquatic SWG final report to CC...November 2017

9. **HCP Annual Report**
    a. Draft 2015 annual report to DCPUD for review.. January 13, 2016
    b. Draft 2015 annual report to CC for 30-day review.................................... February 8, 2016
    c. CC comments on draft 2015 report due to Anchor QEA.............................. March 7, 2016
    d. Final 2015 annual report to DCPUD .... March 23, 2016
    e. Final 2015 annual report due to FERC .... March 31, 2016

10. **Review and Approval of 2016 Hatchery Broodstock Collection Protocol**
    a. Draft to CC:.. February 12, 2016
    b. CC approval of draft protocols .... March 23, 2016
    c. Deadline for submission to NMFS: .... April 15, 2016

11. **Install and Test PIT-tag Detection in Spillway # 2 of the Wells Bypass System**
    a. Biomark to install and evaluate prototype antenna... January 2016
    b. Installation of full test system .... March 2016
    c. Test system with hatchery fish... April 2016
    d. Monitor performance .... April 9-August 19, 2016
    e. Draft report on performance .... September 2016
    f. Final report on performance... December 2016

WELLS HCP HATCHERY COMMITTEE

1. Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan
   a. Ongoing implementation .... January-December 2016
   b. Draft annual report for 2015 to Douglas PUD... June 2016
   c. Draft annual report to Hatchery Committee (HC) .... August 2016
   d. Final annual report to HC .... September 2016
   e. Draft 2017 implementation plan to HC ....July 2016
   f. HC approval of final 2017 implementation plan .... September 2016

2. Review of 5-year M&E report
   a. Review of report findings by M&E Plan objective ....Ongoing
   b. Deadline for identification and prioritization of studies or actions .... March 31, 2016
   c. Implementation of selected studies or actions ....*to be determined*

3. 2016 Broodstock Collection Protocol
   a. Draft to HC for review... February 8, 2016
   b. HC approval of draft protocols .... March 16, 2016
   c. Deadline for submission to NMFS .... April 15, 2016
   d. Implementation ....May 2016 to April 2017

4. Annual Implementation – Okanagan Sockeye Fish/Water Management Tools
   a. Water Year 2015-2016.. October 2015-September 2016
   b. Water Year 2016-2017.. October 2016-September 2017
   c. Record of management decisions .... December 2016

5. Modernization of the Okanagan Sockeye Fish/Water Management Tools
   a. Phase 2 ....October 2015-August 2016
   b. Phase 3 ....September 2016-August 2017
   c. Project completion .... September 2017

6. Methow Steelhead Relative Reproductive Success Study
   a. Implementation: .... March 2010-December 2021
   b. Annual report on genetic analysis:... September/October 2016
   c. Biological data in Annual M&E Report (above): .... September 2016
   d. Final report:... 2021/2022

7. Hatchery Genetic Management Plans
   a. Receive new Methow spring Chinook hatchery permit....................................... May 2016
   b. Receive new Wells steelhead hatchery permit.. September 2016
   c. Receive new Wells summer Chinook hatchery permit................................. February 2017

8. Wells Hatchery Modernization
   a. Construction...Ongoing
   b. Estimated completion.. August 2017

WELLS HCP TRIBUTARY COMMITTEE

1. Plan Species Account Annual Contribution

a. $176,178 in 1998 dollars (estimated $257,066 2016 dollars) .... January 2016

2. Annual Report - Plan Species Account Status, January to December 2015

a. Draft to Tributary Committee (TC): .... January 2016
b. Approval deadline: .... February 2016
c. Integration into HCP Annual Report: .... February 2016

3. General Salmon Habitat Program

a. Project review and funding Decision .... January-December 2016

4. Small Project Program

a. Project review and funding Decision .... January-December 2016

Attachment F

2016 Rocky Reach and Rock Island
HCP Action Plan *Draft*

COORDINATING COMMITTEE		Jan 2016			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 2015 RR Bypass Evaluation Report				D				F																												
Deliver 2016 RR Bypass Operations Plan				D					F																											
Deliver 2015 RI Bypass Evaluation Report				D					F																											
Deliver 2016 RIS Bypass Operations Plan				D				F																												
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring and Report										S																										C
Northern Pikeminnow Ladder Trapping RI/RR																S								C												
Deliver 2016 RI/RR Fish Passage Plan					D			F																												
Deliver 2016 RR/RI Spill Plan							D			F																										
Deliver 2016 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												
2015 HCP Annual Report							D			F																										

HATCHERY COMMITTEE		Jan 2016			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
2015 Hatchery M & E Report								D								F																				
2017 Hatchery M & E work plans																						D						F								
Dryden Water Quality Monitoring (Year 5)							S						C																							
Dryden TMDL check-in		S			C																															
Feasibility Chilled Reuse System at EB						S																														
Chelan Hatchery Rehabilitation Design	S																																			
Continuation of Methow Sp. Ch. Review																																				
Steelhead Residualism Plan - *Draft*										S																										F
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							

TRIBUTARY COMMITTEE	Jan 2016			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

Chelan County PUD Wenatchee River TMDL Compliance at Dryden Acclimation Facility

Rocky Reach and Rock Island HCPs
Hatchery Committees

January 20, 2016

Introduction

- March 7, 2012 – Ecology issues Addendum to Wenatchee River TMDL for DO and pH giving DAF 9.2 microgram/liter waste load allocation
- July 12, 2012 – Chelan proposes to evaluate six actions to determine compliance with the TMDL

CHELAN COUNTY POWER
www.chelanpud.org

Actions

Action	Purpose	Timeline	Decision
1. Measure baseline phosphorus levels in Wenatchee River and at Dryden facility (Chelan PUD) before, during, and after fish on station	Use WQ data to establish baseline phosphorus levels and estimate variability. Then, determine the (1) quantity of phosphorus and (2) the flow “Q” that can be discharged	2013 & 2014 acclimation periods	If background concentration levels exceed wasteload allocation, resize Q to appropriate level or consider other treatment options.

Excerpt from Dryden TMDL Compliance, July 18, 2012

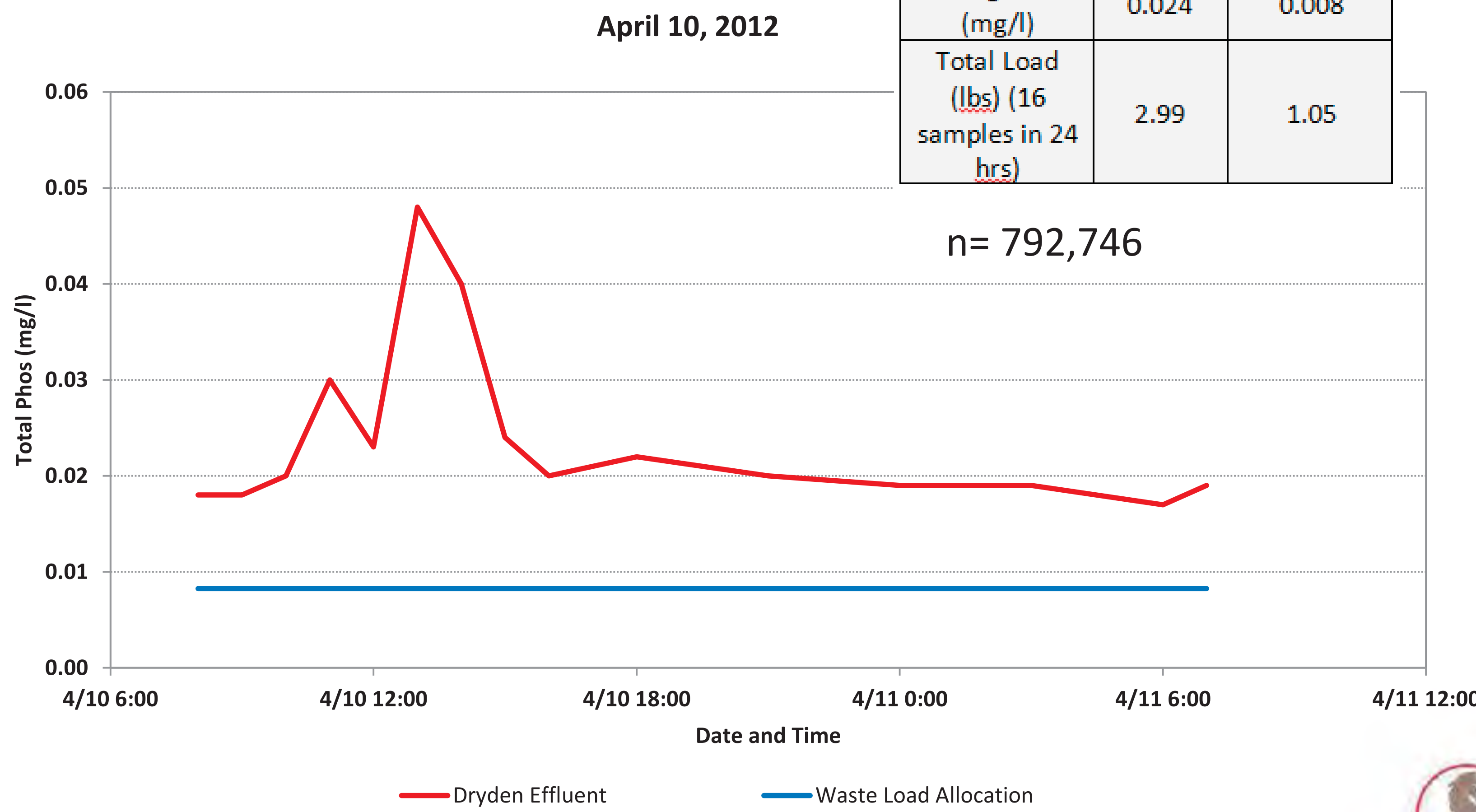
CHELAN COUNTY POWER
www.chelanpud.org

Results


Main St
School St
Main St
Alice Ave
Main St
Wenatchee River
Wenatchee River

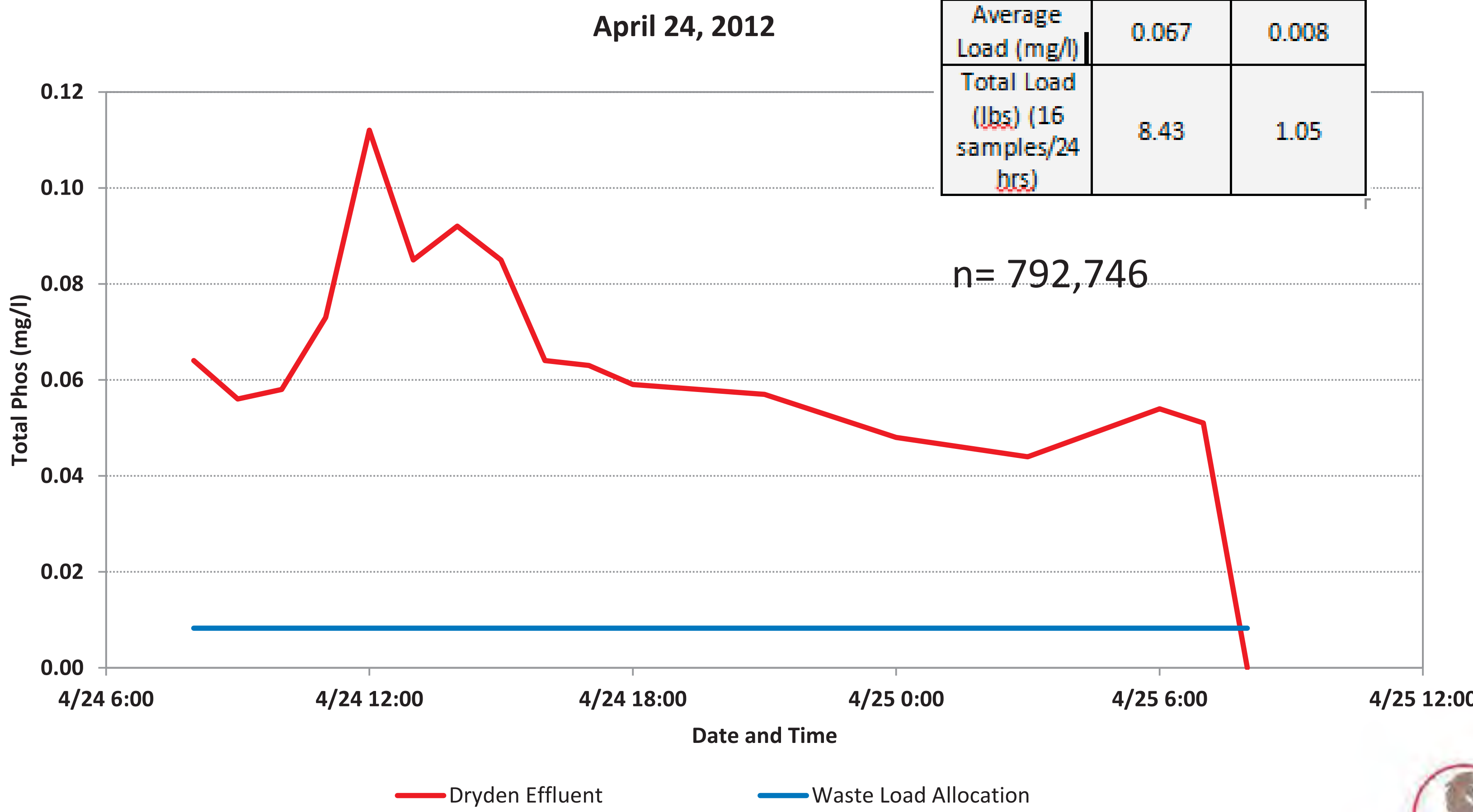
4/10/2012	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.024	0.008
Total Load (lbs) (16 samples in 24 hrs)	2.99	1.05

n= 792,746



CHELAN COUNTY POWER
www.chelanpud.org

4/24/2012	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.067	0.008
Total Load (lbs) (16 samples/24 hrs)	8.43	1.05



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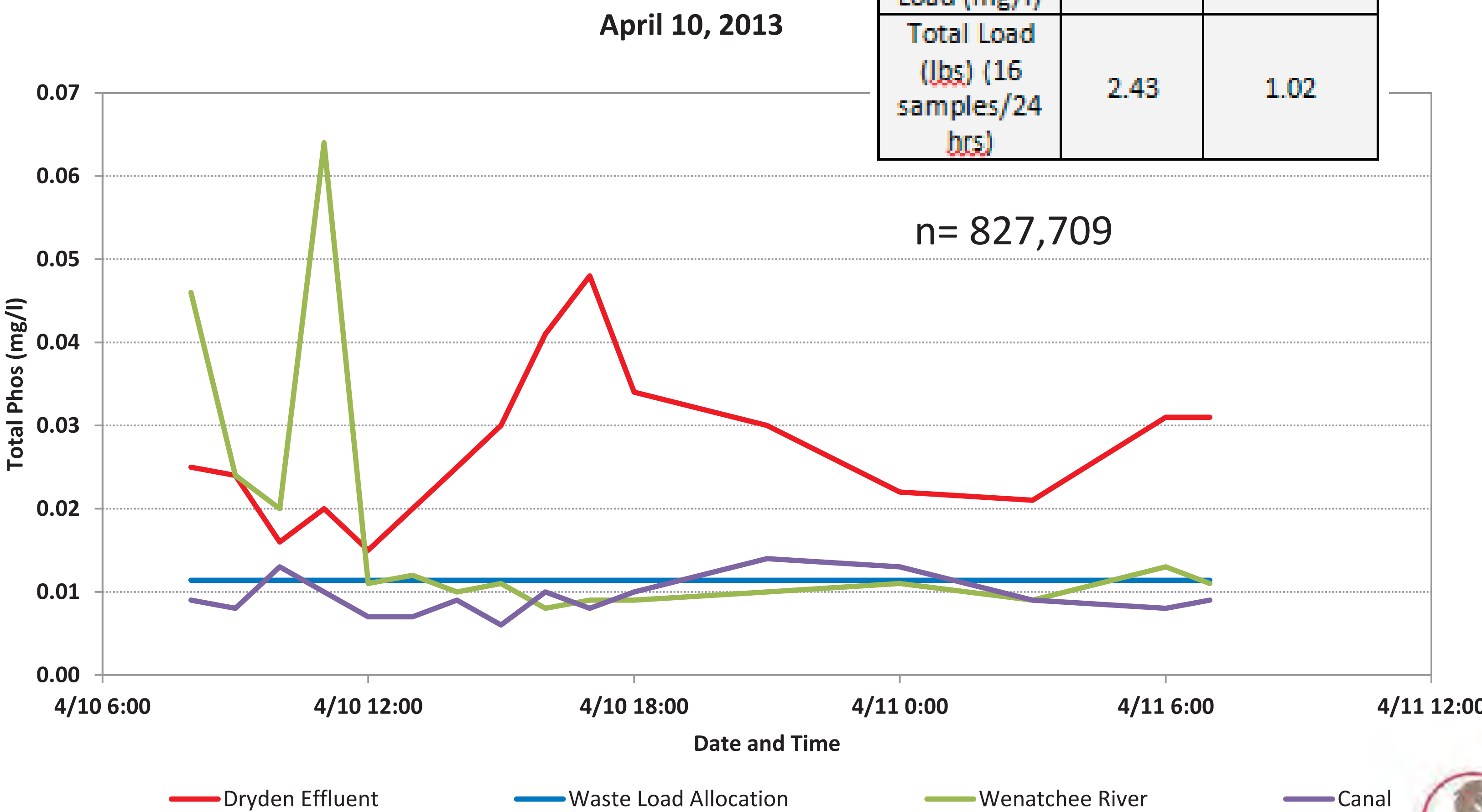
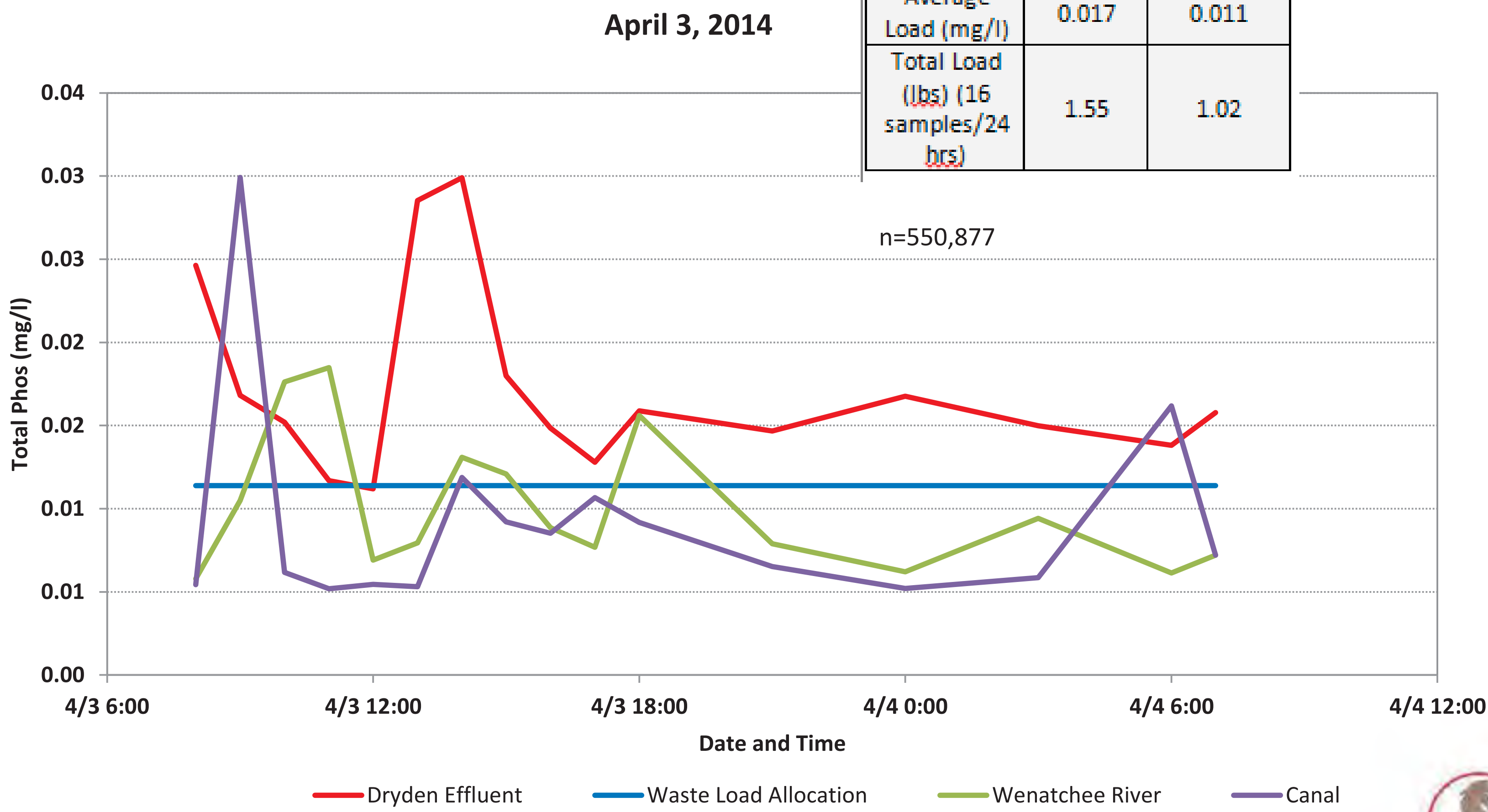
4/10/2013	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.027	0.011
Total Load (lbs) (16 samples/24 hrs)	2.43	1.02



4/3/2014	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.017	0.011
Total Load (lbs) (16 samples/24 hrs)	1.55	1.02



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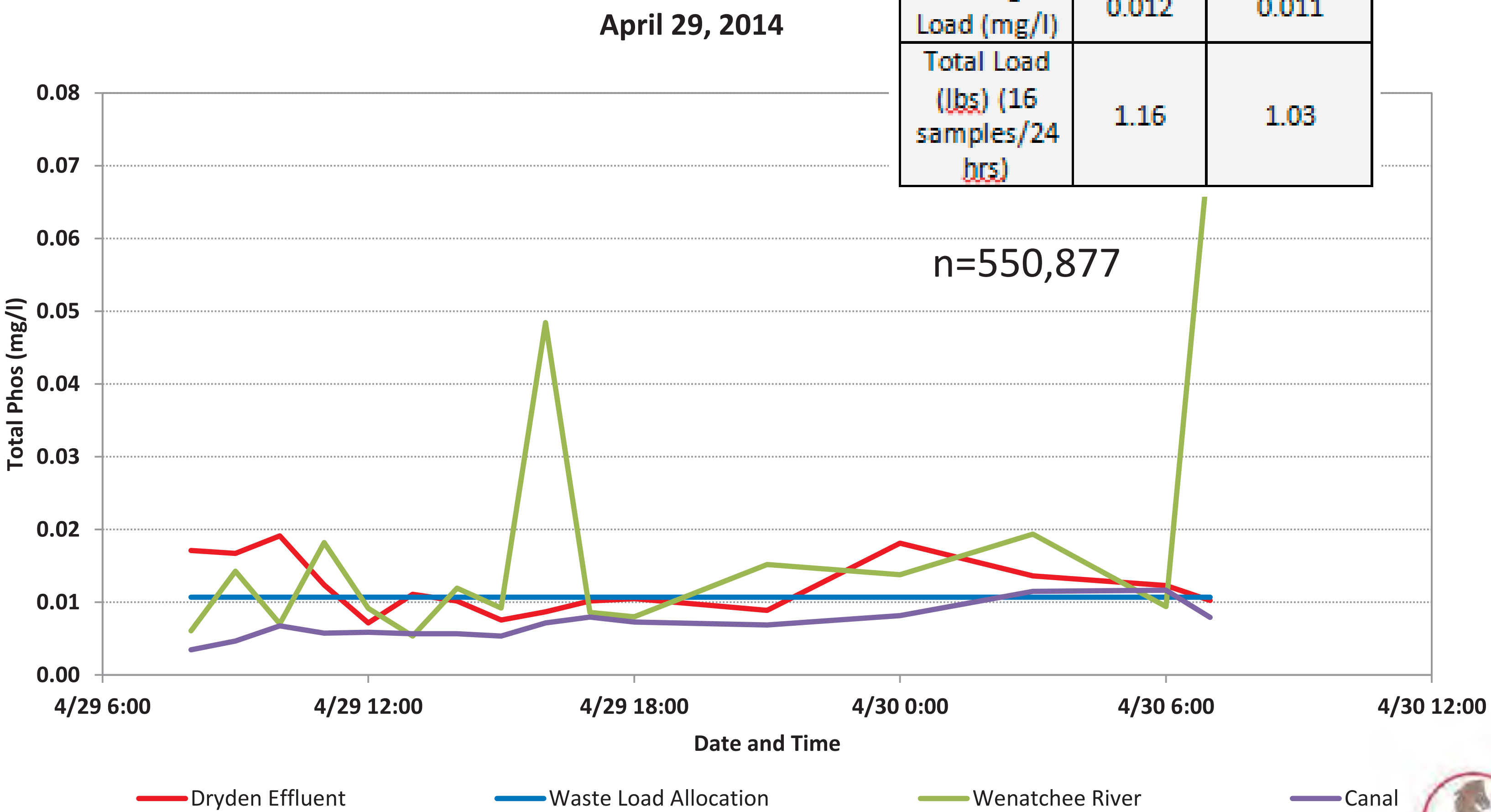
4/29/2014	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.012	0.011
Total Load (lbs) (16 samples/24 hrs)	1.16	1.03



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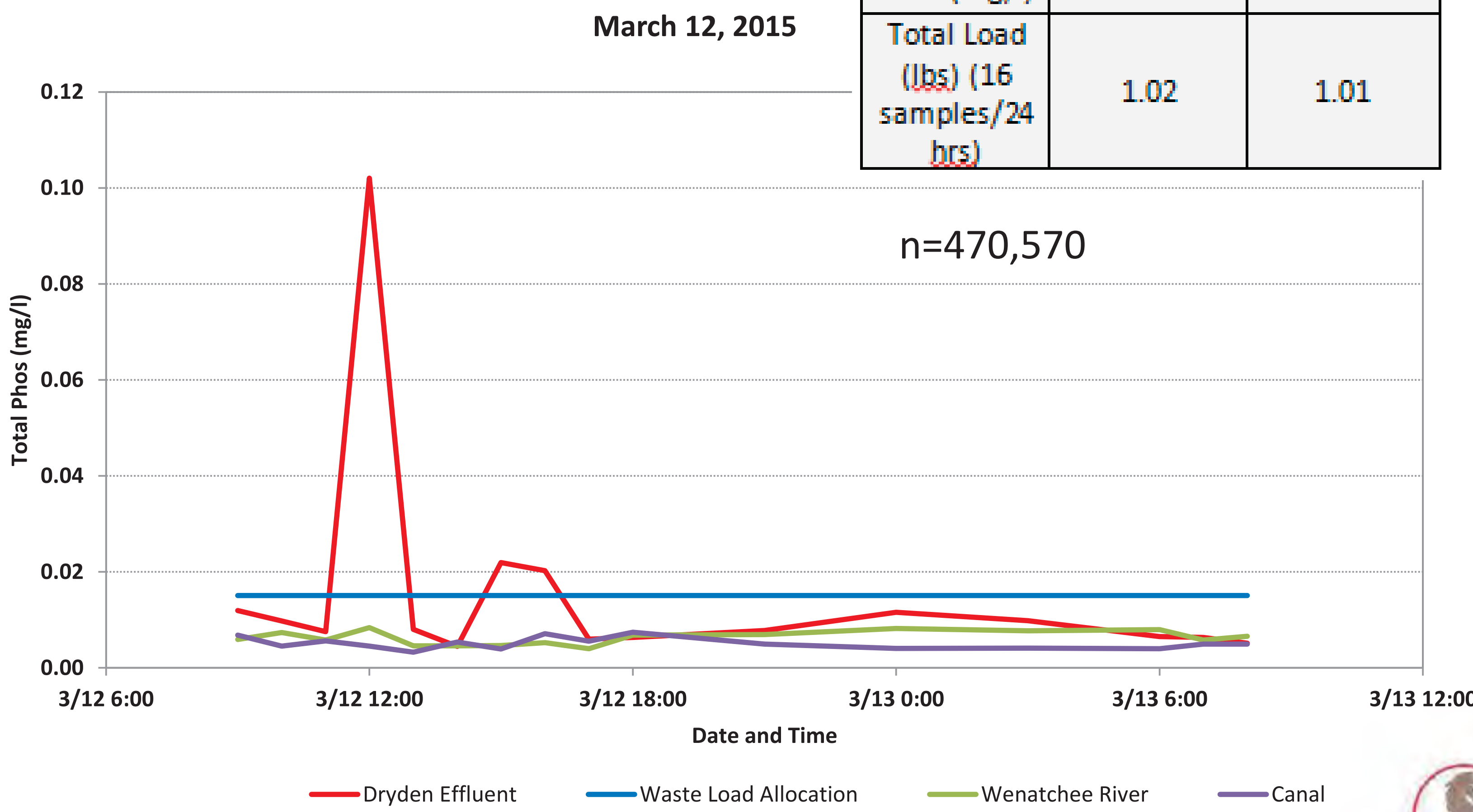
3/12/2015	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.015	0.015
Total Load (lbs) (16 samples/24 hrs)	1.02	1.01



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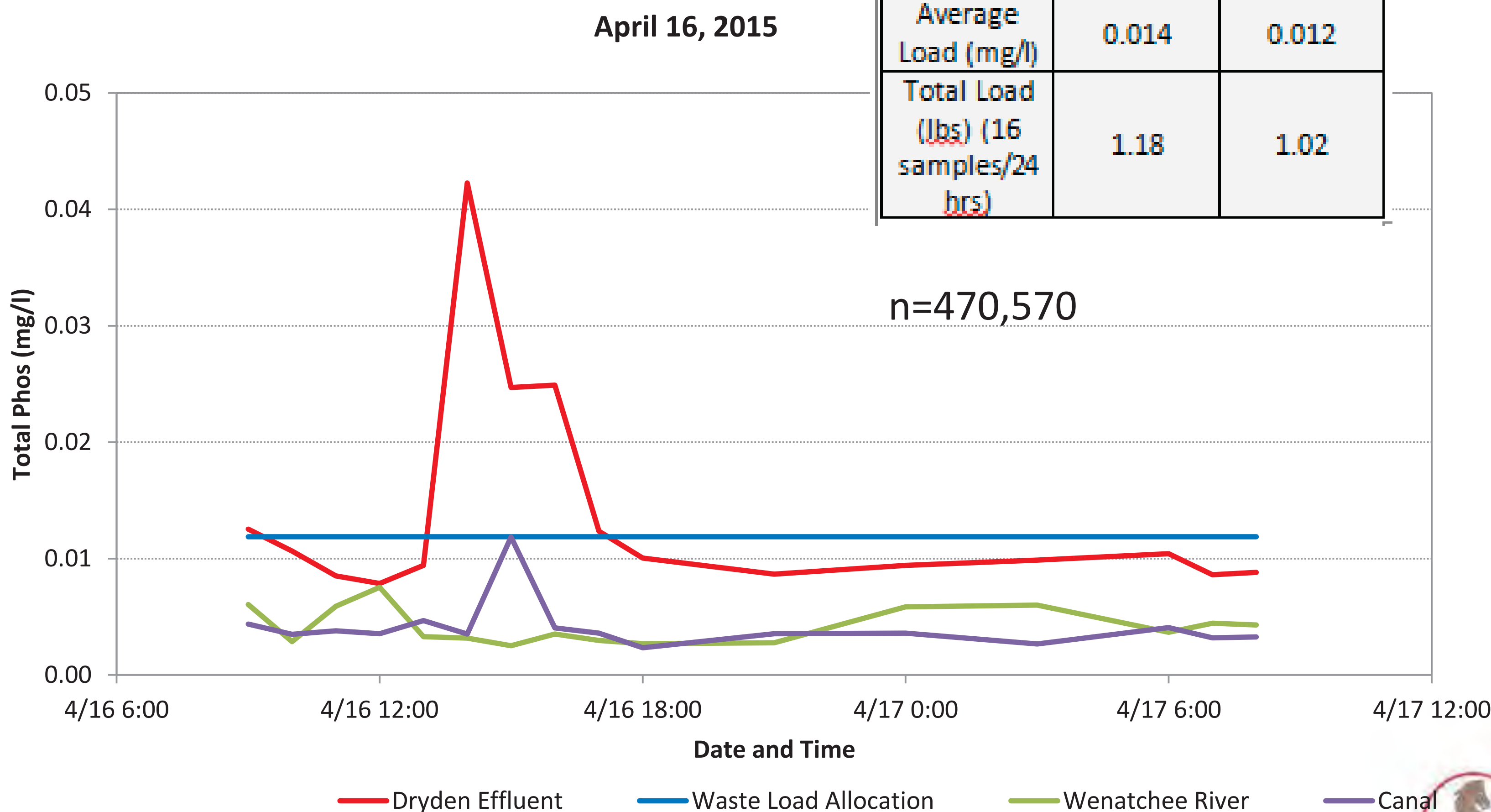
Attachment G

4/16/2015	Dryden Effluent	Waste Load Allocation
Average Load (mg/l)	0.014	0.012
Total Load (lbs) (16 samples/24 hrs)	1.18	1.02



Actions

Action	Purpose	Timeline	Decision
2. Conduct low phosphorus feed trial at Dryden (Grant PUD & Chelan PUD)	Use regular and low phosphorus feeds during acclimation to measure WQ response in effluent and to determine efficacy of future use	2013 acclimation period	If low phosphorus feed reduces effluent phosphorus concentration and meets fish health parameters (evaluated separately at UFWS lab), then consider use for TMDL compliance

Excerpt from Dryden TMDL Compliance, July 18, 2012

Low Phosphorus Feed Study

- GPUD funded an 8 week study at Willard National Fish Hatchery using 0.8% and 1.0% P feed and spring Chinook Salmon (Ann L. Gannam)
- Reduction of P in effluent
- Fish metrics were similar (e.g., growth, Ca, P), but cautions about long-term use and effects
- Subsequent study tested 0.6% and 0.8% and results presented at Portland AFS (not funded by GPUD)
- Results are likely sufficient to support feed makers to produce ultra-low P food
- Recommendation: Use 0.6% P feed to fine tune effluents for short periods if other approaches are not sufficient

Actions

Action	Purpose	Timeline	Decision
3. Benchmark Chelan Falls and Leavenworth circulars (Chelan PUD & USFWS).	Determine efficacy of circular tanks and radial flow separators for phosphorus removal by looking at effluent WQ	2013 & 2014 (Chelan Falls is currently operational, Leavenworth would be considered if infrastructure is built)	If circular tanks and waste removal effectively remove phosphorus, consider future application for Dryden. Consider reuse if Q is reduced significantly.

Excerpt from Dryden TMDL Compliance, July 18, 2012

Actions

Action	Purpose	Timeline	Decision
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)	Optimize smolt release size to decrease precocity, increase SARs, and reduce phosphorus input (i.e., less food)	Begins in 2012 and would focus on 2014 & 2015 release years	If a smaller smolt can improve return performance, consider application of smaller size for Dryden production group

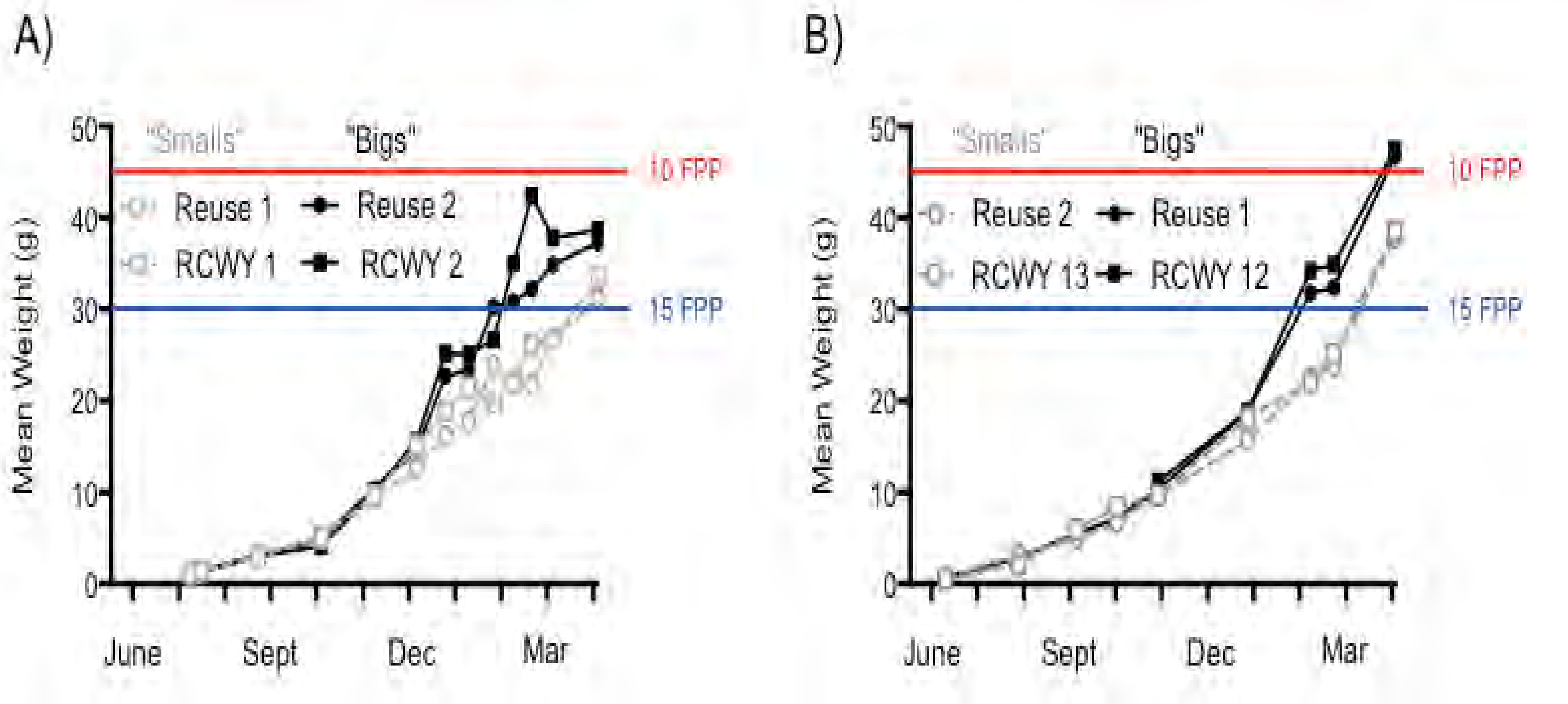
Excerpt from Dryden TMDL Compliance, July 18, 2012

Actions

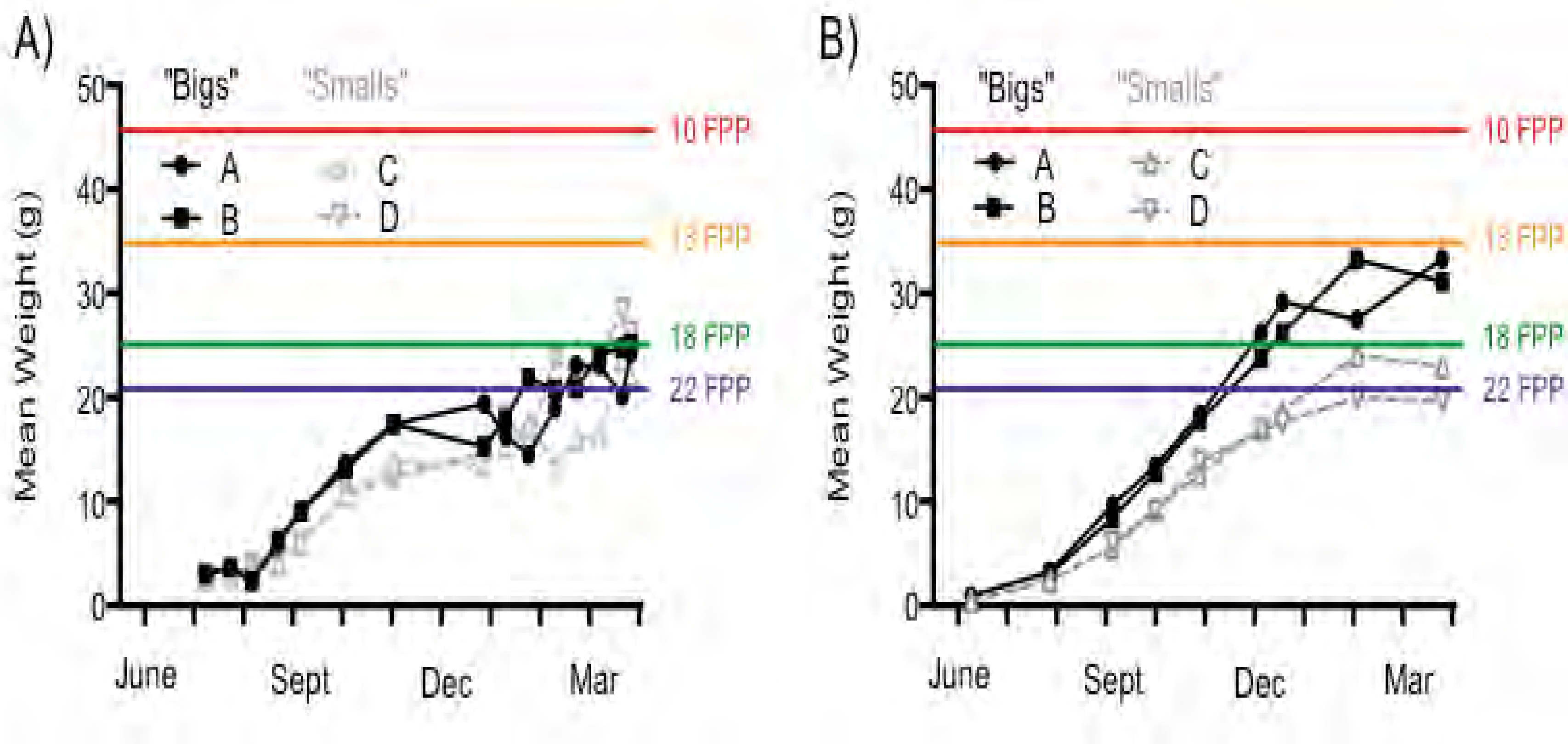
The Study Plan Included:

1. Determining the efficacy of restricted growth at Eastbank hatchery under high autumn/winter temperatures using ration manipulation alone to reduce size and minijack rate
2. Energetic status (adiposity) between treatments in fall and spring
3. Growth and growth physiology (plasma IGF-I), size and condition factor between treatments in fall and spring
4. Smolt development (ATPase) between treatments in fall* and spring
5. Minijack rates between treatments at release

*Previous studies have shown significant evidence of fall smoltification in Eastbank Summer Chinook stocks. Harstad, Larsen, Beckman, unpublished data.



BY2012 (A) and BY2013 (B) Wenatchee Summer Chinook salmon growth profiles. Horizontal lines indicated targeted size at release. Target size goal at release for “Smalls” was 15 FPP and target size for “Bigs” was 10 FPP for both brood years. In BY2013, a subset of fish from each treatment was held back at Eastbank Hatchery in March - April for NOAA’s final sample in mid-April.



BY2012 (A) and BY2013 (B) Chelan Falls Summer Chinook salmon growth profiles. Horizontal lines indicated targeted size at release. Target size goals for each treatment in both brood years were as follows: A = 10 FPP, B = 13 FPP, C = 18 FPP, D = 22 FPP.

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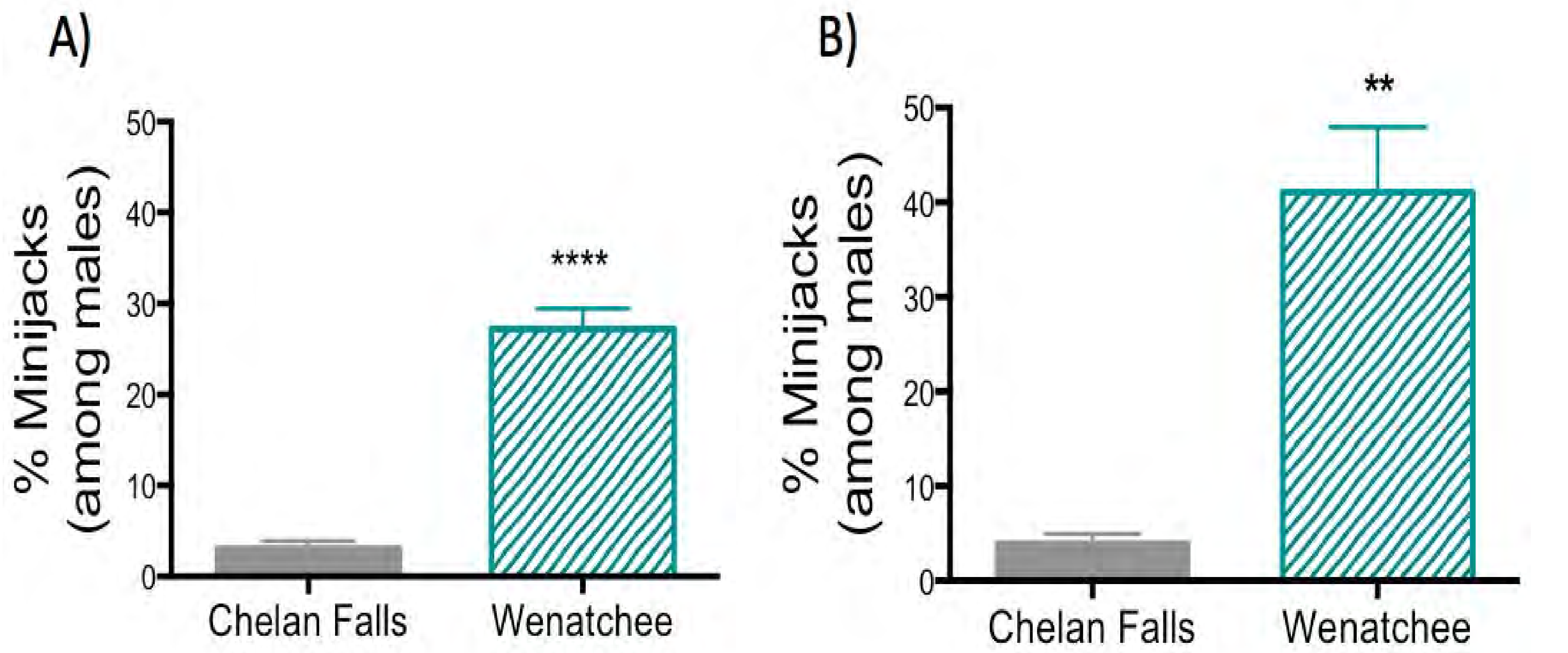

Minijack rates (%) among males for (A) BY2012 and (B) BY2013 Chelan Falls and Wenatchee Summer Chinook Salmon, size treatments combined within population. N = 4. Asterisks indicate significant differences between populations. Error bars = 1 SEM.

Findings

•Size treatments did not play out as originally designed in both studies making it difficult to generate robust inferences about differential effects of release size.

•There were few significant relationships between size or winter growth rate and minijack rates within stocks, years, and treatments. However, when all data were combined the extreme differences in size and growth rate among all treatments provided significant relationships. These relationships emphasize the overwhelming effect overwinter temperature has on the phenotype of the released fish.

•It is recommended that efforts be made to reduce winter temperatures and/or rations in the winter to lower early maturation rates.

Actions

Action	Purpose	Timeline	Decision
5. Evaluate the number of fish released and effects on phosphorus levels (Chelan PUD)	Examine reduction in phosphorus discharge associated with 500k smolt production (reduced from 864k)	2014 acclimation period	Program changes are likely to reduce phosphorus levels (supports decision in Action 1). This is not a proposal for further reductions.

Excerpt from Dryden TMDL Compliance, July 18, 2012

Actions

6. Evaluate Actions 1-5 and select best option(s) for Dryden to meet TMDL standard

Best Solutions

- Modify feeding practices to reduce food waste
- Rear Wenatchee summer Chinook to a smaller size (anticipated to be around 18 fpp) which would require colder overwinter temperatures than Eastbank currently provides

Next Steps

- Conduct feasibility and 30% design by summer 2016
- Complete design in 2017
- Construct 2018
- First fish ponded in summer 2019

Rock Island and Rocky Reach HCP Hatchery Committees
Draft Statement of Agreement
Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook
Draft for Discussion January 20, 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 requirements 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 Wastershed 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 and concluded that the most effective and risk minimizing approach to meeting the requirements 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.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	March 17, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the February 17, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, February 17, 2016, from 9:30 a.m. to 3:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth and Andrew Murdoch (WDFW) will keep the Hatchery Committees updated on the WDFW moratorium on hexacopter use (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will discuss internally the status of facility improvements at the Chewuch Acclimation Facility (AF; Item I-A). *(Note: this item is ongoing.)*
- Bill Gale and Todd Pearsons will circulate information received from Ann Gannam (U.S. Fish and Wildlife Service [USFWS]) regarding the results of a phosphorus study she presented at the American Fisheries Society 2015 conference (Item I-A). *(Note: this item is ongoing.)*
- Hatchery Evaluation Technical Team members will update the Draft Hatchery Monitoring and Evaluation (M&E) Plan Appendices 2 to 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-G). *(Note: this item is ongoing. Montgomery forwarded Appendices 5 and 6 to the Hatchery Committees on February 5, 2016, Appendix 4 on February 9, 2016, and Appendix 2 on March 2,*

2016.)

- Sarah Montgomery will distribute Andrew Dittman's presentation, "Effects of Hatchery Rearing and Release Practices on Olfactory Imprinting and Homing," to the Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC; Item II-A). (*Note: Montgomery distributed the presentation to the Hatchery Committees and PRCC HSC on February 18, 2016.)*
- Charlene Hurst (National Marine Fisheries Service [NMFS]) will send the revised gene flow sliding scale spreadsheet to the Hatchery Committees (Item II-B). *(Note: Hurst sent the revised spreadsheet to Sarah Montgomery on February 19, 2016, which she distributed to the Hatchery Committees that same day.)*
- Charlene Hurst will send an email to the Hatchery Committees describing the gene flow standards that NMFS proposes for Methow spring Chinook salmon, which will be a decision item during the Hatchery Committees conference call in early March 2016 (date to be determined; Item II-B). *(Note: Hurst sent a document describing the gene flow standards to Sarah Montgomery on February 19, 2016, which she distributed to the Hatchery Committees for review that same day.)*
- Keely Murdoch will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan and coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility (Item II-C).
- The Hatchery Committees will discuss Keely Murdoch's study plan at the March 16, 2016, Hatchery Committees meeting (Item II-C).
- Sarah Montgomery and Tracy Hillman will revise the Grant PUD Target Hatchery Replacement Rate (HRR) Proposal to reflect discussions and agreements during the Hatchery Committees February 17, 2016, meeting and distribute it to the Hatchery Committees (Item II-C). *(Note: Montgomery and Hillman revised the Target HRR Agreement on February 19, 2016, and Montgomery distributed it to the Hatchery Committees that same day.)*
- Sarah Montgomery will compile all Hatchery Committees discussions regarding the 5-Year Hatchery M&E Review process into one document, organized by objective, and send it to Catherine Willard (Item II-C). *(Note: Montgomery completed this item, and sent the draft summary to Willard on March 10, 2016.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery M&E Review process

(Item II-C).

- Catherine Willard will send Chelan PUD's Draft 2016 Steelhead Release Plan and Preliminary Results from the 2015 Wenatchee Steelhead Release to Sarah Montgomery, which she will distribute to the Hatchery Committees (Item III-D). *(Note: Willard sent the documents to Montgomery on February 18, 2016, which she distributed to the Hatchery Committees for review that same day.)*
- Todd Pearsons will inquire internally about posting annual reports and 5-year reports on the Grant PUD website (Item IV-A).
- Sarah Montgomery will send a Doodle poll to the Hatchery Committees in order to convene a conference call to discuss two decision items: 1) gene flow standards for Methow spring Chinook salmon; and 2) Chelan PUD's Draft Steelhead Release Plan (Item IV-B). *(Note: Montgomery sent a Doodle poll on February 18, 2016, and a meeting invitation for a March 3, 2016 conference call on February 24, 2016.)*

DECISION SUMMARY

- The Rock Island and Rocky Reach Hatchery Committees representatives present approved the hatchery portion of Chelan PUD's 2016 Action Plan as follows: Chelan PUD, USFWS, WDFW, NMFS, Yakama Nation (YN), and Colville Confederated Tribes (CCT) approved on February 17, 2016 (Item III-A). *(Note: this item is also a decision item at the HCP Coordinating Committees meeting on February 24, 2016.)*
- The Rock Island and Rocky Reach Hatchery Committees representatives approved Chelan PUD's Wenatchee Summer Chinook Statement of Agreement (SOA), *Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook,* as follows: Chelan PUD, USFWS, WDFW, NMFS, YN, and CCT approved on February 17, 2016 (Item III-B).

AGREEMENTS

- The Hatchery Committees and PRCC HSC representatives present agreed to use the methods for calculating and assessing HRR targets described in Grant PUD's Target HRR Proposal, as revised during the Hatchery Committees February 17, 2016, meeting (Item II-C). *(Note: Sarah Montgomery distributed the revised HRR Target Agreement to the Hatchery Committees on February 19, 2016.)*

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on February 19, 2016, notifying them that the NMFS-proposed gene flow standards for Methow spring Chinook salmon are available for review (Item II-B).
- Sarah Montgomery sent an email to the Hatchery Committees on February 11, 2016, notifying them that the Draft Broodstock Collection Protocols are available for review (Item II-F).
- Sarah Montgomery sent an email to the Hatchery Committees on February 5, 2016, notifying them that Draft Hatchery M&E Plan Appendices 5 and 6 are available for review. Montgomery also sent Appendix 4 on February 9, 2016 and Appendix 2 on March 2, 2016 (Item II-G).

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on February 18, 2016, notifying them that the Final Wenatchee Summer Chinook SOA, *Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook,* is available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on March 3, 2016 notifying them that the Chelan PUD Final 2016 Steelhead Release Plan is available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the January 20, 2016, Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. One revision was requested:

- Craig Busack asked to move the Methow spring Chinook salmon gene flow planning discussion to Item II-B on the agenda.

The Hatchery Committees reviewed the revised draft January 20, 2016, meeting minutes. Sarah Montgomery said there are several outstanding comments to be discussed. The Hatchery Committees discussed the outstanding comments and made revisions.

Hatchery Committees members present approved the draft January 20, 2016, meeting minutes, as revised.

Action items from the Hatchery Committees meeting on January 20, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on January 20, 2016)*:

- *Mike Tonseth will add contingencies for overages to the Broodstock Collection Protocols (Item I-A).*
  This item is complete and will be discussed during today's meeting.
- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item is ongoing.
- *Mike Tonseth and Andrew Murdoch (WDFW) will keep the Hatchery Committees updated on the WDFW moratorium on hexacopter use (Item I-A).*
  This item is ongoing.
- *Sarah Montgomery will distribute meeting materials to the Hatchery Committees and the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC; Item I-A).*
  Montgomery distributed the following six documents on January 21, 2016: 1) Chelan PUD's TMDL Compliance at Dryden AF presentation; 2) Chelan PUD's Size-at-Release Target Summary presentation; 3) Chelan PUD's Draft 2016 Rocky Reach and Rock Island HCP Action Plan; 4) Tracy Hillman's HRR Targets spreadsheet; 5) Chelan PUD's Draft SOA for Wenatchee summer Chinook salmon; and 6) Douglas PUD's Draft 2016 Wells HCP Action Plan.
- *Hatchery Committees members will send Tom Kahler questions or topics for Andrew Dittman to discuss at the February 17, 2016, Hatchery Committees meeting by February 3, 2016 (Item I-A).*

This item is complete and will be discussed during today's meeting.

- *Rob Jones (National Oceanic and Atmospheric Administration [NOAA]) will send a letter to the HCP Coordinating Committees regarding changes in NOAA representation on the Hatchery Committees (Item II-A).*
  Dale Bambrick (NOAA) sent a letter regarding changes in NOAA representation on the Hatchery Committees to Tracy Hillman on February 11, 2016, which Kristi Geris forwarded to the Hatchery Committees and HCP Coordinating Committees that same day.
- *Tracy Hillman will calculate 40th percentile hatchery replacement rate (HRR) targets that include harvest (Item II-B).*
  Hillman provided the updated spreadsheet to Sarah Montgomery on January 22, 2016, which she distributed to the Hatchery Committees that same day.
- *Grant PUD will discuss internally approving the use of the 40th percentile approach that includes harvest for calculating HRR targets (Item II-B).*
  Todd Pearsons sent a document titled, "HRR Target Proposal," regarding this topic to Sarah Montgomery on February 9, 2016, which she distributed to the Hatchery Committees that same day.
- *Keely Murdoch will develop her outline, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a draft (Item II-D).*
  Murdoch sent the draft to Sarah Montgomery on January 26, 2016, which she distributed to the Hatchery Committees and Hatchery Evaluation Technical Team (HETT) that same day.
- *The Hatchery Committees will discuss Keely Murdoch's draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," with Andrew Dittman (NOAA) at the February 17, 2016, Hatchery Committees meeting (Item II-D).*
  This item will be discussed today.
- *HETT members will update the Draft Hatchery Monitoring and Evaluation (M&E) Plan Appendices 2 to 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-D).*

This item is ongoing. Montgomery forwarded Appendices 5 and 6 to the Hatchery Committees on February 5, 2016, and Appendix 4 on February 9, 2016.

- *Kirk Truscott will discuss internally the acclimation of Methow spring Chinook salmon at Chewuch Acclimation Facility (AF) under the operation of the Yakama Nation (YN) and the 2013 Final Chewuch Acclimation Statement of Agreement (SOA) by Friday, January 22, 2016 (Item IV-B).*
  Truscott sent an email on January 22, 2016, to Tracy Hillman saying this item is ongoing, and Sarah Montgomery forwarded it to the Hatchery Committees that same day. On January 27, 2016, Truscott sent a second email detailing CCT's preferences regarding the acclimation of Methow spring Chinook salmon at Chewuch AF, which Montgomery forwarded to the Hatchery Committees that same day.
- *WDFW will pursue the feasibility of staffing Chewuch AF for the potential acclimation and release of Methow spring Chinook salmon (Item IV-B).*
  Jeff Korth (WDFW) sent an email on February 12, 2016, to Tracy Hillman and Sarah Montgomery stating that WDFW could not successfully recruit qualified candidates for staffing the Chewuch AF this year, which Montgomery forwarded to the Hatchery Committees that same day.
- *Keely Murdoch will send the 2013 Final Chewuch Acclimation SOA to Kirk Truscott (Item IV-B).*
  This item is complete.
- *Keely Murdoch will discuss internally the status of facility improvements at Chewuch AF (Item IV-B).*
  This item is ongoing. Murdoch said she discussed facility improvements with Cory Kamphaus (YN), and YN plans to cost share improvements to coho salmon-rearing facilities, such as the bubbler, with Chelan PUD.
- *Sarah Montgomery will add brood year 2014 spring Chinook salmon acclimation in the Methow Basin to the February 17, 2016, Hatchery Committees meeting agenda (Item IV-B).*
  Montgomery distributed the Hatchery Committees February 17, 2016, meeting agenda, including this item, on February 5, 2016.
- *Bill Gale will ask Ann Gannam (USFWS) about the results of a phosphorus study she presented at the American Fisheries Society 2015 conference (Item IV-C).*

This item is ongoing. Todd Pearsons and Gale both corresponded with Gannam, and they will circulate information received to the Hatchery Committees.

- *Hatchery Committees members will provide comments on the Chelan PUD draft SOA titled, "Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook," to Alene Underwood by Monday, February 1, 2016 (Item IV-C).*
  This item is complete.
- *Alene Underwood will finalize the draft Wenatchee summer Chinook salmon SOA by Wednesday, February 3, 2016, so that it can be a decision item at the February 17, 2016, Hatchery Committees meeting (Item IV-C).*
  Underwood sent the SOA to Sarah Montgomery on February 3, 2016, which Montgomery forwarded to the Hatchery Committees that same day.

II. Joint HCP-HC/PRCC HSC

A. Imprinting and Homing Presentation and Discussion (Tom Kahler/Andrew Dittman)

Andrew Dittman shared a presentation titled, "Effects of Hatchery Rearing and Release Practices on Olfactory Imprinting and Homing" (Attachment B). *(Note: Sarah Montgomery distributed the presentation to the Hatchery Committees on February 18, 2016.)*

Dittman said he works at the Northwest Fisheries Science Center, and this talk in no way represents official NOAA policy; rather, he only presents the biology of imprinting and homing. A summary of the presentation and questions and comments are included in the following sections.

<u>Background (Slides 1 and 2)</u>

Dittman said salmon learn odors associated with natal streams during development and use olfactory cues when returning upstream.

Experimental Evidence (Slides 3-4)

In a study by Scholz et al. (1976)[1], fish groups that were exposed to different odor cues and released in different rivers returned primarily to their release rivers. Hasler and Scholz (1983)[2] found that imprinting is associated with thyroid hormone surges that occur during smolting.

Sequential Imprinting Hypothesis (Slide 5)

Dittman said fish learn a series of olfactory waypoints as they experience inputs from tributaries during downstream migration. These waypoints are hormonal responses, which may be triggered by novel water input, and when fish migrate back upstream, it is thought the olfactory waypoints guide them to their natal sites.

Straying (Slides 6 to 12)

Dittman said straying is natural and may occur for a variety of reasons, such as age, memory loss, signal change over time, or exhaustion. Fish may make tradeoffs between homing and spawning site selection. Hatchery-origin salmon do not necessarily stray more than natural-origin salmon; however, factors such as transport and release strategies; the location, timing, and duration of acclimation; inappropriate release habitat; and the hatchery environment itself may increase straying. Dittman said Lister et al. (1981[3]) studied the effect of transport distance on homing fidelity to release sites and found that stray rates are low when fish are released at the location at which they were reared or at distances greater than 47 kilometers. Craig Busack asked what the operational definition of straying is for Dittman's presentation. Dittman said he considers a fish not returning to its acclimation tributary a stray. Dittman said some studies found that the time of release was more, or equally, important as the location of release.

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[1] Scholz, A.T., R.M. Horrall, J.C. Cooper, and A.D. Hasler, 1976. Imprinting to chemical cues: the basis for home stream selection in salmon. *Science* 192:1247-1249.

[2] Hasler, A.D. and A.T. Scholz, 1983. Olfactory imprinting and homing in salmon: investigations into the mechanism of the imprinting process. *Zoophysiology* Volume 14.

[3] Lister, D.B., D.G. Hickey, and I. Wallace, 1981. *Review of the effects of enhancement strategies on the homing, straying, and survival of Pacific salmonids*. Prepared for the Canada Department of Fisheries and Oceans, Vancouver, B.C.

Yakima River Spring Chinook Salmon Imprinting and Homing (Slides 15 to 19)

Dittman shared results from the Yakima River spring Chinook salmon Supplementation Program. He said the sequential imprinting hypothesis explains why fish returned with high fidelity to the Easton Acclimation Site; fish traveling upstream receive familiar input from the hatchery, arrive near the hatchery, then continue receiving familiar input from their acclimation site and, therefore, travel upstream toward their acclimation site. In contrast, fish released from the Jack Creek site reach an olfactory fork in the river during upstream migration, where the Teanaway River flows into the Yakima River, and the hatchery (on the Yakima River) provides more attractive olfactory cues due to early imprinting than their acclimation sites, ultimately resulting in high stray rates.

Strategies to Decrease Straying (Slides 30 to 46)

Tilson et al. (1994[4]) found that thyroid hormone levels in fish surge during two life stages, 1) as embryos at the time of hatching and emergence, and 2) as smolts. Salmon imprint to natal sites during these two life stages. Dittman said strategies such as incubating in natural or distinct waters (olfactory enrichment), embryonic imprinting, artificial imprinting cues, out-of-basin rearing, transport to target sites, and monitoring of physiological development and release timing may help to decrease straying. Larval imprinting proposes collecting water from targeted sites and exposing fish during sensitive developmental windows to their target tributary waters. Dittman said storing and freezing water should be considered if the target reaches of tributaries are difficult to access regularly. Dittman said artificial cues such as morpholine and phenyl ethyl alcohol may help decrease straying, but they are hazardous chemicals and, therefore, permitting may be difficult. He said he is currently studying the potential for natural substances like watercress and algae extract to act as artificial cues. Tom Kahler asked if the addition of artificial cues to increase hatchery-origin homing would affect the ability of wild fish to home. Dittman responded that he thinks it would not make

[4] Tilson, M. B., A.T. Scholz, R.J. White, and J.L. Hendrickson, 1995. *Artificial imprinting and smoltification in juvenile kokanee salmon: implications for operating Lake Roosevelt kokanee salmon hatcheries. 1994 Annual Report.* U.S. Department of Energy, Bonneville Power Administration. Project No. 88-63. Contract No. DE-8179-88BP91819.

a difference for wild fish because they are already imprinting on so many odors, and one more odor would likely not change homing behavior.

Potential Solutions and Experiments in the Methow Basin (Slides 47 to 52)

Regarding incubating in natural waters, Greg Mackey asked if natural waters could be treated for disease without changing their imprinting signature. Dittman said he studied the response of the olfactory system in fish to different odors of collected and stored water from the White River using an electro-olfactogram. Fish had no significant change in response from natural waters to frozen or refrigerated water. Ultraviolet (UV)-treated water elicited a change in olfactory response, but fish exposed to the UV-treated water did not have a behavioral change in homing. Fish exhibited a significant olfactory change in response to freeze-dried and reconstituted water; however, Dittman said commercial freeze-drying units still hold potential for future studies.

Peter Graf said there might be tradeoffs between release date and homing and asked if there are data available regarding release date, survival, and homing. Dittman said he believes that the earlier a fish is released into its natal watershed, the better it will imprint and home. However, if the fish does not survive, it also will not return to its natal watershed. He said maximizing survival is likely more important to managers than maximizing imprinting and homing.

Graf asked if fish should still be acclimated to natal water if they are exposed to it during embryonic development. Dittman said it probably would not be a problem to acclimate the fish, but it might be easier to truck release the fish instead. However, he said acclimation and its merits are worth considering.

Mackey asked if fish are unified in thyroid hormone escalation levels when they are nearing release date in the hatchery. He said it might be possible to find an optimal date for stocking fish if the hormone levels in fish peaked at the same time. Dittman said some species are more conducive to a single release date than others, and with wider ranges in size, there would likely be wider ranges in hormone levels. He said the profile of hormone levels across the population might be similar; however, it is largely dependent on their rearing environment (hatchery effects).

Kahler asked if environmental conditions in the Teanaway River were accounted for and corrected in the Yakima River study. Dittman said the numbers of fish spawning in Jack Creek are correlated with flow, and the passive integrated transponder (PIT)-tag results show that some fish migrated into the Teanaway River and back out later in the season. In this study, bigger fish were more likely to stray out of the Teanaway River, and 2015 was a particularly bad year for habitat conditions (and straying) in the Teanaway River.

Tracy Hillman asked why fish that home all the way to the Easton Acclimation Site (responding to smoltification olfactory cues) do not then, in a sequential manner, search for rearing olfactory cues and travel back downstream to the hatchery. Dittman said once the fish have reached the Easton Acclimation Site, they cannot detect any cues coming from the hatchery because it is downstream. Keely Murdoch compared fish homing to the Easton Acclimation Site to White River spring Chinook salmon that reliably swim past their natal hatchery. She said it appears they home to the highest familiar upstream input.

Dittman suggested that Methow spring Chinook salmon may home better if they were reared in a hatchery much farther away from their natal sites, and then acclimated and released, in order to prevent familiar olfactory inputs from the hatchery confusing them as they migrate upstream. Murdoch said Wells Fish Hatchery (FH) and Eastbank Hatchery are both downstream of natal acclimation sites and perhaps far enough away to increase natal homing.

B. Methow Spring Chinook Salmon Gene Flow Sliding Scale (Charlene Hurst)

Charlene Hurst shared a spreadsheet titled, "Methow spring Chinook Gene Flow Analysis" (Attachment C), which Sarah Montgomery distributed to the Hatchery Committees on February 19, 2016. Hurst reviewed the updated spreadsheet. She said the cutoff at which wild fish should not be collected as broodstock is set at 100 fish. She said partial proportion of hatchery-origin spawners (pHOS) is calculated differently by NMFS and the PUDs, and inputting the natural run, or an estimate of it in the spreadsheet, results in an output of both pHOS values. She said NMFS would like to see an overall proportionate natural influence

(PNI) value of 0.5 or higher. She said Winthrop NFH broodstock currently has an assumed 75 percent contribution of Methow FH returns in the model, and if the contribution of Methow FH to Winthrop NFH broodstock increased, the overall 3-population PNI would also increase. She said the three-population gene flow model can also be used as a two-population model if the Winthrop program is input as zero.

Craig Busack said the Hatchery Committees need to agree on management standards for their program based on the three-population gene flow model. He said NMFS is proposing a sliding scale for PNI and pHOS for the PUD program and a percentage for PNI and pHOS for the Winthrop program. Bill Gale said adult management is a joint operation between the programs, and the permits need to fit together to meet that requirement. Todd Pearsons asked why a sliding scale is not proposed for the Winthrop program. He said it does not make sense to have the same percentage of hatchery-origin fish on the spawning grounds regardless of their abundance, especially for a program that is not expected to contribute to natural populations. Tom Kahler asked how the tool and sliding scales translate to management. He said aggressive adult management would be necessary to maximize removal of hatchery returns (particularly those from WNFH) in all but the worst return scenarios. Busack said the tool would inform when adult management should be less or more aggressive.

Gale said, using this tool, Winthrop National Fish Hatchery (NFH) would always need to aggressively remove adults in order to meet its PNI and pHOS goals, which requires both Methow FH and Winthrop NFH to be operating their respective weirs and traps. He said the weirs and traps would have to be operated to full capacity in order to manage Winthrop NFH goals and still allow Methow program fish to reach spawning grounds. Keely Murdoch said if these fish had higher homing fidelity, fewer would return to the hatchery overall. Tom Kahler said that if that were the case, it would be even more difficult to achieve the desired pHOS targets. Gale said the extraction rates at Winthrop NFH and Methow FH would be very high compared to historical rates, and it might be difficult to meet targets.
Mike Tonseth said hatchery returns will be fewer for the next 10-year period (due to decreased program size), which means there will be fewer adults overall, but aggressive extraction would still be needed. Pearsons said the sliding scale makes sense for the PUD

programs because when there are fewer natural-origin spawners, hatchery-origin fish provide a demographic boost, and when there are more natural-origin spawners, the proportion of hatchery-origin fish should decrease. Tonseth said there are not enough data to determine how effective adult management can be at variable spawning escapements. Kirk Truscott said low flow in the Methow River and thus relatively high discharge from Methow FH may have made the hatchery more attractive to returning fish, making adult management more successful in 2015 compared to an average year. Truscott asked what the ramifications would be of not meeting the gene flow targets defined in the spreadsheet. Busack said he will put flexibility in the permit language, and recognizes that the standards are high and may not be achievable in the 10-year period. Gale said changes in the program so far have made a big difference in the number of hatchery fish removed using adult management, and hopefully the natural population will respond.

Referring to the gene-flow analysis spreadsheet, Truscott said “wild run” and “wild escapement” are not the same metric and asked if pre-spawn loss is accounted for. Greg Mackey said the 100-fish limit for natural-origin broodstock collection should be, “100 fish after pre-spawn mortality,” because not all of the fish will convert to the Methow River. Tonseth suggested footnoting the spreadsheet to better define “wild run.” Mackey said the Hatchery Committees could vote on the sliding scale, which only applies to the PUD programs. Gale said he will need more time to review the gene flow standards before agreeing to the standards for either the PUD or the Winthrop programs. Kahler said approval of the standards affects Douglas PUD’s contract with WDFW, and contract negotiations need to be completed in June 2016.

Hurst said she will revise the gene flow sliding-scale spreadsheet and send it to the Hatchery Committees. Busack said he and Hurst will send an email to the Hatchery Committees describing the gene flow standards that NMFS proposes for Methow spring Chinook salmon, which will be a decision item during the Hatchery Committees conference call in early March 2016.

C. 5-Year Hatchery M&E Review Planning – Objectives 4, 5, 7, and 1 (All)

Objective 5

Keely Murdoch shared a paper titled, "Twisp and Chewuch Homing Fidelity Study Options" (Attachment D), which Sarah Montgomery distributed to the Hatchery Committees on January 26, 2016. Murdoch said the paper addresses two options for improving homing fidelity: 1) sequential imprinting; and 2) embryonic imprinting.

Sequential Imprinting

Murdoch said an example of sequential imprinting from Andrew Dittman's presentation occurred when fish returned to the Easton Acclimation Site, passing the hatchery they were reared in, on their way upstream. In the Twisp and Chewuch rivers, fish appear to be confused from the olfactory cues coming from the Methow River, where the Methow FH is located, and instead of returning to their acclimation sites in the Twisp and Chewuch rivers, they stray into the Methow River. Methow FH is not in sequence with the Twisp and Chewuch AFs. She said fish acclimated in the Chewuch River have particularly poor stray rates, which could be attributed to the short distance between the confluence of the Chewuch and Methow rivers and Methow FH. Murdoch said rearing the fish farther downstream and outside of the Methow Basin would allow for sequential imprinting; fish returning upstream would be less likely to stray into the Methow River because the only familiar olfactory cue is the acclimation site (i.e., Twisp or Chewuch rivers). She said a paired release at both Twisp and Chewuch AFs could be a good sequential imprinting study.

Embryonic Imprinting

Murdoch said other methods to increase homing to the Chewuch and Twisp rivers could involve bringing in natal river water during embryonic development (using isobuckets) or setting up temporary incubation facilities in the Twisp River before transfer to the chosen hatchery. She said her paper discusses different methods for marking and detecting study fish, such as spawning-ground surveys, recoveries of coded wire tags, and PIT tags.

Questions and Comments

Todd Pearsons asked where Murdoch proposes to incubate and rear fish. Murdoch said she would propose incubating and rearing fish at Eastbank Hatchery or Wells FH and avoid keeping fish at Methow FH altogether, unless they were transferred from Methow FH as unfertilized gametes. She said embryonic imprinting at Methow FH could confound the study and should be avoided. Pearsons asked if temperature would be a problem for the study at Eastbank Hatchery or Wells FH. He said fish could be incubated at Eastbank Hatchery or Wells FH and transferred as fry to avoid temperature issues affecting precocious maturation. Murdoch replied that initial rearing at Eastbank Hatchery with overwintering at Carlton Ponds and final acclimation upstream in Chewuch or Twisp rivers would fit the sequential imprinting model, but not every Hatchery Committees member supports using Carlton Ponds, and that would also involve more fish transport. Jayson Wahls said Wells FH has similar temperatures to Methow FH but may not currently have space for these study fish.

Murdoch said in this study, the early rearing period would be split; half of the fish would be reared at Methow FH, and half elsewhere. Murdoch said spawning would be done at Methow FH, and then eggs and milt would be transferred to another facility to avoid an eyed-egg transfer. Murdoch said the chosen rearing facility should be downstream of the final AF, and Wells FH would make sense because it is more than 50 river miles away. Wahls asked if the fish should be reared on well water or surface water. Dittman said distance is a more important factor than water source, but they should be reared on well water as much as possible. Mike Tonseth said the fish cannot overwinter at Eastbank Hatchery due to temperatures, and adult management also cannot be performed at Eastbank Hatchery, in contrast to Wells FH, where the volunteer trap can be operated. Greg Mackey said, because water exits the Wells FH through the volunteer channel, it is always open and would be highly attractive to fish. Murdoch asked if the volunteer channel trap is operated during the time of year that spring Chinook salmon would pass Wells FH during upstream migration. Wahls said yes, because the trap is operated for steelhead.

Craig Busack asked how many fish Murdoch proposes to use in this study. Murdoch said half of the Chewuch River release group (about 30,000 fish) and half of the Twisp River release group (15,000 fish) would serve as treatment fish. The other half of the release groups would serve as controls.

Mackey said Wells FH would not be available for this study until brood year 2018 because of construction. Tracy Hillman said it may make sense to start with the embryonic imprinting study in 2016 and 2017 and then consider the sequential studies when Wells FH facility is up and running. Mackey said the embryonic imprinting study may result in more management tools, because it would theoretically allow for acclimating fish to more locations. Murdoch said the study could be performed for 5 years, like the Goat Wall agreement. Bill Gale said the straying difference between the two release groups might not be statistically measurable due to uncertainties introduced by the number of returning adults, out-of-basin straying, and carcass recovery. He said it would be inefficient for the Hatchery Committees to partake in a 5-year study that might not produce statistically significant results. Murdoch said an alternative to a 5-year study would be a before-and-after style study in which the whole program is subjected to the treatment and compared to the previous 15 years of data. She also said that even though the programs and sample sizes are small, which increases the risk of producing statistically insignificant results, the Hatchery Committees should still aim to improve homing fidelity. Hillman said replication, and, therefore, statistical power in this study, would come from the number of years it is performed and the recapture rate of the fish. Dittman asked how reliable PIT-tag detection arrays are in the proposed study area. Murdoch replied that antennas are in place in the Chewuch, Twisp, and Methow rivers. Mackey said spring Chinook salmon likely migrate through the areas that have PIT-tag arrays during high water, which is associated with low detection rates.

Tom Kahler said adult management should not be performed on study fish because they should be allowed to explore and potentially turn around. Murdoch said conservation study fish should be adult-managed, and it is unlikely that Chewuch- or Twisp-acclimated fish that migrate to Methow FH are merely exploring—they would be straying in response to olfactory cues from the hatchery, and are no longer exposed to olfactory cues from their natal sites (confluence is downstream).

Gale asked if all adult-managed fish are bio-sampled for coded wire tags. Tonseth said the study fish could be distinguished using a secondary mark, an elastomer, or a body tag. Gale asked how the logistics of sorting, handling, and collecting data from study fish would work. Murdoch said Methow FH fish are marked differently than Winthrop NFH fish, which allows for samplers to target Methow FH fish for data collection. Gale said he would need to understand the impact of data-collection efforts on Winthrop NFH staff before approving a study design. Murdoch said the cost-benefit analysis of hatchery staff effort versus the cost of additional markings on fish can be decided by the Hatchery Committees once a detailed study plan is developed.

Mackey said the Hatchery Committees should also consider the potential effort put into this study and its potential gains. He said a statistical difference in homing may be detectable, but might not result in biologically meaningful differences. He said extreme results such as 100% decreases in straying are unlikely, and straying may not matter compared to the ultimate goal of promoting the recovery of spring Chinook salmon. Murdoch said extreme decreases in straying, such as down to 5%, are possible, and recalled Dittman's example of the Easton Acclimation Site in the Yakima River study.

Peter Graf said this study would take multiple years, and in the meantime, straying issues continue. He asked if more immediate actions can be taken to address homing fidelity. Murdoch said the rearing location of the entire program could be changed, but that likely would not be approved. Graf asked if fish could be truck planted in the Chewuch River. Murdoch said the current numbers of fish in the Chewuch River are unknown, so deciding on the number to truck plant would be difficult. She said the benefit of beginning the sequential imprinting study in 2018 would be that it gives the Hatchery Committees time to see if programs in the Methow Basin are meeting targets with adult management. She said she will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan and coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility.

Objective 4

Pearsons shared the Grant PUD proposal, "Target HRR Proposal" (Attachment E), which Montgomery distributed to the Hatchery Committees on February 9, 2016. Pearsons said the proposal includes maintaining the same HRR targets for 20 years. Tonseth said HRR is a metric in the M&E Plan, which is subject to review and modification every 5 years, including its appendices, so it would not make sense to propose a 20-year constraint on HRR targets. He said a radical program modification, for example, would result in a change in HRR performance, which should change HRR targets. Pearsons said Grant PUD does not support making the targets harder to achieve every time a program modification is made, and he said changing the HRR targets frequently only makes it more likely that targets are not met. Tonseth said setting a target for 20 years could limit adaptive management, which is already very difficult with HRRs. Gale said demanding incremental program improvements by updating HRR targets frequently should be avoided, but a bad program's underperformance would be perpetuated if HRR targets are not updated frequently enough. Mackey said the Hatchery Committees should revise HRR targets during recalculation.

Murdoch said some programs should be held to targets from other in-basin programs that are performing better. Specifically, she said one standard should be set for Methow spring Chinook salmon programs because they are all capable of achieving the same HRRs and differ only in factors such as transfer methods and crowding at acclimation ponds. She said the differences between programs can be compared and improved upon. Mackey said size-at-release differs between programs, for example, but the Hatchery Committees are already aware of the differences, and HRR does not need to be assessed to look into size-at-release differences. He said the Methow and Chewuch programs are both Methow Composite (MetComp) stock and should share a target, but the Twisp program should have its own target. Mackey said Okanogan and Omak steelhead are separate stocks and should also have separate targets.

Mackey said the most important piece of assessing HRRs is making sure they are above natural replacement rates. He said HRR is useful only as a quick way to assess the hatchery program and is not very informative. HRR includes a conglomeration of factors such as fecundity, in-hatchery survival with multiple components, and out of hatchery survival which also includes multiple components. The components should be looked at individually when considering management changes.

The Hatchery Committees representatives present and Grant PUD agreed to the following HRR targets and edited Grant PUD's Target HRR Proposal *(note: Sarah Montgomery* *distributed the revised Target HRR Agreement to the Hatchery Committees on February 19, 2016.)*:

- Use the estimated 40th percentile HRR target during 5-year evaluation periods.
- Use varying degrees of action depending on the number of years that the HRR deviates from the target; green light (below 40th percentile for 2 years or fewer, with no action) and red light (below 40th percentile for 3 years or more, investigate the cause of the performance issue, and potentially adapt the program if the cause can be attributed to the hatchery program).
- Each program will have its own HRR target, with the following exceptions:
  - Nason Creek will use the Chiwawa spring Chinook salmon target because there are no data for the Nason Creek program to calculate its target.
  - The Methow spring Chinook and Chewuch spring Chinook programs will use the higher of their two targets, because they both include MetComp stock and should be assessed together.

Objective 7

Hillman said the biggest issue identified by the Hatchery Committees for assessing Methow spring Chinook salmon freshwater productivity is that there are only a few years of data available for juvenile productivity. Mackey said more data are being collected to better assess the effects of pHOS on juvenile productivity.

Objective 1

Pearsons said that he recommended the Hatchery Committees discuss Objective 1 in order to confirm that programs are not negatively affecting the abundance of natural-origin spawners. Murdoch said several changes have been made to programs that may increase the abundance of natural-origin spawners. Pearsons said HRRs, stray rates, and other objectives should be put into the context of Objective 1 in order to ensure hatchery programs have a positive effect on the population.

Mackey said the review of Hatchery M&E Report objectives should be documented. Murdoch said the recommendations included in the Hatchery M&E Report are recommendations of the report authors only, and not of the Hatchery Committees. Pearsons said the Hatchery M&E Report can be cited and put into appropriate context in the Hatchery Committees' review of the report.

Montgomery said she will compile all Hatchery Committees discussions regarding the 5-Year Hatchery M&E Review process into one document organized by objective and send it to Catherine Willard. Willard said she will draft a summary of the 5-Year Hatchery M&E Review process.

D. NMFS Consultation Update (Craig Busack)

Craig Busack said he does not have an update from Amilee Wilson (NMFS) regarding the Wenatchee River Steelhead Biological Opinion (BiOp). He said, for the Methow spring Chinook salmon BiOp, the gene flow standards will be decided during the March 2016 (date to be determined) Hatchery Committees conference call, and the consultation will move forward with an approximate target completion date of May 2016. Regarding the bull trout coverage for both BiOps, Busack said he discussed with Karl Halupka (USFWS) whether the 2012 Wells Relicensing Bull Trout BiOp adequately provides bull trout coverage for the Methow Basin, and Halupka said it likely provides adequate coverage. Busack said Halupka also said the YN acclimation sites should have adequate bull trout coverage under the coho salmon BiOp. Bill Gale said USFWS believes the effects of acclimating other species like Methow spring Chinook salmon would be less than the effects already considered in the coho salmon BiOp. Busack said Alene Underwood is working on the revised Hatchery and Genetic Management Plan. He said any sites potentially involved in the proposed imprinting study should also be included in the consultations currently underway.

E. USFWS Consultation Update (Bill Gale)

Bill Gale said the Ecological Services branch of the USFWS is working on a draft Winthrop BiOp for review and should finalize Endangered Species Act Section 7 coverage for effects to bull trout in March 2016. This consultation will provide coverage for the spring Chinook and steelhead programs at Winthrop NFH.

F. Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth shared a document titled, "Draft Upper Columbia River Broodstock Collection Protocols," which Sarah Montgomery distributed to the Hatchery Committees on

February 11, 2016 (Attachment F). Tonseth said the protocols will be discussed at the PRCC HSC meeting on February 18, 2016. Tracy Hillman asked if sockeye salmon broodstock collection should be included in the protocols. Tonseth said only stocks utilizing a PUD facility are included in the protocols. Kirk Truscott said coho salmon historically used a PUD facility and, therefore, are included as a placeholder.

G. HETT Update (Sarah Montgomery)

Sarah Montgomery provided an update on the Draft Hatchery M&E Plan Appendices:

- Appendix 1 does not currently have a deadline, and Tracy Hillman said Appendix 1 is not a critical part of the M&E documentation.
- McLain Johnson (WDFW) will complete Appendix 2 now that the Hatchery Committees have decided how to calculate and assess HRR targets.
- Keely Murdoch is working on Appendix 3.
- Peter Graf completed Appendix 4, which Montgomery distributed to the Hatchery Committees for review on February 9, 2016.
- Catherine Willard completed Appendix 5, which Montgomery distributed to the Hatchery Committees for review on February 5, 2016.
- Matt Cooper completed Appendix 6, which Montgomery distributed to the Hatchery Committees for review on February 5, 2016.

III. Chelan PUD

A. DECISION: Approve 2016 Action Plan (Catherine Willard)

Catherine Willard shared a document titled, “Rock Island and Rocky Reach 2016 Action Plan” (Attachment G). Rocky Reach and Rock Island Hatchery Committees members present approved the hatchery portion of Chelan PUD’s 2016 Action Plan as follows: Chelan PUD, USFWS, WDFW, NMFS, YN, and CCT approved on February 17, 2016. *(Note: this item is also a decision item at the HCP Coordinating Committees meeting on February 24, 2016.)*

B. DECISION: Approve Wenatchee Summer Chinook SOA (Catherine Willard)

Catherine Willard said comments were received and incorporated into the Draft Wenatchee Summer Chinook SOA. The Rock Island and Rocky Reach Hatchery Committees representatives approved Chelan PUD's Wenatchee Summer Chinook SOA, *Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook* (Attachment H), as follows: Chelan PUD, USFWS, WDFW, NMFS, YN, and CCT approved on February 17, 2016. *(Note: Sarah Montgomery distributed the Final Wenatchee Summer Chinook SOA to the Hatchery Committees on February 18, 2016.)*

C. BY 2014 Methow Spring Chinook Salmon Acclimation (Catherine Willard)

Catherine Willard said the YN will operate the Chewuch AF in 2016 (according to email correspondence from Kirk Truscott and Jeff Korth).

D. 2016 Draft Steelhead Release Plan (Catherine Willard)

Catherine Willard shared two documents—"Draft 2016 Wenatchee Steelhead Release Plan" (Attachment I) and "Preliminary Results from the 2015 Wenatchee Steelhead Release"—which Sarah Montgomery distributed to the Hatchery Committees on February 18, 2016. She said the plan is the same as last year, except for the exact number of fish that will be released from each location. She also said Chelan PUD did not meet its 2015 steelhead release obligation; it was short by approximately 50,000 hatchery-by-hatchery steelhead for the Wenatchee steelhead program.

IV. HCP Administration

A. Accessibility of Public HCP-HC Documents

Tracy Hillman said he often receives requests for Hatchery Committees' documents, such as annual and 5-year reports. He asked if there is a central website where these are located. Tom Kahler said Douglas PUD posts the reports to its website. Catherine Willard said Chelan PUD does not have a suitable website for posting these documents. Todd Pearsons said he would look into the possibility of Grant PUD posting annual and 5-year reports on its website.

B. Next Meetings

Sarah Montgomery said she would schedule a conference call in March 2016 for the Hatchery Committees to discuss two decision items: 1) gene flow standards for Methow spring Chinook salmon; and 2) Chelan PUD's 2016 Draft Steelhead Release Plan. The next regularly scheduled Hatchery Committees meetings are on March 16, 2016 (Douglas PUD), April 20, 2016 (Chelan PUD), and May 18, 2016 (Douglas PUD).

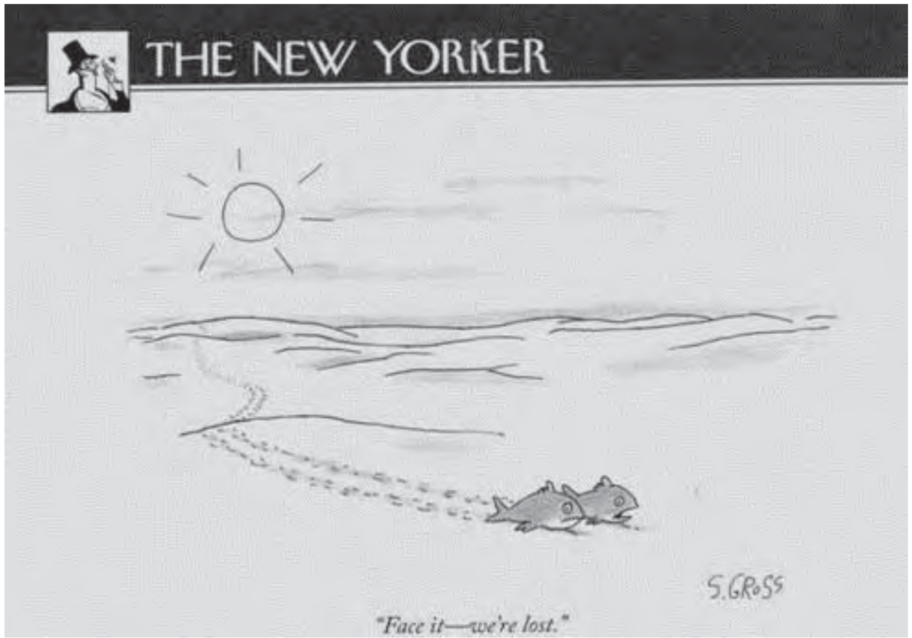
V. List of Attachments

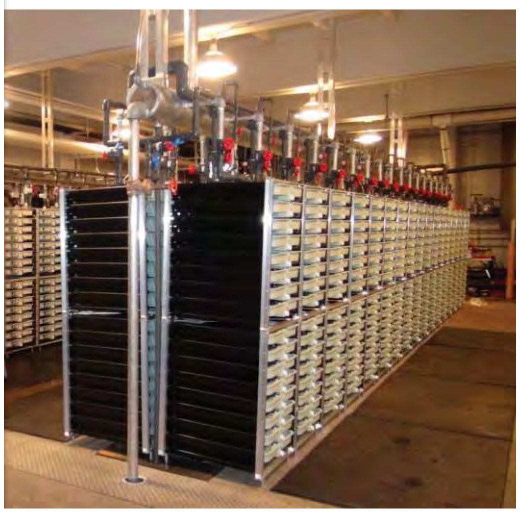
Attachment A	List of Attendees
Attachment B	Effects of Hatchery Rearing and Release Practices on Olfactory Imprinting and Homing
Attachment C	Methow spring Chinook Gene Flow Analysis
Attachment D	Twisp and Chewuch Homing Fidelity Study Options
Attachment E	Target HRR Proposal
Attachment F	Draft Upper Columbia River Broodstock Collection Protocols
Attachment G	Draft 2016 Rock Island and Rocky Reach HCP Action Plan
Attachment H	Improvement Feasibility at Eastbank Hatchery for Wenatchee summer Chinook Draft SOA
Attachment I	Draft 2016 Wenatchee Steelhead Release Plan

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Peter Graf	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Justin Yeager*	National Marine Fisheries Service
Craig Busack*†	National Marine Fisheries Service
Charlene Hurst†	National Marine Fisheries Service
Andrew Dittman	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Charlie Snow†	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

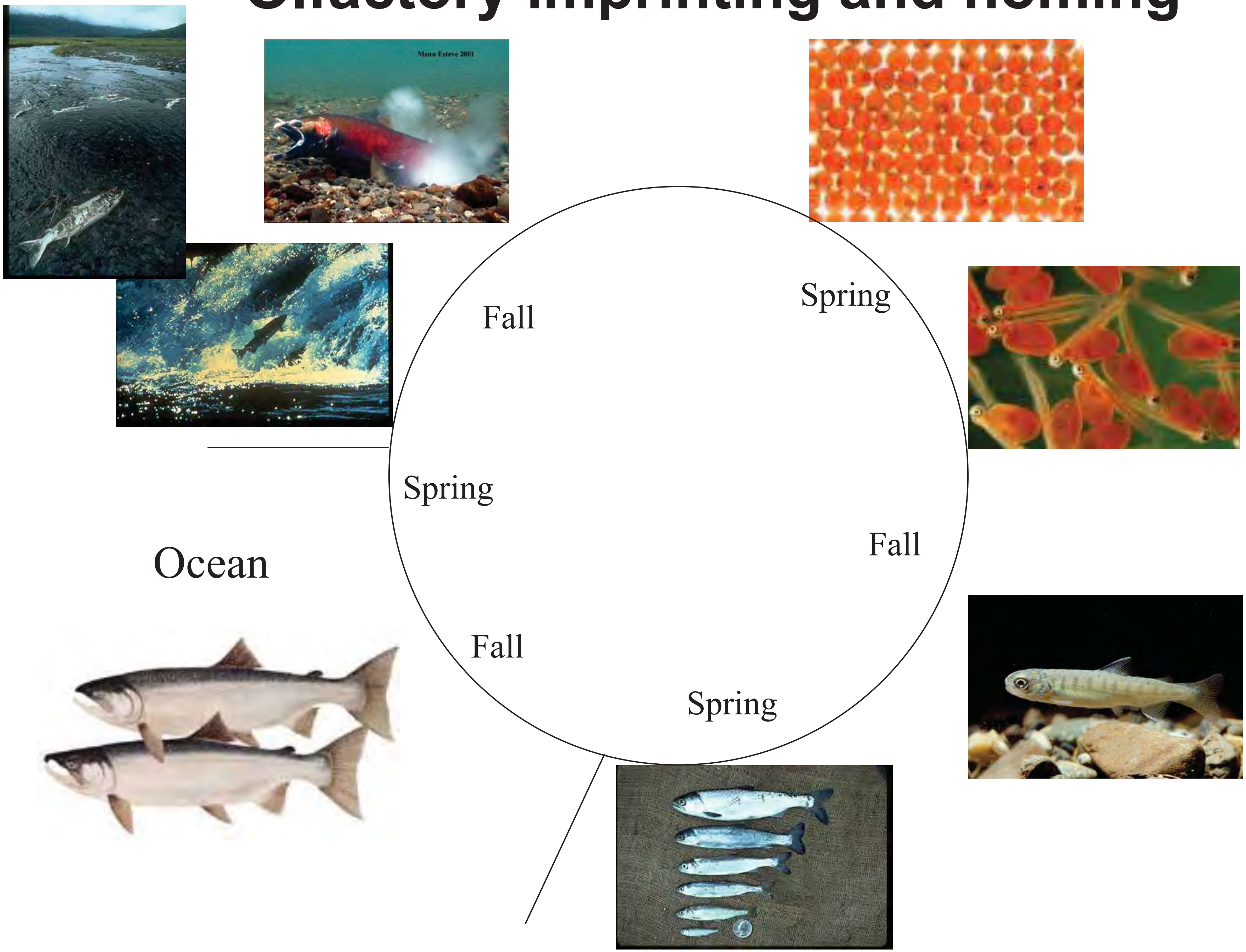
Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone

Effects of hatchery rearing and release practices on olfactory imprinting and homing



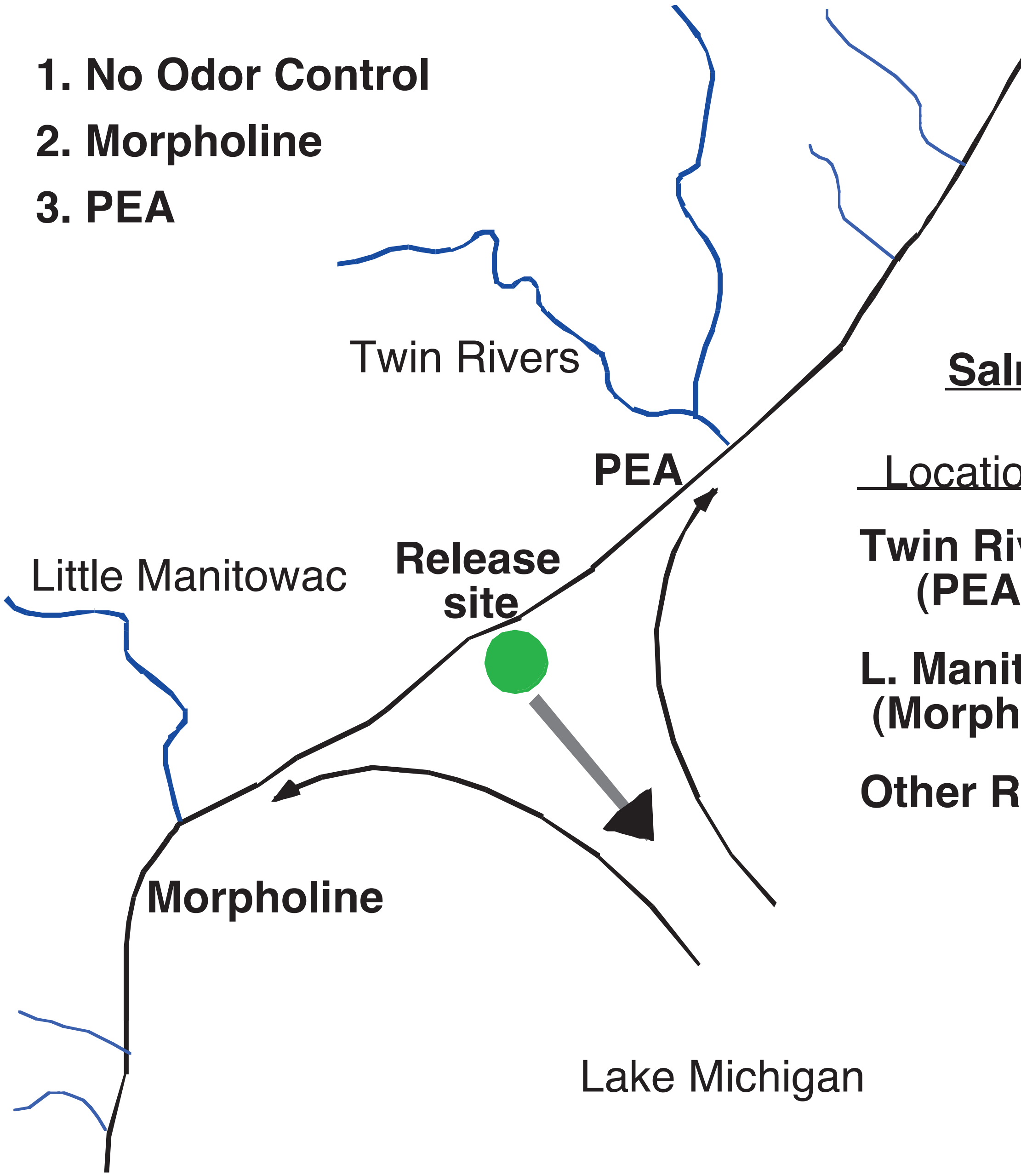


Olfactory imprinting and homing



Experimental evidence for imprinting hypothesis

1. No Odor Control
2. Morpholine
3. PEA

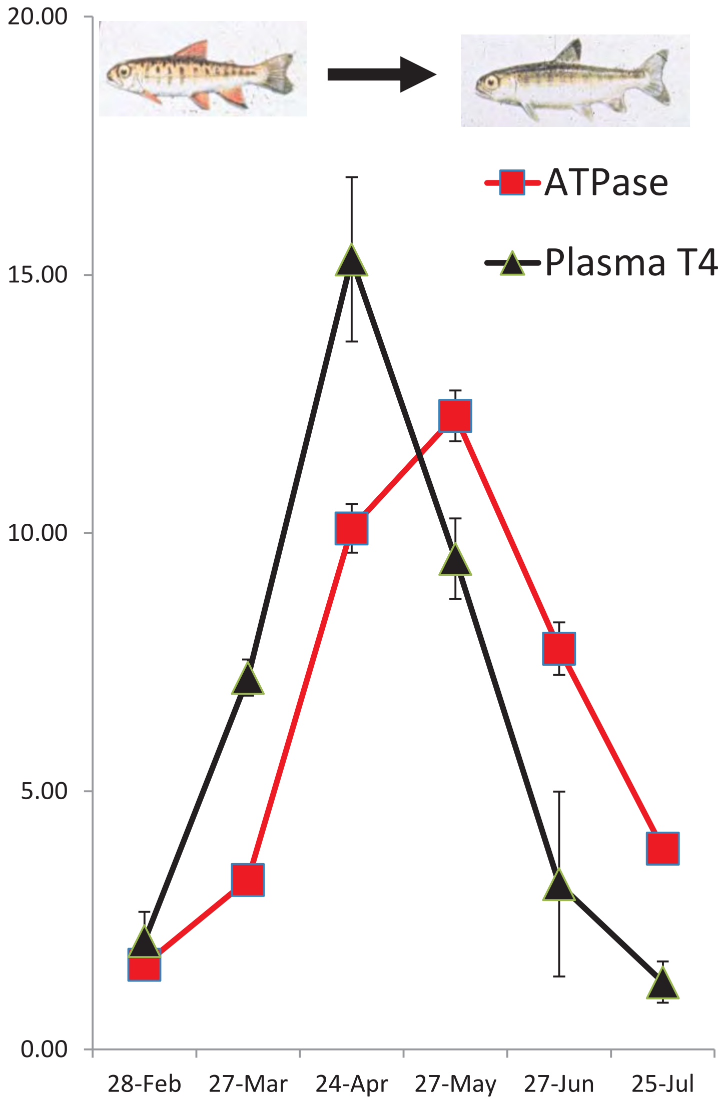


Salmon recovered during homing

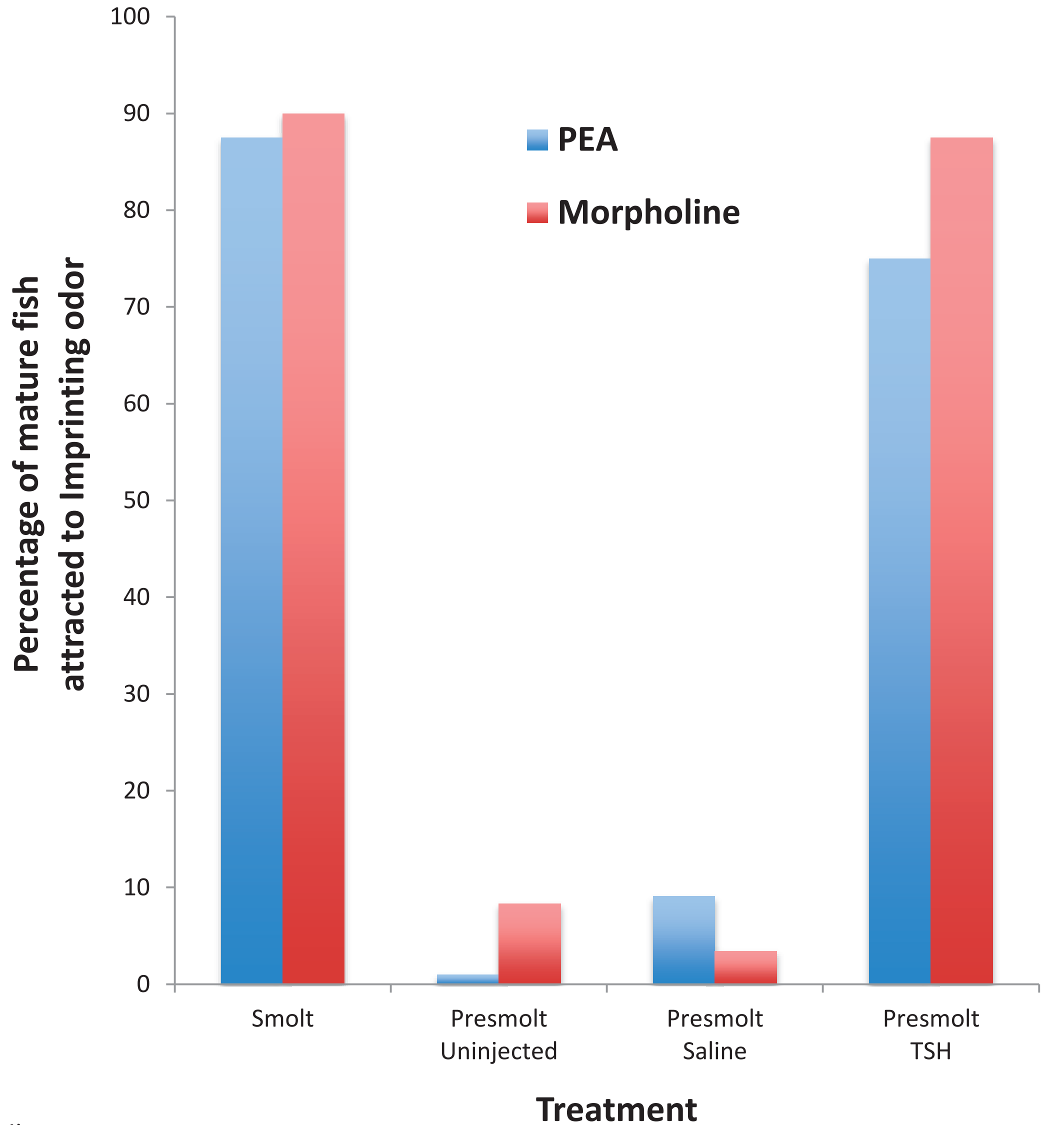
Location	Morpholine	PEA	Control
Twin Rivers (PEA)	**8**	**333**	**55**
L. Manitowac (Morpholine)	**659**	**20**	**76**
Other Rivers	**14**	**9**	**154**

Scholz et al. 1976

Imprinting is associated with thyroid hormone surges that occur during smolting

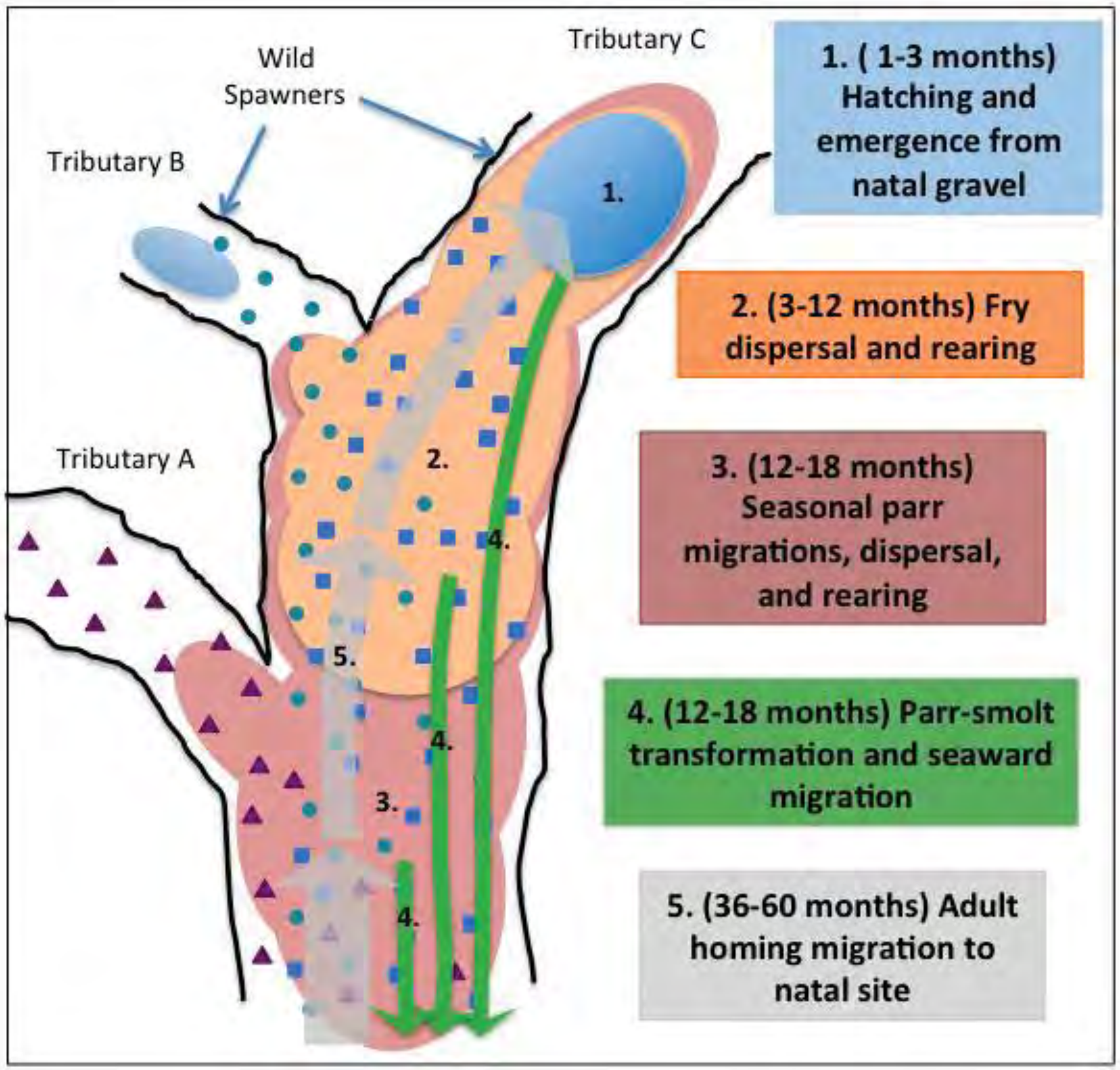


(Dittman et al. unpublished)



Hasler and Scholz 1983

Sequential Imprinting hypothesis



Why do salmon stray?

Failure to home →
- Imperfect imprinting
- Memory loss
- Sensory failure
- Signal changed or masked
- Exhaustion

Decision to stray → Tradeoff between homing and spawning site selection

Genetic strategy → Dynamic equilibrium between homing and straying; metapopulations

After: T. Quinn

Do hatchery salmon stray more?

Keri Wiginton


Do hatchery salmon stray more?
Not necessarily
But the things we do can definitely increase straying
• Transport and release away from the natal hatchery
• Release at inappropriate developmental stages
• Acclimation strategies
• Release into inappropriate habitat
• Effects of rearing environment on imprinting
- Developmental processes
- Environmental complexity

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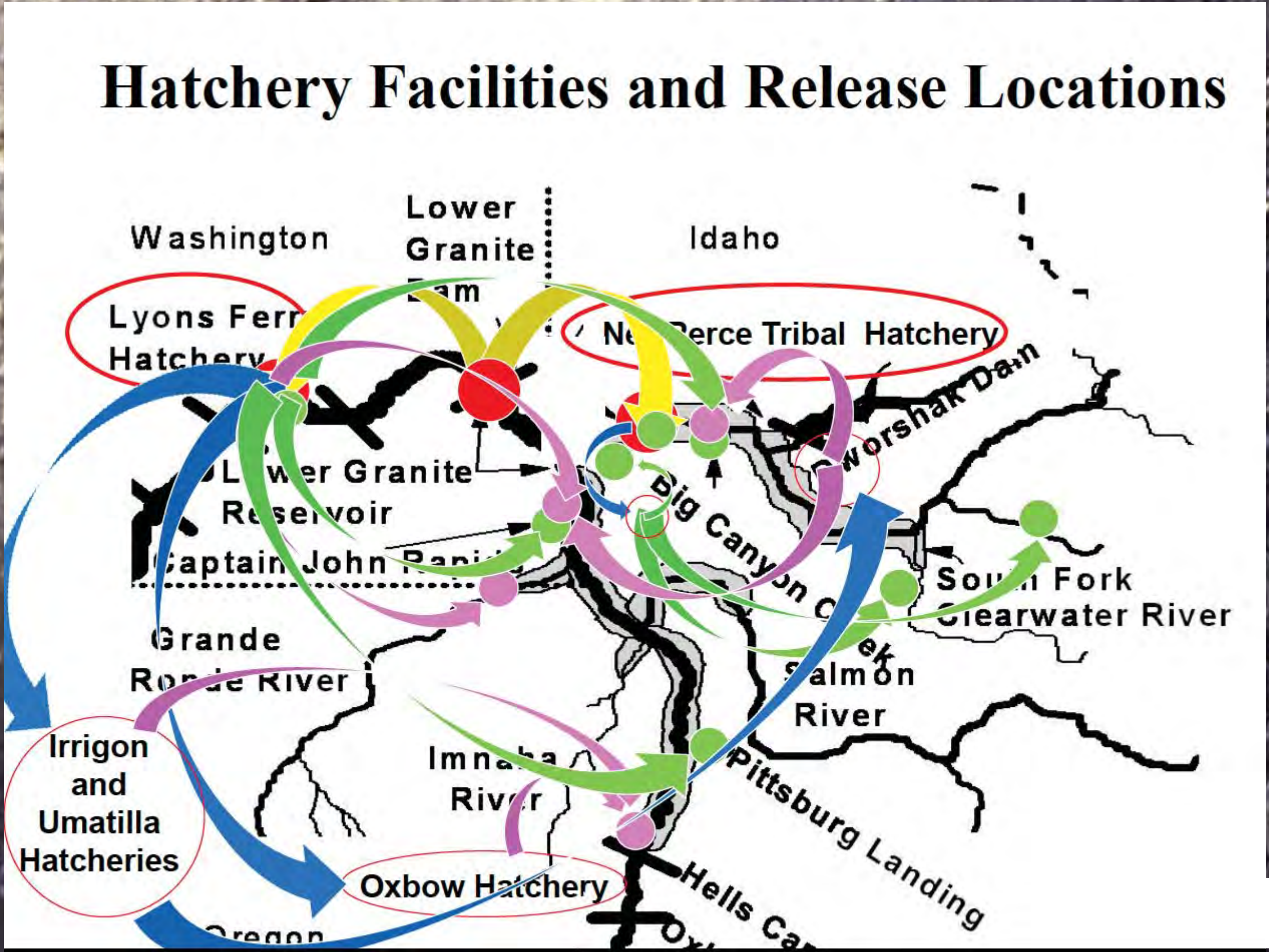


Jay Hesse

Do hatchery salmon stray more?

Effect of transport distance on homing fidelity to release sites (Lister et al. 1981)

Rearing – release distance (km)

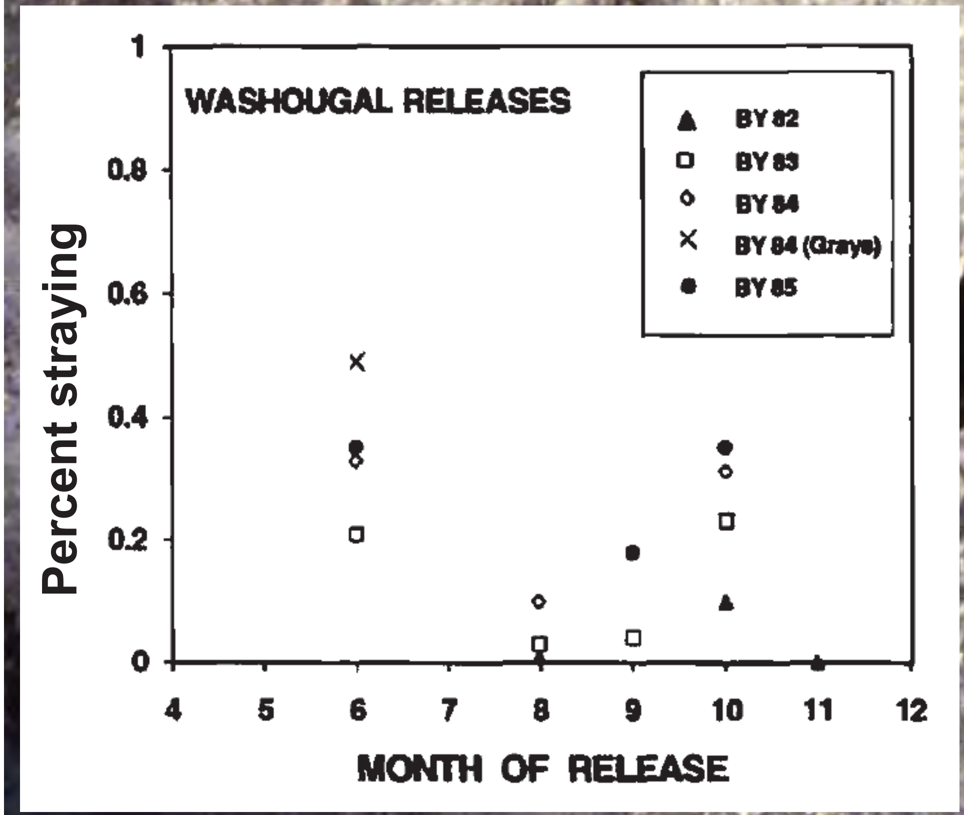
	0	4-29	47-485
Number of studies	10	5	7
Avg. straying from the release site	3%	74%	8%
Range	0-13%	37-100%	1-39%
% straying to rearing site	-	77%	55%

In 5 studies, smolts were released in *other* river systems; only 0 – 6% strayed from the release site.

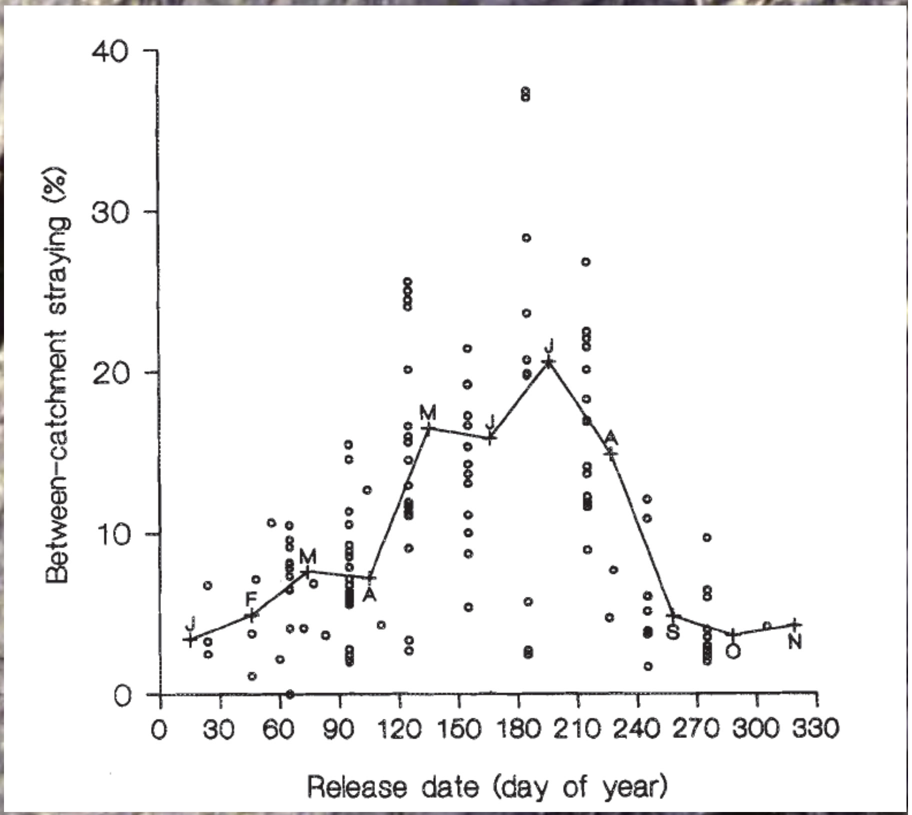
Do hatchery salmon stray more?

Not necessarily

But the things we do can definitely increase straying



Pascual et al. 1995



Unwin and Quinn. 1993

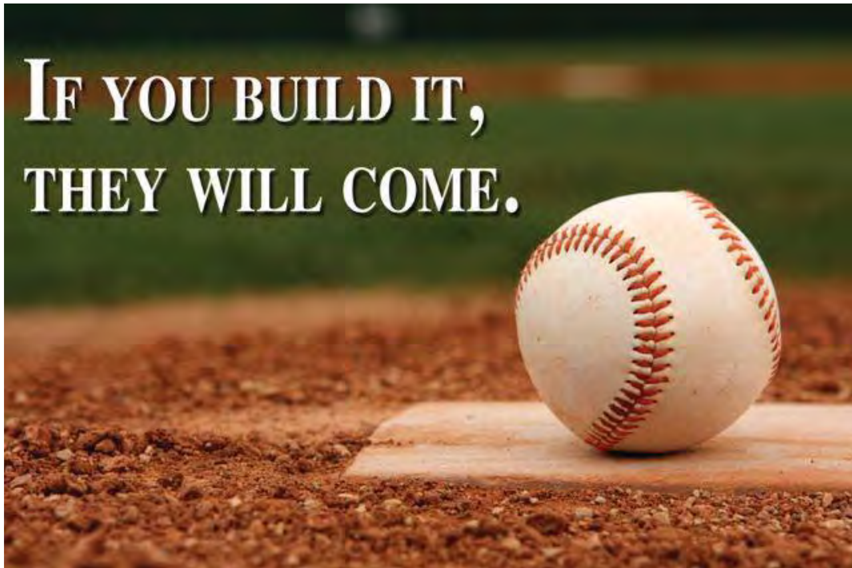
Do hatchery salmon stray more?

Not necessarily

But the things we do can definitely increase straying

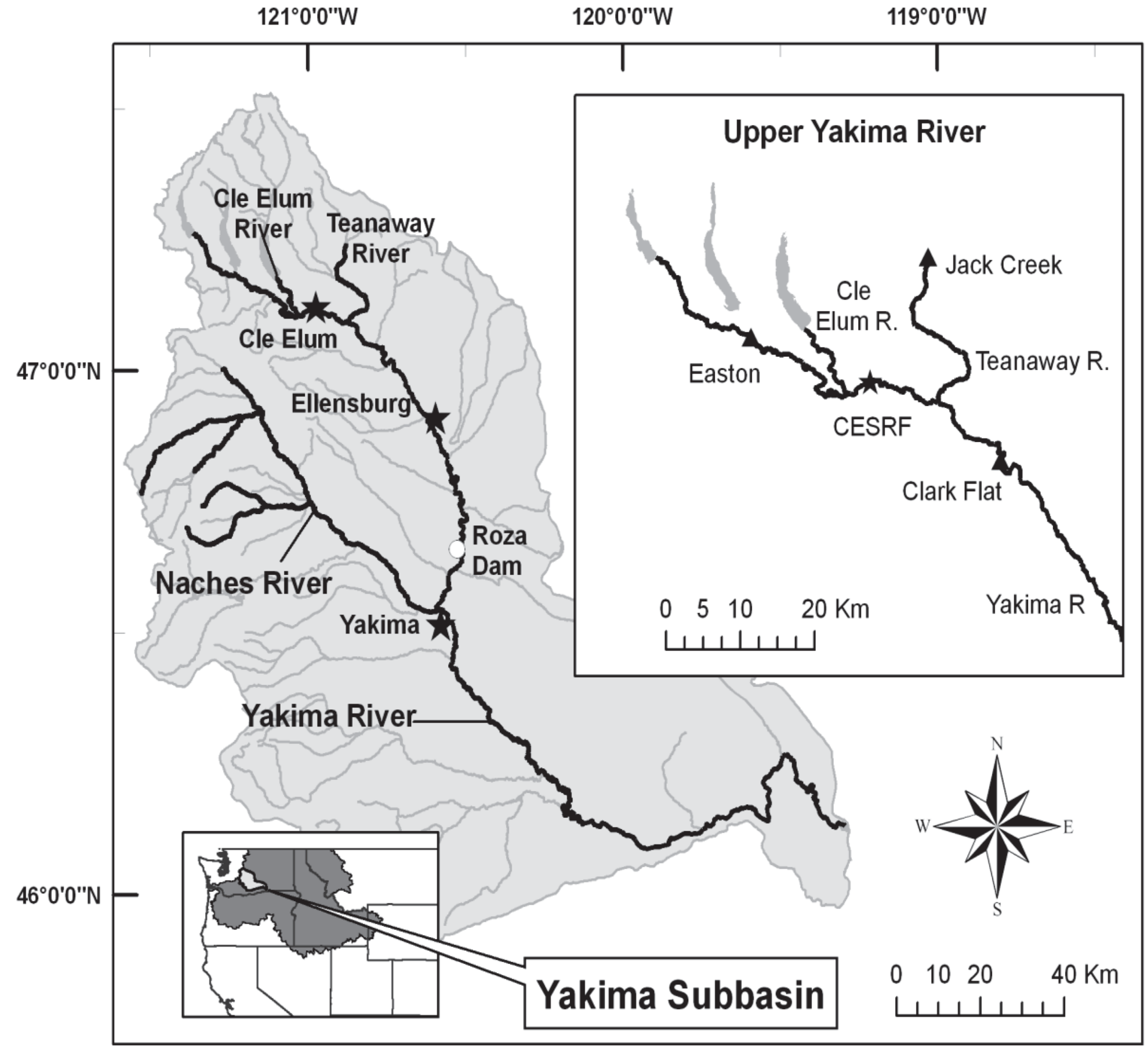
Acclimation: location, timing, duration

Attachment B

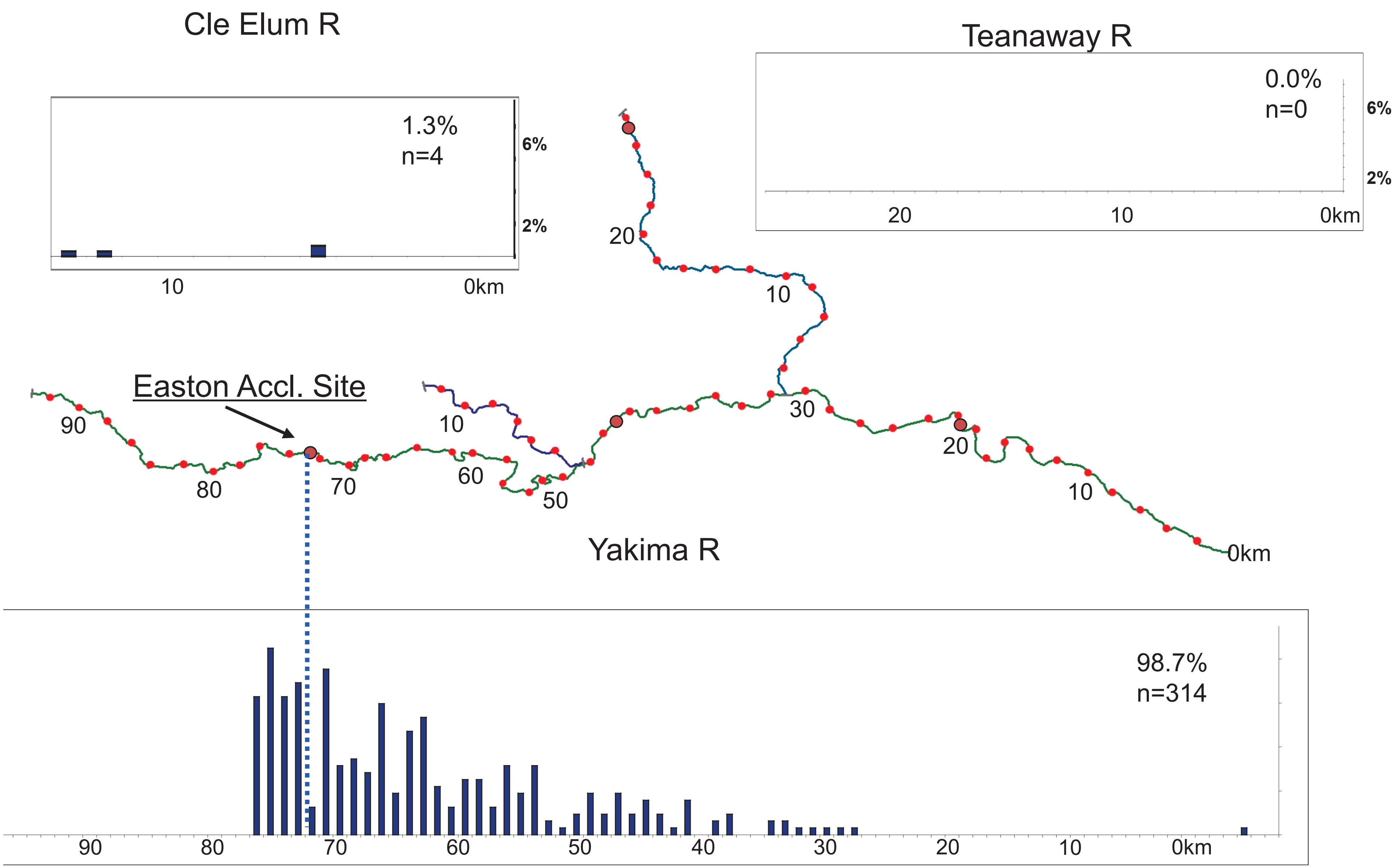


IF YOU BUILD IT,
THEY MAY OR MAY NOT COME.

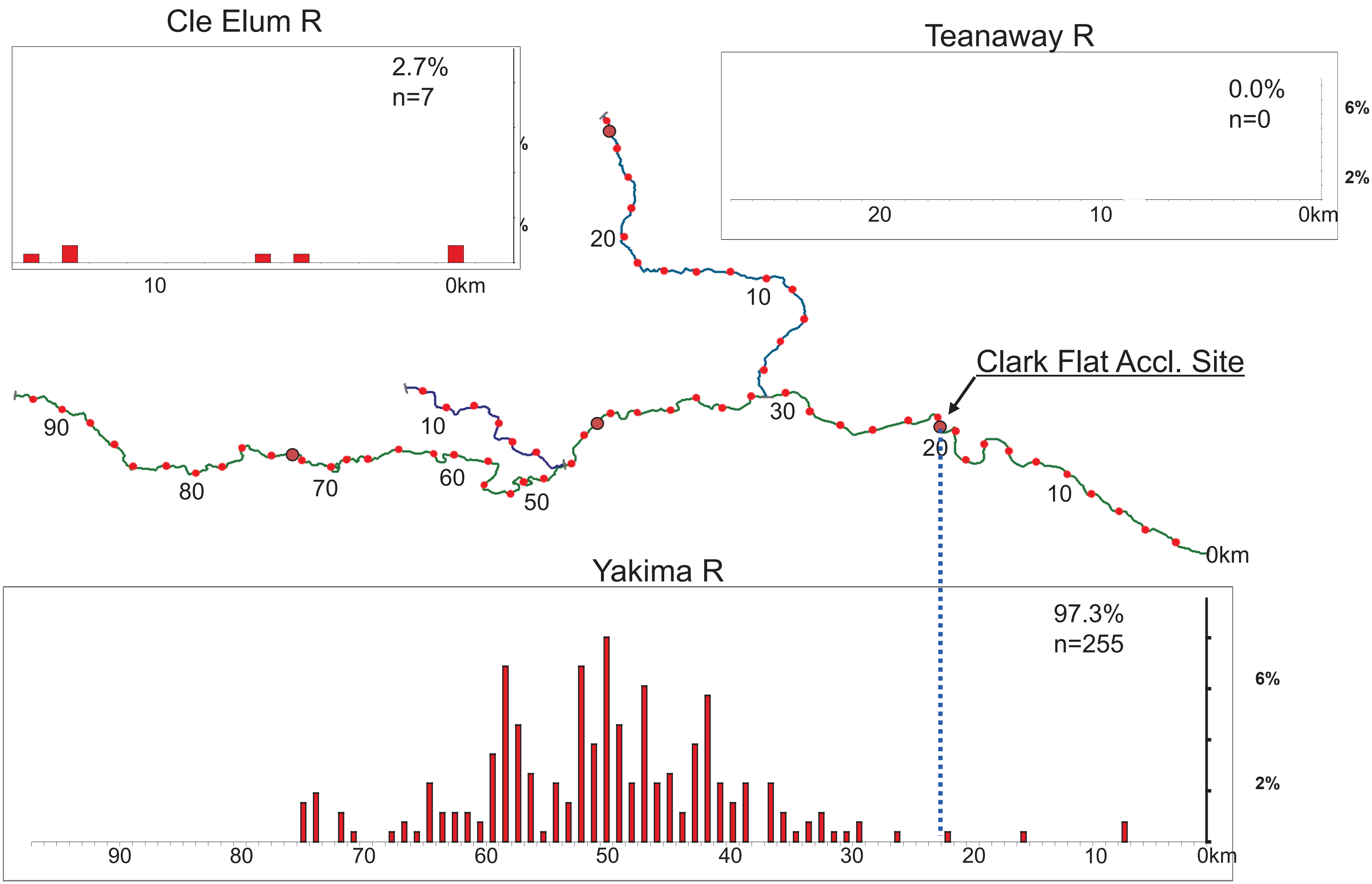
Yakima River Spring Chinook Salmon Supplementation Program



Easton Spawner distribution

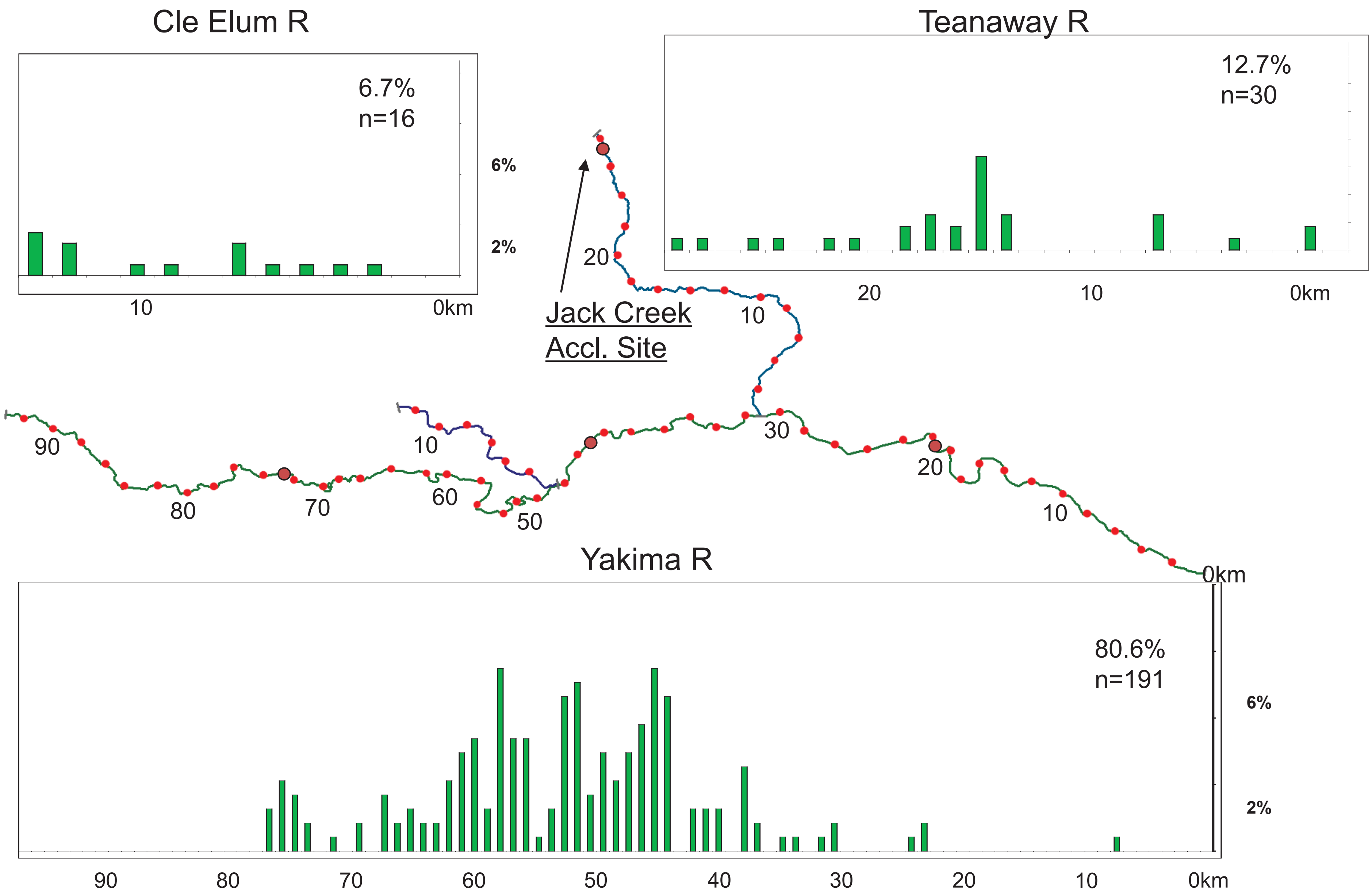


Clark Flat Spawner distribution

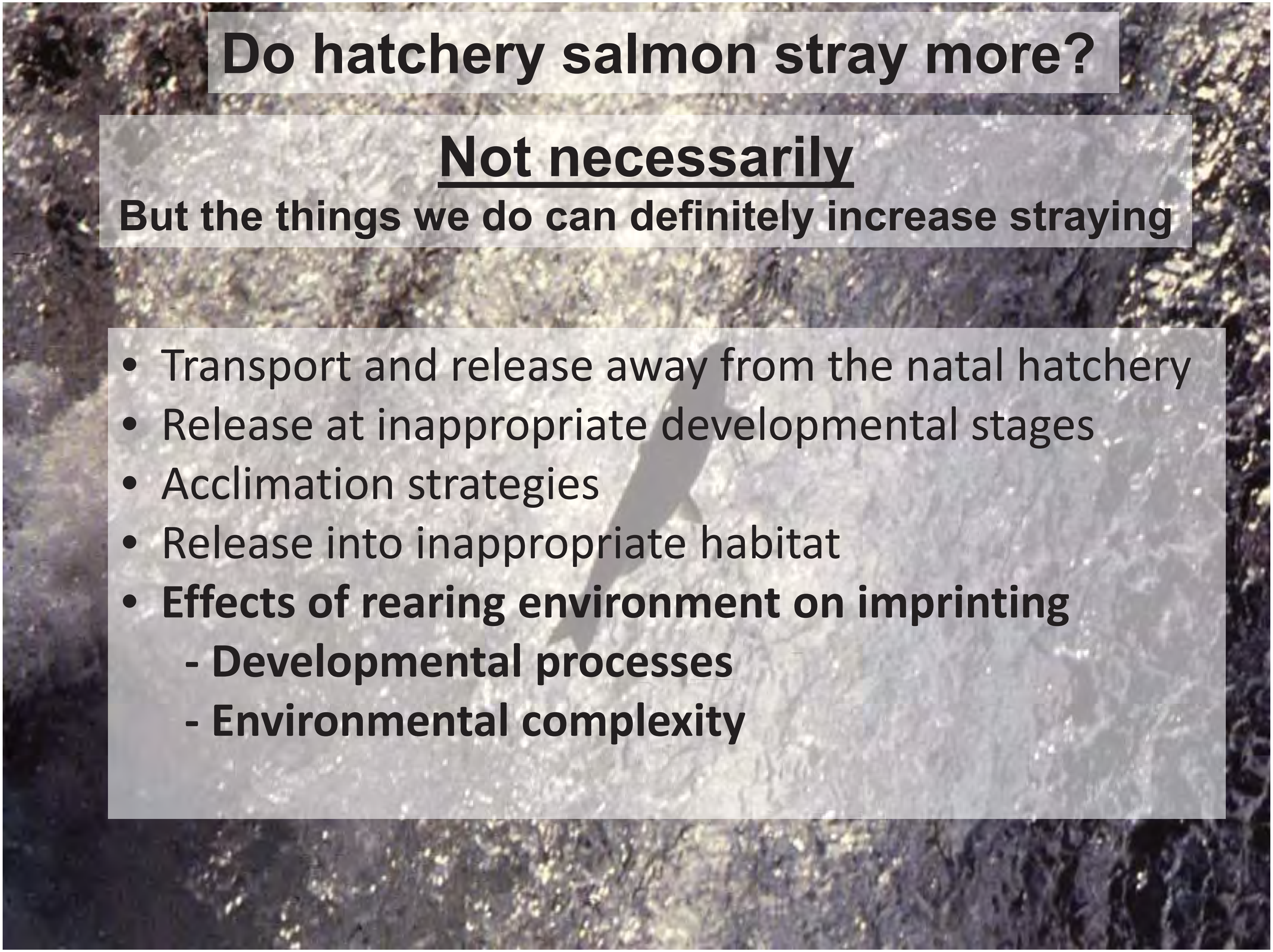


Attachment B

Jack Creek Spawner distribution



Spawner distribution -all treatments


Do hatchery salmon stray more?
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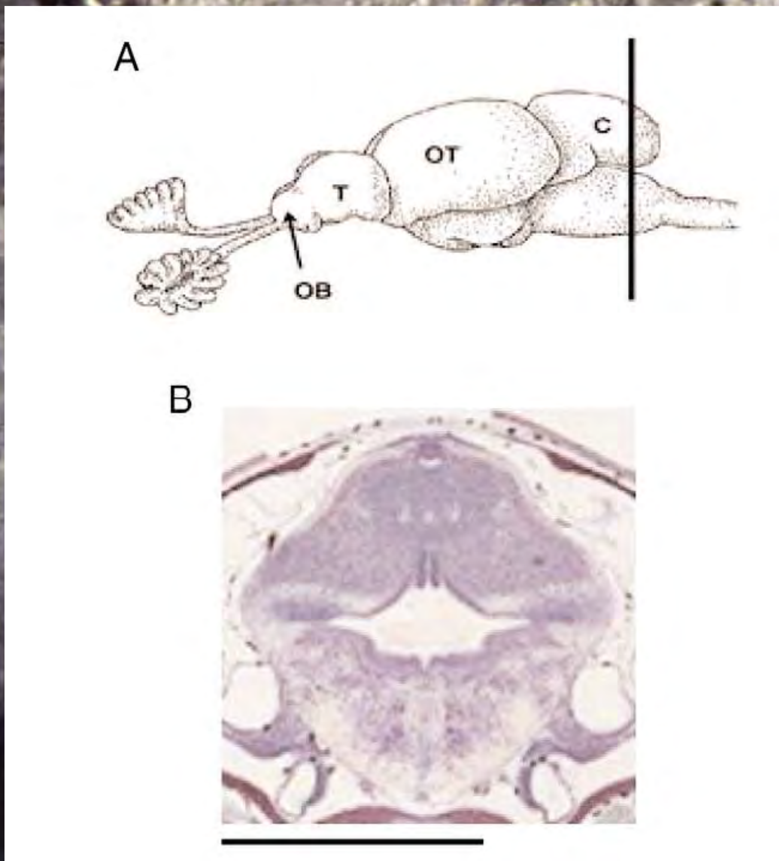
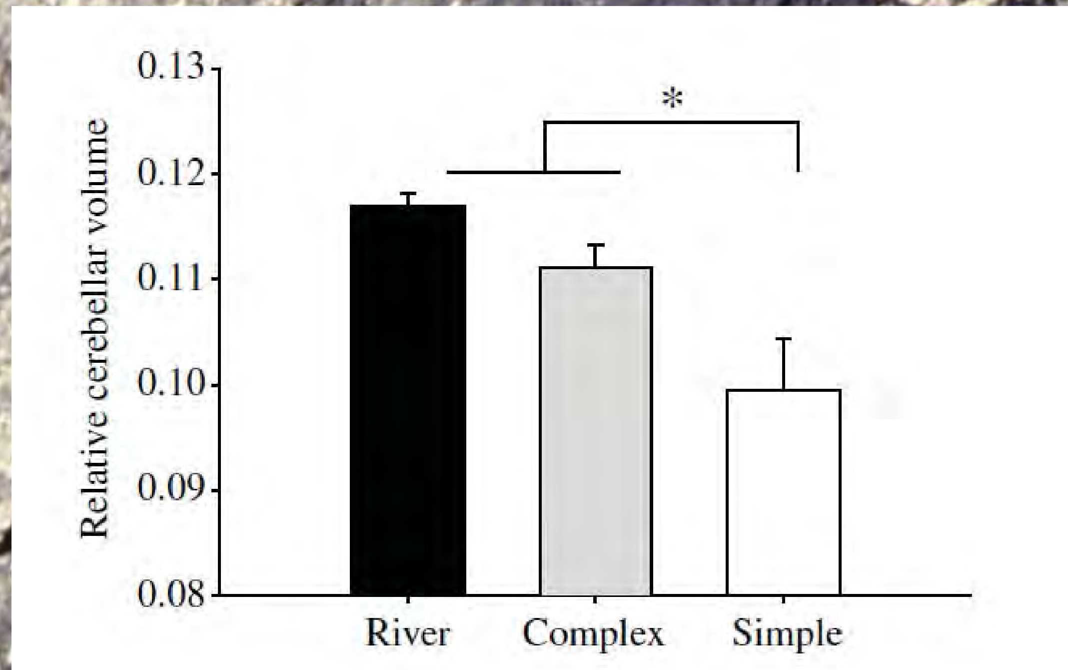
Hatchery rearing affects the brain

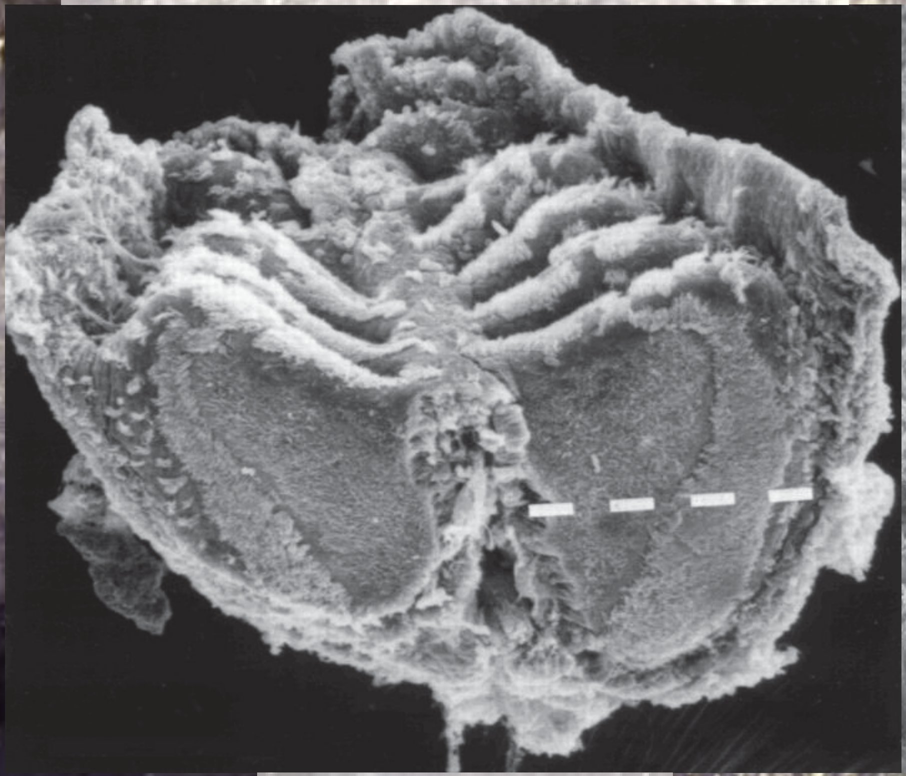




Kihslinger and Nevitt 2006

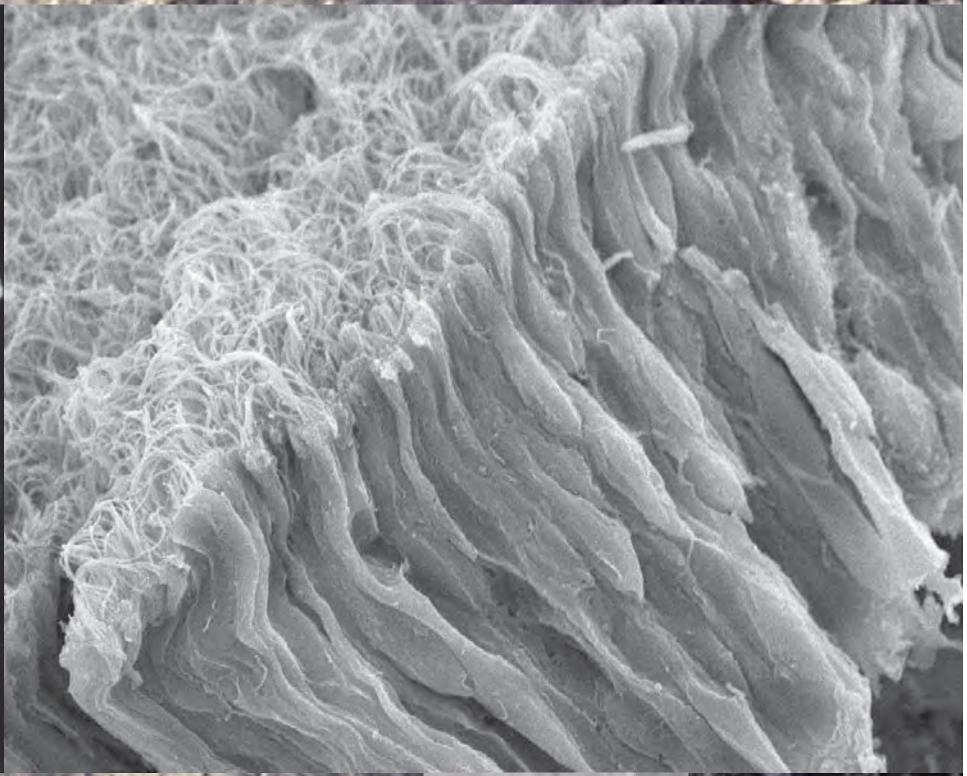
Does hatchery rearing affect the olfactory system?

Olfactory Rosette



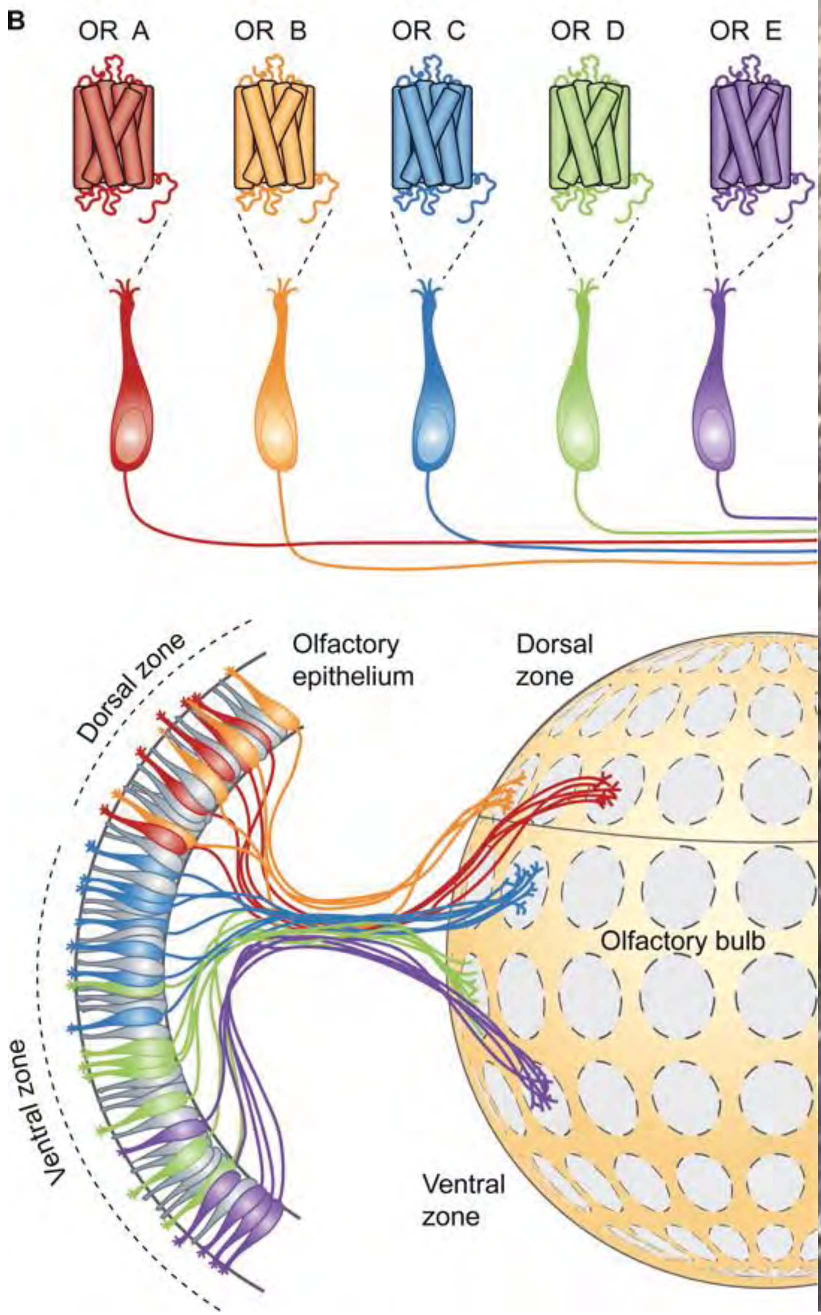
from Weth et al. 1996

Olfactory Epithelium

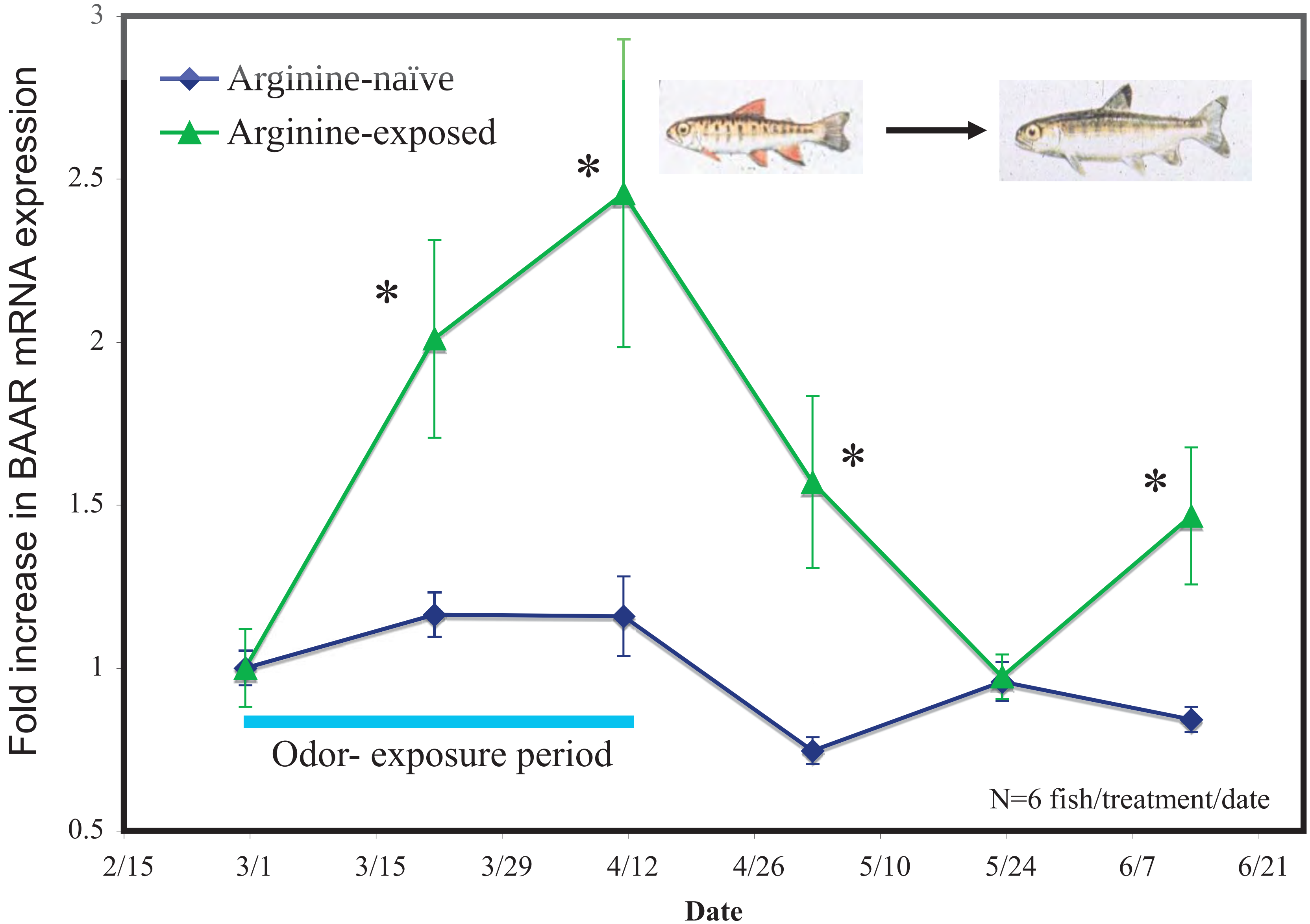


Carla Stehr

Does hatchery rearing affect the olfactory system?



Arginine exposure increased BAAR mRNA expression during smolting



Attachment B

Smolting-associated changes in odorant receptor expression

Wallowa Hatchery steelhead

↓

Reared to yearling stage at Big Beef Creek hatchery in well water

↓

Initiate surface water experiment Jan. 20
- **2 tanks well water**
- **2 tanks surface water**

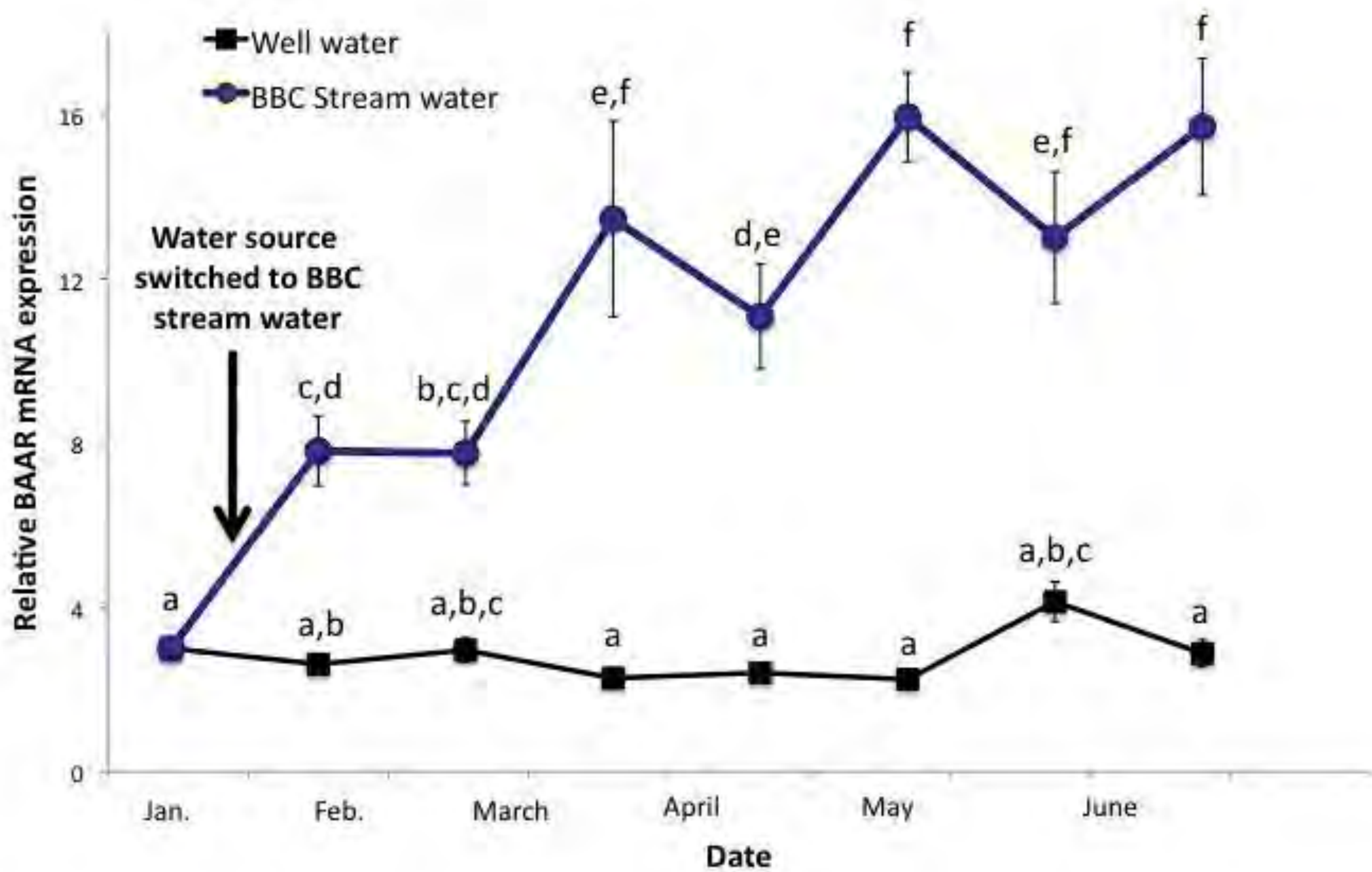
↓

Sample fish for olfactory tissue every 3 weeks

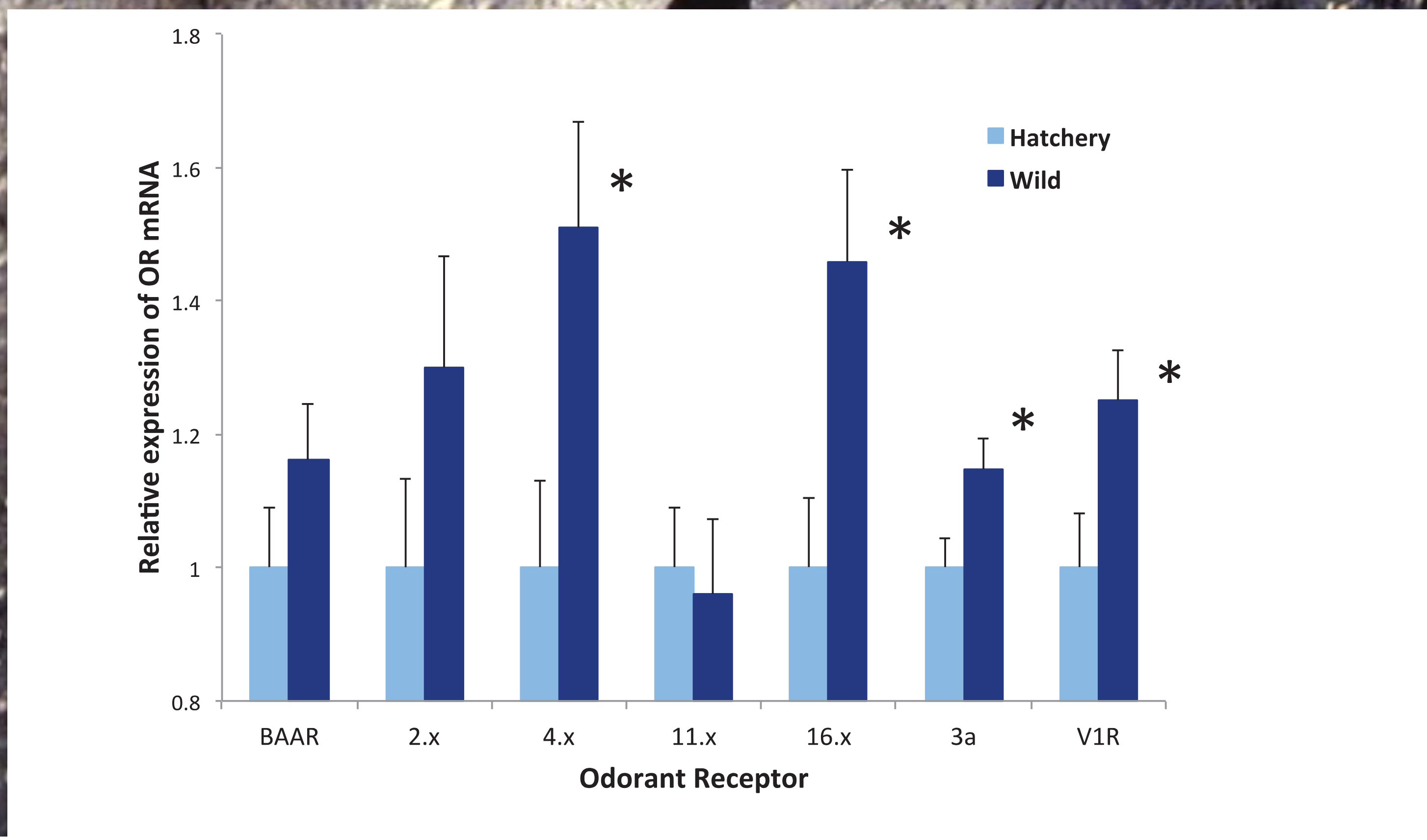
↓

Analyze olfactory development (OR expression)

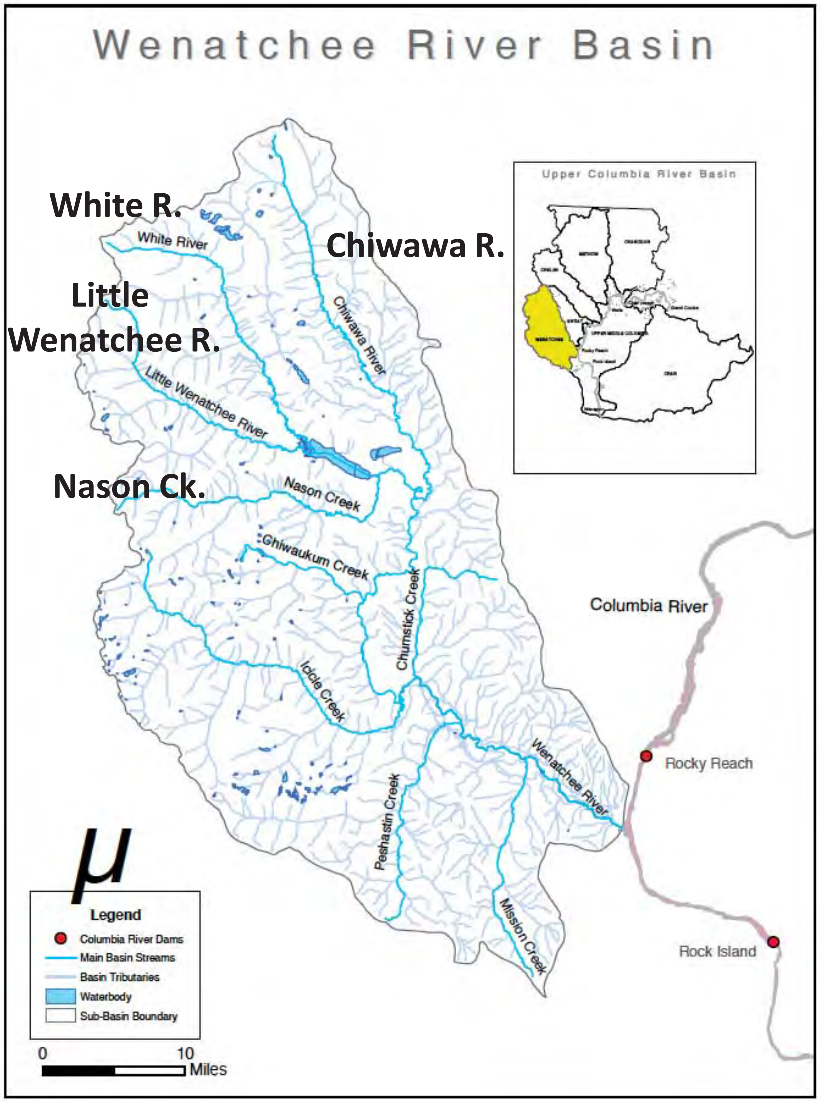
Smolting-associated changes in odorant receptor expression

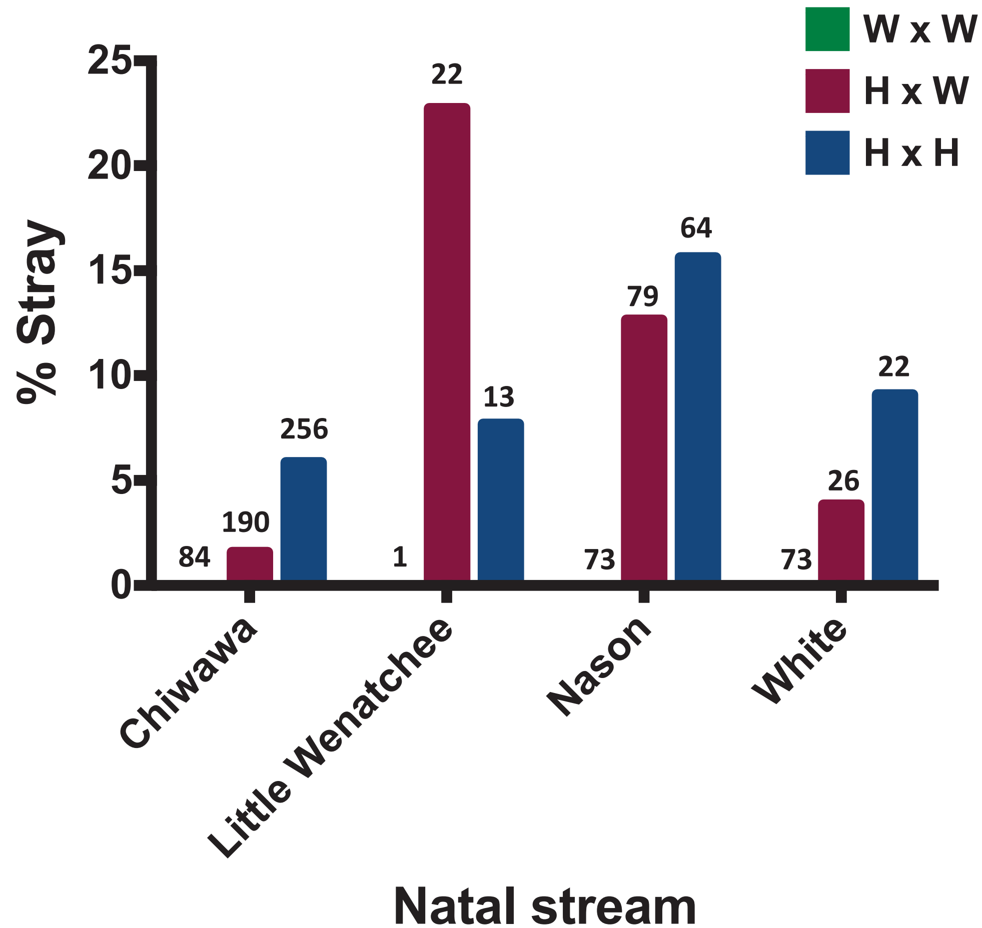


Does hatchery rearing affect the olfactory system?

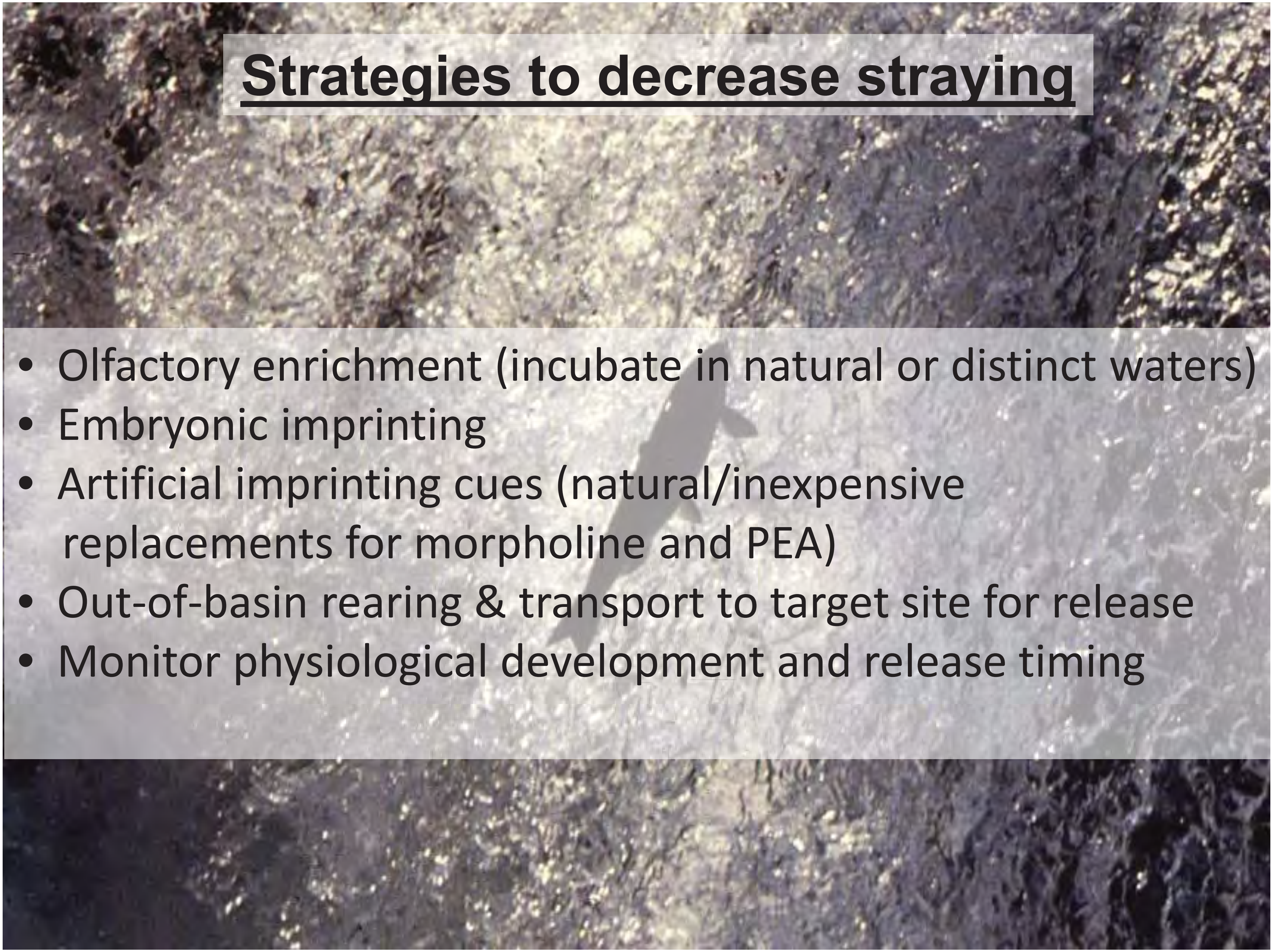


Effects of origin on straying by naturally spawned salmon





Ford et al. 2015. Molecular Ecology


Strategies to decrease straying
• Olfactory enrichment (incubate in natural or distinct waters)
• Embryonic imprinting
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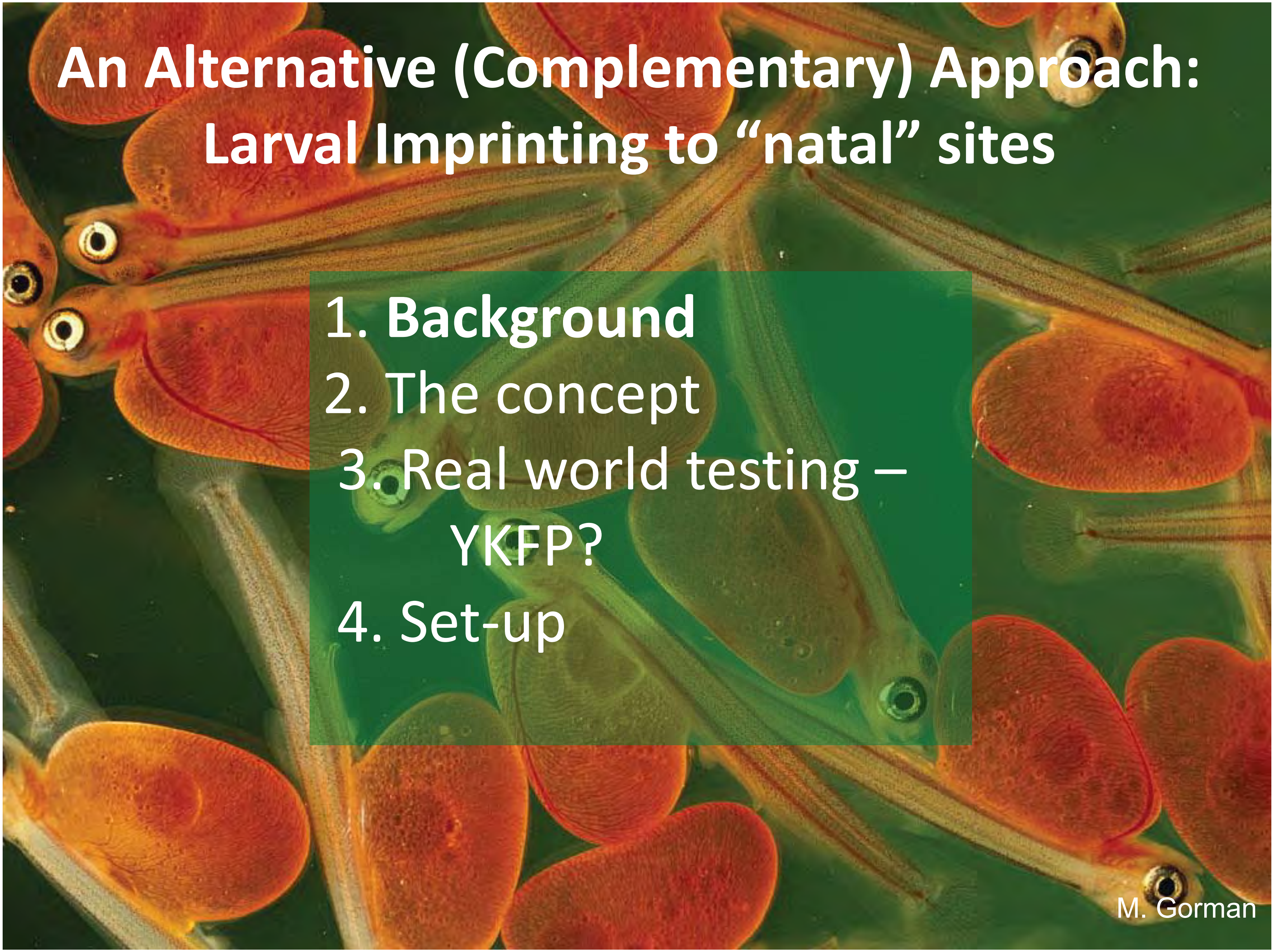
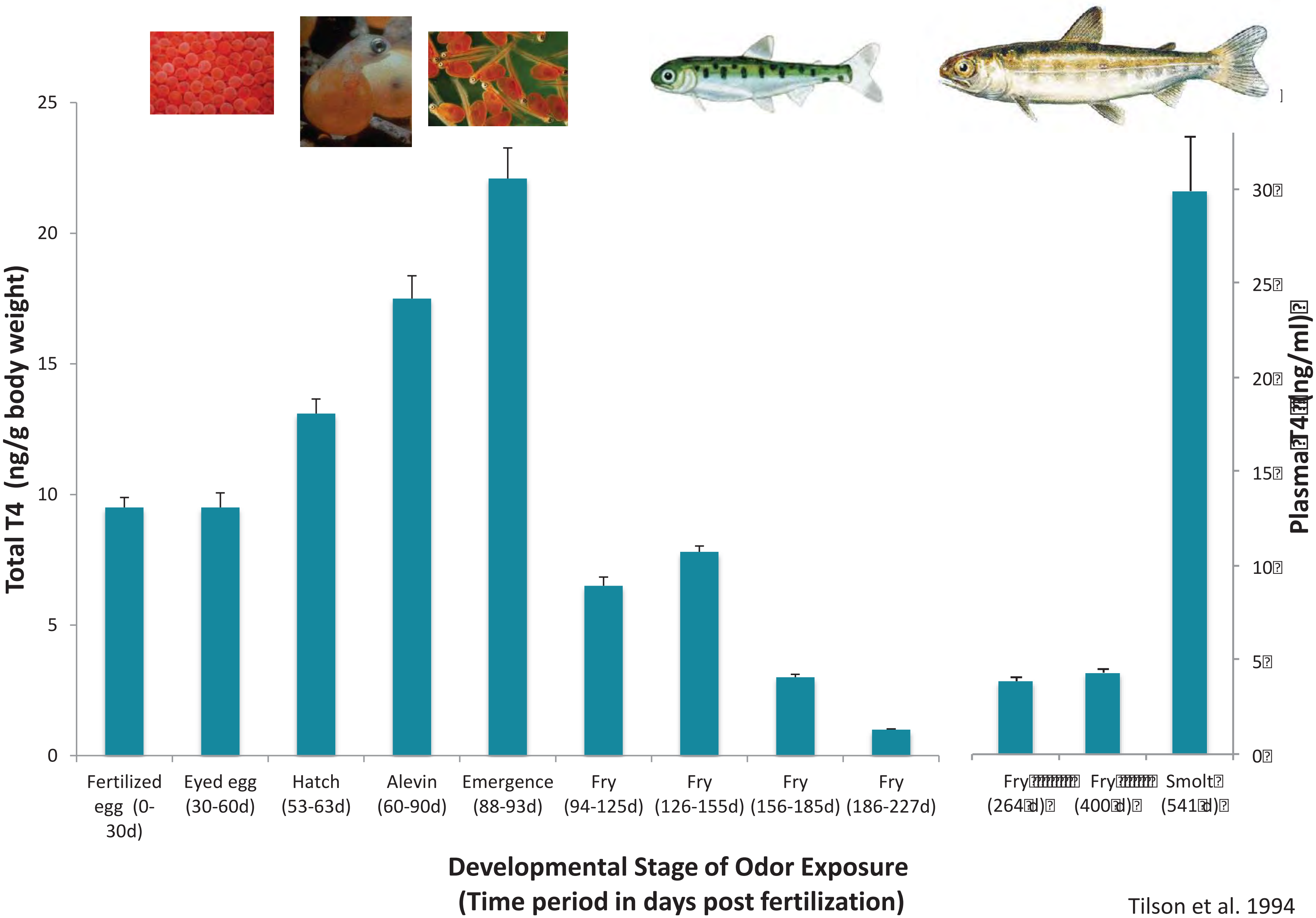
• Out-of-basin rearing & transport to target site for release
• Monitor physiological development and release timing

Attachment B

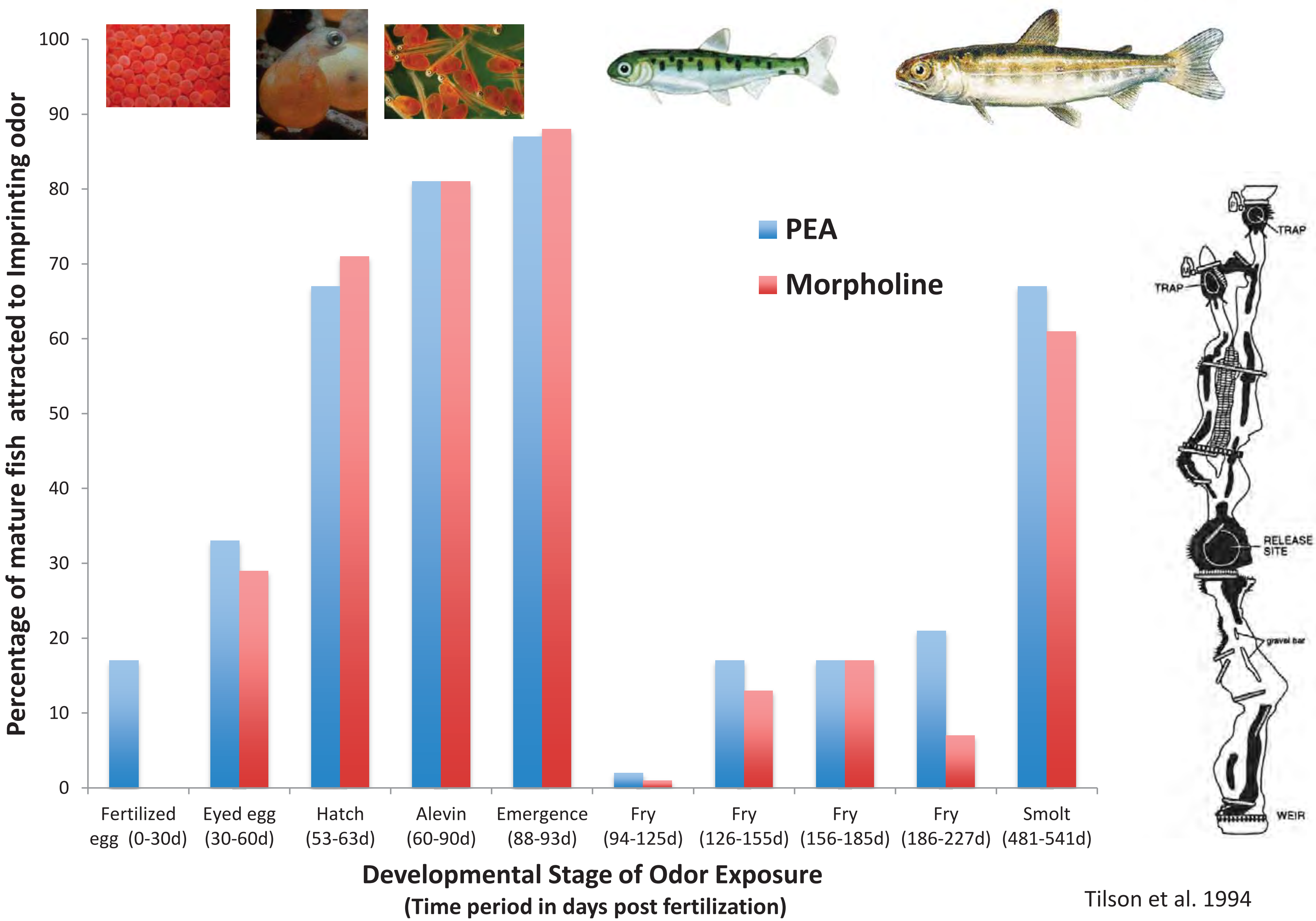


Salmon experience T4 surge as smolts <u>and</u> as embryos



Tilson et al. 1994

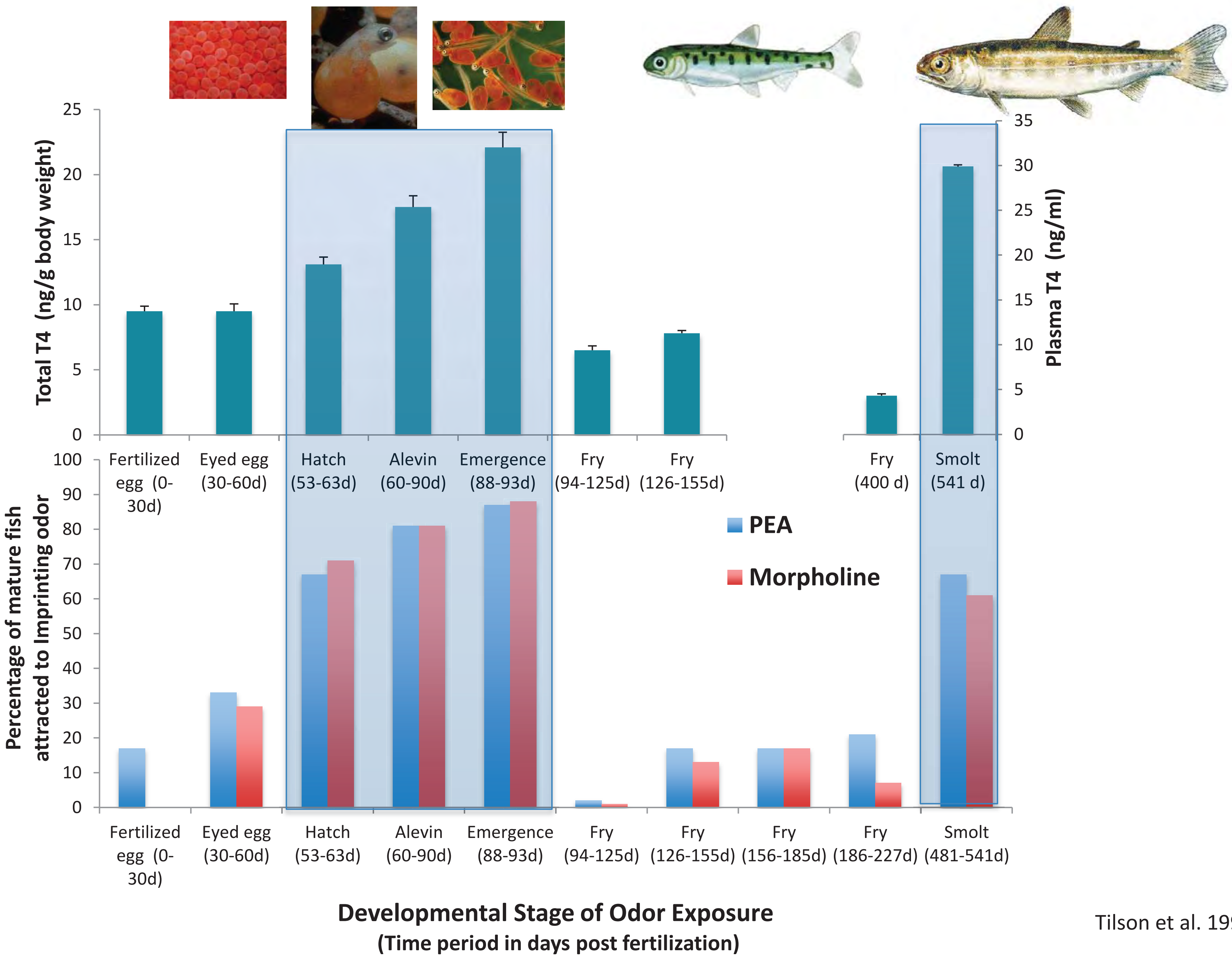
Salmon imprint to natal site as smolts <u>and</u> as embryos



Tilson et al. 1994

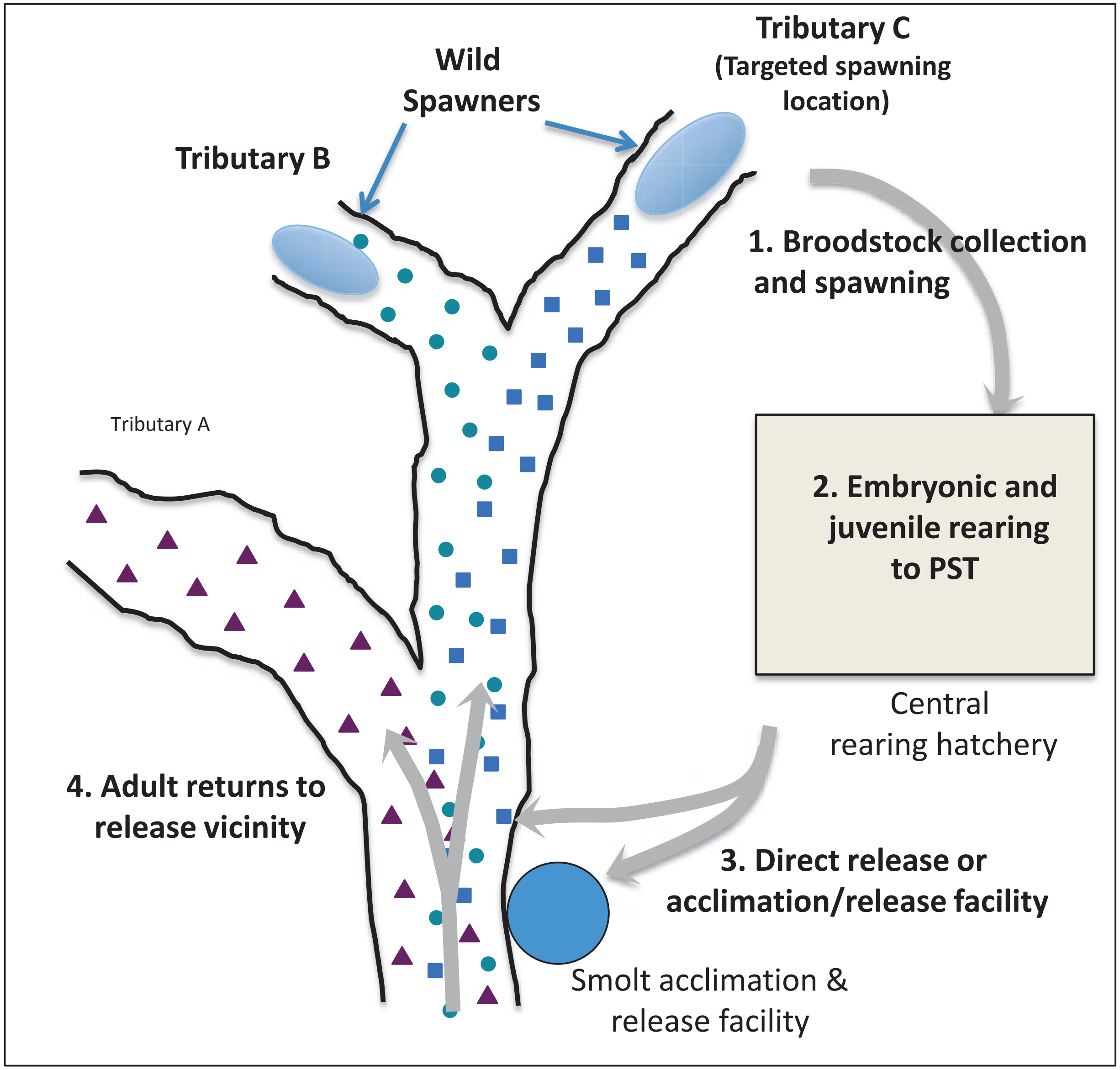
Attachment B

T4 surges are associated with imprinting

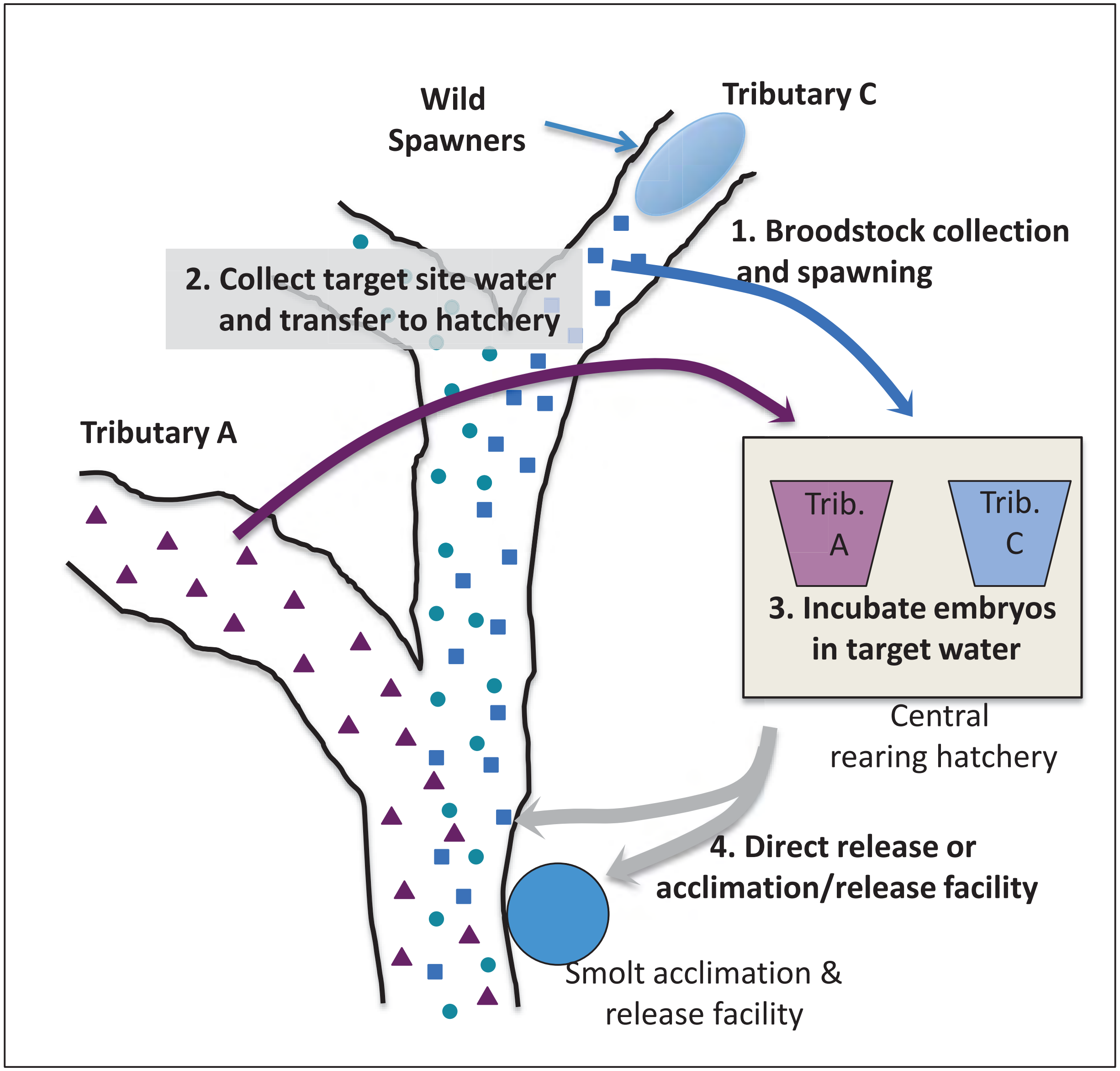


Tilson et al. 1994

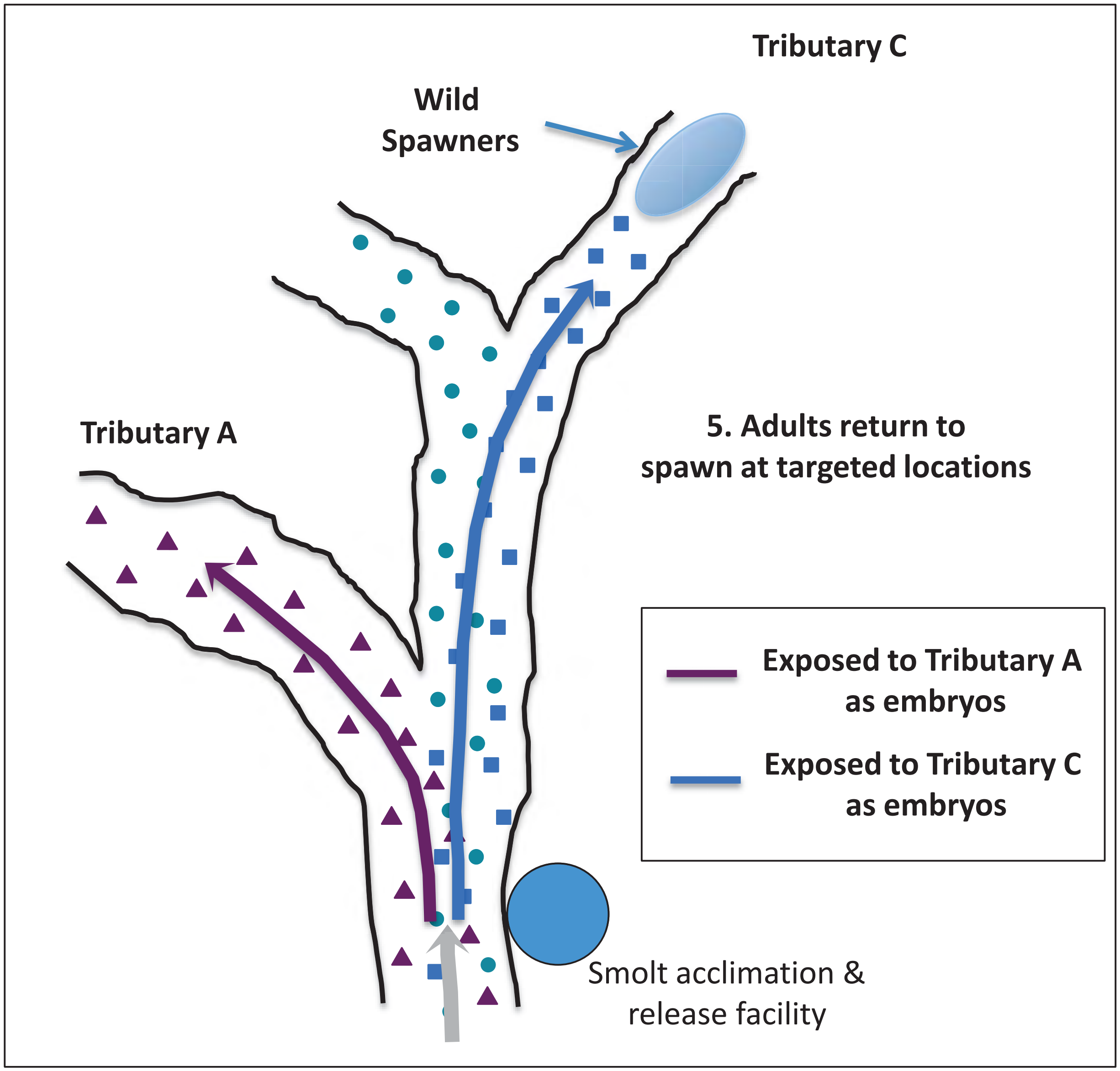
Current supplementation programs

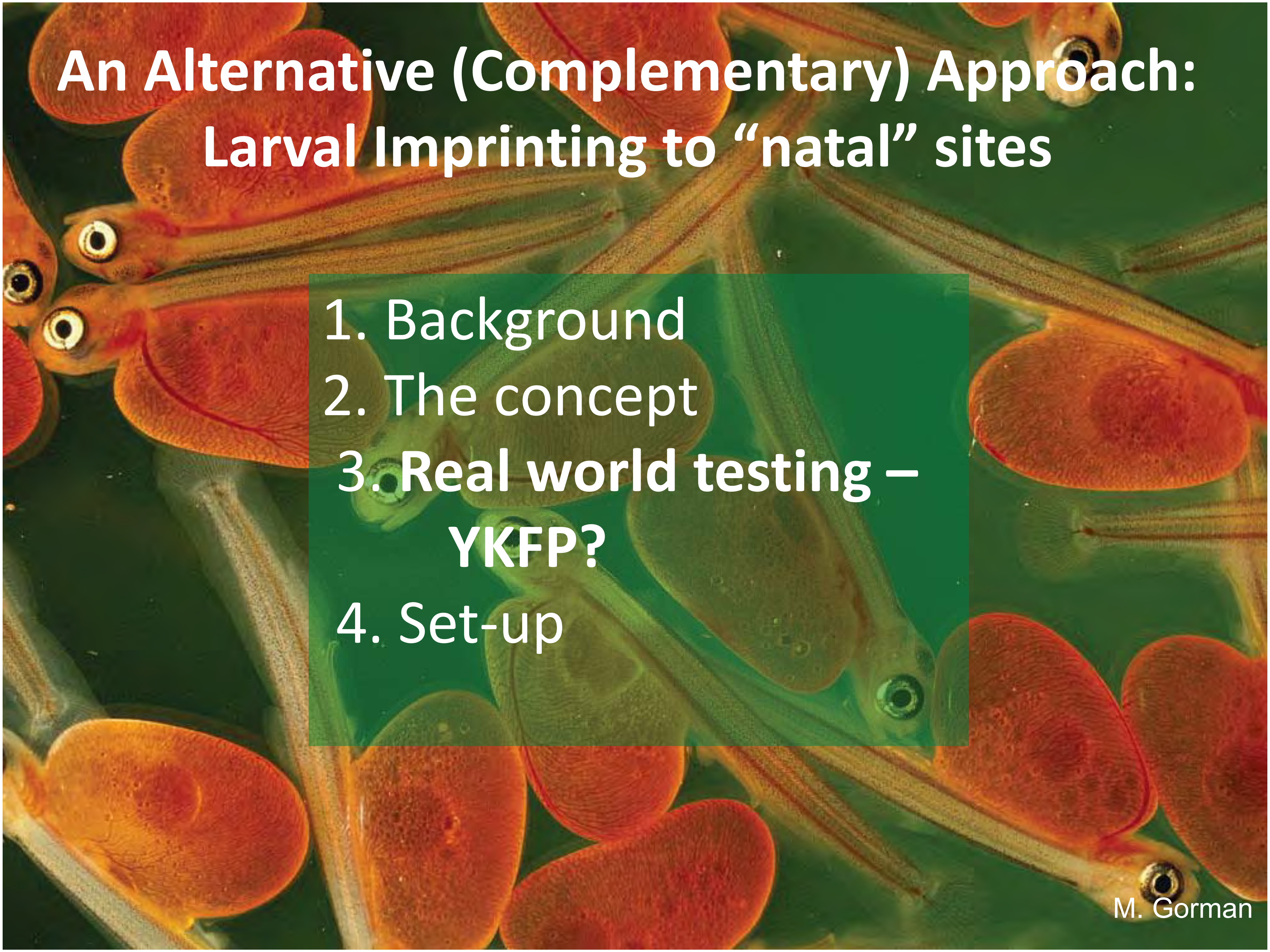


Larval imprinting program

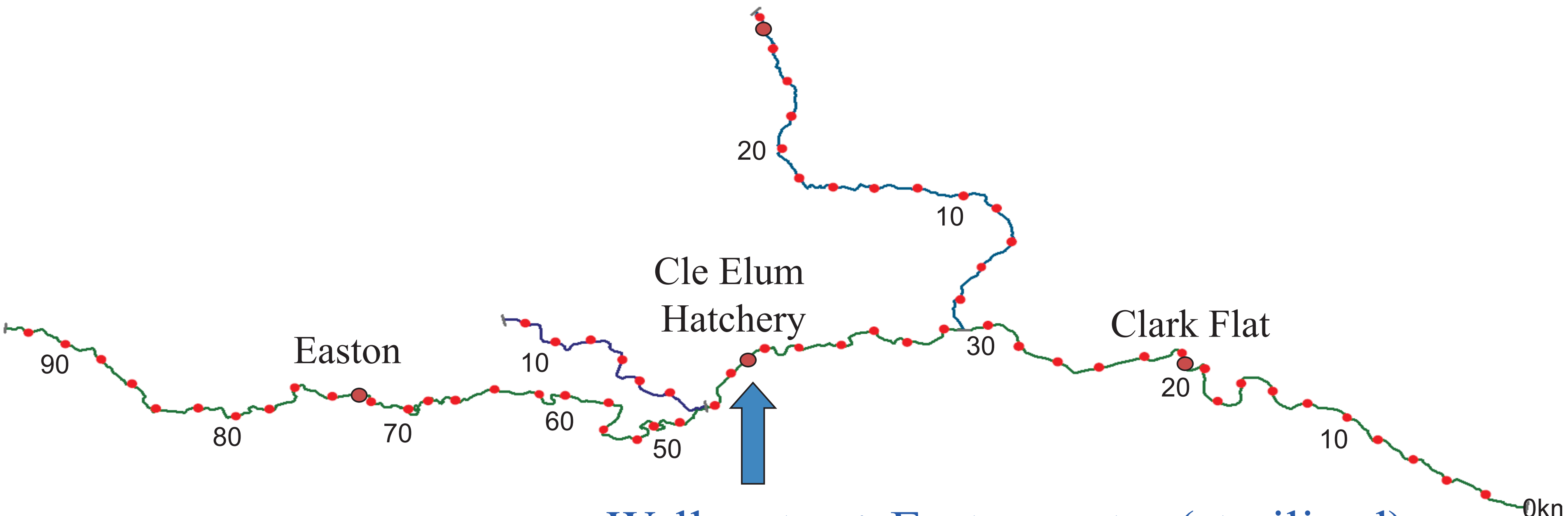


Larval imprinting program




An Alternative (Complementary) Approach:
Larval Imprinting to “natal” sites
1. Background
2. The concept
3. Real world testing –
YKFP?
4. Set-up
M. Gorman

Imprinting Experiment: Age 0 -early rearing/emergence

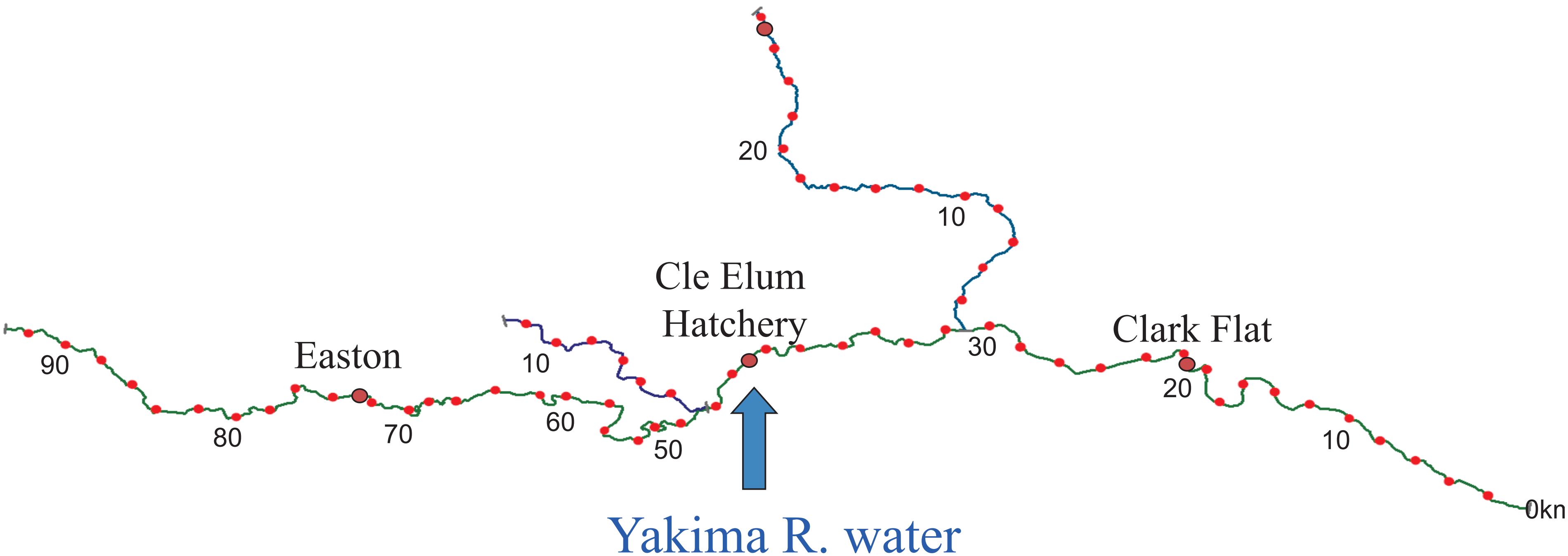


Well water + Easton water (sterilized)

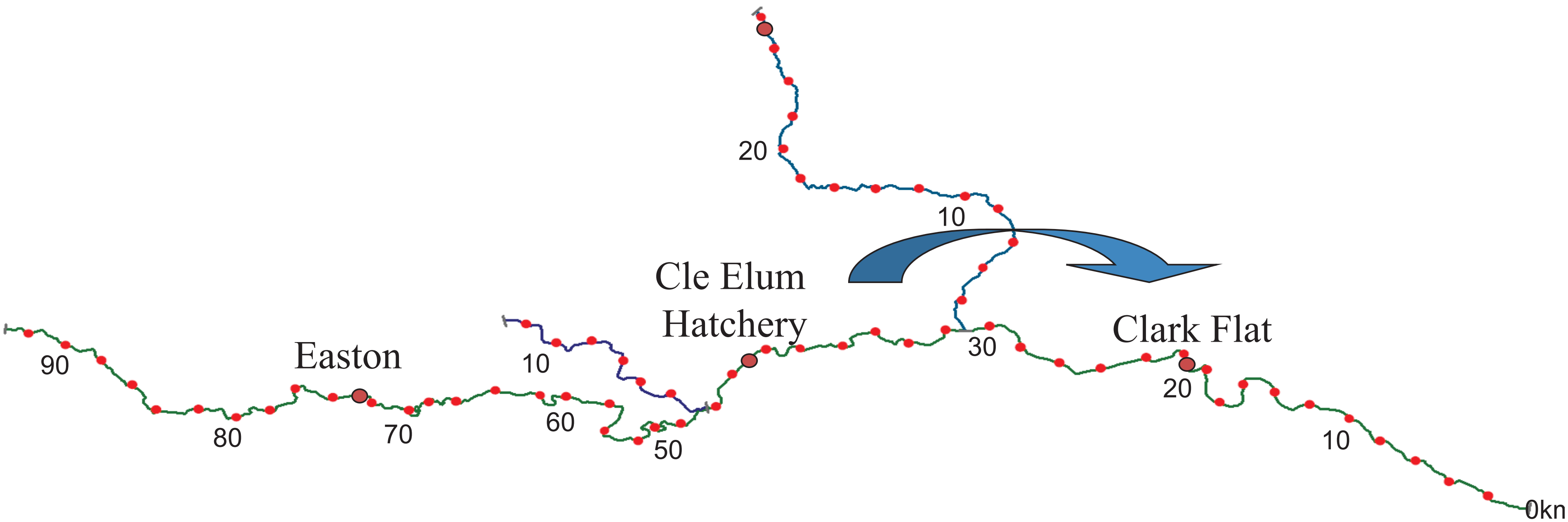
2 Stacks/Raceways = CTL

2 Stacks/Raceways = Easton

Imprinting Experiment: Age 0-1 fry

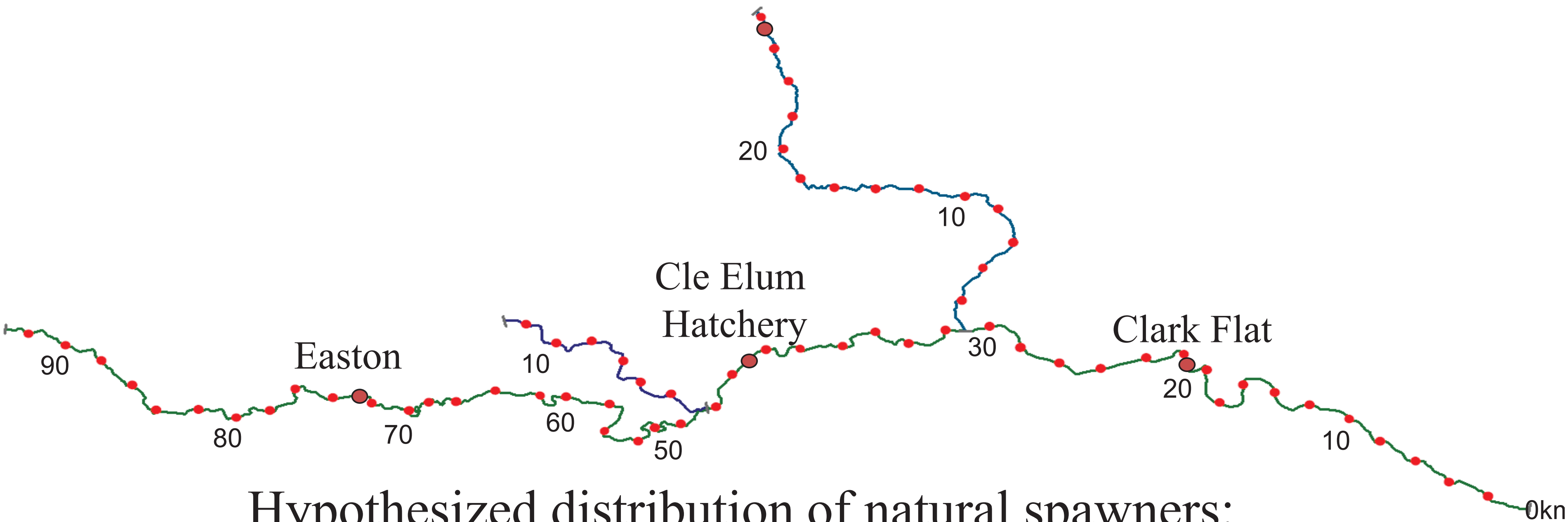


Imprinting Experiment: Age 1+ smolts

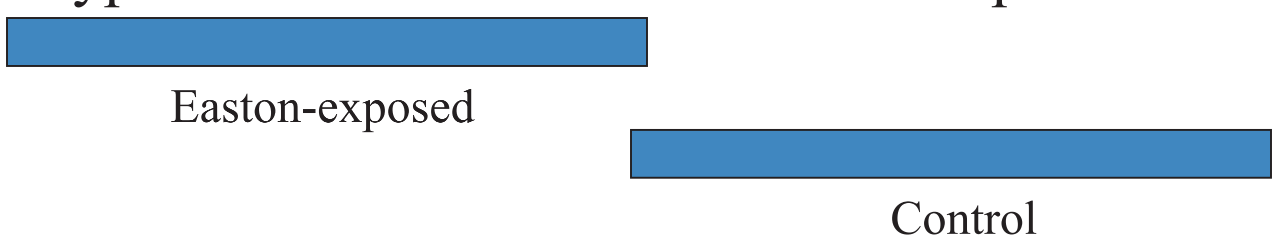


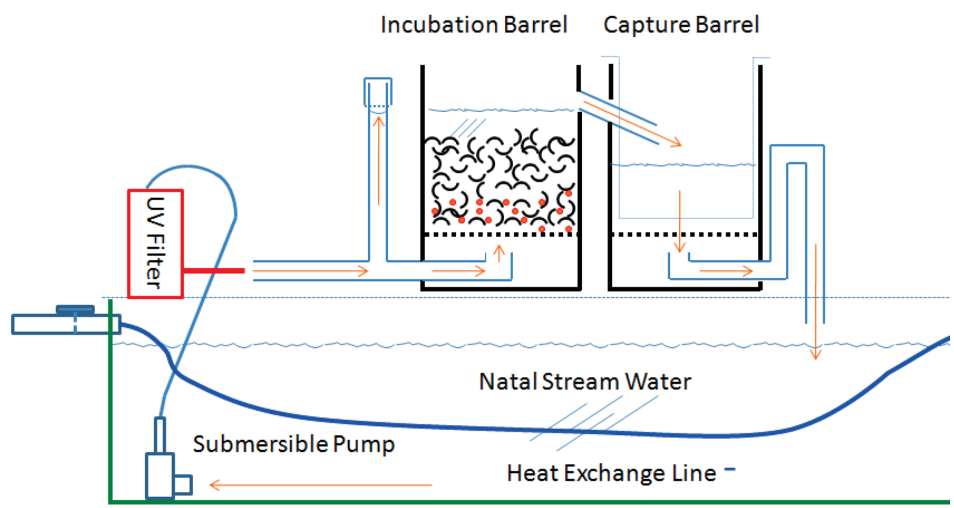
Transfer to Clark Flat for rearing and release

Imprinting Experiment: Age 4 Homing adults



Hypothesized distribution of natural spawners:





Re-circulating Incubation System Concept and Design by S. Schroder, E. Sanborn & E. Jouper. WDFW

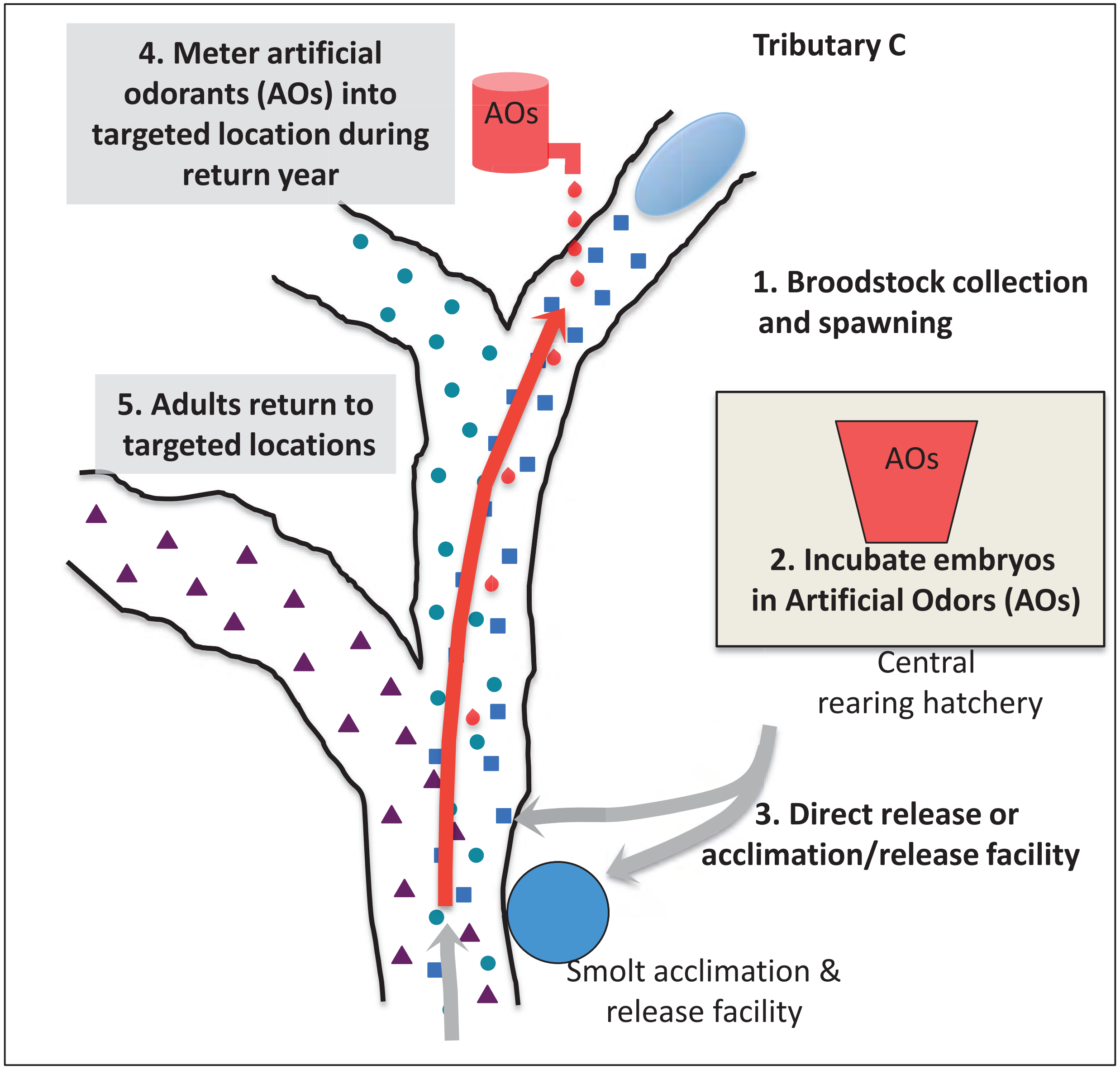
Recirculating incubation system for natal imprinting

S. Schroder, E. Sanborn & E. Jouper. WDFW

Strategies to decrease straying

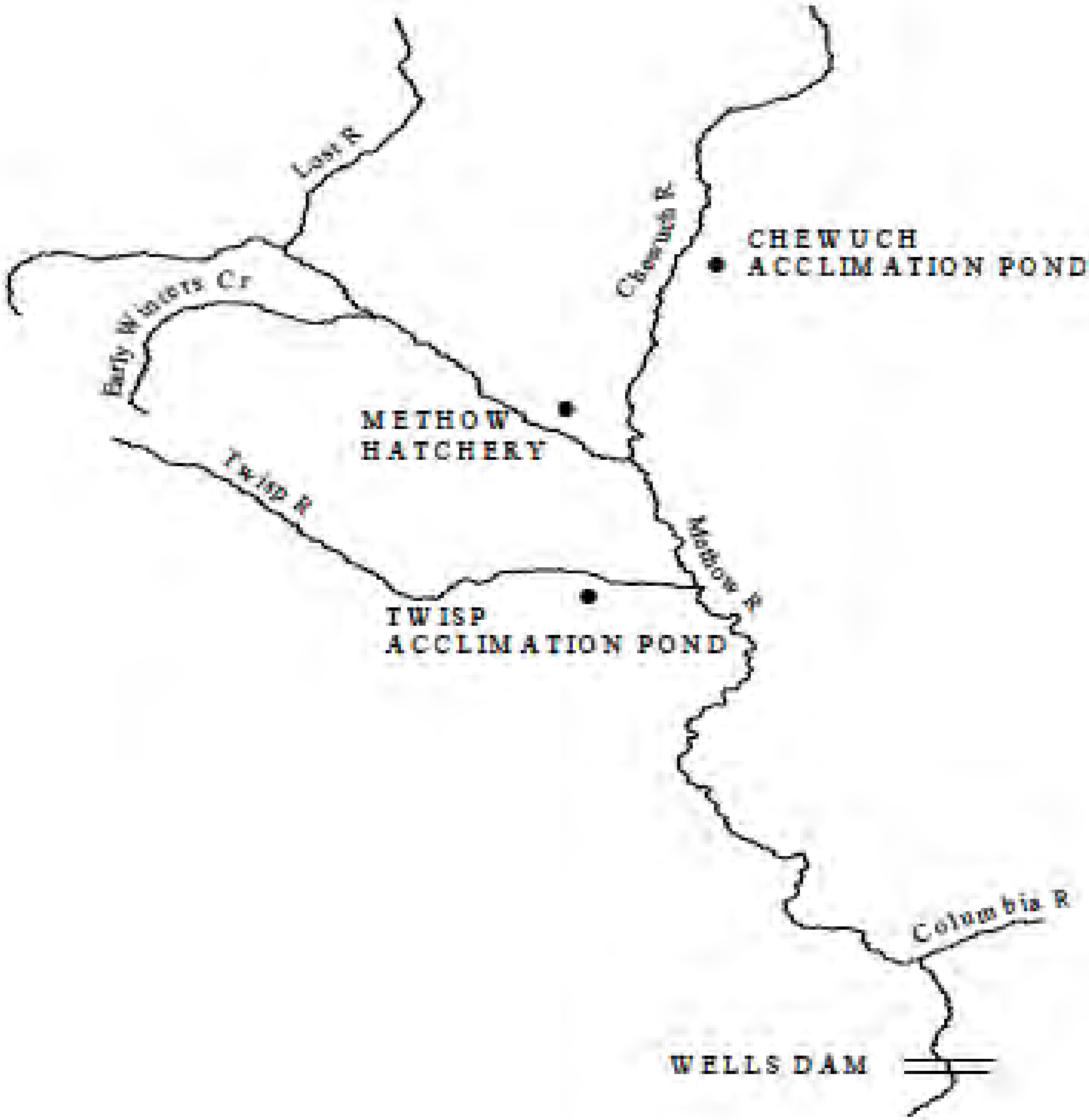
- Olfactory enrichment (incubate in natural or distinct waters)
- Embryonic imprinting
- Artificial imprinting cues (natural/inexpensive replacements for morpholine and PEA)
- Out-of-basin rearing & transport to target site for release
- Monitor physiological development and release timing

Larval imprinting (artificial odors)

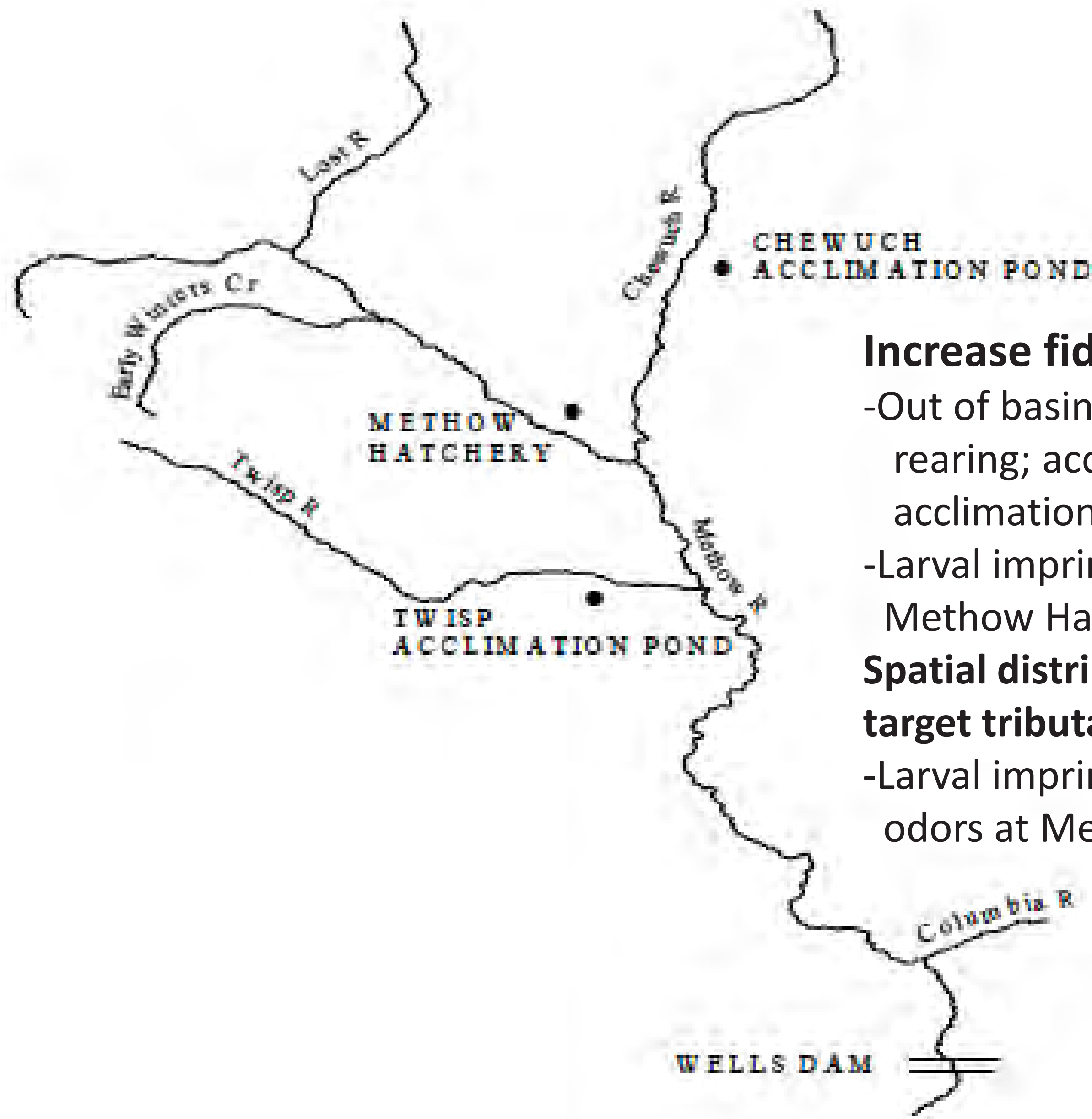


Attachment B

Methow solutions/experiments?



Methow solutions/experiments?



Increase fidelity to Twisp and Chewuch

-Out of basin, Wells, Eastbank, Bonneville rearing; acclimation and release at acclimation sites

-Larval imprinting to target waters at Methow Hatchery?

Spatial distribution of spawners within target tributary

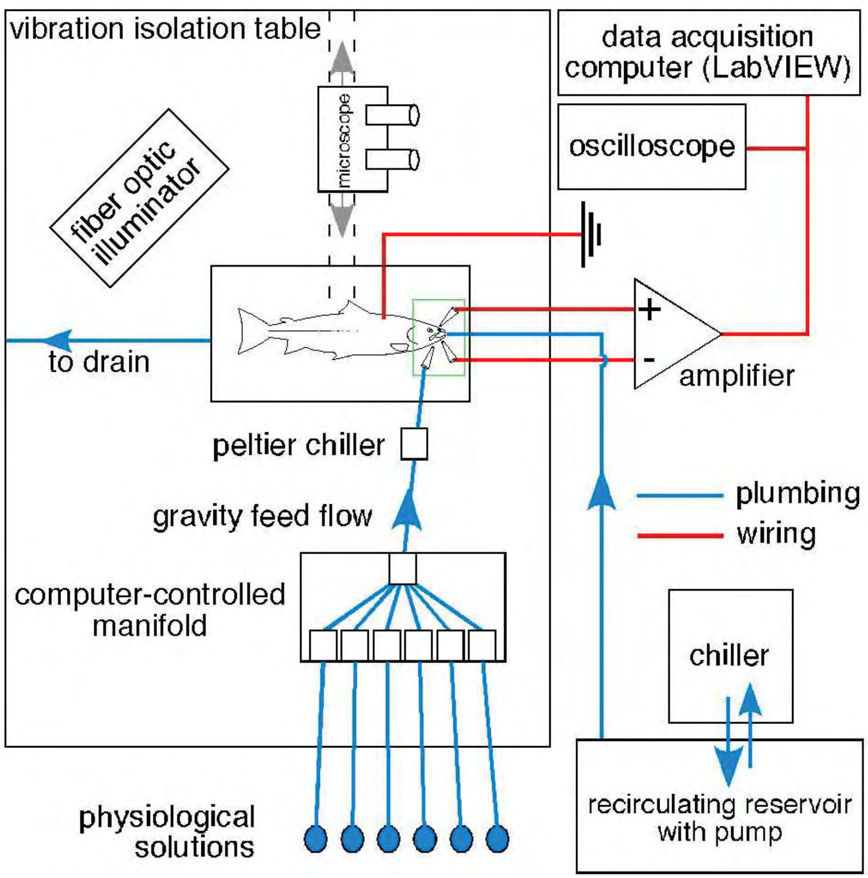
-Larval imprinting to target waters/artificial odors at Methow Hatchery

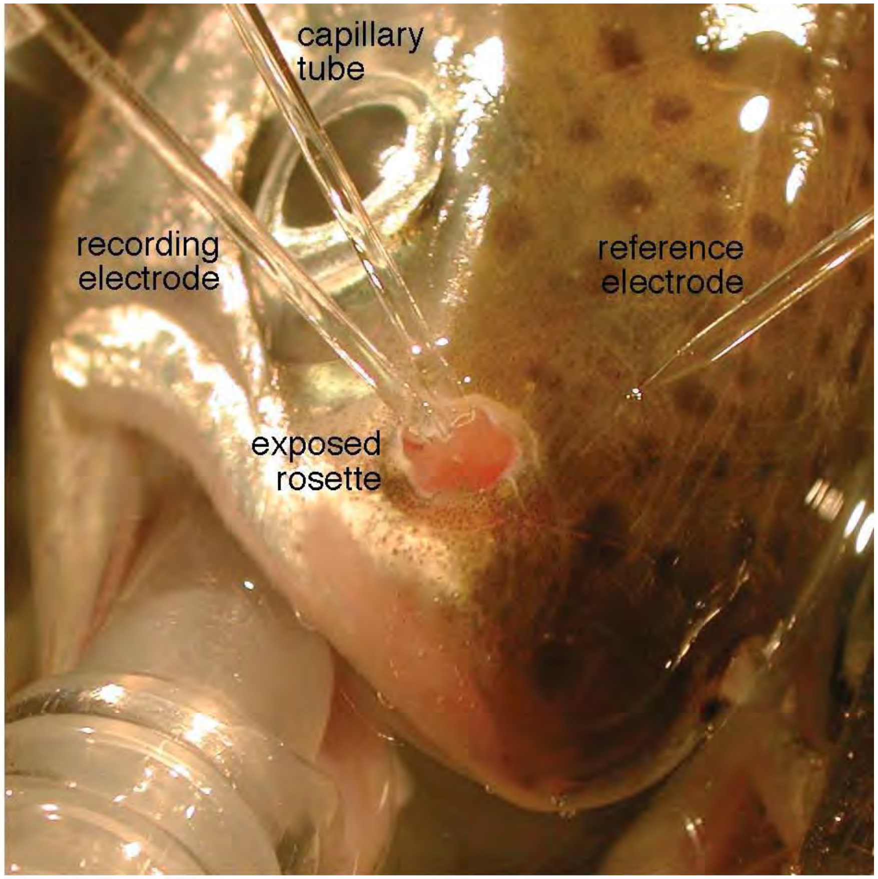
Effects of hatchery rearing on olfactory system and olfactory imprinting

- **We observed differences in imprinting-associated olfactory gene expression in hatchery vs. wild steelhead.**
- **In future studies, we hope to assess these differences in a controlled experiment and assess mechanisms (environmental effects, epigenetics)**
- **We have developed effective physiological tools to assess anthropogenic effects (e.g. transport, hatchery practices, etc) on olfactory imprinting.**

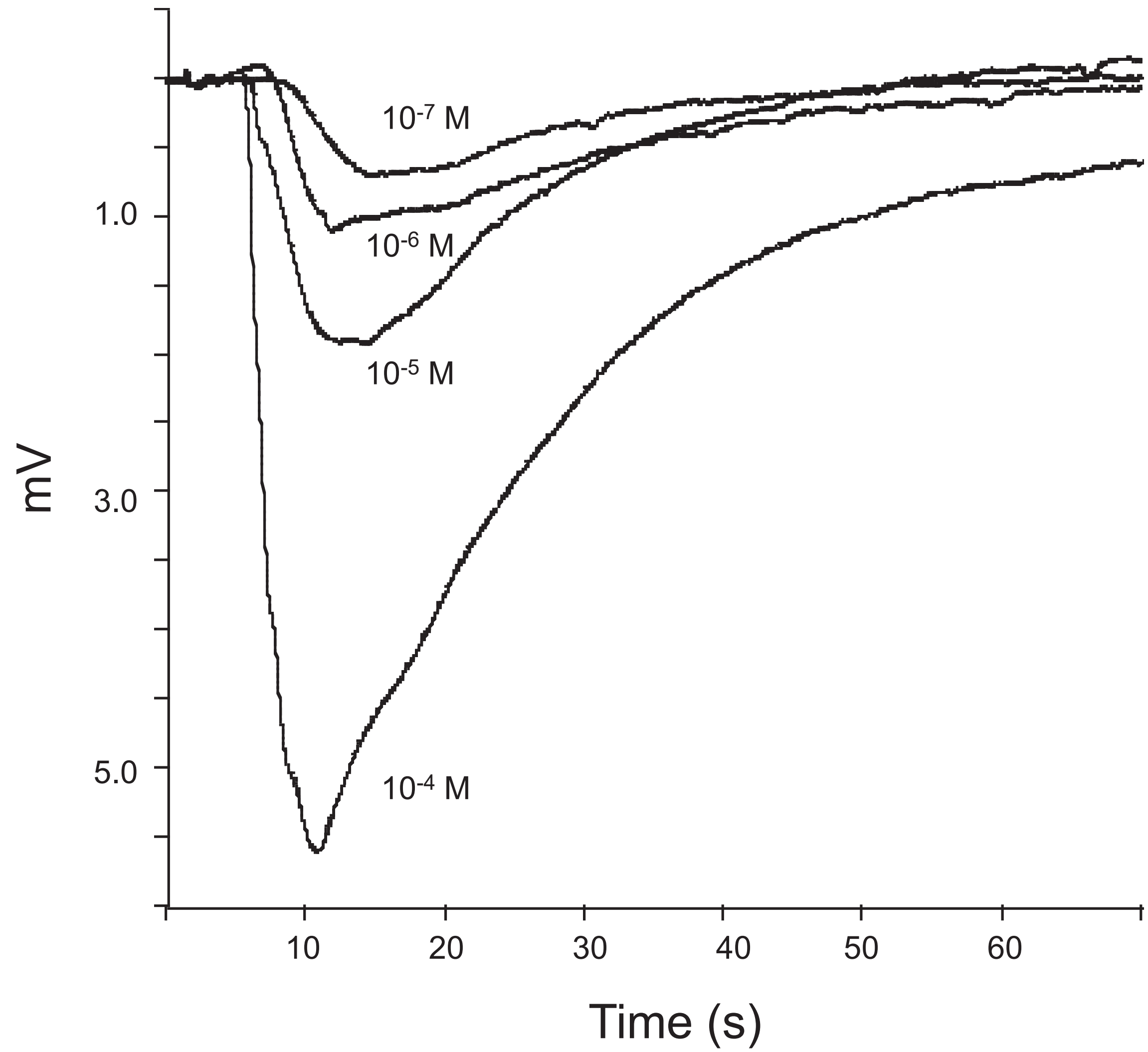
Carla Stehr

EOG apparatus for measuring olfactory sensitivity to imprinted odors

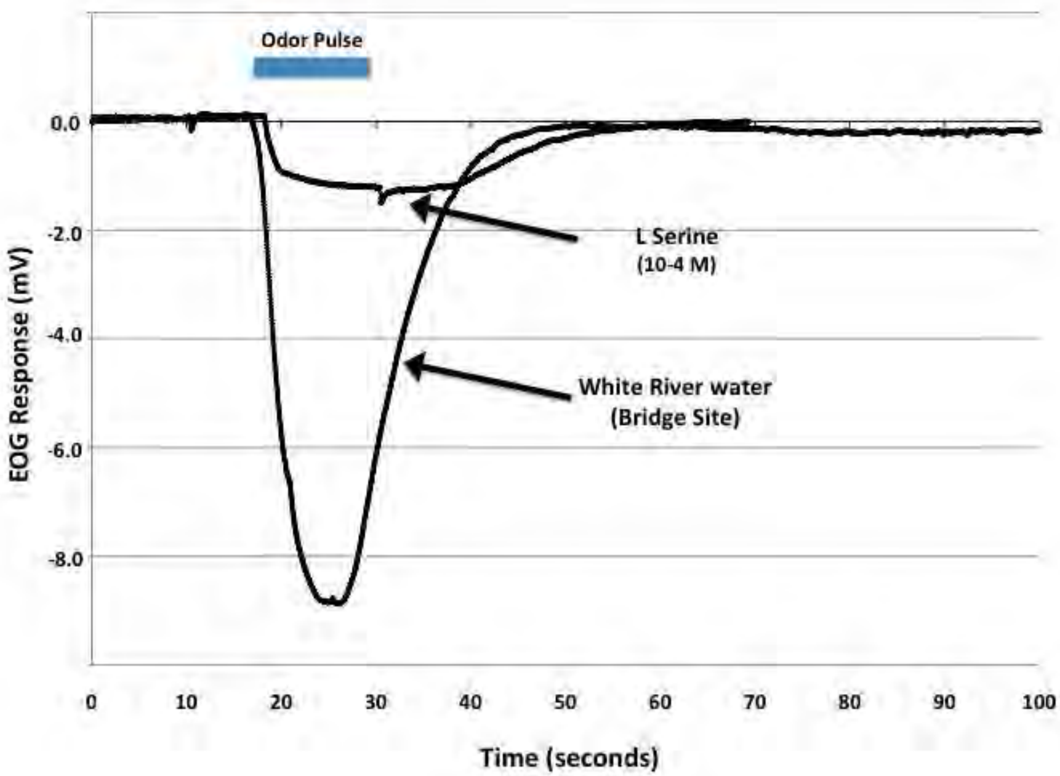




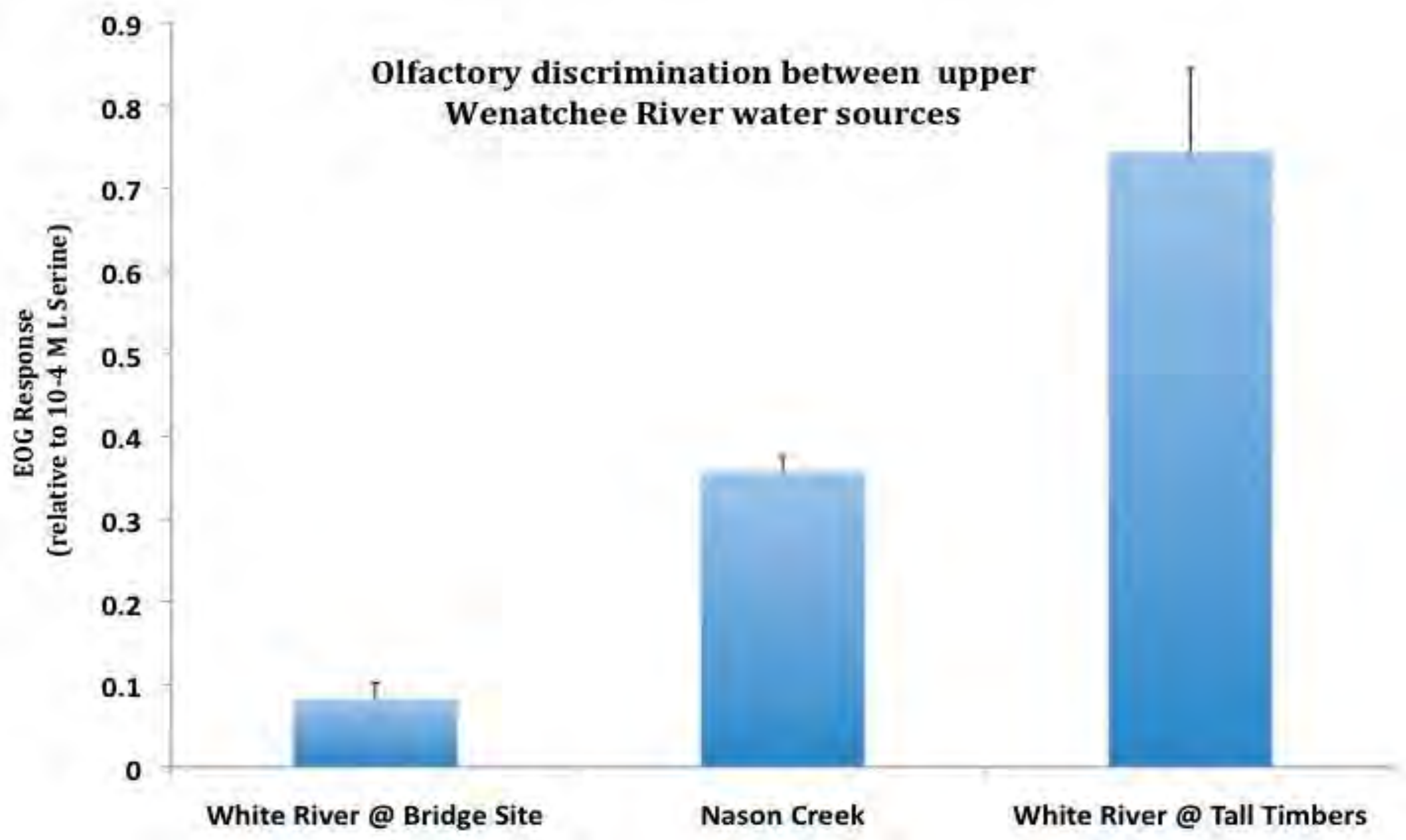
Typical EOG responses of coho salmon to increasing concentration of amino acids



EOG response to White River water (Bridge site)

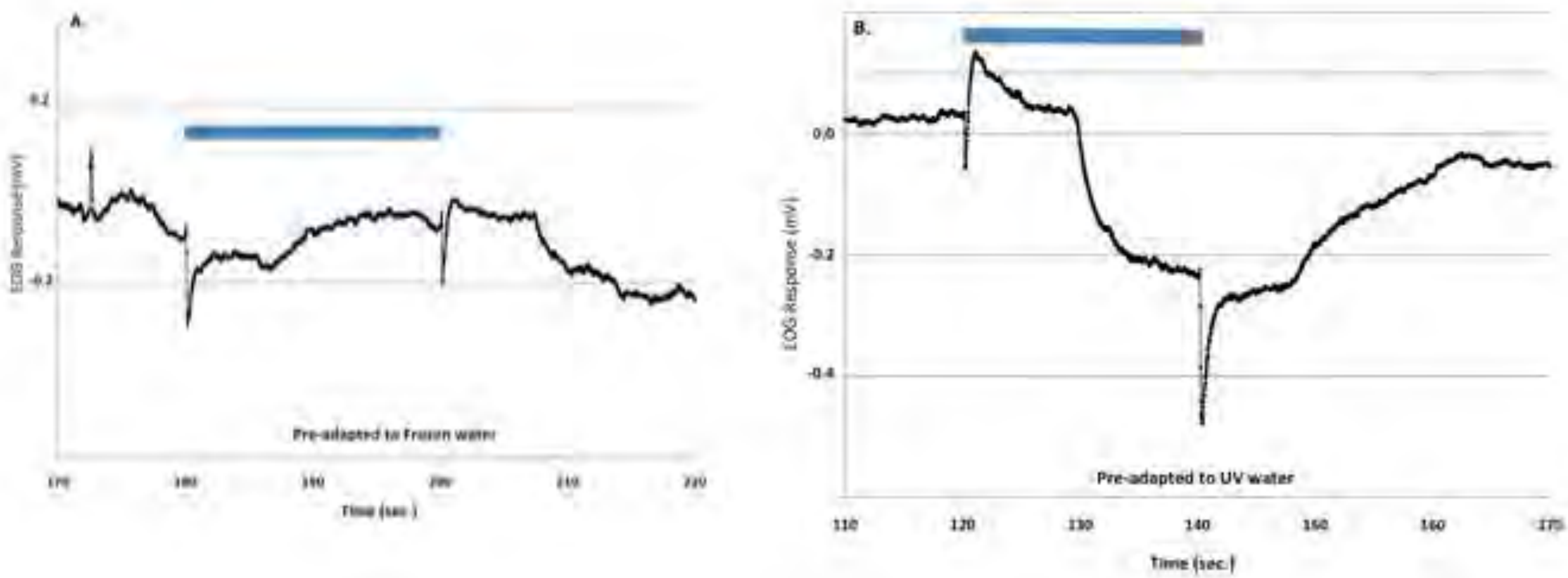


Dittman, May, and Pearsons



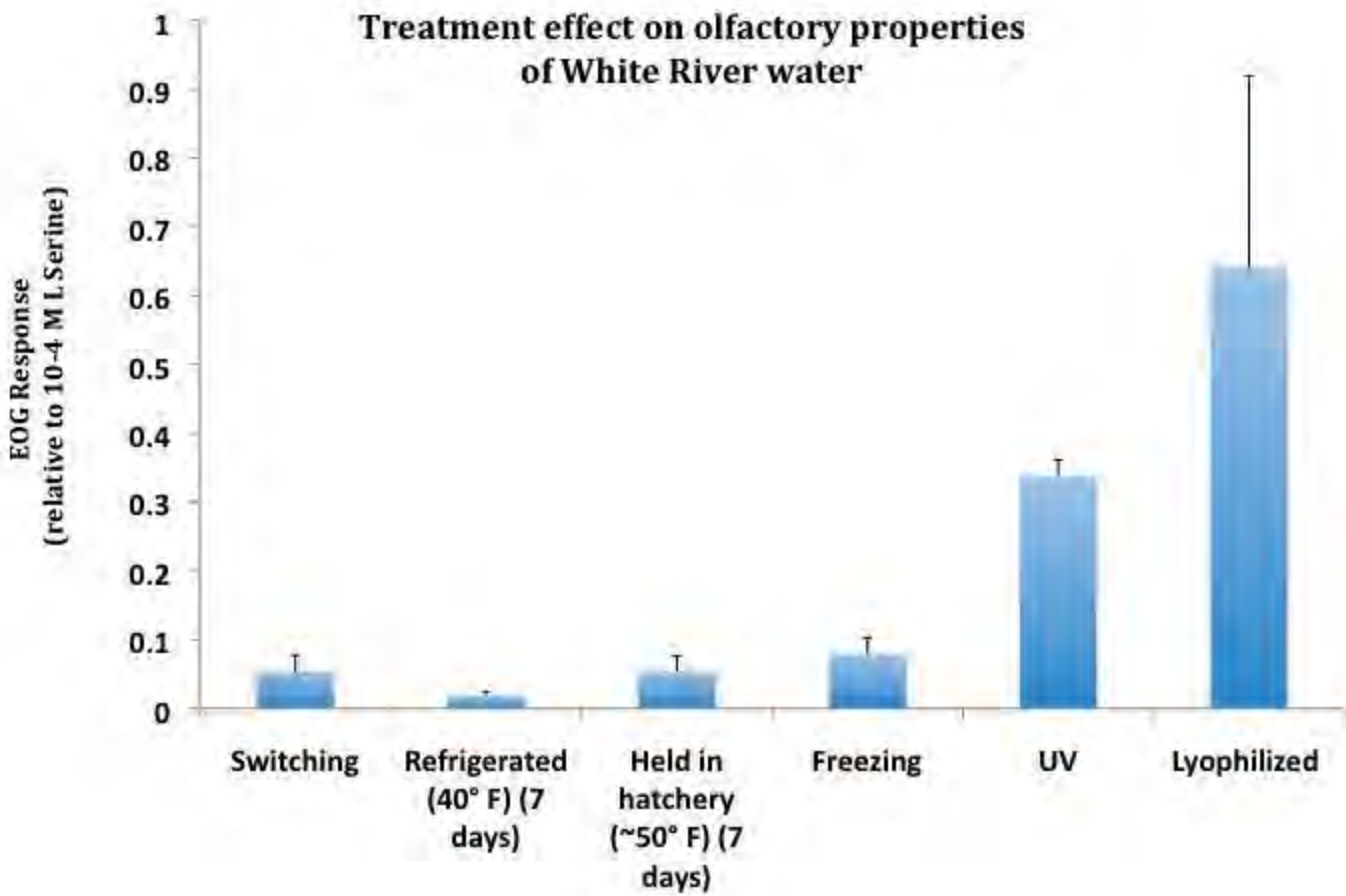
Dittman, May, and Pearsons

EOG Cross Adaptation Studies



Representative EOG traces in salmon pre-adapted to treated water A) Frozen water, B) UV-treated water, and then pulsed with BS water.

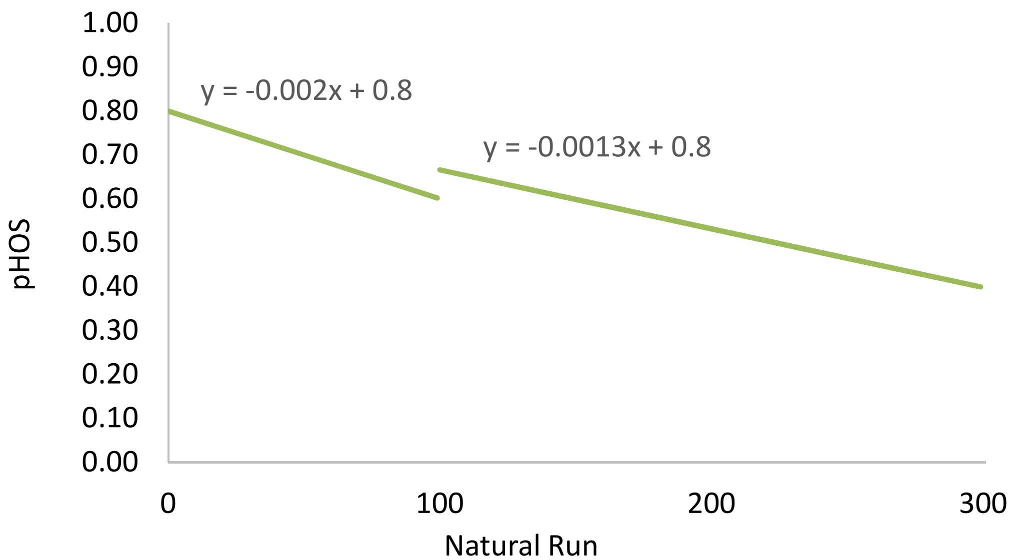
Dittman, May, and Pearsons



Dittman, May, and Pearsons

130 broodstock (≤ 33% of wild run) for PUD program, 500 spawner total

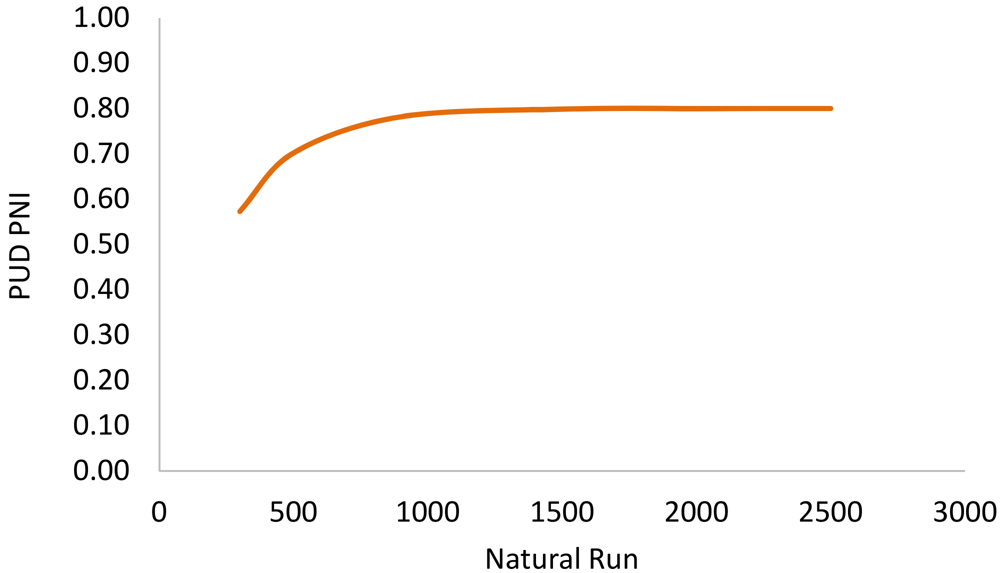
Wild Run	NOB	Wild Escapement	HOS	PNOB	NMFS Calculation PUD pHOS	NMFS Calculation WNFH pHOS	NMFS Calculation Total pHOS	Applicant Calculation PUD pHOS	Applicant Calculation WNFH pHOS
0	0	0	500	0.00	0.8	0.2	1.00	1	1
50	0	50	450	0.00	0.7	0.2	0.90	0.88	0.67
99	0	99	401	0.00	0.602	0.2	0.80	0.75	0.5
100	33	67	433	0.25	0.67	0.2	0.87	0.83	0.59
150	50	101	400	0.38	0.60	0.2	0.80	0.75	0.5
200	66	134	366	0.51	0.53	0.2	0.73	0.66	0.43
250	83	168	333	0.63	0.47	0.2	0.67	0.59	0.38
299	99	200	300	0.76	0.40	0.2	0.60	0.5	0.33



> 300 wild run; assume 75% Methow fish in WNFH broodstock

	NMFS Calculation						Applicant Calculation	
Wild Run	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"
300	0.75	0.6	0.2	0.57	0.57	0.45	0.75	0.5
500	0.8	0.4	0.2	0.68	0.70	0.52	0.50	0.33
900	1	0.3	0.2	0.78	0.78	0.58	0.38	0.29
1500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26
2000	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26
2500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26

a	0.8
b	0.0042



Techniques to improve homing fidelity for Chewuch and Twisp river releases of spring Chinook salmon

Background

Under the Wells Habitat Conservation Plan (HCP), Rocky Reach HCP, and the Priest Rapids Salmon and Steelhead Settlement Agreement, hatchery supplementation is required to mitigate for project losses of migrating salmon and steelhead. As part of this mitigation DCPUD owns and operates spring Chinook acclimation sites on the Chewuch and Twisp rivers. Spring Chinook destined for the acclimation sites are reared at the Methow Fish Hatchery (FH) which is located upstream of both the Chewuch and Twisp rivers. Homing fidelity back to the tributary of acclimation (i.e. Twisp and Chewuch rivers) is low with a proportion of returning fish failing to home and 'straying' to the Methow River, often in the vicinity of the Methow FH. The 5-year analytical report (Murdoch et al. 2012) indicates the mean stray rate for Twisp acclimated spring Chinook is 25%. That is 25% of the Twisp River fish are recovered on spawning grounds outside of the Twisp River or return to Methow Fish Hatchery (Table 1)

Table 1. Stray rates by brood year of Twisp spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012).

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	0	0.00	0	0.00	0.00
1993	3	0.75	1	0.25	0.15
1994	0	0.00	0	0.00	0.00
1996	33	0.66	17	0.34	0.18
1997	6	1.00	0	0.00	0.11
1998	8	0.80	2	0.20	0.45
1999	25	0.56	20	0.44	0.74
2000	12	0.23	40	0.77	0.27
2001	0	0.00	7	1.00	0.13
2002	59	0.47	66	0.53	0.43
2003	2	0.13	13	0.87	0.31
2004	6	0.18	27	0.82	0.18
Mean		0.40		0.43	0.25
SD		0.34		0.35	0.20

Failure to home, and subsequent recovery in non-target locations is a greater problem for Chewuch acclimated fish. The stray rate for Chewuch spring Chinook averages 43% with some years in the 70-80% range (Table 2).

Table 2. Stray rates by brood year of Chewuch spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012)

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	1	1.00	0	0.00	0.03
1993	19	0.86	3	0.14	0.21
1994	0	0.00	0	0.00	0.00
1996	15	0.79	4	0.21	0.46
1997	44	0.62	27	0.38	0.22
2001	46	0.13	321	0.87	0.88
2002	92	0.24	299	0.76	0.74
2003	3	0.12	22	0.88	0.46
2004	35	0.33	70	0.67	0.86
Mean		0.45		0.43	0.43
SD		0.37		0.37	0.34

Since 2014 program size for both the Chewuch and Twisp rivers have been significantly reduced. The program size reduction makes it critical that both programs are performing to standards and achieving the desired goal of supplementing the targeted area. Current release numbers for Chewuch and Twisp Rivers are approximately 61,000 and 30,000, respectively

Methods

Sequential Imprinting Method

The sequential imprinting hypothesis as described by Harden-Jones (1968) and Brannon (1982) shows that salmon learn a series of olfactory cues as they migrate through freshwater, retracing the olfactory pattern as they return as adults. Sequential imprinting also occurs in hatchery fish that are transported and released off-site. The sequential imprinting hypothesis predicts that hatchery fish will return to the release site where they initiated their seaward migration, however if the returning hatchery fish can still detect the odors of their rearing site they will continue onward to their rearing hatchery (Dittman et al. 2010). In cases where the acclimation site is located upstream of the rearing hatchery, returning salmon will bypass the rearing facility and continue onto the release site (Dittman et al. 2010). In an evaluation of homing and spawning site selection in the Yakima River, the sequential imprinting hypothesis explains why fish released from Clark Flat and Jack Creek (both downstream of the Cle Elum Hatchery) are often recovered in the vicinity of the Cle Elum Hatchery, while relatively few fish released from the Easton Acclimation Site (upstream of the rearing facility) were rarely recovered in the vicinity of the Hatchery. Fish released from the upstream Easton site had the highest homing fidelity (95.5%; Dittman et al. 2010). Consistent with the sequential imprinting hypothesis, spring Chinook acclimated at the Easton site returned to the vicinity of the acclimation site; being unable to detect any earlier imprint signal, chose to spawn in the vicinity of their last familiar homing cue (Dittman et al. 2010). Sequential Imprinting also explains patterns of adult returns for programs where hatchery fish are reared in the lower Columbia and then transported to upper Columbia tributaries, such as the Yakama Nation's coho reintroduction project, and the discontinued White River spring Chinook program. Similar the sequential imprinting hypotheses would predict that high stray rates to the Methow FH due to the location upstream of the Chewuch and Twisp Rivers. .

In the Methow Basin, fish returning to both the Twisp River and Chewuch River, continue to recognize upstream olfactory cues from Methow Fish Hatchery. The sequential imprinting hypothesis would predict that a proportion of spring Chinook would continue on past the confluences with the Twisp and Chewuch Rivers to return to the vicinity of the Methow Fish Hatchery, which is what is observed in patterns of spawning and carcass recovery (Murdoch et al. 2012).

To evaluate whether we can improve homing fidelity/ stray rates by making use of sequential imprinting, some number of spring Chinook destined for acclimation at the Twisp and/or Chewuch acclimation ponds would need to be reared at a location downstream of the acclimation site rather than at Methow FH. Possible downstream rearing sites include Wells Fish Hatchery or Eastbank Fish Hatchery. After initial rearing at a downstream facility, the option exists to overwinter acclimate at the Carlton pond prior to final acclimation in the tributaries. Because the Carlton pond is downstream of both the Twisp and Chewuch rivers, acclimation at Carlton would be consistent with the sequential imprinting hypothesis; we would expect high rates of return to the final acclimation/release site.

Embryonic Imprinting Hypothesis

The importance of imprinting at the parr-smolt life stage is commonly known, but embryonic imprinting hypothesis emphasizes the imprinting to the desired 'natal' site earlier during development. Embryonic imprinting for hatchery programs could be tested as either an alternative or complementary method to sequential imprinting (above) to improve homing fidelity to an acclimation site. As suggested by sequential imprinting, adult salmon terminate their spawning migration upon reaching the area associated with olfactory cures learned in the natal redd. Dittman et al. (2015) speculates that hatchery reared salmon returning as adults will seek the earliest detectable imprinted olfactory waypoint as the appropriate location to terminate their spawning migration. If salmon are exposed in the hatchery as embryos to the water derived from the release location, they may spawn in the targeted location.

To evaluate whether embryonic imprinting could be used to improve homing fidelity to tributaries of acclimation (Twisp and/or Chewuch), temporary incubation facilities could reasonably be constructed at a location on the Twisp and Chewuch rivers, or we could develop the means to transport and store water from the Twisp and Chewuch rivers to the Methow Fish Hatchery. If transporting water, care needs to be taken not to alter the chemical properties of the water (Dittman et al. 2015). The amount of time the salmon eggs would need to be exposed to the natal water source is unknown. Fish health concerns also need to be considered when transporting water.

Embryonic imprinting could be tested in combination with the sequential imprinting method (relocating rearing farther downstream) or by itself at the current rearing location.

Other options

As an alternative to evaluating if homing can be improved through sequential imprinting and/or embryonic imprinting, overwinter acclimation facilities could be development to increase the amount of time juvenile Chinook are exposed to the targeted water source, however if the natal source is still upstream (i.e. Methow Fish Hatchery) the sequential imprinting and embryonic imprinting hypotheses both predict that straying back to the rearing hatchery will occur.

Study Design

Location

A homing/straying evaluation should be implemented with either spring Chinook production in the Twisp, the Chewuch, or both locations. The study design would be strengthened by replicate samples at both sites. If only one site is selected for study, the Chewuch allows for the largest sample size and has the most room for improvement. Additionally, due to the larger program size, altering rearing practices or locations for Methow/Chewuch composite spring Chinook could be viewed as less 'risky' than altering rearing practices for the smaller Twisp spring Chinook program.

Paired releases

Ideally paired releases would be released at one or both sites. With paired releases half the program would be reared under current methods, and half the program would be subject to the treatment (either sequential imprinting, embryonic imprinting, or both). The benefit to paired releases is a direct within brood year comparison of both the control and treatment.

Before/after

An alternative to paired releases is a before/after comparison of stray rates. We have over 10 years of stray rate data collected with the current rearing regime, these data could be compared to homing fidelity/stray rate data collected after treatment. The benefit to the before/after study design is that a larger treatment sample size can be obtained.

Timeline

February 2016-March 2016: Final study design development

March –April 2016: Committee approvals

August 2016: Begin implementation with BY 2016. Note: if embryonic imprinting is included in the study design, appropriate incubation measures would need to be in place prior to spawning in 2016. If an alternate downstream rearing site is used, green gametes should be transported prior to fertilization (alternatively eyed eggs could be transported but embryonic imprinting could occur to some degree at the upstream facility which would could undermine the study results).

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Target HRR Proposal

The HC/HSC agreed to a 20 percentile HRR target and green, yellow, and red light standards of 1, 2, and 3 years out of 5 years respectively. This approach seemed to be consistent with the goal of maintaining recently observed survivals at each facility and was in addition to the target of HRR>NRR. HRRs would be expected to be below the 20th percentile 1 year out of five (20 percent of the time) if the facility and environmental survivals were similar to the baseline conditions. Additional years below the 20th percentile would be unlike the baseline period survivals and would warrant additional consideration.

To be consistent with the original agreement and the recent desire by the CCT to boost the target to the 40th percentile, we propose the following and also add additional clarification of other issues related to the HRR target that have not been resolved:

1) Use the estimated 40th percentile HRR target during 5 year evaluation periods
2) The HRR target does not change for 20 years
3) Use varying degrees of action depending upon the number of years that the HRR deviates from the target; green light (below 40 percentile for 2 years or less, no action), yellow light (below 40 percentile for 3-4 years, caution - pay attention), red light (below 40 percentile for 5 years or more, investigate cause of performance issue and potentially adapt program if cause can be attributed to hatchery program)
4) Each HRR target is specific to each program unless insufficient data are available to generate a program specific target (e.g., Nason Creek adopts Chiwawa target). The reason for this is that each program has its own idiosyncrasies and challenges that are built into each program (e.g., segregated, integrated, overwinter, geography, size-at-release, water source, genetic legacy associated with productivity, tag burden, etc.).

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February 8, 2015

To: HCP HC and PRCC HSC

From: Mike Tonseth, WDFW

Subject: ***DRAFT*** **UPPER COLUMBIA RIVER 2016 BY SALMON AND 2017 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 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 (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, Grant County Public Utility Districts (PUDs), and ACOE and are operated by the Washington Department of Fish and Wildlife (WDFW), with the exception of 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).

This protocol is intended to be a guide for 2016 collection of salmon (2016BY) and steelhead (2017BY) 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), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, the USFWS 2008 Rocky Reach Biological Opinion (Service reference number 13260-2008-F-0116) and consultation requirements.

Notable in this year's protocols are:

- Continuing for 2016, no age-2 or 3 males will be incorporated into spring or summer Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only).

- Use of ultrasonography to determine the sex of each fish retained for brood to better ensure achieving the appropriate number of females for program production (Does not include Priest Rapids Hatchery).

- Utilization of genetic sampling/assessment to differentiate Twisp River and Methow River Basin natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir and Methow FH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components for the GPUD, CPUD and DPUD programs.

- Collection of only hatchery adult steelhead at Wells Dam/Hatchery for the Lower Methow safety-net (WFH/MFH), and Wells Hatchery Okanogan and mainstem Columbia safety-net programs.

- Collection of spring Chinook for the Nason Creek and Chiwawa programs using combination of Tumwater Dam and the Chiwawa Weir.

- Targeted collection of 100% of the Wenatchee summer Chinook and Wenatchee hatchery origin steelhead broodstock at Dryden Dam to reduce the number of activities that may contribute to delays in fish passage at Tumwater Dam (some adult collections at Tumwater may be necessary if sufficient adults cannot be acquired at Dryden Dam).

- Targeted collection of 100% of the natural origin steelhead broodstock at Tumwater Dam.

- Collection of summer Chinook broodstock from the Eastbank outfall, sufficient to meet a 576K yearling juvenile Chelan Falls program.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net on-station-released smolts (up to 14 adults). The remainder of the broodstock (46) will be WNFH returns collected at WNFH (or by angling/trapping/tangle netting 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 2017.

- Summer Chinook collections at Wells Dam to support the CJH program may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the YN, Yakima River summer Chinook program.

- Targeted collection of 1,000 adipose present, non-coded wire tagged fall Chinook from the PRD OLAFT.

- Targeted collection of about 400 adipose present, non-coded wire tagged fall Chinook using hook and line efforts in the Hanford Reach.

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 2016 Broodstock Collection Protocols are:

Appendix A: 2016 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2017 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

Methow River Basin

<u>*Spring Chinook*</u>

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) Permit 1196.

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 with natural origin fish. 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 33.3% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch program; 11.8% for the Twisp program). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish Health 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 (combined, these make up the entire Methow Basin spring Chinook population) will either be released back into the Columbia River. Based on the broodstock-collection schedule at Wells Dam (3-day/week, 16 hours/day, up to 48 hours per week cumulatively), extraction of natural-origin spring Chinook is expected to be approximately 33% or less.

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%. Trapping at the Winthrop NFH will be included, if needed, as a result of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2016 is estimated at 3,185 spring Chinook, including 2,678 hatchery and 689 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.

Commented [MT1]: Need Winthrop NFH return estimates before finalizing values.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2016 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Appendix A.

The 2016 aggregate Methow spring Chinook broodstock collection will target up to 122 adult spring Chinook (16 Twisp, 106 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent 3% of the adipose present, CWT tagged hatchery adults and 19% 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 2016 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 57% of the adipose present CWT tagged hatchery adults and 81% 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 2016 aggregate Methow broodstock collection will total 104 natural origin spring Chinook. Broodstock collected for the aggregate Methow 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 1196. The Grant/Douglas/Chelan PUD 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.

Commented [MT2]: Need Winthrop NFH return estimates before finalizing numbers.

Commented [MT3]: Need Winthrop NFH return estimates before finalizing numbers.

Table 1. Brood year 2011-2013 age class-at-return projection for wild spring Chinook above Wells Dam, 2016.

Brood year	Smolt Estimate		Age-at-return: Twisp Basin					Methow Basin				
	Twisp[1]	Methow Basin[2]	Age-3	Age-4	Age-5	Total	SAR[3]	Age-3	Age-4	Age-5	Total	SAR[4]
2011	10,047	36,344	9	79	**13**	101	0.0101	68	394	**101**	563	0.0155
2012	12,277	35,976	11	**97**	16	124	0.0101	67	**389**	100	556	0.0155
2013	24,605	36,242	**22**	194	33	249	0.0101	**67**	393	102	562	0.0155
Estimated 2016 Return			**22**	**97**	**13**	**132**		**67**	**389**	**101**	**557**	

[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] *Mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2008; David Grundy, personal communication).*

4 Mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2002-2008; David Grundy, personal communication).

Table 2. Brood year 2011-2013 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2016.

Commented [MT4]: Need Winthrop NFH return estimates before finalizing numbers.

Stock	Projected Escapement — Origin: Hatchery				Wild				Total: Methow Basin			
	Age-3	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**

%Total				57%				81%				62%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				3%				19%				4%
Winthrop (MetComp)	275	696	106	**1,077**					275	696	106	**1,077**
%Total				40%								34%
Total					89	486	114	**689**				

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		16F/16M	**32**		
Douglas PUD	29,123		8F/8M	**16**		
Grant PUD	134,126		37F/37/M	**74**		
Total	**223,765**		**61F/61/M**	**122**		
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**		**52F/52M**	**104**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**61F/61M**	**122**		

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 20, 2016. Broodstock collection and stock assessment sampling activities authorized through the 2016 Douglas PUD Hatchery M&E Implementation Plan will occur simultaneously up to 3-days/week, up to 16 hours/day (not to exceed 48 cumulative hours per week). 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 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 Well FH pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or transferred to WNFH.

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 22. The trap may be operated up to five days per week/24 hours per day (provided it is manned during active trapping).

Trapping at the Methow Outfall trap and Winthrop NFH ladder operations will run concurrent with the Twisp Weir. Pending development of an adult management plan for spring Chinook in the Methow basin, hatchery-origin adults captured at the Methow Outfall (surplus to the Methow Hatchery program) will be transferred to the WNFH for incorporation into WNFH brood as supported by the HGMP's of both facilities.

<u>*Steelhead*</u>

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations such as at Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, WNFH volunteer trap, Okanogan River Basin and angling in Methow River (Table 5). Generally incubation/rearing occur for the Methow safety net, Okanogan, and Columbia River release at Wells Fish Hatchery (FH) with incubation/early rearing at Methow Hatchery for the Twisp conservation program. The USFWS collects broodstock via hook-and-line in the Methow Basin, returns to WNFH and surplus fish removed at Methow Hatchery and the Twisp Weir.

Specific program brood sources are structured as follows:

Well Hatchery – Twisp River Release

The Wells Hatchery Twisp River release has shifted to a locally collected Twisp wild broodstock conservation program. Adults are collected in the spring of the current spawn year at the Twisp Weir.

Wells Hatchery – Methow River Release

The Wells Hatchery Methow River release (Methow safety net program) has shifted to 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 activities at the Twisp Weir, Methow Hatchery, WNFH, and through hatchery fish intercepted during natural origin brood hook and line collection for the USWFS Winthrop conservation program.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use returns to the Methow Hatchery volunteer trap to the extent possible, and will be augmented with Wells stock as required to fulfill the program. To ensure the safety-net programs have broodstock, a portion of the broodstock requirement (59 adults) will be collected at Wells Dam in the fall of 2016, and held at Wells Hatchery (Table 5). These fall-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural origin fish collected through hook and line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, hatchery origin returns to WNFH will prioritized, followed by excess hatchery fish at the Twisp Weir then from excess hatchery returns to Methow Hatchery. 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.

Okanogan River releases

The Okanogan River uses a combination of natural origin adults collected in Omak Creek and hatchery origin adults collected in Omak Creek or elsewhere in the Okanogan Basin through CCT collection efforts. As a backup to potential collection shortfalls in the Okanogan, a portion of the Okanogan program will be augmented with collection of hatchery origin adults occurring in the fall at Wells Dam. These fall-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2017 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
Twisp Conservation	Methow Hatchery (incubation); Wells Hatchery (rearing)	Douglas PUD	Twisp Acclimation Pond	48,000	Twisp WxW
Methow Safety-Net	Wells Hatchery	Douglas PUD	Methow Hatchery	100,000	HxH: Twisp Weir (up to 25%) + WNFH Hatchery (75%) or WNFH to make up balance
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Wells Hatchery	160,000	HxH: Methow Hatchery returns (1st option); Wells Hatchery/Dam (Wells Stock) (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH	Up to 200,000	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River above Twisp, volunteers to WNFH, and tangle netting in Spring Creek.
Omak Creek	Wells Hatchery	Grant PUD	Omak Creek	Up to 40,000[1]	Okanogan Basin/Omak Creek (up to 16 wild or

					hatchery)
Okanogan	Wells Hatchery	Grant PUD	Okanogan Basin	Up to 90,000[1]	Wells Stock collected at Wells Dam/Hatchery or at tributary locations in the Okanogan Basin operated by the CCT

[1] The Grant PUD programs will total 100,000 smolts, +-10% (58 broodstock). Broodstock collection number, origin, location, and smolt numbers will be consistent with those detailed in National Marine Fisheries Service (NMFS) letter to Randall Friedlander (CCT) and Jeff Grizzel (GPUD) dated February 27, 2014 and detailed in Table 4 and Table 5 herein.

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 2016/2017 to meet production objectives absent a preseason forecast at the present time.

For the 2017 brood steelhead programs operating above Wells Dam, a total of 350 adults (152 natural origin and 198 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 on hand in the event tributary based collection efforts fall short of targets, trapping at Wells Dam and/or Wells FH will selectively retain up to 257 hatchery origin steelhead (west [and east, as necessary] ladder and volunteer trap collection; Table 5).

Twisp Conservation Program

In the spring of 2017, 26 wild steelhead will be targeted at the Twisp Weir and transferred to the Methow Hatchery for spawning, incubation, and early rearing (up to 60-d post ponding to facilitate viral testing of progeny resulting from live spawning females for the YN kelt reconditioning program), after which they will be moved to Wells Hatchery for the balance of rearing (Table 5).

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 the Twisp Weir and moved to Wells Hatchery for spawning. No less than 46 hatchery adults will be targeted at Methow Hatchery and if needed/available, WNFH volunteer traps to meet the balance of the program needs (Table 6). Up to 30 hatchery origin Wells stock collected and held at the Wells Hatchery will be used as a final option if broodstock collection at the Twisp Weir, and WNFH and MH traps are unsuccessful (Table 5).

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will 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 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.

Okanogan Hatchery/Endemic Program

Fifty-eight (58) adult steelhead will be targeted in the Okanogan Basin, including up to 16 natural-origin adults collected from Omak Creek for a 40K endemic program operated by the CCT and funded by GCPUD as part of their 100K UCR steelhead mitigation obligation (Table 5). Additionally, up to 29 hatchery adult steelhead will be targeted at Wells Dam/Hatchery as a back-up collection contingency due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5).

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Number of backup adults[2]	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild				Hatchery	Wild
DPUD Columbia R.	96		Methow FH Wells Dam		Wells Dam	96	
DPUD Methow R.	60		Twisp weir (14) Methow FH (46)	Up to 30	WNFH[3] Wells Dam	90	
DPUD Twisp R.		26	Twisp weir	NA	NA		26
GPUD Okanogan R.	42	16	Omak Cr. Okanogan R.	29	Wells Dam	71	16
USFWS Methow R.		110	Methow R. WNFH[4]	NA	Methow FH		110
Total **(PUD programs)**	**198**	**42**		**59**		**257**	**42**
Total **(All programs)**	**198**	**152**		**59**		**257**	**152**

[1] Assumes a 1:1 sex ration (see table 6).
[2] All backup broodstock are hatchery origin adults.
[3] May include hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH.
[4] May also include excess hatchery origin adults collected at Methow FH and the Twisp Weir.

Commented [MT5]: In the 2014 and 2015 broodstock protocols the number of back up hatchery fish collected was 96 taking the adult broodstock total for this portion of the program to 192. Because this component is collected in the fall, there is no need to offset a potential shortfall situation from a spring collection.

Commented [MT6]: For 2016 (17BY) – this number was reduced by half (from 60) to limit the potential number of excess production to have to manage.

Commented [MT7]: For 2016 (17BY) – this number was reduced by half (from 58) to limit the potential number of excess production to have to manage.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2017 brood summer steelhead programs. Includes primary collection location(s) and mating strategy. *Broodstock totals* <u>*do not*</u> *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	48F/48M		**96**	MFH/Twisp Weir/Wells Dam	1:1
DPUD[2] Methow R.	100,000	30F/30M		**60[4]**	Twisp Weir, MFH, WNFH, Wells Dam	1:1
DPUD Twisp R.	48,000		13F/13M	**26**	Twisp Weir	2x2 Factorial
GPUD Okanogan R.[3]	100,000	21F/21M	8F/8M	**58[5]**	Okanogan R./Omak Creek	1:1

USFWS	200,000		55F/55M	**110[6]**
Total[4]	**608,000**	**99F/99M**	**76F/76M**	**350**

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow hatchery 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.
[3]Okanogan Basin releases, including Omak Creek is100,000 smolts as part of GCPUD's 100K summer steelhead obligation and targets 58 adults in the Okanogan Basin, including up to 16 natural origin adults to fulfill the Okanogan Basin Production of 100,000 smolts comprised of natural origin and locally-adapted steelhead returning to the Okanogan River. Up to an additional 29 adults will be targeted at Wells dam to secure up to 50% of the production goal. Retention of progeny from these fish will be dependent upon success of CCT trapping efforts in Okanogan Basin tributaries.
[4] Up to an additional 30 hatchery adults will be collected at Well FH as a fall back to shortfalls in collections at the Twisp Weir, MFH.[5] Up to an additional 29 hatchery origin adults will be collected at Wells Dam as backup to potential 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.

Overall collection for the PUD programs will be 299 fish (a combination of program specific and back-up adults; Table 5) 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 run-timing of hatchery and natural origin steelhead at Wells Dam and the Twisp Weir. Trapping at the Wells Dam ladders will occur between 01 August and 31 October, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September on the west ladder (Appendix D). Operational criteria and dates for the Twisp Weir are still under construction.

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.

Surplus UCR Juvenile Steelhead Management

In the event excess juvenile are produced from the over-collection efforts to support the Methow safety net and /or Okanogan safety net programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met.

2. Used to support any shortfalls in the Wells Columbia River release provided fish health and/or marking requirements for the program can be met.

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 and/or CCT fishery managers).

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 Carlton Pond.

The TAC 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012, and 2013 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 2016, up to 106 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 53 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.

Should use of Wells Dam be needed to meet any shortfalls in broodstock for summer/fall Chinook programs occurring in the Okanogan Basin, 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.

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		53F/53M	**106**	Wells Dam	1:1
Total	**200,000**		**106**	**106**		

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 force 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,
- 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 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.

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 following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

WDFW will target 494 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs, 70 adults for the Lake Chelan triploid program, and up to 174 for the YN 275K-350K green egg request for the Yakima summer Chinook program (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 11 and terminate by August 31.

Commented [MT8]: Need confirmation from YN to finalize numbers.

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams have traditionally been supported through adult broodstock collections at the Wells Hatchery volunteer channel. For 2015, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Eastbank Outfall (EBO) using in-channel seining/netting beginning July 1 (or earlier if summer Chinook are detected in the outfall) through September 15. Collection efforts in the EBO in 2013 and 2014 were sufficient to meet the adult requirements for the Chelan Falls program (in 2015 only 56% of the program was met through EBO collections – the balance was attained through broodstock collected at the CJH volunteer trap). 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 from the Wells Volunteer channel to make up the difference. The 2015 broodstock target for the Chelan Falls program is 350 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

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 2015.

Program	Production target	Number of Adults[2]		Total	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	95F/95M		**190**	Wells VC[3]	1:1
Wells 0+	484,000	152F/152M		**304**	Wells VC[3]	1:1
Lk. Chelan Triploid	NA	35F/35M		**70**	Wells VC[3]	1:1
Chelan Falls 1+	576,000	175F/175M		**350**	EB outfall	1:1
Yakama Nation	350,000[1]	87F/87M		**174**	Wells VC[3]	NA
Total	**1,730,000**	**544F/544M**		**1,088**		

[1] The YN request is for between 275K and 350 green eggs to support the Yakima River summer Chinook program.
[2] 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.
[3] Wells Hatchery volunteer channel trap.

Commented [MT9]: Need confirmation on needs from YN.

Wenatchee River Basin

In 2016 the Eastbank Fish Hatchery (FH) is expecting to 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 2016 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 80 natural origin spring Chinook (Table 10). The spring Chinook production obligation 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 142 adults (70 natural origin and 72 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2016 is estimated at XXX spring Chinook, including XXX hatchery and XX 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%.

Commented [MT10]: Need Wenatchee River spring Chinook forecast from Andrew Murdoch before values can be provided.

Early TAC estimates suggest sufficient fish will likely be available to meet production obligations.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2016.

	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									
Estimated hatchery return									
Total									

Commented [MT11]: Need Wenatchee River spring Chinook forecast from Andrew Murdoch before values can be provided.

Early TAC estimates suggest sufficient fish will likely be available to meet production obligations.

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: Hatchery	Number of Adults: Wild	**Total**	Collection location	Mating protocol
Chiwawa Conservation	144,026	18F/18M	40F/40M	**80[1]**	Chiwawa Weir and Tumwater Dam[4]	2x2 factorial
Nason Conservation	125,000		35F/35M	**78[2]**	Tumwater Dam[4]	2x2 factorial
Nason Safety net	98,670	36F/36M[3]		**72**	Tumwater Dam	1:1
Total	**367,969**	**102**	**150**	**260[2]**		

[1] Includes 36 hatchery origin adults (represents ~50% of the adult target) to ensure the Chiwawa production goal is met if insufficient NO adults are collected).
[2] Includes ~10% additional NO fish to account for fish that may assign back to the White River spawning aggregate. No more than 70 NO fish will be retained for spawning.
[3] Due to the lack of returning hatchery fish from the Nason program (first age-4 returns are expected in 2017), Chiwawa hatchery fish will be collected to satisfy the Nason Cr. safety net program.
[4] 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).

Commented [MT12]: Need Wenatchee River spring Chinook forecast from Andrew Murdoch before values can be provided.

Early TAC estimates suggest sufficient fish will likely be available to meet production obligations.

Commented [MT13]: Buffer that was included in the 2015 protocols as a fallback buffer in case collections at the Chiwawa weir came up short.

Do we still want to include a hatchery buffer for production? Any unneeded adults would be surplussed at the close of collection and prior to spawning.

Chiwawa River Conservation Program Broodstocking:

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 30 previously PIT-tagged NO spring Chinook from the Chiwawa River would 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 of adults needed to meet the Chiwawa Conservation program (up to ~70 total or ~35 females) would be collected at the Chiwawa Weir.
    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 15 through August 1 (not to exceed 15 cumulative trapping days). 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.

- Additionally, no more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS.
- In the absence of adequate redd count data to calculate the 10% threshold, if after 15-days of weir operation, 67 bull trout encounters, or 15 August, the NO broodstock target is not reached, the balance of the mitigation obligation will be met through hatchery fish already retained for the Chiwawa program at TWD.
- To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program, HO adults (presently estimated at 50% 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.
- 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 (2011-2015) with conversion rates from Bonneville Dam.

	Detections at Bonneville Dam		Detections at Tumwater Dam			
Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2011	16	115	12	0.750	81	0.704
2012	7	60	5	0.714	52	0.867
2013	2	29	2	1.000	22	0.759
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
Mean	8.0	62.4	5.2	0.660	42.4	0.687
Geomean	6.6	56.1	3.7	0.569	37.6	0.671

Nason Creek Conservation Program Broodstocking:

Commented [MT14]: Need Wenatchee River spring Chinook forecast from Andrew Murdoch before values can be provided.

Early TAC estimates suggest sufficient fish will likely be available to meet production obligations.

- Up to ~78 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 70 NO adults will be retained to produce the necessary Nason Conservation program.
  - Collection of HO fish may occur in the event NO collection/retention falls short of expectation.
  - 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 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 Wenatchee Population or Leavenworth), will be released upstream of Tumwater Dam..
  - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the lowest assignment probabilities will be return to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

Commented [MT15]: Need Wenatchee River spring Chinook forecast from Andrew Murdoch before values can be provided.

Early TAC estimates suggest sufficient fish will likely be available to meet production obligations.

- Up to ~66 HO spring Chinook adults 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.

Nason Creek spring Chinook Rearing/Release Strategy:

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 spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be force 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 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.

Steelhead

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 1395 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 138 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 68 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. Hatchery x wild and hatchery x hatchery parental cross and unknown hatchery parental cross adults will be excluded from the broodstock collection. Hatchery steelhead parental origins will be determined through evaluation of VIE tags, adipose/CWT presence/absence, and PIT tag interrogation during collection. 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 females 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.

Table 12. Number of broodstock needed for the combined 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		34F/34M	**68**	TWD[3]/Dryden LBT-RBT[4]	2x2 factorial
Wenatchee Safety net[2]	123,650	35F/35M		**70**	Dryden LBT-RBT[4] /TWD[4]	1:1
Total	**247,300**	**70**	**68**	**138**		

[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 minimizes 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 2016 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012 and 2013 spawn escapement to the Wenatchee River indicate sufficient summer Chinook will 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 dam 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 270 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 135 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 01 July 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.

Table 13. Number of broodstock needed for the combined 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		86F/86M	**172**		
Grant PUD	181,816		49F/49M	**98**		
Total	**500,001**		**135F/135M**	**270**	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 2016 up to 1,000 adipose present, non-coded wire tagged (high proportion of natural origin) fall Chinook adults will be targeted at the OLAFT (as approved by the PRCC-HSC). Additional NO adults targeted as a continued pilot evaluation through hook-and-line angling efforts in the Hanford Reach 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 400 adults may be collected through the hook-and-line efforts. 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, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from either hook-and-line caught broodstock or OLAFT collections will be prioritized for PRH programs (i.e. OLAFT and Hanford Reach anger caught fish will be externally marked, 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 OLAFT and angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,219 females will need to be collected (3,536 spawned) 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, hook-and-line efforts on the Hanford Reach, and/or the Priest Rapids Dam off ladder trap (OLAFT; 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.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: the PRD off ladder trap (OLAFT – operated 4-days per week/8 hrs/day to collect up to 1,000 presumed NOR's), hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), and the Priest Rapids Hatchery volunteer channel trap.

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.

4) Only adipose present, non-CWT males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only progeny of adipose present, non-wired fish encountered through hook-and-line angling and at the OLAFT will be prioritized for retention into the program.

6) Broodstock collected from the OLAFT and by hook-and-line will exclude age-2 and to the degree possible age-3 fish (<75 cm) 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 (e.g. collection of 1 in 5 age-3 fish for broodstock from the OLAFT).

7) All gametes of fish spawned from hook-and-line broodstocking efforts and/or OLAFT collections will be incorporated into the PRH based program.

8) Real time otolith reading and an alternative mating strategy will be implemented in 2016 similar to 2015. Otoliths from males from the OLAFT and ABC collections will be collected during the peak spawning week and read prior to spawning. If the male is

natural origin, then it will be spawned with 4 females, otherwise it will be spawned with two.

9) All eggs or juveniles leaving PRH (including surplus) will have a unique otolith mark so that returning adults can be identified.

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.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,176F/1,088M	**3,264**		
ACOE-PRH	1,700,000	661F/331M	**992**		
ACOE – Ringold[1]	3,500,000	1,360F/680M	**2,040**		
Total	**10,799,504**	**4,197F/2,099M**	**6,296**		

Collection location	Estimated number of adults: Hatchery	Estimated number of adults: Wild	Total		
Priest Rapids Hatchery	**3,372F/1,358M**	**117F/49M**	**4,896**	PRH volunteer trap	1:2
OLAFT[2]	**307F/153M**	**360F/180M**	**1,000**	PRD off-ladder trap	1:2, 1:4
ABC[3]	**23F/45M**	**113F/219M**	**400**	Hanford Reach	1:2, 1:4
Total	**3,702F/1,556M** (5,258; 83.5%)	**590F/448M** (1,038; 16.5%)	**6,296**		

[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 2015. 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 and H/W were derived through otolith results from 2012 and 2014.

Appendix A

2016 Biological Assumptions for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Program	Mean Values for 2010-2014								Mean Values
	ELISAs		Fecundity		Prespawn Survival				2008-2012 Brood
	H	W			H		W		
	> 0.12	> 0.2	H	W	M	F	M	F	G-E-R Survival
Methow SPC	0.333	0.006	3,663	4,181	0.974	0.996	0.983	1.000	0.892
Twisp SPC	0.118	0.028	3,379	4,014	1.000	1.000	1.000	0.923	0.907
Twisp SHD	[redacted]	[redacted]	[redacted]	5,334	[redacted]	[redacted]	1.000	0.981	0.713
Wells SHD	[redacted]	[redacted]	5,739	5,938	0.954	0.950	na	na	0.620
Okanogan Safety Net	[redacted]	[redacted]	5,739	[redacted]	[redacted]	0.950	[redacted]	[redacted]	0.620
Wells SUC 1+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Wells SUC 0+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.796
YN Green Eggs	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Methow SUC	0.000	0.010	[redacted]	4,721	[redacted]	[redacted]	0.980	0.960	0.837
Chelan Falls 1+[a]	0.051	[redacted]	4,372	[redacted]	0.985	0.944	[redacted]	[redacted]	0.844
Wenatchee SUC	0.000	0.010	[redacted]	4,902	[redacted]	[redacted]	0.974	0.955	0.796
Wenatchee SHD	[redacted]	[redacted]	5,866	5,790	0.972	0.913	0.962	0.943	0.658
Nason SPC[b]	0.113	0.035	[redacted]	4,647	[redacted]	[redacted]	0.990	0.971	0.812
Chiwaw SPC	0.115	0.027	3,889	4,689	0.991	0.991	0.988	0.973	0.812
Priest Rapids FAC 0+[c,d]	[redacted]	[redacted]	3,719	[redacted]	0.082	0.861	[redacted]	[redacted]	0.825
ACOE @PRH	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.825
ACOE @Ringold	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.781

[1] Fecundities, ELISA's and prespawn survival values are based upon only three years data due to the shift in broodstock collection location from the Wells volunteer channel to the Eastbank Outfall.
[2] Green egg to release survival is based upon survival performance of fish acclimated and released from the Chiwawa program. Spring 2016 will be the second juvenile release from the Nason Creek program.
[3] Green egg to release survival.

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								
2016	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2018	13-17	Forced
2016	Wells SUC 0+ (DPUD)	480,000	Ad + CWT		Columbia R. at Wells Dam	2017	50	
2016	Wells SUC 1+ (DPUD)	320,000	Ad + CWT		Columbia R. at Wells Dam	2018	10	
2016	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2018	10-22	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	??
2016	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2017	50	??
2016	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2018	10	??
2016	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Riverside Pond	2018	10	??
2016	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2018	10	??
2016	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2017	50	??
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	2018	15	??

Commented [MT16]: Need parties to confirm/correct anticipated PIT numbers.

Commented [MT17]: We had been evaluating 10, 13, 18, and 22 size at release levels. Are we still testing or are we narrowing it down to one or another value?

Commented [MT18]: The Wenatchee summer Chinook program had been evaluating size at release of 10 and 15 fpp for 11-14BY. The Question to the group is whether we are still evaluating this or are we settling on a single value until the feasibility analysis is complete on a chilled reuse system at EB.

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Commented [MT25]: Need confirmation from USFWS.

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					Tonasket Pond			
2016	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT?	Columbia R. at CJH	2018	15	??
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)	5,400 PIT	Nason Cr. direct release	2018	6	Forced/Volitional
2017	Wenatchee Mixed (HxH/WxW) (CPUD)	53,170	Ad + CWT (HxH) CWT only (WxW)	4,300 PIT	Chiwawa R. direct release	2018	6	Forced/Volitional
2017	Wenatchee Mixed (HxH/WxW) (CPUD)	102,359	Ad + CWT (HxH) CWT only (WxW)	8,278 PIT	Wenatchee R. direct release	2018	6	Forced/Volitional
2017	Wenatchee HxH (CPUD)	25,000	Ad + CWT	2,022 PIT	Wenatchee R. at BBP	2018	6	Volitional

Commented [MT27]: Need input from CCT.

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	??
2017	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K [6]	Ad /CWT (TBD) [7]	Up to 20,000 PIT [8]	Okanogan/Similkameen Omak, Salmon, Antoine, other tribs. (TBD)	2018	5-8	??
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	??

[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 2015.
[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] Dependent upon conditions in pending Section 10 Permit.
[8] Total PIT tag release in the Okanogan 20,000
[9] 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.

Commented [MT28]: Need input from USFWS.

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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 for cast may be available to lay out what the expected surplus is, how many can expected to be removed through each action, etc. Preseason forecasts for steelhead will be available in September

Wenatchee Spring Chinook

Commented [MT31]: This section to be completed once the Wenatchee spring Chinook forecast is available.

Pre-season estimates for age-4 and age-5 adults project a total of 3,851 (935 natural origin [24.3%] and 2,915 hatchery origin [75.7%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 3,517 Chiwawa spring Chinook are to reach Tumwater Dam in 2015, of which about 655 (18.6%) and 2,915 fish (81.4%) are expected to be natural and hatchery origin spring Chinook, respectively. Additionally, about 162 natural origin spring Chinook are expected back to Nason Creek with the balance 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 2016. Estimates were generated by recently developed run prediction and pre-spawn mortality models (WDFW unpublished data).

	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									
Estimated hatchery return									
Total									

[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 conservation fisheries or adult removal at Tumwater Dam (TWD), the expected number of age- 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 (NORs; 4.5 times the number of NOR's in the Chiwawa River). The combined HO and NO returns will represent about 4 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportion number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2015. The conservation fishery is estimated to remove about 259 HOR Chiwawa adults (Table 3) which will require additional adult management to occur at TWD.

Additional Adult Management

2016 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks) and up to about 50% of the age-4 and age-5 hatchery origin adults (about 399 males and 680 females according to current models, Table 2). In addition to the conservation fishery, approximately 252 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, the balance will be surplused at TWD and used for tribal and/or food bank disbursements or nutrient enhancement projects (Table 3).

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2016.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners
	Wild	Hatchery	Wild[1]	Hatchery[2]		
Females[4]						
Males[4]						
Sub-total						
Pre-spawn survival[6]						
Expected PNI						
Expected pHOS						

[1] Wild broodstock needs of 80 wild NO fish (32 females/32 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.
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD and through the conservation fishery.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ration for hatchery and wild fish of the same age class.
[5] This should result in approximately 452 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn. Due to the expected poor environmental conditions expected in the Wenatchee Basin in 2015, prespawn survival values applied to the 2015 estimate is based upon the lowest observed survival to date (2001). 2001 was a water year very similar to how 2015 is shaping up.

Table 3. Estimated returns of Icicle Hatchery, Chiwawa Hatchery, and Chiwawa wild adults and estimated number of adults removed through adult management activities in the Wenatchee Basin in 2016.

	Estimated Returns			
	Icicle	Chiwawa HO	Chiwawa NO	Total
Estimated return				
% of return				
Harvest at2% take limit[1]				
	Estimated Chiwawa Hatchery Fish Removed			
	Fishery	Broodstock	TWD removal	Total

Number of HO adults removed by method[3]	259	98	722	1,079

[1] For Wenatchee River fishery area only. Does not include Icicle River fishery harvest.
[2] While included as harvest, it is NO incidental hooking mortality associated with HO fish removal.
[3] Only includes age-4 and age-5 adults

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at Tumwater Dam or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2017. Adult management plans will be finalized then and appended to this document.

Methow Spring Chinook

Commented [MT32]: This section to be completed once the spring Chinook forecast for the WNFH program is available.

Pre-season estimates project a total of 3,185 (507 natural origin [15.9%] and 2,678 hatchery origin [84.1%]) spring Chinook back to Methow Basin. Of the 2,678 hatchery returns, about 1,537 are estimated to from the conservation program with the balance of 1,077 from the WNFH safety net program (Table 4).

Table 4. Brood year 2010-2012 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2015.

	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	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**
%Total				57%				81%				62%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				3%				19%				4%
Winthrop (MetComp)	275	696	106	**1,077**					275	696	106	**1,077**
%Total				40%								34%
Total					89	486	114	**689**				

It is likely that some level of adult management will be required to limit the number of hatchery spring Chinook on the spawning grounds. Because a conservation fishery is not yet possible under current permit limitations, adult management will need to occur through operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH).

Presently hatchery fish from MH fish 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 in natural origin brood for the MH conservation program, and c) to support the 400K safety net program at WNFH. As such WNFH will operate their return channel to support removal of excess safety net fish. MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH needs) to WNFH to support the safety net program or retain adults to facilitate testing translocation of conservation fish to under seeded spawning areas as approved by the HCP HC and PRCC HSC.

In-season assessment of the magnitude 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 Permit 1196.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at the Twisp Weir (primarily as an action related to the steelhead RSS to meet a 1:1 hatchery:wild spawning composition upstream of the weir), the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2016, 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:** Throughout all trapping activities described in this plan, the two PIT tag antennae arrays within the Tumwater Dam ladder (weir 15 and 18, see Appendix 2), will be monitored by WDFW and Chelan PUD and detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at weir 15 and last detection at weir 15 or weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish encountering weir 15. 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) **Improved Fish Handling Efficiency**: Several infrastructure improvements at Tumwater allow WDFW and other operators to cycle through sampled fish more quickly. These improvements consist of an additional holding tank and an improved conveyance system between the trap and holding tank. The facility improvements and additional staffing by WDFW (3 operators instead of 2) during peak spring Chinook and sockeye passage (i.e. June 1 and July 15), will ensure that the trapping denil is operated constantly allowing unimpeded passage through the trap. Historically, the trapping denil has been periodically shut down while fish were being processed.

3) **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).

4) **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.

5) **Planned Tumwater trapping operations from September 1 until mid-December:** The trap will return to a 24 hours/7day/week manned or unmanned active trapping for steelhead and Coho broodstock collection and adult steelhead management. During this time period bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will continue to be implemented.

6) **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.

7) **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 2015. 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					
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 2016 brood will end in June 2016. However it is anticipated that adult management will occur for the 2017 brood 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 2016, 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 five days per week, 24 hours per day beginning July 1 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 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.

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 2016. 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
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	Start	End
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.
[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 5d/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 5d/week 24hr/day 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.

Wells Dam Ladder and Hatchery Volunteer Traps

For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps is summarized in Table 3):

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 construction activities on the hatchery modernization preclude use of either the West ladder or volunteer traps.

If the East ladder trap is used, it may begin as early as May 1 and 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. Anticipated trap operation is not expected to go beyond November 15.

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 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 East ladder trap. Anticipated trap operation is not expected to go beyond November 15.

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.

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 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.

Table 3. 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 2015. Blue denotes steelhead, brown spring Chinook, pink summer Chinook, 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		15 Jul					
Sp Chinook run comp					1 May		15 Jul					
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[5]									1 Sep		15 Nov	
Wells Volunteer Trap												
Su. SHD BS collection[1]									1 Sep		15 Nov	
SHD pHOS mgt.[6]		15 Feb				15 June			1 Sep			15 Dec
Su. Chin BS collection[4]							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] 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.
[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock will follow an up to 3d/week 16hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2015 brood will end in June 2015. However it is anticipated that adult management will occur for the 2017 brood beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Specific operation details for the Methow Hatchery volunteer trap and Twisp Weir are still being worked through. Once those details have been fleshed out more thoroughly, this section will be updated.

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.

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 2016. Blue denotes steelhead, brown spring Chinook, and green Coho.

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				1-30 Apr								
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 2016 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.

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 Trap (OLAFT) in 2016. Blue denotes steelhead, purple fall Chinook, and orange sockeye.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chin. BS collection[2]									1 Sep		15 Nov	
Fall Chinook Run Comp.[3]									1 Sep		15 Nov	
Sockeye BS Collection						22 Jun	10 Jul					

[1] Steelhead VSP monitoring targets 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] To acquire the target 1,000 adipose present, non-CWT adult fall Chinook for broodstock, the OLAFT is operated up to 5 days per week, 8 hours per day. Three of the five days are concurrent with the SHD VSP monitoring. The trap is opened to passage each night.
[3] Fall Chinook run composition runs concurrent with SHD VSP monitoring and/or fall Chinook broodstock collection activities.
[4] 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. 2016 Columbia River at mouth salmon and steelhead returns – actual and forecast.

			2015 Forecast	2015 Return	2016 Forecast
Spring Chinook	**Upper Columbia**	**Total**	**27,500**	**37,500**	**27,600**
	Upper Columbia	*Wild*	*4,500*	*5,800*	*5,000*
Summer Chinook	**Upper Columbia**	**Total**	**73,000**	**126,900**	**93,300**
Fall Chinook	**Upriver Bright - URB**		**518,300**		
Sockeye	Wenatchee		106,700	139,900	57,800
	Okanogan		285,500	370,900	41,700
	Total Sockeye		**392,200**	**510,800**	**99,500**

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The 2015 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 2015 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

2015 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin
https://grantpud.box.com/s/qkx0lhv7qmkvcn1jandrz1ahvbkv5rx1

2015 Priest Rapids Hatchery Implementation Plan
https://grantpud.box.com/s/xhmr8ajpmfkt3vyzo6fjghy84od8nkxi

Appendix G

DRAFT
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.

<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 needs (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:

- 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:
- 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
- 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.

2016 Rocky Reach and Rock Island
HCP Action Plan ***Draft***

COORDINATING COMMITTEE

	Jan 2016			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 2015 RR Bypass Evaluation Report				D				F																												
Deliver 2016 RR Bypass Operations Plan				D					F																											
Deliver 2015 RI Bypass Evaluation Report				D					F																											
Deliver 2016 RIS Bypass Operations Plan				D				F																												
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring and Report										S																										C
Northern Pikeminnow Ladder Trapping RI/RR																S								C												
Deliver 2016 RI/RR Fish Passage Plan					D			F																												
Deliver 2016 RR/RI Spill Plan							D			F																										
Deliver 2016 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												
2015 HCP Annual Report							D			F																										

HATCHERY COMMITTEE

	Jan 2016			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
2015 Hatchery M & E Report								D								F																				
2017 Hatchery M & E work plans																						D						F								
Dryden Water Quality Monitoring (Year 5)							S						C																							
Dryden TMDL check-in		S			C																															
Feasibility Chilled Reuse System at EB						S																														
Chelan Hatchery Rehabilitation Design	S																																			
Continuation of Methow Sp. Ch. Review																																				
Steelhead Residualism Plan - *Draft*										S																										F
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							

Attachment G

TRIBUTARY COMMITTEE		Jan 2016			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

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)

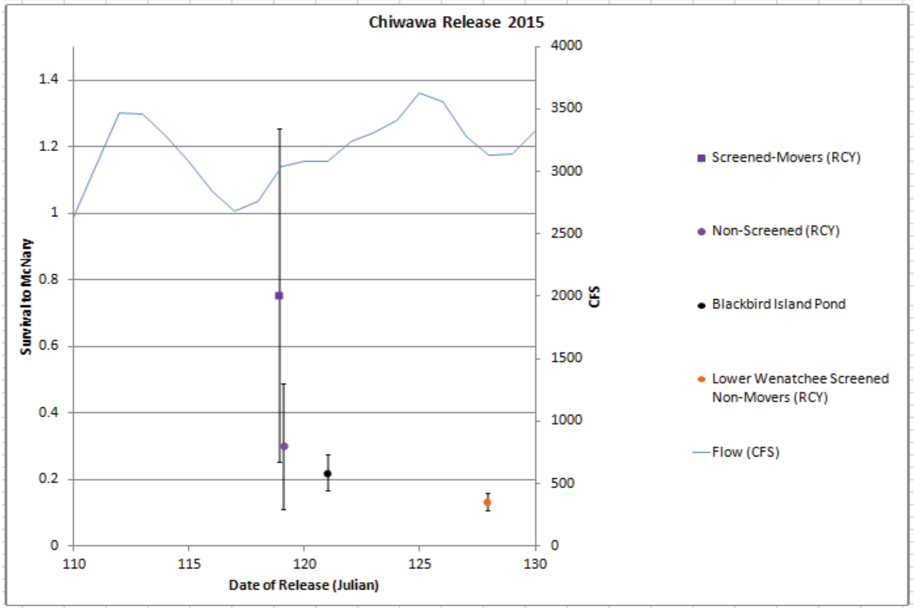
Statement

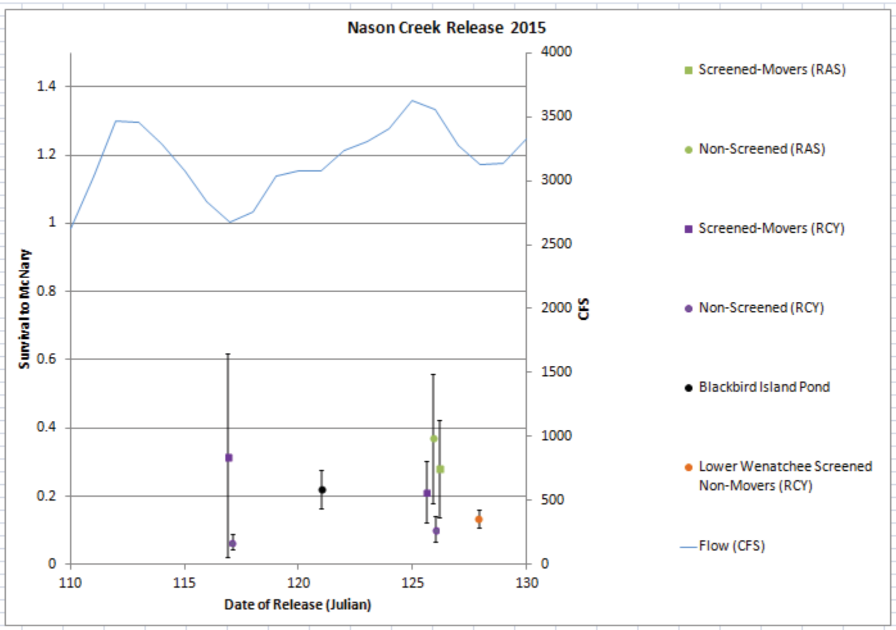
The Rock Island and Rocky Reach Habitat Conservation Plans' (HCP) Hatchery Committees (HC) agree that Chelan PUD will proceed with a feasibility for design of a chilled, partial water reuse aquaculture system at Eastbank Hatchery for Wenatchee summer Chinook, to enable Chelan PUD to meet phosphorus discharge limits under the Wenatchee River Total Maximum Daily Load (TMDL) for dissolved oxygen and pH.

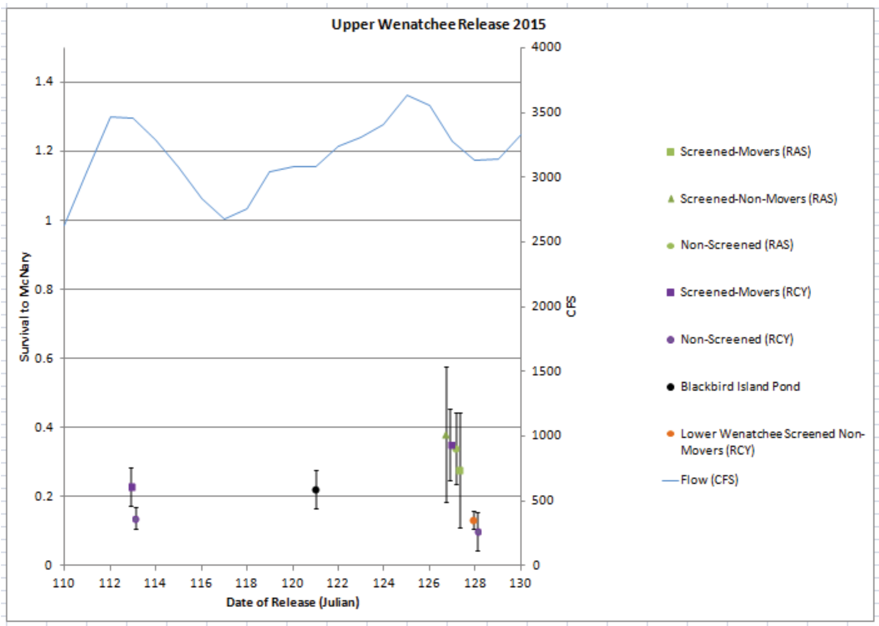
Background

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.

Apparent juvenile survival to McNary by release type and grouped by release location. Each release site includes releases to Blackbird Pond and the non-movers to the lower Wenatchee.







Release dates 4/23/15 to 5/8/15.

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.

Based on Release Type			
	# of tags	Detected post July 1	
Screened Movers	5693	10	0.18%
Screened Non-Movers	3192	13	0.41%
Non-Screened	8049	39	0.48%
Based on Rearing Vessel Raceway vs Circular			
Outdoors/Raceway	12929	51	0.39%
Indoors/Circular	4005	11	0.27%
Based on Release Location			
Chiwawa	1708	20	1.17%
Nason	5029	14	0.28%
Upper Wenatchee	5787	13	0.22%
Lower Wenatchee	2596	12	0.46%
Blackbird	1814	3	0.17%
Based on WxW or HxH			
HxH	9012	35	0.39%
WxW	7921	27	0.34%

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	April 21, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chair		
Cc:	Sarah Montgomery		
Re:	Final Minutes of the March 3, 2016 HCP Hatchery Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees met by conference call on Friday, March 3, 2016, from 9:00 a.m. to 10:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Charlene Hurst (National Marine Fisheries Service [NMFS]) will send the revised gene flow analysis spreadsheet to the Hatchery Committees (Item II-A). *(Note: Craig Busack sent the revised spreadsheet to the Hatchery Committees on March 9, 2016, which Sarah Montgomery forwarded to the Hatchery Committees on March 16, 2016.)*
- Charlene Hurst will revise the Gene Flow Management Standards and send it to the Hatchery Committees (Item II-A). *(Note: Craig Busack sent the revised Gene Flow Management Standards to the Hatchery Committees on March 9, 2016, which Sarah Montgomery forwarded to the Hatchery Committees on March 16, 2016.)*
- Bill Gale, Craig Busack, and Charlene Hurst will discuss gene flow standards and provide an update to the Hatchery Committees regarding the U.S. Fish and Wildlife Service's (USFWS) position on the standards prior to the Hatchery Committees' March 16, 2016, meeting (Item II-A). *(Note: Gale, Busack, Hurst, and Matt Cooper discussed gene flow standards on March 4, 2016. Feedback from that discussion is included in the revised gene flow standards distributed on March 16, 2016.)*
- Bill Gale will calculate necessary adult removal rates at different smolt-to-adult return levels under the recommended gene flow standards for Methow spring Chinook salmon (Item II-A). *(Note: Gale calculated removal rates, which are included in the revised gene flow standards distributed on March 16, 2016.)*

DECISION SUMMARY

- The Hatchery Committees representatives approved the "USFWS proposal" in the revised Gene Flow Management Standards, and the revised Methow spring Chinook Gene Flow analysis spreadsheet distributed on March 16, 2016 with an email vote as follows: Chelan PUD, Douglas PUD, NMFS, USFWS, the Yakama Nation (YN), the Washington Department of Fish and Wildlife (WDFW), and the Colville Confederated Tribes (CCT) approved both documents. Grant PUD (Priest Rapids Coordinating Committee Hatchery Sub-Committee [PRCC HSC]) also indicated support via email (Item II-A). *(Note: A portion of the Hatchery Committees representatives supported the NMFS proposed gene flow standards for Methow spring Chinook salmon during the Hatchery Committees March 3, 2016, conference call as follows: Chelan PUD, Douglas PUD, NMFS, YN, WDFW, and CCT. The USFWS requested more time to discuss the gene flow standards, and the revised version of the standards distributed by NMFS on March 16, 2016 was later approved.)*
- The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's Draft 2016 Steelhead Release Plan as follows: Chelan PUD, NFMS, USFWS, WDFW, YN, and the CCT approved on March 3, 2016 (Item III-A).

AGREEMENTS

- There were no agreements discussed during today's meeting besides the decisions detailed in the above section.

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on March 11, 2016, notifying them that the Draft (version 2) Broodstock Collection Protocols are available for review with comments due to Mike Tonseth by March 25, 2016 (Item IV-A).
- Sarah Montgomery sent an email to the Hatchery Committees on March 18, 2016, notifying them that Draft Hatchery Monitoring and Evaluation (M&E) Plan Appendices 2, 4, 5 and 6 are available for review before the Hatchery Committees April 20, 2016 meeting (Item IV-A).

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on March 3, 2016, notifying them that the Chelan PUD Final 2016 Steelhead Release Plan is available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on March 20, 2016, notifying them the National Marine Fisheries Service (NMFS) final Gene Flow Management Standards are available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on March 20, 2016, notifying them the NMFS final Methow spring Chinook Gene Flow Analysis is available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and said the purpose of today's call is to approve the Chelan PUD 2016 Steelhead Release Plan and further discuss Methow spring Chinook salmon gene flow standards.

II. Joint HCP-HC/PRCC HSC Discussion Items

A. Gene flow standards for Methow spring Chinook salmon

Charlene Hurst shared three documents titled, "Revised Methow spring Chinook Gene Flow Analysis" (Attachment B), "Draft Gene Flow Management permit language for PUD programs" (Attachment C), and "Draft Gene Flow Management permit language for the Winthrop program" (Attachment D), which Sarah Montgomery distributed to the Hatchery Committees on March 1, 2016. Hurst said the gene flow analysis spreadsheet has been revised in order to decrease the total proportion of hatchery-origin spawners (pHOS) from 0.8 to 0.6, and PUD pHOS from 0.6 to 0.4 under wild run sizes of 300 to 500 fish, and to incorporate comments from Bill Gale. Keely Murdoch asked how the revisions affect total spawning escapement. Mike Tonseth said if the natural run is 300 fish, and the PUD pHOS is 0.4, the total escapement equals 500 fish. Hurst said the pHOS values were set based on meeting the spawning escapement goal of 500 fish.

Todd Pearsons said he questions whether programs will be able to achieve the proposed pHOS at spawning escapements higher than 500 fish, and said Greg Mackey has modeled whether or not programs are able to remove sufficient hatchery-origin fish from traps to meet these pHOS values. Mackey said his modeling assumed that approximately 78% of Methow hatchery-origin fish could be removed at Methow Fish Hatchery (FH), 20% of Methow FH hatchery-origin fish could be removed at Winthrop National Fish Hatchery (NFH), and 29% could also be removed at Wells Dam. However, none of these assumptions had been tested in the field and the assumptions were best professional opinion of several biologists familiar with the programs including but not limited to Bill Gale, Mackey, and Mike Tonseth. Using these assumptions, previous modeling showed that pHOS down to approximately 0.25 might be achievable. He said it is doubtful whether removals above 87% are achievable with the current release strategy relying on off-station releases. Mackey said the pHOS values for spawning escapements above 500 fish would be hard to meet. He said with the approximately 135,000 Methow composite (MetComp) fish used for the modeling effort, 87% of the returning hatchery-origin adults had to be removed to reach a pHOS of 0.26. He said the modeling he performed did not include the 45% increase of Chelan PUD's MetComp fish that are now at Methow FH, and meeting a pHOS of 0.25 considering this increase in release size will require more than 87% of hatchery-origin fish to be removed. Pearsons asked if it would be possible to set a sliding scale for proportionate natural influence (PNI) up to 300 fish, and above 300, set PNI at 0.67 for the basin because it would likely correspond to pHOS values of 0.4 across different run sizes. Kirk Truscott said if the PUD PNI is increased for run sizes greater than 500 fish, the 3-population model output for basin-wide PNI decreases. Mackey said Douglas PUD has concern that the PUD PNI is set very high in order to meet the basin-wide PNI of 0.67, and said it seems too high for a minimum permit requirement, but would be an appropriate management goal.

Hurst asked if more hatchery-origin fish could be removed by running the Methow FH trap full-time. Mackey said the modeling was based on an estimate of the maximum amount of hatchery-origin fish that could be removed, not on how many hours the trap is operated. He said the modeled removal of hatchery-origin fish at Wells Dam, for example, is based on the incidental trapping of hatchery-origin fish while trying to collect wild fish. Truscott said there may be complications with removing hatchery-origin fish at Wells Dam, because the Chief Joseph Hatchery segregated program fish are adipose-clipped and marked with coded wire tags (CWTs); they could resemble hatchery fish from the Methow Basin. Gale said Winthrop NFH fish are not targeted for removal at Wells Dam but that the removal envisioned would be part of the removal of adipose-present adults during natural-origin recruit broodstock collection for Methow FH. Mackey said removing a moderate percentage of fish at Wells Dam does not provide significant benefit to adult management because it decreases the number of fish that can be removed at Methow FH; the removal percentages are not additive so removing fish at one location decreases the number removed at the next location; therefore, the total number removed by employing multiple removal sites is not as great as might be expected. Truscott said the Methow spring Chinook salmon programs should not rely on adult management at Wells Dam, because the CCT have concerns about the accidental removal of adipose-present Okanogan spring Chinook salmon marked with CWTs from the Endangered Species Act (ESA) 10j "non-essential experimental" population.

Gale said the discussion of gene flow standards is better suited for an in-person meeting, and suggested that parties write up concerns or proposed changes regarding the proposed gene flow standards and circulate them to the Hatchery Committees for discussion at the next regularly scheduled meeting on March 16, 2016. Gale shared a document titled, "Draft thoughts on NMFS proposed gene flow standards" (Attachment E), which Montgomery distributed to the Hatchery Committees on February 29, 2016.

Pearsons said Grant PUD supports the proposed gene flow standards. He suggested that pHOS values be set at an attainable level, and that PNI should not have a sliding scale when natural runs are greater than 300 fish. Gale said the 3-population PNI is the most biologically significant measurement, and the 3-population PNI target should have the most sway on Hatchery Committees support of the standards. He said the PUD PNI targets can be thought of as management targets rather than biologically significant targets. Gale said he could not support the changes proposed by Grant PUD, especially given that the target extraction rate for Winthrop NFH is much higher than the PUD programs, thus suggesting that the proposed extraction rates for the PUD programs should not be considered unachievable. Pearsons said the extraction rate targets differ based on the goals of the programs; the Winthrop NFH program only aims for hatchery-origin fish to occupy spawning areas when natural runs are very low (e.g., safety net), in contrast to the PUD program, which aims to be the main source of hatchery-origin fish to spawning grounds across a range of spawning escapements (e.g., conservation hatchery program).

Pearsons said Grant PUD is concerned about agreeing to permit conditions for gene flow standards that are not confidently attainable. Mackey agreed, and said the permit conditions should reflect the minimum acceptable level of gene flow. Mackey added that the discussion is not solely about the proportion of hatchery fish on the spawning grounds—broodstock collection fish are natural-origin spring Chinook salmon that are, in effect, removed from spawning grounds—and said that it does not make sense from a biological perspective to remove, for example, 80% of the returning hatchery adults that were produced from wild fish removed from the population for brood just to reach a genetic target for hatchery programs. He said when that occurs it is equivalent to killing the wild broodstock because their progeny are not allowed to reach the spawning grounds. Tom Kahler said the Methow program could act as the safety-net component for the Methow basin by performing targeted releases of conservation fish (progeny of wild-by-wild crosses) to the respective release locations at release numbers calculated to achieve pHOS targets without needing to manage returns to those locations, and the remainder of the PUD release obligation could be met with hatchery-by-hatchery crosses from a segregated program released directly from the Methow FH outfall where they could be effectively managed, thus eliminating the need for the safety-net component of the Winthrop NFH program. He said that safety-net component of the Winthrop NFH program could then be repurposed for summer Chinook or coho salmon production. Such a strategy could substantially increase the number of natural-origin spawners by reducing their number in the Methow FH broodstock. Alene Underwood agreed and said the biological effects of an unnecessarily large hatchery program are legally risky. Craig Busack said his goal in designing the gene flow standards is to meet the mitigation obligations of the HCPs in an ESA-defensible manner, and to finish the permits by May at the request of Douglas and Chelan PUDs. Mackey said the permit language can be written with a clearly stated biologically defensible management goal for gene flow, but the actual permit conditions can be a minimum acceptable gene flow operating level for the programs. Hurst edited the spreadsheet to show the revised proposed gene flow standards for the PUD program pHOS (i.e., 0.4).

Gale said he would have to discuss internally the changes to the proposal and extraction rates. He said he is not currently certain that the proposed gene flow standards are in the best interest of natural-origin spring Chinook salmon in the Methow basin. Kahler asked whether the gene flow standards are an item requiring Hatchery Committees approval. Mackey replied that Hatchery Committees' approval is not technically required for Douglas PUD and WDFW (as applicants) to move forward with acquiring permits from NMFS; however, for NMFS consultation purposes, the programs need to fit together. Gale said he does think Hatchery Committees consensus is needed before applicants can move forward with acquiring permits, and Murdoch agreed.

Tracy Hillman thanked the members for their candid discussions and asked each representative if they supported the proposed gene flow standard as modified by Grant PUD. Tonseth said WDFW supports the proposed basin PNI minimum of 0.5 as long as language is included in the permits that parties will strive to exceed the minimum every year. Murdoch said the gene flow standards are greatly improved, and said YN particularly supports lower levels of natural-origin adult removal. Murdoch asked that NMFS summarize the proposed standards in a short document and distribute to the Hatchery Committees. Hurst said she will write a summary of the revised gene flow standards proposal and send it to the Hatchery Committees.

Truscott said the standards are a vast improvement from past. He asked why the Winthrop NFH pHOS is 0.2 for small run sizes, and noted that a pHOS of greater than 0.2 might be required to reach the minimum escapement target of 500 fish.

Hurst emphasized that NMFS has been asked to complete the permits in May 2016. Kahler said if the permits are not completed by June, Douglas PUD cannot hire additional full-time WDFW staff for adult management. He said NMFS requested that the Hatchery Committees provide perspective and technical input on the gene flow standards because they collectively oversee the programs these permits apply to; however, Douglas PUD and WDFW are the permit applicants and can therefore move forward with the permit application. Gale said the permit application should not move forward without consensus of all Hatchery Committees parties, because they have a responsibility to oversee the implementation of hatchery programs. Busack said he intends to discuss the standards with USFWS further and hoped the standards will be agreed upon before the Hatchery Committees March 16, 2016 meeting. Otherwise, the permits will likely not be complete in May 2016. Gale said he, Busack, and Hurst will discuss gene flow standards and provide an update to the Hatchery Committees regarding USFWS' position before the Hatchery Committees March 16, 2016 meeting.

A portion of the Hatchery Committees representatives supported the NMFS proposed gene flow standards for Methow spring Chinook salmon as revised during the Hatchery Committees March 3, 2016, conference call as follows: Chelan PUD, Douglas PUD, NMFS, YN, WDFW, and the CCT indicated support. Grant PUD (PRCC HSC) also indicated support during the conference call. *(Note: A revised version of the Gene Flow Management Standards and Methow spring Chinook Gene Flow analysis spreadsheet was distributed on March 16, 2016. Both documents were approved by email vote by all Hatchery Committees representatives, as well as Grant PUD [PRCC HSC.])*

III. Chelan PUD

A. DECISION: Draft Steelhead Release Plan

Catherine Willard shared a document titled, "Draft 2016 Steelhead Release Plan" (Attachment F), which Sarah Montgomery distributed to the Hatchery Committees on February 18, 2016. Willard said there are no substantive changes from the 2015 Steelhead Release Plan to the draft 2016 Steelhead Release Plan. The Rock Island and Rocky Reach Hatchery Committees representatives approved Chelan PUD's Draft 2016 Steelhead Release Plan as follows: Chelan PUD, USFWS, WDFW, NMFS, YN, and the CCT approved on March 3, 2016.

IV. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees meetings are on March 16, 2016 (Douglas PUD), April 20, 2016 (Chelan PUD), and May 18, 2016 (Douglas PUD).

B. List of Attachments

Attachment A	List of Attendees
Attachment B	Revised Methow spring Chinook Gene Flow Analysis
Attachment C	Draft Gene Flow Management permit language for PUD programs

Attachment D	Draft Gene Flow Management permit language for the Winthrop program
Attachment E	Draft thoughts on NMFS proposed gene flow standards
Attachment F	Draft 2016 Steelhead Release Plan

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Alene Underwood*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons†	Grant PUD
Justin Yeager*	National Marine Fisheries Service
Craig Busack*	National Marine Fisheries Service
Charlene Hurst	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

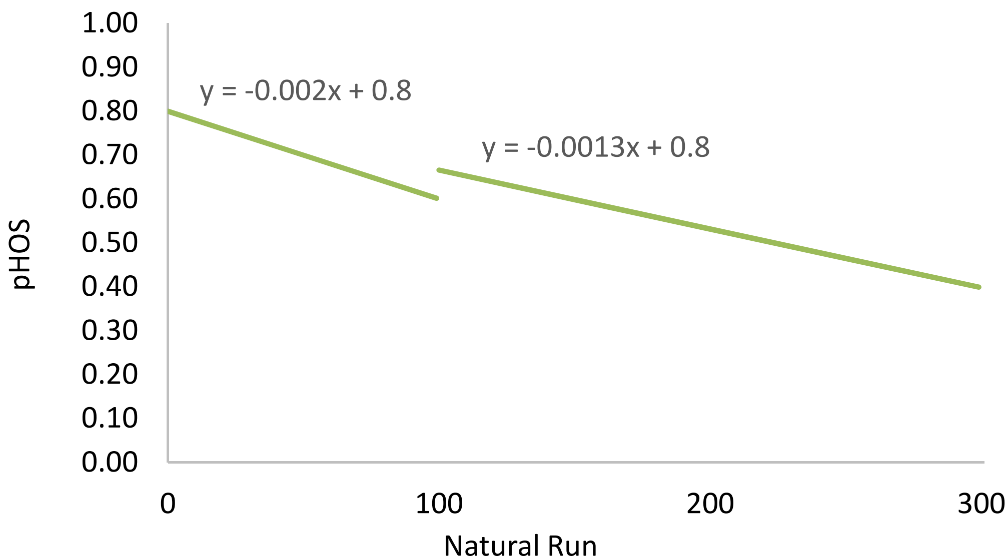
Note:

*Denotes Hatchery Committees member or alternate

†Joined for the joint HCP-HC/PRCC HSC discussion

130 broodstock (≤ 33% of wild run) for PUD program, 500 spawner total

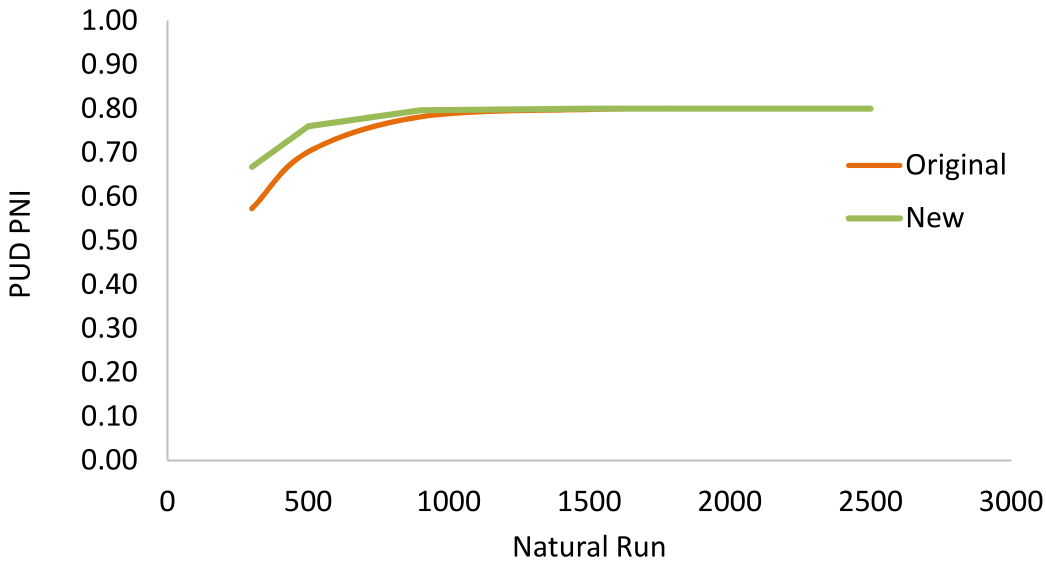
					NMFS Calculation			Applicant Calculation	
Wild Run	NOB	Wild Escapement	HOS	PNOB	PUD pHOS	WNFH pHOS	Total pHOS	PUD pHOS	WNFH pHOS
0	0	0	500	0.00	0.8	0.2	1.00	1	1
50	0	50	450	0.00	0.7	0.2	0.90	0.88	0.67
99	0	99	401	0.00	0.602	0.2	0.80	0.75	0.5
100	33	67	433	0.25	0.67	0.2	0.87	0.83	0.59
150	50	101	400	0.38	0.60	0.2	0.80	0.75	0.5
200	66	134	366	0.51	0.53	0.2	0.73	0.66	0.43
250	83	168	333	0.63	0.47	0.2	0.67	0.59	0.38
299	99	200	300	0.76	0.40	0.2	0.60	0.5	0.33



> 300 wild run; assume 75% Methow fish in WNFH broodstock

Original		NMFS Calculation					Applicant Calculation	
Wild Run	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"
300	0.75	0.6	0.2	0.57	0.57	0.45	0.75	0.5
500	0.8	0.4	0.2	0.68	0.70	0.52	0.50	0.33
900	1	0.3	0.2	0.78	0.78	0.58	0.38	0.29
1500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26
2000	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26
2500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26

a	0.8
b	0.0042



New

Wild Run	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"	b
300	0.75	0.4	0.2	0.67	0.67	0.5	0.50	0.33	0.006
500	0.8	0.4	0.2	0.68	0.76	0.52	0.50	0.33	
900	1	0.3	0.2	0.78	0.80	0.58	0.38	0.29	
1500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26	
2000	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26	
2500	1	0.25	0.2	0.8	0.80	0.6	0.31	0.26	

Gene Flow Management

13. When the natural run size is < 300, a set of equations will be used to determine the allowable PUD partial pHOS (calculated as $HOS_{PUD}/(HOS_{PUD} + HOS_{WNFH} + NOS)$), based on achieving a 500 total spawner escapement. When the natural run is ≥ 100 fish, that equation will be y = -0.0013x + 0.8. When the run is < 100 fish, pHOS will be determined by the equation y = -0.002x + 0.8.

14. When the natural run size is ≥ 300, the Permit Holders will manage to a PNI target as determined by the equation PUD PNI = 0.8(1-e^(-0.006x)), where x equals the natural run size.

Table 1. Sliding scale the PUD PNI equation was based on for returning adult Methow spring Chinook salmon.

Natural Run	PUD pHOS	PUD pNOB	2-pop PNI	PUD PNI (equation)
300	0.40	0.75	0.67	0.67
500	0.40	0.80	0.68	0.76
900	0.30	1.00	0.78	0.80
1500	0.25	1.00	0.8	0.80
2000	0.25	1.00	0.8	0.80
2500	0.25	1.00	0.8	0.80

15. Hatchery-origin adults will be removed at one or more of Methow Hatchery, WNFH, Twisp weir, and Wells dam to achieve, on average[1], the partial pHOS target when natural run size is < 300 and the PNI target when natural run size is ≥ 300.

16. NMFS recognizes that due to the lack of control structures in the Methow Basin, removal of hatchery-origin adults is challenging, and thus the PNI target may initially be difficult to achieve. The PNI target should be considerably easier to achieve beginning in 2018, when the first 4-yr olds from the reduced releases return. NMFS also recognizes that there may a substantial disparity in spawning success of hatchery-origin fish in different areas. Therefore:

    a. Until 2018, NMFS anticipates that the gene flow target may not be met, but does expect aggressive attempts to substantially increase PNI and/or decrease partial pHOS from existing levels.
    b. To facilitate meeting gene flow targets, Permit Holders may need to operate hatchery ladders full-time during a large portion of the run for removal of hatchery-origin fish.
    c. NMFS is open to scientifically defensible calculations of effective pHOS based on relative effectiveness of hatchery-origin spawners.

[1] The most recent three years for each situation (i.e. when natural run size is < 300 or when natural run size is ≥ 300).

17. Hatchery-origin spring Chinook salmon from outside the Methow Basin that are encountered at any of the fish collection sites shall not be returned to waters of the Methow Basin.

18. In the event that the average target(s) are not met three years after implementation of this permit, the Permit Holders will discuss with NMFS the remaining challenges and potential solutions for achieving gene flow targets.

Gene Flow Management

13. Hatchery-origin adults will be removed at one or more of Methow Hatchery, WNFH, Twisp weir, and Wells dam to achieve, on average[1], a partial pHOS of 0.2 (calculated as $HOS_{WNFH}/(HOS_{PUD} + HOS_{WNFH} + NOS)$ regardless of natural run size.

14. NMFS recognizes that due to the lack of control structures in the Methow Basin, removal of hatchery-origin adults is challenging, and thus the pHOS target may be difficult to achieve initially while removal options are explored further. NMFS also recognizes that there may a substantial disparity in spawning success of hatchery-origin fish in different areas. Therefore:

    a. To facilitate meeting gene flow targets, hatchery ladders may need to be operated full-time during a large portion of the run to remove hatchery-origin fish.
    b. NMFS expects that the pHOS goal may not be met initially while operators are experimenting with removal options, but does expect aggressive attempts to substantially decrease pHOS from existing levels.
    c. NMFS is open to scientifically defensible calculations of effective pHOS based on relative effectiveness of hatchery-origin spawners.

15. Hatchery-origin spring Chinook salmon from outside the Methow Basin that are encountered at any of the fish collection sites shall not be returned to waters of the Methow Basin.

16. In the event that the average target(s) are not met three years after implementation of this permit, the Permit Holders will discuss with NMFS the remaining challenges and potential solutions for achieving gene flow targets.

[1] Three-year running average.

After reviewing the gene flow standards analysis prepared by NMFS and circulated to the all the Methow basin parties through the PUD HCP hatchery committee (sent via email on Feb 19, 2016) the Fish and Wildlife Service has a number of concerns and questions. Most of these concerns are directly related to how adoption of these standards within the HCP-HC arena for the program at Methow FH may affect either directly or indirectly the current ongoing consultation for the Winthrop NFH spring Chinook salmon program. In the hopes of facilitating future discussions between the FWS and NMFS please consider the following:

Important Caveat- The thoughts below are simply draft considerations meant to facilitate discussion, admittedly in some cases they may be the result of a miscommunication or misunderstanding and should not be thought of as representing a FWS position or finding.

Question and Concerns

- The current PNI sliding scale under discussion originated from a pHOS sliding scale developed by NMFS after discussions with the parties. This sliding scale considered the aggregate pHOS of both Winthrop NFH and Methow FH returning spring Chinook Salmon adults and had a maximal value of pHOS ≤ 0.4 (at NOR runs > 300) with reduced pHOS steps at increasing NOR run sizes. Conversely the current sliding scale being proposed has an aggregate target of ≤0.8 at the same NOR run size. This seems like a marked change in strategy, how will this be described/justified in the BiOp?
- The current PNI sliding scale allows an aggregate pHOS from both programs of >0.5 for all NOR run sizes < 900. In the last 13 years there has only been a single year where the NOR run exceeded 900. Allowing an aggregate pHOS >0.5 in virtually all years appears to be a marked change from earlier guidance that NMFS has provided.
- We are assuming that these gene flow standards will be evaluated on some type of multi-year metric, but how specifically does NMFS plan to measure compliance for both programs?
- The current scheme holds WNFH to a pHOS target of 0.2 at all NOR run sizes (i.e. WNFH is held constant while MFH slides along a continuum). While the Service agrees with the intent of prioritizing MFH returns for supplementation purposes we are concerned that the current WNFH target is not feasible given the lack of infrastructure in the Methow basin. NMFS initially asked the parties to analyze the feasibility of meeting an aggregate pHOS target of 0.25. Attached to the HGMP submission for both the MFH and WNFH program was supplemental information described this analysis. The results of this work indicate that WNFH may be able to reach an pHOS target <0.2 as a multi-year average based on the following key assumptions; 1) maximal removal of HOR adults at both Winthrop NFH and Methow FH facilities, and 2) that there are fisheries operating in both the mainstem Columbia River (above Wells Dam) and in the Methow basin. The current proposed standards do not indicate if these assumptions are still inherent in the NMFS analysis.
- Additional evaluation and consideration is needed to be made to address the merits and risks regarding the exclusion of the area around the hatcheries from pHOS and PNI calculations. Data

suggest that few NOR fish are observed spawning in these areas, thus gene flow from HOR adults to the NOR population is not likely occurring at a biologically significant level. Escapement data suggests that, on an annual average, fewer than 2% of adult spawners in the Methow FH and WNFH outfalls (MH1 and WN1) are NOR adults and, on an annual average, fewer than 5% of adult spawners in combined reaches M7 and M6 (Wolf Creek > Foghorn Dam > Winthrop Bridge) are NOR adults. Similarly the M5 and M4 reaches (Winthrop Bridge > MVID Diversion > Twisp Confluence) occasionally includes small numbers of redds, and HOR carcass recoveries, many of which are likely drifting down from upstream mainstem reaches and hatchery outfall channels.

	2006-2015 Estimated pHOS Values			
Survey Reach	**Avg pHOS**	**Max of pHOS**	**Min of pHOS**	**Avg Expanded Annual NOR Escapement**
M6	0.975	1.000	0.957	2.4
M7	0.945	1.000	0.874	5
MH1	0.980	1.000	0.923	1.5
WN1	0.982	1.000	0.909	1.7

*note redds were not documented in all years below Winthrop Bridge. Carcasses are dominated by HOR fish. I am not certain it was surveyed each year so it was left out of this table.

The following are items that need further discussion and agreement between all the parties:

- There has been a long history of analysis and discussion regarding the management of gene flow betweem the hatchery and natural populations in the Methow basin. To what extent does NMFS plan to describe this in the pending BiOps?
- Collaborative sdult management in the Methow basin is currently in its infancy (began in 2015). Therefore, the BiOp needs to characterize this proposed management scheme as an experimental approach while providing a degree of flexibility, how this intent is framed and or described in the BiOps for these two programs is key to understanding the feasibility of these standards.
- In order to increase the likelihood of meeting the proposed adult management plan the Permits for these programs need to require the operators to operate the existing hatchery ladders and traps to the maximal amount practicable to ensure that both programs can meet these targets. If after maximal extraction efforts HOR's are needed to meet escapement goals, adult outplanting (along with associated effectiveness monitoring) is likely the best tool for meeting HOR escapement targets, pulsing or somehow reducing the effectiveness of hatchery trapping to achieve hatchery escapement targets should be precluded by the permits.
- Until such time that the fishery parties agree to a framework for the development of conservation fisheries. WNFH pHOS targets should be relaxed until these additional management tools are available.

- The spawning that occurs in the hatchery outfalls (Reaches MH1 and WN1) and the“hatchery zone” of the Methow River (Reaches M6, M5, M4 and possibly M7) should be excluded from the calculation of Methow/Chewuch PNI. I would propose that the FWS, the PUDs, and WDFW should commit to continued monitoring of spawning in this area and when NOR adults constitute >5% of the spawner population in these areas we should revisit this topic.

DRAFT Memorandum

Date: February 17th, 2016

To: HCP Hatchery Committees

From: Chris Moran (WDFW), McLain Johnson (WDFW) and Catherine Willard (CPUD)

Re: 2016 Wenatchee Steelhead Release Plan (Brood Year 2015)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin in 2015 as part of the Rock Island and Rocky Reach HCP requirements. As of February, approximately 199,454 Wenatchee summer steelhead (91,538 HxH and 107,916 WxW) are on station at the Facility.

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa Acclimation Facility ("Facility") (Figure 1) following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank Hatchery to the Facility in November and released in April through May. The Facility consists of three, in line circular, dual-drain tanks within an enclosed building and are operated on a partial water reuse system (RAS). The two outer tanks hold steelhead during rearing and the center tank is used solely for receiving fish that are allowed to move from the outer tanks to the center tank during release. Fish are not provided the opportunity to move to the center tank until gates are removed (typically April 20th). When the center tank contains a pre-determined number of fish for a release, fish are loaded into a hatchery truck and truck-planted at one of five release locations. This "screening" method has been used to differentiate between apparent active migrants (fish that move from the outer tanks to the center tank) from apparent non-active migrants (fish that do not move from the outer tank to the center tank).

In addition to the circular vessels, there are three traditional flow-through raceways (RCY) located outside. The smaller of the three, Raceway Three (RCY3) is used to rear steelhead when it is not needed for rearing "high ELISA" spring Chinook juveniles. Raceways One (RCY1) and Two (RCY2) are located adjacent to each other. The wall between the two raceways contains a gated opening that when removed, allows fish to move between the raceways. In addition to removing the gate, the water is lowered in the receiving pond (typically April 20th) to establish a directional flow that apparent active migrant fish may cue to. Similar to the RAS vessels, this set-up allows for a screening method that attempts to differentiate between apparent active- and apparent non-active migrants. When RCY1 contains the pre-determined number of fish suitable for release, fish are loaded into a transport truck and truck-planted at one of five release locations. Historically, this screening method has been termed a volitional release but is currently termed a screening method as this more accurately describes the end result of the action.

2016 Release Strategy Objectives

- Evaluate best hatchery management practices for hatchery releases to optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (Draft NMFS Wenatchee River Steelhead Section 10 Permit).
- Assess hatchery release practices to inform development of a residualism baseline for the Wenatchee steelhead program consistent with the Draft NMFS Wenatchee River Steelhead Section 10 Permit DRAFT Steelhead Residual Management Plan.
- Utilize data collected from the 2016 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. 2013).

Methods

The 2016 release strategy will evaluate the effectiveness of the screening method, and the role of rearing vessel (RAS versus FT), and brood origin on fish performance (e.g., juvenile survival and SARS); the 2016 release plan methodology is a repeat of the 2015 release plan. Additionally, a similar evaluation of this screening method (termed volitional release) was conducted in 2013, where approximately 20,000 passive integrated transponder (PIT) tagged juvenile steelhead were utilized for detailed monitoring and evaluation of post release performance. For 2016, the release numbers and locations identified in Table 1 will build on the 2013 and 2015 release data and enable a more thorough investigation of the screening methodology at the program level.

- 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.

Release Timing

Wagner et al. (1963) suggested that the optimal release date of hatchery steelhead is equal to the peak of the wild steelhead emigration in the same watershed. Additionally the Draft NMFS Wenatchee River Steelhead Section 10 Permit states the following "The Permit Holders will release hatchery origin smolts at 6 fish per pound when fish are ready to emigrate directly to the ocean and during the period in which natural origin smolts out-migrate from the Wenatchee Basin". Based on the last five years of Lower Wenatchee smolt trap outmigration data, natural origin Wenatchee steelhead emigration peaks the first week of May. In 2013 survival to McNary Dam for Wenatchee hatchery steelhead juveniles was found to be negatively related to release date (r=-0.506, p=0.04) and positively related to juveniles detected in the Wenatchee Basin after July 1 (Figure 1). In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase smolt to smolt survival, all fish located at the Facility will be released by May 8th; fish acclimated at Blackbird Island Pond will be allowed to volitionally move out of the pond through the end of June (after which time the pond outlet will be closed as in years past).

Release Location

In an effort to reduce potential steelhead residualism, consistent with objectives of this steelhead release plan and found in the Draft NMFS Wenatchee River Steelhead Section 10 permit, two historic hatchery steelhead release locations, RKM 15.6 of the Chiwawa River and RKM 19.3 of Nason Creek, will be eliminated for the 2016 release. Hausch and Melnychuk (2012) completed a meta-analysis of hatchery practices and residualization of hatchery steelhead and found that releases of fish located closer to a confluence with a major river produced fewer residuals than those located further upstream. The remaining release locations, one each in Nason Creek, Chiwawa River, upper Wenatchee River, and the lower Wenatchee River are included in Table 1 below.

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2013). Additionally, assessment of smolt index and precocial maturation will be conducted via non-lethal sampling from Raceways 1 and 2 (n=200 "first movers"; n=200 "late movers", n= 200 "non-movers") and the two RAS vessels (n=200 "first movers"; n=200 "late movers", n= 200 "non-movers").

Table 1. Steelhead release numbers and locations, 2016.

Vessel	Origin[1]	Estimated Number Released	Estimated # PIT-tagged	Destination	rkm	Screened or non-screened method
RAS1	WxW	6,136	1,100	Nason	7.0	Non-screened
RCY1	Mixed	20,768	2,100	Nason	7.0	Screened
RAS2	WxW	6,342	1,100	Nason	7.0	Screened
RCY2	Mixed	20,769	2,100	Nason	7.0	Non-screened
		54,015		**Total**		
RAS1	WxW	6,136	1,100	U. Wenatchee	79.2	Non-screened
RCY1	Mixed	34,333	3,470	U. Wenatchee	79.2	Screened
RAS2	WxW	6,343	1,100	U. Wenatchee	79.2	Screened
RCY2	Mixed	34,334	3,470	U. Wenatchee	79.2	Non-screened
		81,146		**Total**		
RCY2	Mixed	19,652	1,990	Chiwawa	11.4	Non-screened
RCY1	Mixed	19,652	1,990	Chiwawa	11.4	Screened
		39,304		**Total**		
RCY1	Mixed	TBD		L. Wenatchee	40.2	Non-movers
ELISA	HxH	24,969	2,520	Blackbird	40.5	N/A

[1]Mixed = HxH and WxW.
[2]Both forced and volitional releases will occur April 20 - May 8; any remaining non-migrants will be released by May 8.

Figure 1. Chiwawa Acclimation Facility site description.

REFERENCES

Hausch, S. J., and M. C. Melnychuk. 2012. Residualization of hatchery steelhead: a meta-analysis of hatchery practices.

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Partridge, F.E. 1986. Effect of steelhead smolt size on residualism and adult return rates. Idaho Department of Fish and Game, Boise, Idaho.

Wagner, H. 1968. Effect of stocking time on survival of steelhead trout, *Salmo gairdnerii*, in Oregon. Transactions of the American Fisheries Society 97:374-379.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	April 21, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the March 16, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD headquarters in East Wenatchee, Washington, on Wednesday, March 16, 2016, from 9:30 a.m. to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing. Johnson sent an email update to the Hatchery Committees on April 5, 2016, stating that their workgroup is drafting an updated timeline and they plan to have a draft for review by May 1, 2016.)*
- Keely Murdoch will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan, and will coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility (Item II-A). *(Note: this item is ongoing. Murdoch sent the Draft Chewuch Homing Study Proposal to the Hatchery Committees on April 11, 2016.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item II-A). *(Note: this item is ongoing.)*
- Hatchery Evaluation Technical Team (HETT) members will update Draft Hatchery M&E Plan Appendices 2 through 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-E). *(Note: this item is ongoing.)*
- Sarah Montgomery will send Draft Hatchery M&E Plan Appendices 2, 4, 5 and 6 to the Hatchery Committees for review (Item II-E). *(Note: Montgomery sent the*

Appendices to the Hatchery Committees on March 18, 2016.)

- Tracy Hillman will distribute the paper, "Olfactory navigation during spawning migrations: a review and introduction of the Hierarchical Navigation Hypothesis," to the Hatchery Committees (Item I-A). *(Note: Hillman sent the paper to Sarah Montgomery on March 16, 2016, which she forwarded to the Hatchery Committees that same day.)*
- Sarah Montgomery will forward information received from Todd Pearsons regarding Grant PUD's website, which publically hosts M&E documents (Item I-A). *(Note: Montgomery forwarded Pearsons' emails to the Hatchery Committees on March 16, 2016.)*
- A portion of the Hatchery Committees representatives will convene as a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin (Item II-A). *(Note: The workgroup met on March 23, 2016.)*
- Sarah Montgomery will send a Doodle poll to the Hatchery Committees to convene a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin (Item II-A). *(Note: Montgomery sent the Doodle poll to the Hatchery Committees on March 17, 2016.)*
- Tracy Hillman will call Kirk Truscott to discuss the imprinting and homing workgroup (Item II-A). *(Note: Hillman and Truscott discussed the workgroup on March 21, 2016.)*
- The Hatchery Committees will provide comments on WDFW's Draft (Version 2) Broodstock Collection Protocols to Mike Tonseth by March 25, 2016 (Item II-D).
- Mike Tonseth will send the final draft Broodstock Collection Protocols to the Hatchery Committees for approval via email on or before April 12, 2016 (Item II-D). *(Note: Tonseth sent the final draft Broodstock Collection Protocols to the Hatchery Committees on April 8, 2016, requesting an email vote by April 13, 2016.)*
- Tracy Hillman will calculate carrying capacity for Chiwawa River spring Chinook salmon for discussion at the May 18, 2016, Hatchery Committees meeting (Item II-E).
- Catherine Willard will provide an update on Blackbird Pond Acclimation passive integrated transponder (PIT)-tag data results at the April 20, 2016, Hatchery Committees meeting (Item III-A).

DECISION SUMMARY

- There were no decisions approved during today's meeting.

AGREEMENTS

- The Rocky Reach and Rock Island Hatchery Committees approved the WDFW Request for Juvenile Hatchery Steelhead for Conducting Efficiency Trials at Lower Wenatchee River Smolt Trap (Attachment C) via email from March 29 to 30, 2016. Montgomery distributed the document to the Hatchery Committees on March 29, 2016.

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on March 18, 2016, reminding them the Draft Hatchery M&E Plan Appendices 2, 4, 5, and 6 are available for review before the Hatchery Committees April 20, 2016 meeting (Item II-E).

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on March 20, 2016, notifying them the National Marine Fisheries Service (NMFS) final Gene Flow Management Standards are available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on March 20, 2016, notifying them the NMFS final Methow spring Chinook Gene Flow Analysis is available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on March 30, 2016 notifying them that the Final 2015 Wells HCP Annual Report is available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on April 8, 2016 notifying them that the Final 2015 Rocky Reach and Rock Island HCP Annual Reports are available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on April 14, 2016 notifying them that the Final 2016 Broodstock Collection Protocols are available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the February 17, 2016, Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Catherine Willard requested removing the size target recommendation for brood year (BY) 2016 Wenatchee and Chelan Falls summer Chinook salmon agenda item because it will be discussed during the Broodstock Collection Protocols discussion.
- Willard also requested removing Objective 1 from the Five-Year Hatchery M&E Review planning discussion, because discussion was completed at the February 17, 2016, Hatchery Committees meeting.

The Hatchery Committees reviewed the revised draft February 17, 2016, meeting minutes. Sarah Montgomery said there are several outstanding comments to be discussed. The Hatchery Committees discussed the outstanding comments and made revisions.

Hatchery Committees members present approved the draft February 17, 2016, meeting minutes, as revised.

Action items from the Hatchery Committees meeting on February 17, 2016, and conference call on March 3, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on February 17, 2016 or March 3, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item is ongoing. Mike Tonseth said WDFW is working with a genetics lab to identify gaps in genetic sampling.
- *Mike Tonseth and Andrew Murdoch (WDFW) will keep the Hatchery Committees updated on the WDFW moratorium on hexacopter use (Item I-A).*
  This item is complete. Tonseth said the moratorium on hexacopter use is currently being worked through the legislature, and he will update the Hatchery Committees

when there is a change.

- *HETT members will update the Draft Hatchery Monitoring and Evaluation (M&E) Plan Appendices 2 to 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-D).*
  This item is ongoing. Montgomery forwarded Appendices 5 and 6 to the Hatchery Committees on February 5, 2016, Appendix 4 on February 9, 2016, and Appendix 2 on March 2, 2016. Keely Murdoch said Appendix 3 can be completed after proportionate natural influence standards for the Methow basin are determined.
- *Keely Murdoch will discuss internally the status of facility improvements at Chewuch AF (Item IV-B).*
  This item is complete.
- *Bill Gale and Todd Pearsons will circulate information received from Ann Gannam (U.S. Fish and Wildlife Service [USFWS]) regarding the results of a phosphorus study she presented at the American Fisheries Society 2015 conference (Item I-A).*
  This item is complete. Gale said, when he receives the information from Gannam, he will send it to the Hatchery Committees.
- *Sarah Montgomery will distribute Andrew Dittman's presentation, "Effects of Hatchery Rearing and Release Practices on Olfactory Imprinting and Homing," to the Hatchery Committees and Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC; Item II-A).*
  This item is complete. Montgomery distributed the presentation to the Hatchery Committees and PRCC HSC on February 18, 2016. Tracy Hillman said he recently read an interesting paper regarding homing, olfaction, and hierarchical imprinting, and said he would send the paper to the Hatchery Committees.
- *Charlene Hurst (National Marine Fisheries Service [NMFS]) will send the revised gene flow sliding scale spreadsheet to the Hatchery Committees (Item II-B).*
  This item is complete and was discussed during the Hatchery Committees March 3, 2016, conference call. Hurst sent the revised spreadsheet to Sarah Montgomery on February 19, 2016, which Montgomery distributed to the Hatchery Committees that same day.
- *Charlene Hurst will send an email to the Hatchery Committees describing the gene*

flow standards that NMFS proposes for Methow spring Chinook salmon, which will be a decision item during the Hatchery Committees conference call in early March 2016 (date to be determined; Item II-B).
This item is complete and was discussed during the Hatchery Committees March 3, 2016, conference call. Hurst sent a document describing the gene flow standards to Sarah Montgomery on February 19, 2016, which Montgomery distributed to the Hatchery Committees for review that same day.

- *Keely Murdoch will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan and coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility (Item II-C).*
  This item is ongoing and will be discussed today.
- *The Hatchery Committees will discuss Keely Murdoch's study plan at the March 16, 2016, Hatchery Committees meeting (Item II-C).*
  This item will be discussed today.
- *Sarah Montgomery and Tracy Hillman will revise the Grant PUD Target Hatchery Replacement Rate (HRR) Proposal to reflect discussions and agreements during the Hatchery Committees February 17, 2016, meeting and distribute it to the Hatchery Committees (Item II-C).*
  This item is complete. Montgomery and Hillman revised the Target HRR Agreement on February 19, 2016, and Montgomery distributed it to the Hatchery Committees that same day.
- *Sarah Montgomery will compile all Hatchery Committees discussions regarding the 5-Year Hatchery M&E Review process into one document, organized by objective, and send it to Catherine Willard (Item II-C).*
  This item is complete. Montgomery sent a draft of the summary document to Willard on March 10, 2016.
- *Catherine Willard will draft a summary of the 5-Year Hatchery M&E Review process (Item II-C).*
  This item is ongoing. Willard said she will send a draft to the Hatchery Committees for review prior to the April 20, 2016, meeting.
- *Catherine Willard will send Chelan PUD's Draft 2016 Steelhead Release Plan and Preliminary Results from the 2015 Wenatchee Steelhead Release to*

Sarah Montgomery, which she will distribute to the Hatchery Committees (Item III-D).
Willard sent the documents to Montgomery on February 18, 2016, which Montgomery distributed to the Hatchery Committees for review that same day.

- *Todd Pearsons will inquire internally about posting annual reports and 5-year reports on the Grant PUD website (Item IV-A).*
  This item is complete. Pearsons said Grant PUD can house reports on their external website. He said they will host the two most-recent annual reports and the most-recent 5-year report. Sarah Montgomery said she will forward Pearsons' email regarding the website to the Hatchery Committees.
- *Sarah Montgomery will send a Doodle poll to the Hatchery Committees in order to convene a conference call to discuss two decision items: 1) gene flow standards for Methow spring Chinook salmon; and 2) Chelan PUD's Draft Steelhead Release Plan (Item IV-B).*
  This item is complete. Montgomery sent a Doodle poll on February 18, 2016, and a meeting invitation for a March 3, 2016, conference call on February 24, 2016.
- *Charlene Hurst (National Marine Fisheries Service [NMFS]) will send the revised (version 2) gene flow analysis spreadsheet to the Hatchery Committees (Item II-A).*
  This item is complete. Craig Busack sent the revised spreadsheet to the Hatchery Committees on March 9, 2016, which Sarah Montgomery forwarded on March 16, 2016.
- *Charlene Hurst will revise the Gene Flow Management Standards and send it to the Hatchery Committees (Item II-A).*
  This item is complete. Craig Busack sent the revised standards to the Hatchery Committees on March 9, 2016, which Sarah Montgomery forwarded on March 16, 2016.
- *Bill Gale, Craig Busack, and Charlene Hurst will discuss gene flow standards and provide an update to the Hatchery Committees regarding the U.S. Fish and Wildlife Service's position on the standards prior to the Hatchery Committees' March 16, 2016, meeting (Item II-A).*
  This item is complete. Gale said because there are a lot of unknowns in the implementation of these programs, flexible language should be included in the

permits to reflect discussions in the February 17, 2016, and March 3, 2016, Hatchery Committees meeting and conference call, respectively. He said his concerns for the gene flow standards have largely been met in the current proposed version. Murdoch said she will review the standards and provide a Yakama Nation (YN) vote on them soon.

- *Bill Gale will calculate necessary adult removal rates at different smolt-to-adult return levels under the recommended gene flow standards for Methow spring Chinook salmon (Item II-A).*
  This item is complete. Gale said he calculated the removal rates, which are included in the revised gene flow standards that were distributed on March 16, 2016.

II. Joint HCP-HC/PRCC HSC

A. 5-Year Hatchery M&E Review Planning – Objective 5 (All)

Objective 5

Keely Murdoch said she is still working on the study plan draft and will try to have something for the Hatchery Committees to review at the April 20, 2016, meeting. She said the embryonic imprinting section is largely blank. Tom Kahler said he and Murdoch may want to discuss the draft with Andrew Dittman (NMFS), and that they should consider designing pilot studies, since some techniques contemplated for application in the proposed study are theoretical or have not been previously implemented at the production scale. He said the Hatchery Committees should convene a workgroup including Murdoch, Jayson Wahls (WDFW), Mike Tonseth, representatives from the PUDs, and other participants to discuss the logistical and fish-health aspects of designing a study plan for imprinting and homing in the Methow basin.

Tonseth asked if any part of the draft study plan could affect the 2016 Broodstock Collection Protocols. Murdoch said she does not think so, because if a pilot study were implemented in 2016, the eggs would be spawned at the same location as described in the protocols. Tonseth said the study may require an amendment to the protocols, but that can be determined once the study plan is further developed. Catherine Willard asked if hatchery-by-hatchery fish would be used for the pilot study. Kahler said the workgroup will discuss these aspects of the potential study plan. Murdoch said, as long as fish health is maintained throughout the process of bringing water into the hatchery, she does not see a risk to using hatchery-by-wild or wild-by-wild fish. Kahler said, if there were a risk for fish health, the Hatchery Committees would have to decide how much of a risk the study fish pose to loss in production. He said it may not make sense to use conservation fish for testing a new method in a pilot study. Wahls said Trista Welsh-Becker (WDFW) should be invited to the workgroup meeting. Bill Gale suggested that someone call Kirk Truscott to inform him of the workgroup, and Tracy Hillman said he would call Truscott to discuss the purpose of the workgroup. Kahler said the workgroup can meet at Douglas PUD, and asked Sarah Montgomery to schedule a 2-hour meeting between March 21 and April 1, 2016. Montgomery said she will send a Doodle poll to the Hatchery Committees to convene a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin.

B. USFWS Consultation Update (Bill Gale)

Bill Gale said he received an update on U.S. Fish and Wildlife Service (USFWS) consultations from Karl Halupka (USFWS). Gale said USFWS has a target completion date of April 2016 for the Wenatchee River Steelhead Biological Opinion (BiOp). He said Halupka is discussing revisions with reviewers this week. Gale said, for the Methow spring Chinook salmon consultation, the USFWS is moving forward with a strategy that relies on the 2012 Wells Relicensing Bull Trout BiOp for coverage. He said Halupka is working on a memorandum to internally document this strategy and analysis, but its completion is second in priority to completing the Wenatchee River Steelhead BiOp. Gale said USFWS has approved the approach of extending the Section 10 permit for the Okanogan consultation, but he does not know the current status of the permit revision. Gale said he received a draft BiOp for Winthrop National Fish Hatchery (WNFH) operations, which is currently being reviewed and has a target completion date of April 2016.

C. NMFS Consultation Update (Justin Yeager)

Justin Yeager said he spoke with Craig Busack, who stated the Wenatchee River Steelhead BiOp is under general council review. He said, for the Methow spring Chinook salmon BiOp, gene flow standards are still being decided by the Hatchery Committees. He said NMFS is working on the permits and BiOp with a target completion date of May 2016. Amilee Wilson said NMFS has a target completion date of March 2016 for the

Wenatchee River steelhead Section 7 consultation, and NMFS is waiting for USFWS to complete their consultation.

D. Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth shared a document titled, "Draft (Version 2) Upper Columbia River Broodstock Collection Protocols," which Sarah Montgomery distributed to the Hatchery Committees on March 11, 2016 (Attachment B). Tonseth said he also distributed a version of the draft Broodstock Collection Protocols with all changes tracked so Hatchery Committees members could see all of the changes and responses to comments, of which a few remain to be discussed.

Todd Pearsons asked if backup steelhead adults could be collected at the Wells Fish Hatchery (FH) volunteer channel in the spring rather than in the fall (page 8). Jayson Wahls said they were able to collect enough fish this year, and they may have more adults starting next spring due to increased amounts of water. Tonseth asked the Hatchery Committees if they would rather collect fish in the fall or in the spring. Pearsons said fewer fish are being used for backup now, and last year, spring collection was used as a backup to fall collection because some fish died. He said just collecting fish in the spring might be a better choice. Wahls said most of those fish were collected at Ringhold FH and then trucked to Wells FH. Tonseth said it might make the most sense to target fall collection of fish, and then operate the volunteer trap in the spring to see if they can meet fall collection. Wahls said they performed test trials from 2007 to 2010, and in some years, they collected 200 to 300 fish, and, in other years, only around 50 fish were collected. He said they would expect to be able to collect at least 30 fish. Tonseth said this affects the Colville Confederated Tribe's Okanogan Program, and he should get feedback from Kirk Truscott. Wahls said it would be easiest for the facility if fish were collected in the fall.

Tonseth said he is still receiving information to respond to some of the comments from Grant PUD. He said the second draft is available for review, and the Wells Coordinating Committee will discuss it during their next meeting.

Tom Kahler said he added a few new comments to the draft Broodstock Collection Protocols. He said the YN uses an extended trapping schedule in the fall when they are collecting coho salmon. He said Douglas PUD is seeking a modification to the trapping schedule this spring, because the west ladder trap will likely not be available until June. He said Douglas PUD is also going to perform a bull trout study, and may need a longer trapping period each week in order to get a large enough sample size for the study. Tonseth said he would incorporate Kahler's comments into the newest draft. He said the Broodstock Collection Protocols are due to the National Oceanic and Atmospheric Administration (NOAA) on April 15, 2016, and he requested that the Hatchery Committees provide comments on the draft before March 25, 2016. He said he would send a revised (final) draft version of the protocols for a Hatchery Committees email vote on or before April 12, 2016.

Gale said if 30 backup surplus hatchery steelhead are collected in the fall at Methow FH and WNFH, it may have complications for the WNFH spawning channel study. He said WNFH is looking for known WNFH-origin returns to be directed towards the WNFH spawning channel. He said, in the past, they have tried to direct known PIT-tagged returning fish to the spawning channel. Gale said he would want known hatchery fish caught during backup collection to be prioritized for spawning channel work. Tonseth said that is a small and workable change. Gale said he would add a comment about it in the document, and said this is the last year of the spawning channel work anyway.

Gale said he has spoken with Jim Craig (USFWS) and Steve Lewis (USFWS), and the USFWS has a concern to discuss with the Hatchery Committees. He said the USFWS is in a difficult position by continuing to approve Broodstock Collection Protocols and adult management at Tumwater Dam. He said the USFWS needs to know what the plan moving forward will be for assessment of lamprey distribution in the Wenatchee basin. He said he does not want this to affect a timely approval of Broodstock Collection Protocols, and it would be helpful for USFWS if a plan was developed to assess lamprey passage through the fishway at Tumwater Dam.

Alene Underwood said she appreciates that Gale brought up this concern. She said there is an upcoming meeting to discuss lamprey, and the Rocky Reach Fish Forum has also discussed this topic extensively, even though lamprey at Tumwater Dam are not under the purview of the Rocky Reach Fish Forum. She said Chelan PUD intends to have open dialogue with USFWS so that expectations are clear and discussions are consistent, and is meeting with Jessica Gonzales (USFWS) and Steve Lewis soon. She said Chelan PUD has agreed to develop a plan to address lamprey at Tumwater Dam. Keely Murdoch asked if Bob Rose (YN) and Ralph Lampman (YN) have also been involved in these discussions. Underwood replied yes and said the notes from the Rocky Reach Fish Forum are publically available for anyone to review.

Gale asked why the Rocky Reach Fish Forum is not an appropriate forum for discussing lamprey at Tumwater Dam. Underwood said the Tumwater Dam fishway was constructed for salmon and steelhead passage, and moving forward, feasibility about lamprey passage in the fishway or any operational conditions will be openly discussed outside of the Rocky Reach Fish Forum. If any changes are made to the fishway to improve lamprey passage, it would be approved by the Coordinating Committees to ensure salmon and steelhead passage remains adequate. Gale asked if the Rocky Reach Fish Forum representatives also thought that lamprey passage at Tumwater Dam is not under the purview of the Forum. Underwood said it was not discussed as any type of agreement, but Chelan PUD believes that lamprey plans, as part of the Rocky Reach Federal Energy Regulatory Commission license, only apply to lamprey at the Rocky Reach Hydroelectric Project and not at Tumwater Dam. She said a few Rocky Reach Fish Forum representatives had questions and comments about designing lamprey plans for Tumwater Dam, and it was stated that anyone could participate with Chelan PUD in plan design, though not under the purview of the Forum. Gale said his concern is that USFWS would like to see progress made within the next year, and he does not want lamprey at the Tumwater Dam fishway to affect Hatchery Committees approval of the Broodstock Collection Protocols. Underwood said the Hatchery Committees representatives and alternates have a responsibility to implement the hatchery programs. She said there is a collision of priorities that should be recognized when talking about Endangered Species Act (ESA)-listed species at Tumwater Dam. Gale said it is certainly recognizable that Hatchery Committees members have agency directives, and for the USFWS, lamprey are important.

As a final discussion item under Broodstock Collection Protocols, Catherine Willard said, regarding size-at-release targets for Wenatchee summer Chinook salmon brood year 2015 and future brood years, the size at release target will be smaller at 18 fish-per-pound (FPP) in preparation to meet the total maximum daily load requirements for the Wenatchee River. She said warm water temperatures at Eastbank FH present a challenge to reaching a small size-at-release target and the new chilled partial reuse system should improve the water temperature challenge. Willard said, regarding size-at-release targets for Chelan Falls summer Chinook salmon,with a 13 fish-per-pound target, the minijack rate has been very low and juvenile outmigration survival high at Chelan Falls. She said 10 to 13 fish-per-pound will be set as the target for Chelan Falls for BY2015 and BY2016. She said lethal precocious maturation sampling will be performed in 2016, and Chelan PUD will revise the size targets once they have full performance information from the adult fish. Tonseth said he would put the size targets for BY2016 in Appendix B of the Broodstock Collection Protocols, and for BY2015, the size targets are captured in Hatchery Committees meeting minutes.

Tracy Hillman recalled that in 2015, more steelhead and Chinook salmon juveniles were available than needed, and the Hatchery Committees had to decide what to do with the excess fish. He asked if the protocols this year address overages in juveniles. Tonseth said overages are expected in the steelhead programs upstream of Wells Dam, which are addressed on page 12 of the protocols. He said any other overages would be dealt with on a case-by-case basis. He said an overage is expected for BY 2016; however, fall collection has been decreased so the overage should be lesser than previous years.

Tonseth said the Final Broodstock Collection Protocols are due to NOAA on April 15, 2016. He said previously, when the Hatchery Committees approved the protocols, NMFS and USFWS abstained from voting because of their regulatory obligations, and their concurrences came after the submission deadline. He said now, NMFS and USFWS do vote on the protocols, and their approval is considered ESA-concurrent. Kahler said this also applies to the Wells Coordinating Committee.

E. HETT Update (Sarah Montgomery)

Sarah Montgomery provided an update on the Draft Hatchery M&E Plan Appendices:

- McLain Johnson (WDFW) completed Appendix 2, which Montgomery distributed to the Hatchery Committees for review on March 2, 2016.
- Keely Murdoch is working on Appendix 3.
- Peter Graf completed Appendix 4, which Montgomery distributed to the Hatchery Committees for review on February 9, 2016.
- Catherine Willard completed Appendix 5, which Montgomery distributed to the Hatchery Committees for review on February 5, 2016.
- Matt Cooper completed Appendix 6, which Montgomery distributed to the Hatchery Committees for review on February 5, 2016.
- Appendix 1 does not currently have a deadline, and Tracy Hillman said Appendix 1 is not a critical part of the M&E documentation.

Hillman asked the Hatchery Committees to provide guidance on what types of carrying capacity estimates he should calculate for Appendix 1. He said juvenile salmon data provide the best carrying capacity estimates, but most of the Chinook salmon and steelhead programs do not have juvenile data. He asked whether spring Chinook salmon carrying capacity should be estimated only in places with smolt traps and whether the Hatchery Committees should also request summer Chinook salmon estimates. He said there is potentially a lot of work involved in finishing Appendix 1, and he wants to be efficient.

Hillman said carrying capacity changes with variations in the quality and quantity of habitat, and it should be kept in mind that the Tributary Committees, Salmon Recovery Funding Board, Bonneville Power Administration, and others are funding projects to improve habitat, which can add error or variance to average carrying capacity calculations. He said the HETT has previously discussed the two types of carrying capacity that he could calculate. Population equilibrium carrying capacity is the average capacity based on stock-recruitment models. Habitat capacity is the maximum number of fish that the habitat can sustain. He said managers often use equilibrium population capacity to manage programs. However, to understand how many fish an area of habitat can support, one would need to estimate habitat capacity using habitat models or quantile regression. He said the HETT asked him to calculate both types of carrying capacities.

Willard asked how the appendices and the carrying capacity estimates will be used. Tom Kahler said in the M&E Plan, spawning escapement, and carrying capacity are derived variables. Carrying capacity estimates are also used to normalize escapement and natural-origin recruits. This allows for comparison of supplemented populations with reference populations. Willard said the Hatchery Committees should focus on using carrying capacity estimates to inform hatchery programs. Alene Underwood said carrying capacity estimates could help inform the composition of the programs during the next recalculation in order to ground-truth that the 7 percent mitigation is being allocated in an efficient manner (between conservation and safety net groups). Gale agreed, and said many sources of information are available, and they should be discussed during recalculation, whether or not they are considered by decision-makers.

Hillman said he will calculate carrying capacity estimates for Chiwawa River spring Chinook salmon for discussion during the May 18, 2016, Hatchery Committees meeting. Hillman said, in the past, it is possible that carrying capacity has been overestimated for streams such as the Chiwawa River. He said some fish leave the system during summer and fall, and those fish may contribute to smolt and adult production. He said looking at the condition of the Chiwawa River basin, one would think that it should support more fish than it does. He said in years with lower escapements, juvenile survival is higher and fish are larger, while years with higher escapements, juvenile survival is lower and fish are smaller. This clearly demonstrates density-dependence. This is consistent with the findings of the Independent Scientific Advisory Board. Murdoch said capacity estimates should be labeled as current to clarify that historical or potential capacity may be higher. Hillman agreed and said the current analyses include data from 1991 to present and, therefore, do represent recent conditions. He said there are a number of activities that have affected habitat conditions in the Chiwawa River basin, including mining, logging, roads, and recreation. Nevertheless, habitat within the Chiwawa basin is in relatively good condition. He said the Hatchery Committees need to define recruits, because capacity estimates will differ if recruits are modeled as recruits produced within the

Chiwawa River basin or those produced within and outside the Chiwawa River basin.

III. Chelan PUD

A. Blackbird Pond Acclimation PIT tag data results (Catherine Willard)

Catherine Willard said she presented the PIT-tag data results to the Icicle Chapter of Trout Unlimited, and Kirk Truscott requested she share the presentation with the Hatchery Committees. Because Truscott is not in attendance at today's meeting, Willard said she would present the materials at the April 20, 2016, Hatchery Committees meeting.

IV. HCP Administration

A. Chairman Feedback

Tracy Hillman said he has been chairing and supporting the Hatchery Committees for approximately 1 year, and asked if representatives present had any feedback or suggestions for him or for Sarah Montgomery, who has been supporting the Hatchery Committees for approximately 9 months. The representatives present thanked Hillman and Montgomery for their support, and said Hillman's expertise and chairing style have been very helpful to the Hatchery Committees.

B. Next Meetings

The next Hatchery Committees meetings are on April 20, 2016 (Chelan PUD Auditorium), May 18, 2016 (Douglas PUD), and June 15, 2016 (Chelan PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft (Version 2) Upper Columbia River Broodstock Collection Protocols
Attachment C	Request for Juvenile Hatchery Steelhead for Conducting Efficiency Trials at Lower Wenatchee River Smolt Trap

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons†	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Justin Yeager*	National Marine Fisheries Service
Amilee Wilson†	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Brian Lyon	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife
Chris Moran†	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Research Office
3515 Chelan Hwy 97-A Wenatchee, WA 98801 (509) 664-1227 FAX (509) 662-6606

March 11, 2016

To: HCP HC and PRCC HSC

From: Mike Tonseth, WDFW

Subject: ***DRAFT*** **UPPER COLUMBIA RIVER 2016 BY SALMON AND 2017 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 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 (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, Grant County Public Utility Districts (PUDs), and ACOE and are operated by the Washington Department of Fish and Wildlife (WDFW), with the exception of 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).

This protocol is intended to be a guide for 2016 collection of salmon (2016BY) and steelhead (2017BY) 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), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, the USFWS 2008 Rocky Reach Biological Opinion (Service reference number 13260-2008-F-0116) and consultation requirements.

Notable in this year's protocols are:

- Continuing for 2016, no age-2 or 3 males will be incorporated into spring or summer Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only).

- Use of ultrasonography to determine the sex of each fish retained for brood to better ensure achieving the appropriate number of females for program production (does not include Priest Rapids Hatchery).

- Utilization of genetic sampling/assessment to differentiate Twisp River and Methow River Basin natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir and Methow FH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components for the GPUD, CPUD and DPUD programs.

- Collection of only hatchery adult steelhead at Wells Dam/Hatchery for the Lower Methow safety-net (WFH/MFH), and Wells Hatchery Okanogan and mainstem Columbia safety-net programs.

- Collection of spring Chinook for the Nason Creek and Chiwawa programs using combination of Tumwater Dam and the Chiwawa Weir.

- Targeted collection of 100% of the Wenatchee summer Chinook and Wenatchee hatchery origin steelhead broodstock at Dryden Dam to reduce the number of activities that may contribute to delays in fish passage at Tumwater Dam (some adult collections at Tumwater may be necessary if sufficient adults cannot be acquired at Dryden Dam).

- Targeted collection of 100% of the natural origin steelhead broodstock at Tumwater Dam.

- Collection of summer Chinook broodstock from the Eastbank outfall, sufficient to meet a 576K yearling juvenile Chelan Falls program. Summer Chinook collections at Wells Dam may be used to support the Chelan Falls program if broodstock collection efforts at EB Hatchery fall short and if a facility use agreement between CPUD and DPUD can be worked out.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net on-station-released smolts (up to 14 adults). The remainder of the broodstock (46) will be WNFH returns collected at WNFH (or by angling/trapping/tangle netting 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 2017.

- Summer Chinook collections at Wells Dam to support the CJH program may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the YN, Yakima River summer Chinook program.

- Targeted collection of 1,000 adipose present, non-coded wire tagged fall Chinook from the PRD OLAFT.
- Targeted collection of about 400 adipose present, non-coded wire tagged fall Chinook using hook and line efforts in the Hanford Reach.

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 2016 Broodstock Collection Protocols are:

Appendix A: 2016 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2017 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

Methow River Basin

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) Permit 1196.

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 with natural origin fish. 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 33.3% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch program; 11.8% for the Twisp program). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish

Health 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 (unless adult holding is not yet available due to the Wells modernization project, in which case fish will be held at Methow FH pending results), 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 (combined, these make up the entire Methow Basin spring Chinook population) will be released back into the Columbia River. Based on the broodstock-collection schedule at Wells Dam (3-day/week, 16 hours/day, up to 48 hours per week cumulatively), extraction of natural-origin spring Chinook is expected to be approximately 33% or less.

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%. Trapping at the Winthrop NFH will be included, if needed, as a result of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2016 is estimated at 3,452 spring Chinook, including 2,763 hatchery and 689 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.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2016 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Appendix A.

The 2016 aggregate Methow spring Chinook broodstock collection will target up to 122 adult spring Chinook (16 Twisp, 106 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 5% of the CWT tagged hatchery adults and 19% 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 2016 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 42% of the CWT tagged hatchery adults and 81% 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 2016 aggregate Methow broodstock collection will total 104 natural origin spring Chinook. Broodstock collected for the aggregate Methow 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 1196. The Grant/Douglas/Chelan PUD 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.

Table 1. Brood year 2011-2013 age class-at-return projection for wild spring Chinook above Wells Dam, 2016.

Brood year	Smolt Estimate		Age-at-return: Twisp Basin					Age-at-return: Methow Basin				
	Twisp[1]	Methow Basin[2]	Age-3	Age-4	Age-5	Total	SAR[3]	Age-3	Age-4	Age-5	Total	SAR[4]
2011	10,047	36,344	9	79	**13**	101	0.0101	68	394	**101**	563	0.0155
2012	12,277	35,976	11	**97**	16	124	0.0101	67	**389**	100	556	0.0155
2013	24,605	36,242	**22**	194	33	249	0.0101	**67**	393	102	562	0.0155
Estimated 2016 Return			**22**	**97**	**13**	**132**		**67**	**389**	**101**	**557**	

[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] *Mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2008; David Grundy, personal communication).*
4 Mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2002-2008; David Grundy, personal communication).

Table 2. Brood year 2011-2013 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2016.

	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	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**
%Total				41.5%				80.8%				49.4%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				5.0%				19.2%				7.8%
Winthrop (MetComp)	383	1,028	67	**1,478**					383	1,028	67	**1,478**
%Total				53.5%								42.8%
Total	585	1,911	267	**2,763**	89	486	114	**689**	674	2,397	381	**3,452**

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: Hatchery	Number of Adults: Wild	**Total**		
Chelan PUD	60,516		16F/16M	**32**		
Douglas PUD	29,123		8F/8M	**16**		
Grant PUD	134,126		37F/37/M	**74**		
Total	**223,765**		**61F/61/M**	**122**		
By program		Number of Adults: Hatchery	Number of Adults: Wild	**Total**	Collection location	Mating protocol
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**52F/52M**	**104**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**61F/61M**	**122**		

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 20, 2016. Broodstock collection and stock assessment sampling activities authorized through the 2016 Douglas PUD Hatchery M&E Implementation Plan will occur simultaneously up to 3-days/week, up to 16 hours/day (not to exceed 48 cumulative hours per week). 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 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 Well FH (or immediately transferred to Methow FH taking into account the status of adult holding during the modernization project) pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or transferred to WNFH.

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 22. The trap may be operated up to five days per week/24 hours per day (provided it is manned during active trapping).

Trapping at the Methow Outfall trap and Winthrop NFH ladder operations will run concurrent with the Twisp Weir. Pending development of an adult management plan for spring Chinook in the Methow basin, hatchery-origin adults captured at the Methow Outfall (surplus to the Methow Hatchery program) will be transferred to the WNFH for incorporation into WNFH brood as supported by the HGMP's of both facilities.

<u>*Steelhead*</u>

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations such as at Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, WNFH volunteer trap, Okanogan River Basin and angling in Methow River (Table 5). Generally incubation/rearing occur for the Methow safety net, Okanogan, and Columbia River release at Wells Fish Hatchery (FH) with incubation/early rearing at Methow Hatchery for the Twisp conservation program. The USFWS collects broodstock via hook-and-line in the Methow Basin, returns to WNFH and surplus fish removed at Methow Hatchery and the Twisp Weir.

Specific program brood sources are structured as follows:

Wells Hatchery – Twisp River Release

The Wells Hatchery Twisp River release is a locally collected Twisp wild broodstock conservation program. Adults are collected in the spring of the current spawn year at the Twisp 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 activities at the Twisp Weir, Methow Hatchery, WNFH, and through hatchery fish intercepted during natural origin brood hook and line collection for the USWFS Winthrop conservation program. As a backup to potential collection shortfalls in the Methow safety net program as a result of uncertainties in spring collection efficiencies, a portion of the Methow program will be augmented with collection of hatchery origin adults (30) occurring in the fall at Wells Dam.

These fall-collected Wells stock fish will be considered surplus to any spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use returns to Wells Hatchery and may be augmented with adult returns to the Methow Hatchery and Winthrop FH if needed to fulfill the program. To ensure the safety-net programs (Methow and Okanogan) have broodstock, a portion of the broodstock requirement (60 adults) will be collected at Wells Dam in the fall of 2016, and held at Wells Hatchery (Table 5). These fall-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural origin fish collected through hook and line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, hatchery origin returns to WNFH will be prioritized, followed by excess hatchery fish at the Twisp Weir then from excess hatchery returns to Methow Hatchery. 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.

Okanogan River releases

The Okanogan River uses a combination of natural origin adults collected in Omak Creek and hatchery origin adults collected in Omak Creek or elsewhere in the Okanogan Basin through CCT collection efforts. As a backup to potential collection shortfalls in the Okanogan, a portion of the Okanogan program will be augmented with collection of hatchery origin adults (30) occurring in the fall at Wells Dam. These fall-collected Wells stock fish will be considered surplus to any spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Commented [TP1]: Couldn't we collect back-up adults in the spring at Wells Hatchery volunteer channel?

The whole point behind the fall collection was to mitigate for poor collection efficiencies at the various spring sites. This would be a question to the group as whole – particularly the CCT as the Okanogan program would likely be impacted the most.

Jayson Wahls may be able to give us some insight as to what we could expect for spring volunteers and what the gender composition may be.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2017 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
Twisp Conservation	Methow Hatchery (incubation); Wells Hatchery (rearing)	Douglas PUD	Twisp Acclimation Pond	48,000	Twisp WxW
Methow Safety-Net	Wells Hatchery	Douglas PUD	Methow Hatchery	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	Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH	Up to 200,000	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River above Twisp, volunteers to WNFH, and tangle netting in Spring Creek.
Omak Creek	Wells Hatchery	Grant PUD	Omak Creek	Up to 40,000[1]	Okanogan Basin/Omak Creek (up to 16 wild or hatchery)
Okanogan	Wells Hatchery	Grant PUD	Okanogan Basin	Up to 90,000[1]	42 Wells Stock collected at Wells Dam/Hatchery or at tributary locations in the Okanogan Basin operated by the CCT

[1] The Grant PUD programs will total 100,000 smolts, +-10% (58 broodstock). Broodstock collection number, origin, location, and smolt numbers will be consistent with those detailed in National Marine Fisheries Service (NMFS) letter to Randall Friedlander (CCT) and Jeff Grizzel (GPUD) dated February 27, 2014 and detailed in Table 4 and Table 5 herein.

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 2016/2017 to meet production objectives absent a preseason forecast at the present time.

For the 2017 brood steelhead programs operating above Wells Dam, a total of 350 adults (152 natural origin and 198 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 on hand in the event tributary based collection efforts fall short of targets, trapping at Wells Dam and/or Wells FH will selectively retain up to 257 hatchery origin steelhead (west [and east, as necessary] ladder and volunteer trap collection; Table 5).

Twisp Conservation Program

In the spring of 2017, 26 wild steelhead will be targeted at the Twisp Weir and transferred to the Methow Hatchery for spawning, incubation, and early rearing (up to 60-d post feeding to facilitate viral testing of progeny resulting from live spawning females for the YN kelt reconditioning program), after which they will be moved to Wells Hatchery for the balance of rearing (Table 5).

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 the Twisp Weir and moved to Wells Hatchery for spawning. No less than 46 hatchery adults will be targeted at WNFH and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). Up to 30 hatchery origin Wells stock collected and held at the Wells Hatchery will be used as a final option if broodstock collection at the Twisp Weir, and WNFH and MH traps are unsuccessful (Table 5).

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will 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 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.

Okanogan Hatchery/Endemic Program

Fifty-eight (58) adult steelhead will be targeted in the Okanogan Basin, including up to 16 natural-origin adults collected from Omak Creek for a 40K endemic program operated by the CCT and funded by GCPUD as part of their 100K UCR steelhead mitigation obligation (Table 5). Additionally, up to 30 hatchery adult steelhead will be targeted at Wells Dam/Hatchery as a back-up collection contingency due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5).

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Number of backup adults[2]	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild				Hatchery	Wild
DPUD Columbia R.	96		Wells FH/Dam Wells Dam		Methow FH	96	
DPUD Methow R.	60		Twisp weir (14) Methow FH (46)	Up to 30	WNFH[3] Wells Dam	90	
DPUD Twisp R.		26	Twisp weir	NA	NA		26
GPUD Okanogan R.	0-58[6]	0-58[7]	Omak Cr. Okanogan R. Wells FH[5]	30	Wells Dam	0-88	0-58
USFWS Methow R.		110	Methow R. WNFH[4]	NA	Methow FH		110
Total **(PUD programs)**	**156-214**	**26-84**		**60**		**186-273**	**26-84**
Total **(All programs)**	**156-214**	**136-194**		**60**		**186-274**	**136-194**

[1] Assumes a 1:1 sex ration (see table 6).
[2] All backup broodstock are hatchery origin adults.
[3] May include hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH.
[4] May also include excess hatchery origin adults collected at Methow FH and the Twisp Weir.
[5] Spring collection of hatchery origin steelhead as needed to meet program shortfall for the Okanogan Program.
[6] Dependent upon number of NOR broodstock collected in the Okanogan Basin to achieve 58 total broodstock for the Okanogan program.

[7] Depending upon NOR abundance trapping efficiency and issuance of a new Section 10 Permit for the Okanogan steelhead program to allow, up to 100% wild collected in the Okanogan Basin to achieve program broodstock target.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2017 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	48F/48M		**96**	Wells Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	30F/30M		**60[4]**	Twisp Weir, MFH, WNFH, Wells Dam	1:1
DPUD Twisp R.	48,000		13F/13M	**26**	Twisp Weir	2x2 Factorial
GPUD Okanogan R.[3]	100,000	21F/21M	8F/8M	**58[5]**	Okanogan R./Omak Creek	1:1
USFWS	200,000		55F/55M	**110[6]**		
Total[4]	**608,000**	**99F/99M**	**76F/76M**	**350**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow hatchery 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.
[3] Okanogan Basin releases, including Omak Creek is100,000 smolts as part of GCPUD's 100K summer steelhead obligation and targets 58 adults in the Okanogan Basin, including up to 16 natural origin adults to fulfill the Okanogan Basin Production of 100,000 smolts comprised of natural origin and locally-adapted steelhead returning to the Okanogan River. Upon issuance of a new Section 10 permit for the Okanogan Steelhead program, up to 58 natural origin steelhead may be collected in the Okanogan Basin to fulfill the broodstock target, consistent with the Section 10 Permit provisions. Retention of progeny from these fish will be dependent upon success of CCT trapping efforts in Okanogan Basin tributaries.
[4] Up to an additional 30 hatchery adults will be collected at Well FH as a fall back to shortfalls in collections at the Twisp Weir, MFH.
[5] Up to an additional 29 hatchery origin adults will be collected at Wells Dam as backup to potential 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.

Overall collection for the PUD programs will be 299 fish (a combination of program specific and back-up adults; Table 5) 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 run-timing of hatchery and natural origin steelhead at Wells Dam and the Twisp Weir. Trapping at the Wells Dam ladders will occur between 01 August and 31 October, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September on the west ladder (Appendix D). Operational criteria and dates for the Twisp Weir are still under construction.

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.

Surplus UCR Juvenile Steelhead Management

In the event excess juvenile are produced from the over-collection efforts to support the Methow safety net and /or Okanogan safety net programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met.

2. Used to support any shortfalls in the Wells Columbia River release provided fish health and/or marking requirements for the program can be met.

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 and/or CCT fishery managers).

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.

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 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012, and 2013 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 2016, up to 106 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 53 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.

Should use of Wells Dam be needed to meet any shortfalls in broodstock for summer/fall Chinook programs occurring in the Okanogan Basin, 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.

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		53F/53M	**106**	Wells Dam	1:1
Total	**200,000**		**106**	**106**		

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 force 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,
- 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 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.

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 following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

WDFW will target 494 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs, , and up to 174 for the YN 275K-350K green egg request for the Yakima summer Chinook program (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 11 and terminate by August 31.

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams have traditionally been supported through adult broodstock collections at the Wells Hatchery volunteer channel. For 2016, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Eastbank Outfall (EBO) using in-channel seining/netting beginning July 1 (or earlier if summer Chinook are detected in the outfall) through September 15. Collection efforts in the EBO in 2013 and 2014 were sufficient to meet the adult requirements for the Chelan Falls program (in 2015 only 56% of the program was met through EBO collections – the balance was attained through broodstock collected at the CJH volunteer trap). 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 from the Wells Volunteer channel (contingent on agreement between Chelan and Douglas PUD) or other HCP approved location to make up the difference. The 2016 broodstock target for the Chelan Falls program is 350 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

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 2016.

Program	Production target	Number of Adults[2]		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	95F/95M		**190**	Wells VC[3]	1:1
Wells 0+	484,000	152F/152M		**304**	Wells VC[3]	1:1
Chelan Falls 1+	576,000	175F/175M		**350**	EB outfall	1:1

Yakama Nation	350,000[1]	87F/87M		**174**	Wells VC[3]	NA
Total	**1,730,000**	**544F/544M**		**1,018**		

[1] The YN request is for between 275K and 350K green eggs to support the Yakima River summer Chinook program.
[2] 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.
[3] Wells Hatchery volunteer channel trap.

Wenatchee River Basin

In 2016 the Eastbank Fish Hatchery (FH) is expecting to 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 2016 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 80 natural origin spring Chinook (Table 10). The spring Chinook production obligation 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 142 adults (70 natural origin and 72 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2016 is estimated at 2,101 spring Chinook, including 1,359 hatchery and 752 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%.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2016.

	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	306	146	**452**	102	18	**150**	510	242	**752**
Estimated hatchery return	1,236	113	**1,349**				1,236	113	**1,349**
Total	1,542	256	**1,801**	102	18	**150**	**1,746**	**355**	**2,101**

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	144,026	18F/18M	40F/40M	**80**[1]	Chiwawa Weir and Tumwater	2x2 factorial

					Dam[4]	
Nason Conservation	125,000	0	35F/35M	**78[2]**	Tumwater Dam[4]	2x2 factorial
Nason Safety net	98,670	36F/36M[3]	0	**72**	Tumwater Dam	1:1
Total	**367,969**	**108**	**150**	**266[2]**		

[1] Includes 36 hatchery origin adults (represents ~50% of the adult target) to ensure the Chiwawa production goal is met if insufficient NO adults are collected).
[2] Includes ~10% additional NO fish to account for fish that may assign back to the White River spawning aggregate. No more than 70 NO fish will be retained for spawning.
[3] Due to the lack of returning hatchery fish from the Nason program (first age-4 returns are expected in 2017), Chiwawa hatchery fish will be collected to satisfy the Nason Cr. safety net program.
[4] 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).

Chiwawa River Conservation Program Broodstocking:

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 30 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 of adults needed to meet the Chiwawa Conservation program (up to ~70 total or ~35 females) would be collected at the Chiwawa Weir.
    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 15 through August 1 (not to exceed 15 cumulative trapping days). 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.
    - Additionally, no more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS.
    - In the absence of adequate redd count data to calculate the 10% threshold, if after 15-days of weir operation, 67 bull trout encounters, or 15 August, the NO broodstock target is not reached, the balance of the mitigation obligation will be met through hatchery fish already retained for the Chiwawa program at TWD.
    - To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program, HO adults (presently estimated at 50% 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.
    - 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 (2011-2015) with conversion rates from Bonneville Dam.

	Detections at Bonneville Dam		Detections at Tumwater Dam			
Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2011	16	115	12	0.750	81	0.704
2012	7	60	5	0.714	52	0.867
2013	2	29	2	1.000	22	0.759
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
Mean	8.0	62.4	5.2	0.660	42.4	0.687
Geomean	6.6	56.1	3.7	0.569	37.6	0.671

Nason Creek Conservation Program Broodstocking:

- Up to ~78 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 70 NO adults 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.
    - 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 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 Wenatchee Population or Leavenworth), will be released upstream of Tumwater Dam..
- In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the lowest assignment probabilities will be return to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- Up to ~72 HO spring Chinook adults 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.

Nason Creek spring Chinook Rearing/Release Strategy:

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 spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be force 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 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.

**NOTE: Due to the uncertainty of having a reliable surface water intake structure (compromised by heavy bedload movement during fall [2015] and winter [2016] freshets) at the Nason Creek Acclimation Facility in time for acclimation of this brood year, alternate rearing strategies and/or locations may need to be considered by the HSC.

<u>*Steelhead*</u>

Commented [TP2]: We should affirm in the HSC that the release plan for Nason and Carlton as described here will also be implemented for BY 2014 and 2015.

As I have stated at previous HSC meetings, this protocol is specific to the 2016 brood Chinook and 2017 brood steelhead programs. Development/concurrence of release plans for other brood years, even if identical to the 2016 brood would either need to be appended to the final brood protocols for those brood years or have that concurrence captured in the meeting minutes.

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 1395 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 138 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 68 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. 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 females 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.

Table 12. Number of broodstock needed for the combined 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	34F/34M	**68**	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**	**68**	**138**		

[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 2016 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012 and 2013 spawn escapement to the Wenatchee River indicate sufficient summer Chinook will 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 dam 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 270 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 135 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 27 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.

Table 13. Number of broodstock needed for the combined 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		86F/86M	**172**	Dryden LBT-RBT[1] /TWD[2]	1:1
Grant PUD	181,816		49F/49M	**98**		
Total	**500,001**		**135F/135M**	**270**		

[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 2016 up to 1,000 adipose present, non-coded wire tagged (high proportion of natural origin) fall Chinook adults will be targeted at the OLAFT). Additional NO adults targeted as a continued pilot evaluation through hook-and-line angling efforts in the Hanford Reach 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 400 adults may be collected through the hook-and-line efforts. 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, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from either hook-and-line caught broodstock or OLAFT collections will be prioritized for PRH programs (i.e. OLAFT and Hanford Reach anger caught fish will be externally marked, 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 OLAFT and angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,219 females will need to be collected (3,536 spawned) 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, hook-and-line efforts on the Hanford Reach, and/or the Priest Rapids Dam off ladder trap (OLAFT; 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 from BY 2015 become available, the PRCC-HSC may choose to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: the PRD off ladder trap (OLAFT – operated 4-days per week/8 hrs/day to collect up to 1,000 presumed NOR's), hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), and the Priest Rapids Hatchery volunteer channel trap.

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.

4) Only adipose present, non-CWT males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only progeny of adipose present, non-wired fish encountered through hook-and-line angling and at the OLAFT will be prioritized for retention into the program.

6) Broodstock collected from the OLAFT and by hook-and-line will exclude age-2 and to the degree possible age-3 fish (<75 cm) 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 (e.g. collection of 1 in 5 age-3 fish for broodstock from the OLAFT).

7) All gametes of fish spawned from hook-and-line broodstocking efforts and/or OLAFT collections will be incorporated into the PRH based program.

8) Real time otolith reading and an alternative mating strategy will be implemented in 2016 similar to 2015 unless the PRCC-HSC agrees that the PNI objective in 2016 can be met without implementing 1x4 matings. Otoliths from males from the OLAFT and ABC collections will be collected during the peak spawning week and read prior to spawning. If the male is natural origin, then it will be spawned with 4 females, otherwise it will be spawned with two.

9) All eggs or juveniles leaving PRH (including surplus) will have a unique otolith mark so that returning adults can be identified.

10) 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.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,176F/1,088M		**3,264**		
ACOE-PRH	1,700,000	661F/331M		**992**		
ACOE – Ringold[1]	3,500,000	1,360F/680M		**2,040**		
Total	**10,799,504**	**4,197F/2,099M**		**6,296**		
Collection location		Estimated number of adults: Hatchery	Estimated number of adults: Wild	Total		
Priest Rapids Hatchery		**3,372F/1,358M**	**117F/49M**	**4,896**	PRH volunteer trap	1:2
OLAFT[2]		**307F/153M**	**360F/180M**	**1,000**	PRD off-ladder trap	1:2, 1:4
ABC[3]		**23F/45M**	**113F/219M**	**400**	Hanford Reach	1:2, 1:4
Total		**3,702F/1,556M** (5,258; 83.5%)	**590F/448M** (1,038; 16.5%)	**6,296**		

[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 2015. 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 and H/W were derived through otolith results from 2012 and 2014.

Appendix A

2016 Biological Assumptions for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Program	Mean Values for 2010-2014								Mean Values 2008-2012 Brood
	ELISAs		Fecundity		Prespawn Survival				
	H	W			H		W		
	≥ 0.12	≥ 0.2	H	W	M	F	M	F	G-E-R Survival
Methow SPC	0.333	0.006	3,663	4,181	0.974	0.996	0.983	1.000	0.892
Twisp SPC	0.118	0.028	3,379	4,014	1.000	1.000	1.000	0.923	0.907
Twisp SHD	[redacted]	[redacted]	[redacted]	5,334	[redacted]	[redacted]	1.000	0.981	0.713
Wells SHD	[redacted]	[redacted]	5,739	5,938	0.954	0.950	na	na	0.620
Okanogan Safety Net	[redacted]	[redacted]	5,739	[redacted]	[redacted]	0.950	[redacted]	[redacted]	0.620
Wells SUC 1+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Wells SUC 0+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.796
YN Green Eggs	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Methow SUC	0.000	0.010	[redacted]	4,721	[redacted]	[redacted]	0.980	0.960	0.837
Chelan Falls 1+	0.051	[redacted]	4,372	[redacted]	0.985	0.944	[redacted]	[redacted]	0.844
Wenatchee SUC	0.000	0.010	[redacted]	4,902	[redacted]	[redacted]	0.974	0.955	0.796
Wenatchee SHD	[redacted]	[redacted]	5,866	5,790	0.972	0.913	0.962	0.943	0.658
Nason SPC[b]	0.113	0.035	[redacted]	4,647	[redacted]	[redacted]	0.990	0.971	0.812
Chiwawa SPC	0.115	0.027	3,889	4,689	0.991	0.991	0.988	0.973	0.812
Priest Rapids FAC 0+	[redacted]	[redacted]	3,719	[redacted]	0.820	0.861	[redacted]	[redacted]	0.825
ACOE @PRH	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.825
ACOE @Ringold	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.781

[1] Fecundities, ELISA's and prespawn survival values are based upon only three years data due to the shift in broodstock collection location from the Wells volunteer channel to the Eastbank Outfall.
[2] Green egg to release survival is based upon survival performance of fish acclimated and released from the Chiwawa program. Spring 2016 will be the second juvenile release from the Nason Creek program.
[3] Green egg to release survival.

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				
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	2		
2016	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond	2018	15	Volitional
2016	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT?	Columbia R. at CJH	2		
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	Columbia River at PRH	2017	50	Forced
2016	Priest Rapids FAC 0+	600,000	Ad+CWT+		Columbia River at PRH	2017	50	Forced

Commented [MT3]: Need confirmation from USFWS.

Commented [MT4]: Need input from CCT.

	(GPUD)		Oto	43,000 spread across the fish released from PRH				
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
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	2		
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

Commented [MT5]: Need input from USFWS.

[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 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 for cast may be available to lay out what the expected surplus is, how many can 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 3,851 (935 natural origin [24.3%] and 2,915 hatchery origin [75.7%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 3,517 Chiwawa spring Chinook are to reach Tumwater Dam in 2016, of which about 655 (18.6%) and 2,915 fish (81.4%) are expected to be natural and hatchery origin spring Chinook, respectively. Additionally, about 162 natural origin spring Chinook are expected back to Nason Creek with the balance 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 2016. Estimates were generated by recently developed run prediction and pre-spawn mortality models (WDFW unpublished data).

	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	306	146	**452**	102	48	**150**	510	242	**752**
Estimated hatchery return	1,236	113	**1,349**				1,236	113	**1,349**
Total	1,542	259	**1,801**	102	48	**150**	**1,746**	**355**	**2,101**

[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 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 1.8 times the expected number of Natural Origin Returns (NORs; 3 times the number of NOR's in the Chiwawa River). The combined HO and NO returns will represent about 2 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportion number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2016. The conservation fishery is estimated to remove up to 358 HOR Chiwawa adults (Table 3) which will require additional adult management to occur at TWD.

Additional Adult Management

2016 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks) and up to about 78% of the age-4 and age-5 hatchery origin adults (about 481 males and 565 females according to current models, Table 2). In addition to the conservation fishery, approximately 108 HO and 150 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, the balance will be surplused at TWD and used for tribal and/or food bank disbursements or nutrient enhancement projects (Table 3).

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2016.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	436	729	189	94	376	**283**
Males[4]	316	620	127	14	433	**141**
Sub-total		1,349	316	108	809	**424**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.80**
Expected pHOS						**0.25**

[1] Wild broodstock needs of 80 wild NO fish (40 females/40 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.
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD and through the conservation fishery.
[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 283 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Estimated returns of Icicle Hatchery, Chiwawa Hatchery, and Chiwawa wild adults and estimated number of adults removed through adult management activities in the Wenatchee Basin in 2016.

	Estimated Returns			
	Icicle	Chiwawa HO	Chiwawa NO	Total
Estimated return	5,986	1,349	452	7,787
% of return[3]	0.769	0.173	0.058	
Harvest at2% take limit[1]	1,192	358	9[2]	1,559
	Estimated Chiwawa Hatchery Fish Removed			
	Fishery	Broodstock	TWD removal	Total
Number of HO adults removed	358	108	688	1,154

by method[3]

[1] For Wenatchee River fishery area only. Does not include Icicle River fishery harvest.
[2] While included as harvest, it is NO incidental hooking mortality associated with HO fish removal.
[3] Only includes age-4 and age-5 adults

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at Tumwater Dam or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2017. Adult management plans will be finalized then and appended to this document.

Methow Spring Chinook

Pre-season estimates project a total of 3,452 (689 natural origin [7.8%] and 2,763 hatchery origin [92.2%]) spring Chinook back to Methow Basin. Of the 2,763 hatchery returns, about 1,148 are estimated to be from the conservation program with the balance of 1,478 from the WNFH safety net program (Table 4).

Table 4. Brood year 2010-2012 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2016.

	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	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**
%Total				41.5%				80.8%				49.4%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				5.0%				19.2%				7.8%
Winthrop (MetComp)	383	1,028	67	**1,478**					383	1,028	67	**1,478**
%Total				53.5%								42.8%
Total	585	1,911	267	**2,763**	89	486	114	**689**	674	2,397	381	**3,452**

Some level of adult management will be required to limit the number of hatchery spring Chinook on the spawning grounds. Because a conservation fishery is not yet possible under current permit limitations, adult management will need to occur through operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH).

Presently hatchery fish from MH fish 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 in natural origin brood for the MH conservation program, and c) to support the 400K safety net program at WNFH. As such WNFH will operate their return channel to support removal of excess safety net fish. MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH 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.

General details are as follows:

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.
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, but not to exceed 33% of the wild run. Hatchery fish may be collected as broodstock dependent on collection success of wild fish.
e. The Twisp Weir will be fished for the duration of the broodstock collection, only, in 2016. 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. Tentatively, 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 coupled with fish counts, will be used in conjunction with fish counts at Wells Dam 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 and Winthrop FH 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 will cease at Methow Hatchery if:

1. Removal of MFH origin adults meets the targets established (in this document and as adjusted in-season), or
2. Removal of WNFH origin adults meets the targets established (in this document and as adjusted in-season), or
3. 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 will cease at Winthrop Hatchery if:
1. Removal of WNFH and MFH origin adults meets the targets established (in this document and as adjusted in-season), 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 or surplusing.
2. Returns to MFH will be transferred to WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or suplusing.

vi. Conservation program returns may also be transported to specific reaches of the Methow and/or Chewuch Rivers 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 284 NO spawners. Based upon the sliding PNI scale for NO run sizes <300 fish, the initial goal for 2016 will be to manage for a minimum spawning escapement of 500 spawners to achieve this, an estimated 79.3% of the hatchery returns (1,377 HO fish) will need to be removed (Table 5). This will result in approximately 216 hatchery origin spawners on the spawning grounds after accounting for prespawn mortality.

Table 5. Calculated targets and projected adult management results for Methow spring Chinook in 2016.

Wild Spawning Escapement	pNOB[2]	pHOS	PNI Target[3]	Allowable Hatchery Spawners	Hatchery surplus	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawning escapement
284[1]	1.00	0.432	0.607	216	165 MH	472	0.793[4]	500
					1,212 WNFH			
				Adjusted for Pre-spawn loss	Total Surplus			
				514	1,377			

[1] Adjusted for prespawn mortality. Includes about 57 NO fish expected to go into the Twisp River basin.
[2] pNOB of conservation program only.
[3] Based on 3-pop model and assumes a minimum of 75% conservation program adults for WNFH broodstock.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value includes hatchery adults needed to meet WNFH and Okanogan 10(j) production components.In-season assessment of the magnitude 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 Permit 1196.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at the Twisp Weir (primarily as an action related to the steelhead RSS to meet a 1:1 hatchery:wild spawning composition upstream of the weir), the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2016, 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:** Throughout all trapping activities described in this plan, the two PIT tag antennae arrays within the Tumwater Dam ladder (weir 15 and 18, see Appendix 2), will be monitored by WDFW and Chelan PUD and detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at weir 15 and last detection at weir 15 or weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish encountering weir 15. 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) **Improved Fish Handling Efficiency**: Several infrastructure improvements at Tumwater allow WDFW and other operators to cycle through sampled fish more quickly. These improvements consist of an additional holding tank and an improved conveyance system between the trap and holding tank. The facility improvements and additional staffing by WDFW (3 operators instead of 2) during peak spring Chinook and sockeye passage (i.e. June 1 and July 15), will ensure that the trapping denil is operated constantly allowing unimpeded passage through the trap. Historically, the trapping denil has been periodically shut down while fish were being processed.

3) **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).

4) **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.

5) **Planned Tumwater trapping operations from September 1 until mid-December:** The trap will return to a 24 hours/7day/week manned or unmanned active trapping for steelhead and Coho broodstock collection and adult steelhead management. During this time period bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will continue to be implemented.

6) **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.

7) **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 2016. 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					
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 2016 brood will end in June 2016. However it is anticipated that adult management will occur for the 2017 brood 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 2016, 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 five days per week, 24 hours per day beginning July 1 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 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.

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 2016. 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
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.
[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 5d/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 5d/week 24hr/day 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.

Wells Dam Ladder and Hatchery Volunteer Traps

For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps is summarized in Table 3):

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 construction activities on the hatchery modernization preclude use of either the West ladder or volunteer traps.

If the East ladder trap is used, it may begin as early as May 1 and 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. Anticipated trap operation is not expected to go beyond November 15.

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 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 East ladder trap. Anticipated trap operation is not expected to go beyond November 15.

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.

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 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.

Table 3. 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 2016. Blue denotes steelhead, brown spring Chinook, pink summer Chinook, 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		15 Jul					
Sp Chinook run comp					1 May		15 Jul					
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[5]									1 Sep		15 Nov	
Wells Volunteer Trap												
Su. SHD BS collection[1]									1 Sep		15 Nov	
SHD pHOS mgt.[6]		15 Feb				15 June			1 Sep			15 Dec
Su. Chin BS collection[4]							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] 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.
[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock will follow an up to 3d/week 16hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2016 brood will end in June 2016. However it is anticipated that adult management will occur for the 2017 brood beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Specific operation details for the Methow Hatchery volunteer trap and Twisp Weir are still being worked through. Once those details have been fleshed out more thoroughly, this section will be updated.

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 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 2016. Blue denotes steelhead, brown spring Chinook, and green Coho.

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				1-30 Apr								
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 2016 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 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 Trap (OLAFT) in 2016. Blue denotes steelhead, purple fall Chinook, and orange sockeye.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chin. BS collection[2]									1 Sep		15 Nov	
Fall Chinook Run Comp.[3]									1 Sep		15 Nov	
Sockeye BS Collection						22 Jun	10 Jul					

[1] Steelhead VSP monitoring targets 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] To acquire the target 1,000 adipose present, non-CWT adult fall Chinook for broodstock, the OLAFT is operated up to 5 days per week, 8 hours per day. Three of the five days are concurrent with the SHD VSP monitoring. The trap is opened to passage each night.
[3] Fall Chinook run composition runs concurrent with SHD VSP monitoring and/or fall Chinook broodstock collection activities.
[4] 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. 2016 Columbia River at mouth salmon and steelhead returns – actual and forecast.

			2015 Forecast	2015 Return	2016 Forecast
Spring Chinook	**Upper Columbia**	**Total**	**27,500**	**37,500**	**27,600**
	Upper Columbia	*Wild*	*4,500*	*5,800*	*5,000*
Summer Chinook	**Upper Columbia**	**Total**	**73,000**	**126,900**	**93,300**
Fall Chinook	**Upriver Bright - URB**		**518,300**		
Sockeye	Wenatchee		106,700	139,900	57,800
	Okanogan		285,500	370,900	41,700
	Total Sockeye		**392,200**	**510,800**	**99,500**

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The 2016 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 2016 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

2016 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin and Methow Summer Chinook Salmon
https://grantpud.box.com/s/qkx0lhv7qmkvcn1jandrz1ahvbkv5rx1

2016 Priest Rapids Hatchery Implementation Plan
https://grantpud.box.com/s/xhmr8ajpmfkt3vyzo6fjghy84od8nkxi

Appendix G

DRAFT
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.

<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 needs (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 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
- 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.

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Research Office
3515 State Highway 97A
Wenatchee, WA 98801
(509) 664-3148

Date: March 24th, 2016
To: Rock Island and Rocky Reach HCP Hatchery Committees
From: Josh Williams, Juvenile Biologist (WDFW)
McLain Johnson, Team Leader (WDFW)
Cc: Catherine Willard, Senior Fisheries Biologist (CCPUD)
Subject: Request for Juvenile Hatchery Steelhead for Conducting Efficiency Trials at Lower Wenatchee River Smolt Trap

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Since relocation of the Lower Wenatchee River smolt trap from its former location at the old Monitor Bridge, to its current upstream location near the city of Cashmere wastewater treatment facility, mark recapture trials for steelhead have been limited. Currently, only two mark recapture trials (using juvenile hatchery steelhead) have been conducted, which were in 2014 and over similar environmental conditions. Because natural origin (NO) juvenile steelhead captures are low at the Lower Wenatchee River smolt trap, the use of hatchery surrogates is necessary in order to develop trap efficiency models used for calculating NO smolt estimates for the Wenatchee basin.

WDFW is proposing to conduct up to five (5) mark recapture releases of 450 fish each (2,250 total) beginning mid-April and extending through the first week of May. The intent is to conduct the mark recapture trials over a broader range of flows to reduce the high variance in the current estimates and provide a more accurate smolt estimate. Because of the potential for behavioral differences between WxW and HxH progeny, we propose to use a 50/50 mix by parental cross per release to determine which group, if any, may be the best surrogate for NO migrants. If results from the 2016 trials look promising, then WDFW would request additional fish over a broader time frame in 2017 to further refine the efficiency model and subsequent estimates. Fish used in the trials would be marked with a fin clipped in the upper or lower tip of the caudal fin (no PIT Tags or other tags used). Selection of fish used in the trials would preclude retention of PIT tagged fish from the production at large currently being used to evaluate forced versus volitional releases and residualism studies.

Regards,

Josh Williams

720 Olive Way, Suite 1900
Seattle, Washington 98101
Phone 206.287.9130
Fax 206.287.9131
www.anchorqea.com

FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	May 23, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the April 20, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, April 20, 2016, from 9:30 a.m. to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will send Okanogan program proportionate natural influence (PNI) and proportion of hatchery-origin spawners (pHOS) goals to Keely Murdoch for use in the Draft Hatchery M&E Plan Appendix 3 (Item II-A).
- Craig Busack will send the draft Methow spring Chinook Program permits to the Hatchery Committees (Item II-A).
- Keely Murdoch will revise Draft Hatchery M&E Plan Appendix 3 and send it to Sarah Montgomery by Wednesday, May 18, 2016, which she will forward to the Hatchery Committees for review (Item II-B). *(Note: Murdoch sent Appendix 3 to Montgomery on Monday, May 16, 2016, which she forwarded to the Hatchery Committees.)*
- The Hatchery Committees will discuss Draft Hatchery M&E Plan Appendices 2 to 6 during the June 15, 2016 Hatchery Committees meeting (Item II-B).

- Catherine Willard will send a Doodle poll to the Hatchery Committees in order to determine a date for visiting the Issaquah Salmon Hatchery (Item II-C). (*Note: Willard sent the poll to Sarah Montgomery, which she forwarded to the Hatchery Committees on April 25, 2016.)*
- The imprinting and homing workgroup will visit the Issaquah Salmon Hatchery on May 26, 2016 (Item II-C).
- Tracy Hillman will send his paper titled, "Assessment of Factors Limiting the Productivity of Summer Chinook Salmon in the Mid-Columbia River" to Craig Busack (Item II-D). (*Note: Hillman sent the paper to Busack on April 20, 2016.)*
- Mike Tonseth will discuss foregoing additional steelhead adult management at Tumwater Dam with Andrew Murdoch (WDFW; Item III-A).

DECISION SUMMARY

- The Hatchery Committees approved the Final 2016 Broodstock Collection Protocols via email on March 13, 2016. Sarah Montgomery distributed the document to the Hatchery Committees for approval on April 7, 2016, and the final version was distributed on March 14, 2016.

AGREEMENTS

- There were no agreements during today's meeting.

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on May 16, 2016, notifying them that Draft Hatchery M&E Plan Appendices 2 through 6 are available for review before the Hatchery Committees June 15, 2016 meeting (Item II-B).

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on March 30, 2016, notifying them that the Final 2015 Wells HCP Annual Report is available for download from the Hatchery Committees Extranet site.

- Sarah Montgomery sent an email to the Hatchery Committees on April 8, 2016, notifying them that the Final 2015 Rocky Reach and Rock Island HCP Annual Reports are available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on April 14, 2016, notifying them that the Final 2016 Broodstock Collection Protocols are available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the March 3, 2016, and March 16, 2016, Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Keely Murdoch added a discussion about the Yakama Nation (YN) Statement of Work (SOW) for Releasing Adult Pacific Lamprey in the Tumwater Dam Fish Ladder
- The U.S. Fish and Wildlife Service (USFWS) Consultation Update was removed because USFWS did not attend the meeting.

The Hatchery Committees reviewed the revised draft March 3, 2016, conference call minutes, and the revised draft March 16, 2016. Sarah Montgomery said there are several outstanding comments to be discussed. The Hatchery Committees discussed the outstanding comments and made revisions.

Hatchery Committees members present approved the draft March 3, 2016, conference call minutes, as revised. Hatchery Committees members present approved the draft March 16, 2016, meeting minutes, as revised.

Action items from the Hatchery Committees meeting on March 16, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on March 16, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species*

(Item I-A).
This item is ongoing. Johnson sent an email update to the Hatchery Committees on April 5, 2016, stating that their workgroup is drafting an updated timeline and they plan to have a draft for review by May 1, 2016.

- *Keely Murdoch will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan, and will coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility (Item II-A).*
  This item is complete. Keely Murdoch sent the Draft Chewuch Homing Study Proposal to the Hatchery Committees on April 11, 2016.
- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item II-A).*
  This item is ongoing.
- *Hatchery Evaluation Technical Team (HETT) members will update Draft Hatchery M&E Plan Appendices 2 through 6 and send revised versions to Sarah Montgomery by Thursday, February 4, 2016, which she will forward to the Hatchery Committees for review (Item II-E).*
  This item is ongoing. Keely Murdoch said she is still working on Appendix 3 and has requested information about the Okanogan program to include in the appendix. Kirk Truscott said he would send Okanogan program PNI and pHOS goals to Keely Murdoch.
- *Sarah Montgomery will send Draft Hatchery M&E Plan Appendices 2, 4, 5 and 6 to the Hatchery Committees for review (Item II-E).*
  This item is complete. Montgomery sent the Appendices to the Hatchery Committees on March 18, 2016.
- *Tracy Hillman will distribute the paper, "Olfactory navigation during spawning migrations: a review and introduction of the Hierarchical Navigation Hypothesis," to the Hatchery Committees (Item I-A).*
  This item is complete. Hillman sent the paper to Sarah Montgomery on March 16, 2016, which she forwarded to the Hatchery Committees that same day.
- *Sarah Montgomery will forward information received from Todd Pearsons regarding Grant PUD's website, which publically hosts M&E documents (Item I-A).*

This item is complete. Montgomery forwarded Pearsons' emails to the Hatchery Committees on March 16, 2016.

- *A portion of the Hatchery Committees representatives will convene as a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin (Item II-A).*

  This item is complete. The workgroup met on March 23, 2016.

- *Sarah Montgomery will send a Doodle poll to the Hatchery Committees to convene a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin (Item II-A).*

  This item is complete. Montgomery sent the Doodle poll to the Hatchery Committees on March 17, 2016.

- *Tracy Hillman will call Kirk Truscott to discuss the imprinting and homing workgroup (Item II-A).*

  This item is complete. Hillman and Truscott discussed the workgroup on March 21, 2016.

- *The Hatchery Committees will provide comments on WDFW's Draft (Version 2) Broodstock Collection Protocols to Mike Tonseth by March 25, 2016 (Item II-D).*

  This item is complete.

- *Mike Tonseth will send the final draft Broodstock Collection Protocols to the Hatchery Committees for approval via email on or before April 12, 2016 (Item II-D).*

  This item is complete. Tonseth sent the final draft Broodstock Collection Protocols to the Hatchery Committees on April 8, 2016, requesting an email vote by April 13, 2016.

- *Tracy Hillman will calculate carrying capacity for Chiwawa River spring Chinook salmon for discussion at the May 18, 2016, Hatchery Committees meeting (Item II-E).*

  Hillman said this item is complete and will be discussed today.

- *Catherine Willard will provide an update on Blackbird Pond Acclimation passive integrated transponder (PIT)-tag data results at the April 20, 2016, Hatchery Committees meeting (Item III-A).*

  This item will be discussed today.

II. Joint HCP-HC/PRCC HSC

A. NMFS Consultation Update (Craig Busack)

Craig Busack said he heard that Karl Halupka (USFWS) plans to have a final version of the Wenatchee River Steelhead Biological Opinion (BiOp) completed in May. Keely Murdoch asked if this would be a final draft for review or a final version. Alene Underwood said she had also asked Amilee Wilson about the state of the draft. Busack said he believes this will be a final version, and that Amilee Wilson (NMFS) thought that Chelan PUD's comments had been adequately addressed in the latest version of the BiOp. Todd Pearsons said he thought that Halupka was going to meet individually with parties to discuss the draft and the Incidental Take Statement (ITS). Tonseth said that WDFW has worked with USFWS on the draft BiOp, and that National Marine Fisheries Service (NMFS) has also worked with USFWS on the draft. Busack said NMFS is hoping the USFWS Wenatchee River Steelhead BiOp is completed soon because the NMFS Wenatchee River Steelhead BiOp is also near completion. Busack said Wilson received the NMFS Wenatchee River Steelhead BiOp from General Counsel, and General Counsel asked for a take surrogate for ecological interactions. He said Wilson has been working on developing a take surrogate, and the BiOp is very near completion. Tracy Hillman asked what a take surrogate is. Busack said take surrogates are used when there are effects of interest that cannot be measured directly. He said, for example, PNI and pHOS standards are take surrogates that are used instead of measuring the fitness of individual fish over time and correlating that with hatchery impacts.

Busack said, for the Methow spring Chinook consultation, NMFS has developed draft permits. He said one confusing thing about the current draft is that YN should not have been included as an authorized agent under the Methow Hatchery permit, because they will receive their own permit. He said if an entity hires YN, they would be covered in the same way as other contractors. Busack said NMFS historically has issued one 1196 permit covering the different PUD programs, and NMFS would prefer to continue issuing permits in that manner. He said review processes are very complicated and making a separate permit for Chelan PUD would cause delay. Underwood said she is surprised to hear that NMFS drafted one permit covering the different PUD programs, because Chelan PUD's desire to have its own permit is consistent with how they applied for coverage (with WDFW as a co-permittee), and has been known and requested for the duration of the consultation process.

Busack said that would cause a delay in issuing the permit. He said NMFS is also undergoing a new National Environmental Policy Act (NEPA) process for the Methow program permits. Truscott asked to whom Busack distributed the draft 1196 permits. Busack said he initially sent them to the permit parties, but he would send the next draft to the Hatchery Committees.

Busack welcomed Emi Kondo (NMFS) to the meeting via phone, and said Kondo is a NMFS attorney working on the NEPA process for the Methow permits. Kondo said NMFS is waiting for approval from General Counsel and leadership, but tentatively planning to complete an Environmental Assessment or Environmental Impact Statement. Kondo said NMFS is tentatively planning to complete the NEPA process in July 2016. Pearsons asked whether the permit would be issued before or after the NEPA analysis is completed. Kondo replied that the permit will likely be issued when the analysis is complete. Busack said NMFS cannot issue permits until USFWS has finished their permitting process for the same programs in the Methow basin. Pearsons asked if USFWS still plans to write a memorandum documenting Halupka's gap analysis, which states that the existing coverage for bull trout is adequate. Busack replied yes, based on his last conversation with Halupka.

Busack said the Chelan Hatchery and Genetic Management Plan (HGMP) is currently under review and open to public comment. He said, for Methow summer steelhead, a NEPA process is already underway; however, it cannot be completed until the proposed action with respect to gene flow is clarified. A management framework was developed in 2013, but Busack feels it is inconsistent with the approach being taken for spring Chinook salmon, so it likely needs to be modified. Once this is done, the NEPA process covering Methow steelhead can be continued. Truscott stated that a different HGMP provides coverage for the Okanogan steelhead program.

Busack said NMFS would like to include the existing programs at Chief Joseph Fish Hatchery in the Tribal Resource Management Plan (TRMP) program, because the existing coverage for Chief Joseph Fish Hatchery (FH) expires soon. Truscott said the CCT are still in discussions about the inclusion of Chief Joseph FH into the TRMP, and CCT would not want to delay the issuance of a BiOp for the TRMP by including the Chief Joseph FH programs. He said the changes to the HGMP would be that fewer fish are released than in the original HGMP.

Regarding the Mitchell Act lawsuit, Busack said NMFS is being sued for funding hatchery programs without having Endangered Species Act (ESA) coverage for the funding itself. He said NMFS is developing a BiOp to cover the funding of the Mitchell Act programs. He said, to his knowledge, the only connection to Upper Columbia programs is that hatcheries in the lower Columbia River support the mid-Columbia coho salmon programs, but all coho salmon programs have explicit ESA coverage. He said NMFS hopes to have the BiOp completed by August 2016 so that they can disperse funds to the programs.

Busack said the Puget Sound early-run winter steelhead consultation has been signed, and fish have been released. He added that NMFS has hired four new staff to work on consultations such as the ones he described during this update.

B. HETT Update (Sarah Montgomery)

Sarah Montgomery said she distributed Draft Hatchery M&E Plan Appendices 2, 4, 5, and 6 to the Hatchery Committees on March 18, 2016, for review. She said Keely Murdoch is working on Appendix 3. Keely Murdoch said she would gather more information about the Okanogan program, with a target completion date of May 18, 2016. The Hatchery Committees will review Appendices 2 through 6 during the June 15, 2016, meeting.

C. Draft Chewuch Homing Study Proposal (Keely Murdoch)

Keely Murdoch said the imprinting and homing workgroup met on March 23, 2016. She said they primarily discussed a study plan for embryonic imprinting and briefly discussed methods for implementing a sequential imprinting study. She said the attendees were herself, Greg Mackey, Tom Kahler, Catherine Willard, Mike Tonseth, Jason Wahls (WDFW), Trista Welsh-Becker (WDFW, now at USFWS), and Charlie Snow (WDFW). She said Mackey and Kahler also discussed the draft study plan with Andrew Dittman (National Oceanic and Atmospheric Administration) via phone prior to the workgroup meeting. Keely Murdoch shared a document titled, "Draft Chewuch Homing Study Proposal" (Attachment B), which Sarah Montgomery distributed to the Hatchery Committees on April 11, 2016. She said the workgroup agreed that the treatment would be confined to the Chewuch River, and the Twisp River would remain untreated and serve as a control, meaning that the entire study would be a before-after control-impact (BACI) study. She said the treatment would consist of applying Chewuch River water from the eye-up throughout feeding stages. She said the fish will be incubated in isobuckets with a recirculating system, so that one truckload of water is estimated to last 1 week. In addition, she said there would be a chiller to control water temperatures. Keely Murdoch said, based on information from Welsh-Becker, ultraviolet (UV) sterilization will likely be used to disinfect the water. UV treatment is known to change water chemistry, but research by Dittman suggests the imprinting signal may be retained. Mackey said many of these methods are based on a study being performed at the Issaquah Salmon Hatchery, which the Hatchery Committees plan to visit in order to observe its system and facility.

Murdoch said the document is still in its draft stages, and specifically needs work in the analytical section on how homing and straying data will be analyzed. Tracy Hillman suggested the study plan reference Appendix C of the 5-year Hatchery M&E Report, which describes methods for analyzing BACI study design.

Keely Murdoch said the timeline for the implementation of the embryonic imprinting study has been pushed back 1 year (starting in brood year [BY] 2017) to allow time to make and test the incubation system, as well as time for planning any infrastructure modifications.

Mackey said it would be important to run trials with hatchery-by-hatchery fish before using wild broodstock, so that wild-by-wild fish from endangered broodstock are not placed into a new system that has not been fully tested. He said they foresee using a UV treatment system, a chiller, and a filtering system for larger pathogens like the one at Issaquah Salmon Hatchery. Tonseth said another option for conducting facility testing would be to use an unlisted stock as a surrogate, such as eggs from Winthrop National Fish Hatchery. Keely Murdoch said time could be saved if the system were tested with hatchery-by-hatchery steelhead in the spring of 2017, in which case the system would be running smoothly in time to implement the study for BY 2017 spring Chinook salmon. She said that would provide 1 year to make any necessary infrastructure changes. Tonseth said the timing of making infrastructure changes is likely the biggest limitation to starting the study in 2017.

Todd Pearsons said that time should be allowed to work out bugs in the system, because this is pioneering work, and it will likely be challenging. He said one of the lessons learned from the size-target study was that it took a few years for fish culture staff to get the system and methodology running smoothly. He said there are ecological issues and uncertainties that will be worthwhile to work out before the study begins using wild-by-wild eggs. For example, the effects of the UV system on water chemistry are unknown, and it is possible that something in the UV treatment process would cause a fish to detect a difference in treated water compared to control water, thus affecting the imprinting signal. Also, it is unknown whether water should be UV treated throughout the entire study, or just when pathogen risks are highest (like from the beginning of the study to the eyed-egg stage). Busack said there is vulnerability from an ESA perspective in using wild-by-wild eggs, and that hatchery-by-hatchery spring Chinook salmon should at least be used to test the system first. Pearsons replied that using hatchery-by-hatchery spring Chinook salmon at a production scale could create issues in meeting PNI objectives. Keely Murdoch emphasized that the work described in this study plan is not entirely pioneering. Rather, incubation methods are already being implemented at Issaquah Salmon Hatchery, which the Hatchery Committees have already learned from and plan to visit in order learn more. Keely Murdoch said as long as there are no glitches during the incubation process, the worst-case scenario in using Methow Composite wild-by-wild fish is that they mostly return to the Methow River, which is already occurring. She said she does not see a need to test the incubation system at full production scale with Chinook salmon, and testing with steelhead in the spring should be sufficient.

Mackey said he calculated that the average rate at which fish released into the Chewuch did not home back to the Chewuch is 32 percent. He said the target from the M&E plan is 5 percent, so the study would ideally result in a change in the stray rate of 27 percent. He said the magnitude of this change is very large, with the desired change nearly the size of the mean itself. He conducted a quick two-tailed power analysis to estimate the number of years it would take to detect a certain effect size and found that it would take at least 4 years to detect a change in the mean stray rate of 27%. He said these results should be reviewed and discussed further, but using at least five brood cohorts might be a good starting point. Busack said a 5 percent stray rate might not be a realistic target value for the Methow basin, and management targets should be defined before the study is undertaken. He said the Hatchery Committees should discuss what degree of improvement is meaningful from a management perspective.

Keely Murdoch said the imprinting and homing workgroup will visit the Issaquah Salmon Hatchery, which rears Kokanee, but if they visit in the spring, there may not be eggs on station. Mackey said it is important to see how the facility is plumbed regardless of whether or not they have eggs on station. Willard said she will send a Doodle poll to the Hatchery Committees in order to determine a date for visiting the Issaquah Salmon Hatchery.

D. Carrying Capacity Estimates (Tracy Hillman)

Tracy Hillman shared a presentation titled, "Carrying Capacity: Chiwawa Spring Chinook" (Attachment C). *(Note: Sarah Montgomery distributed the presentation to the Hatchery Committees following the meeting on April 21, 2016.)* Hillman said the purpose of this presentation is to share carrying capacity estimates for Chiwawa River spring Chinook salmon, and get feedback from the Hatchery Committees about how he should estimate carrying capacity for other programs to include in Appendix 1 of the Draft Hatchery M&E Plan. A summary of the presentation and questions and comments are included in the following sections.

<u>Background (Slides 1-5)</u>

The definition of carrying capacity varies depending on which model or method one uses. "Habitat capacity" is the number of individuals or biomass the resources of a given area can support through the most unfavorable period of the year, also called the maximum environmental load. "Population capacity," on the other hand, is the maximum equilibrium population size estimated using population models such as the logistic equation or some stock-recruitment models, which defines an upper limit to population growth as density increases. Both types are considered carrying capacity. Fish experience bottlenecks during their life cycle, which limit population size. For example, fish may experience streamflow and temperature problems during summer rearing. Fish that pass through a summer bottleneck may not fill winter habitat due to the mortality in the summer. In this case, the winter period is recruitment limited.

Population Regulation (Slides 6-7)

Carrying capacity can most easily be estimated when population growth is density-dependent. Population growth is affected by mechanisms whose effectiveness increases as population size increases. For example, if the number of parr per spawner decreases with increased number of total spawners, a density-dependent factor is likely occurring and regulating the population.

Methods for Estimating Carrying Capacity (Slides 8-10)

Hillman's methods for estimating carrying capacity focused on stock-recruitment models. Hillman used three types of stock-recruitment models: Ricker, Beverton-Holt, and Smooth Hockey Stick. The Ricker model curve peaks and then decreases, which is appropriate for when organisms exhibit scramble competition for a resource, and thus, all suffer if the resource is limiting. For example, ocean-type Chinook salmon data often fit a Ricker curve because spawning habitat becomes limiting, and the overall population decreases. The Beverton-Holt and Smooth Hockey Stick curves both increase then flatten out. With the Beverton-Holt curve, one cannot estimate the number of spawners needed to fully saturate the habitat due to the asymptotic nature of the curve, whereas using the Smooth Hockey Stick model, which does reach a maximum, one can estimate the maximum number of spawners. Hillman said the Beverton-Holt and Smooth Hockey Stick model fit the Chiwawa River spring Chinook salmon data equally well, because they represent a situation where fish compete for a limiting resource (contest competition), which is often appropriate for tributary rearing of salmonids.

Results (Slides 11-16)

Hillman said for the population carrying capacity of Chiwawa Spring Chinook salmon parr, he found the models best fitting the data were the Beverton-Holt and Smooth Hockey Stick models. For habitat carrying capacity, which was estimated using quantile regression and estimating 90 percent reference intervals, he said there is variability among the models. For comparison, he also included results from a quantile regression forest model (QRFM) used by

Integrated Status and Effectiveness Monitoring Program (ISEMP), which calculated the quantity and quality of habitat in the Chiwawa basin. The estimates of habitat carrying capacity are higher than population carrying capacity.

Hillman said confidence intervals in the models tighten over time because more data give a better estimate for the alpha and beta parameters in the models. He said the estimates of carrying capacity do not vary much after approximately 20 years of data are used in the models.

Hillman said, for the population carrying capacity of Chiwawa Spring Chinook salmon smolts, the three models all fit the data approximately equally well. That is, theoretic information criteria (AICc) was unable to identify a best-fitting model. Similar to the data for parr, habitat carrying capacity estimates are higher than population carrying capacity estimates.

Hillman said carrying capacity estimates for smolts vary more than parr likely due to variable winter conditions. He said more years of data are required to stabilize the parameters in the models when there are more life stages included in the analyses. He said the Ricker model fit the data best over time (highest r-squared value), so it is possible that scramble competition is occurring for winter habitat.

Hillman said it was difficult to fit the models to the Chiwawa spring Chinook salmon adult data because ocean conditions primarily affect adult recruitment. He noted that adding parameters to the models that describe ocean conditions could increase the precision of the estimates. He suggested that management decisions be made based on parr and smolt carrying capacity estimates because the results are more related to in-watershed conditions.

<u>Summary (Slides 17-18)</u>

In summary, Hillman said carrying capacity estimates for Chiwawa spring Chinook smolts are on average about half the size of the estimates for parr. He suggested the movement of parr into the Wenatchee River during the winter partially affects the estimates. Hillman said the Ricker model is probably not the best model to use for estimating carrying capacity for parr. Both the Beverton-Holt and Smooth Hockey Stick explained most of the information in the parr data.

Hillman said estimating carrying capacity for Chiwawa spring Chinook salmon parr, smolts, and adults took a long time, and not all programs have comparable datasets. He said adult data need to be included in the 5-year report, but for estimating carrying capacity within basins, he requested guidance from the Hatchery Committees on how to move forward.

Hillman asked if there are other dataset for parr. Mackey said there are 2 years of parr data for Twisp River spring Chinook salmon. Hillman said he could estimate carrying capacity for spring Chinook salmon and summer Chinook salmon for some programs, but steelhead will be difficult. Mackey said the only other data for the Methow is from screw traps to estimate basin-wide spring Chinook salmon carrying capacity. Tonseth said there is likely not enough available data to estimate carrying capacity for steelhead. Mackey asked if it would be reasonable to replicate the Chiwawa River snorkel methods in other streams to verify that other streams exhibit similar fish densities and then use the Chiwawa River estimate of carrying capacity based on the amount of habitat found during surveys to extrapolate carrying capacity for other streams. Hillman said that would be possible and has performed the calculations for other systems in the past. Mackey said it would only be reasonable if the Chiwawa River has similar densities to other streams.

Hillman said he would estimate carrying capacity for spring Chinook and summer Chinook salmon using all three models and will work with Mackey to acquire the appropriate data for the Methow River.

Hillman asked the Hatchery Committees how they plan to use these results and Appendix 1. He said the data change yearly, so it could be a methodology section. Busack said ocean variability is important to consider in the stock-recruitment analyses; for example, coho salmon returns have been low recently despite the availability of habitat. Hillman said he presented a paper on summer Chinook salmon stock-recruitment modeling to the Coordinating Committees that addressed the effects of ocean conditions on productivity.

Hillman will send the paper to Busack. He said the Adaptive Management Implementation Plan (AMIP) life cycle modeling group might also be a good resource for this discussion.

Mackey said Appendix 1 is included in the Draft Hatchery M&E Plan so there is a convenient and acknowledged source of carrying capacity information that can be used for reporting and identifying management strategies. He said, for example, it can be used to determine if too many or too few spawners are returning. Mike Tonseth said one management goal is to optimize the number of spawners, which can be accomplished through adult management. He said adult management already biases the number of spawners by prioritizing gene flow management over filling the habitat to carrying capacity. Hillman said harvest levels and adult management can be incorporated into the analyses. Truscott said the estimates may destabilize due to the changes in the last 2 years with adult management. Tonseth said water conditions in 2015 may also widen the variance on carrying capacity estimates. Hillman added that major rain-on-snow events act as density-independent effects.

Hillman said he and Andrew Murdoch will continue to draft Appendix 1 using this feedback, with a focus on methodology with some populations as examples. He said the methods will likely change over time.

Todd Pearsons said carrying capacity estimates can also be used to assess how fish should be divided into conservation and safety-net programs. He suggested compiling a table with carrying capacity estimates that the Hatchery Committees can review to inform hatchery programs. Hillman said he is producing tables for spring Chinook salmon in the Chelan PUD and Grant PUD annual reports, so one can track estimates of carrying capacity over time. He said this cannot be done for every stock, and smolt estimates would need to be adjusted for fish that migrate out of a watershed and survive downstream. Hillman said he was surprised at the relatively low carrying capacity estimates for the Chiwawa River basin, because there appears to be a lot of high-quality habitat. He said he thinks the system is nutrient-limited, and high flows also affect the number of fish in the system.

Kirk Truscott asked if hatchery-origin and natural-origin fish spawned in the same locations and proportions, would population capacity be higher. Hillman said he thinks it is possible. The upper river is fully seeded during high spawner escapements; however, changes in abundance and distribution occur in tributary streams with changing spawner abundance. He said density of fish does not vary much within multiple channels with logjams over time, because these habitat types are preferred habitat for juvenile spring Chinook. Densities in less preferred habitat and in tributaries changes considerably with spawning escapement. Regarding the geographic distribution and correlated habitat used by hatchery fish, Keely Murdoch asked if the density-dependence signal could be caused by years in which hatchery fish are more numerous on spawning grounds. Hillman said that is possible. He indicated that there are studies that have shown strong density dependence within tributaries when ocean conditions are poor, because hatchery adults return to the same location instead of colonizing vacant habitat.

III. Yakama Nation

A. SOW for Releasing PIT-Tagged Pacific Lamprey in Tumwater Dam Fishway

Keely Murdoch shared a document titled, "SOW for Releasing Adult Pacific Lamprey within Tumwater Dam Fish Ladder" (Attachment D). *Note: Montgomery distributed the document to the Hatchery Committees on April 19, 2016.*

Keely Murdoch welcomed Ralph Lampman (YN) to the meeting, and said he is a Pacific lamprey biologist. Lampman said lamprey are not currently present above Tumwater Dam, and YN recently planted several adult lamprey upstream of Tumwater Dam in March 2016. He said YN proposes to release lamprey in the fish ladder to study how they navigate through the fishway. He said the proposal includes releasing 30 fish divided into three release locations: near the entrance; in the middle of the fishway near the PIT-tag array; and above the PIT-tag array between the counting station and the PIT-tag array. Keely Murdoch said the purpose of this SOW is to determine where problems may be occurring in the fishway, and it is being presented to the Hatchery Committees due to potential implications for spring Chinook salmon data collection at Tumwater Dam. Specifically, a PIT-tagged lamprey stuck to the array for an extended period could cause tag collision.

Alene Underwood said the SOW includes moving lamprey off of the PIT-tag array if one becomes stuck. She asked who is monitoring for this, and what actions would be taken. Lampman said YN would share the identification number of PIT tags, and would monitor data periodically. Keely Murdoch said PIT- tag data at Tumwater Dam are already being monitored very closely for spring Chinook salmon because there are delay targets that, if exceeded, trigger the opening of the ladder for free passage. She said it would be noted relatively quickly if a lamprey were stuck on an array for this reason. She said removing the lamprey from the array might be done best by coordinating with WDFW, which has staff members on site at Tumwater Dam more regularly than YN. Underwood said she agrees that monitoring for spring Chinook salmon delay would likely mean that a lamprey attached to an array would be detected; however, she said there is a gap between when lamprey are proposed to be released in the fishway and when spring Chinook salmon arrive at Tumwater Dam. Catherine Willard said YN could set up an email alert in the PIT Tag Identification System (PTAGIS) to notify them if a tag is detected in a specific location.

Kirk Truscott asked how feasible it is to move a lamprey off of one of the arrays.
Mike Tonseth replied that it is not very feasible because the arrays are located at the top of the ladder below the grating, and depending on where the lamprey is in the fishway, it could be difficult to remove it from the array, especially during high flows. Tonseth said the fishway is shut down when flows exceed 10,000 cubic feet per second (cfs), and with the robust snowpack in 2015/2016, it is possible that lamprey could be trapped in the fishway if it is closed due to high flows. He said YN should look at the hydrograph forecast to ensure that when lamprey are released, flows greater than 10,000 cfs are not expected. Tracy Hillman commented that April is the peak time for steelhead movement and asked if that might be an issue for this proposal. Tonseth said the potential issue would be tag collision due to a lamprey stuck on an array, but it would be unlikely to have a lamprey stuck on both arrays at the same time; therefore, detection of migrating steelhead is not expected to be an issue. Lampman said, because the arrays are in areas of fast-moving water, he doubts a lamprey would stick to an array for very long, and noted that lamprey are more active at night.

Tonseth said he has more concern that a lamprey would go into the collection chamber. Underwood asked if WDFW are operating the trap nonstop for adult management. Tonseth replied yes. Underwood said the ladder itself would not be open past the last gate, so examining how lamprey want to exit the fish ladder would not be possible because they would have to use the Denil fishway. Tonseth said, because steelhead migration may peak early this year, it is possible that the ladder could be fully opened if WDFW have collected enough steelhead for adult management by a certain date. Lampman said he spoke with Andrew Murdoch, who said that the number of steelhead passing Tumwater Dam has recently decreased. Tonseth said that may make it appropriate to open up the fishway for full passage and not operate the trap until spring Chinook salmon arrive, so lamprey movement throughout the entire fishway can be monitored. He said video monitoring will also be active.

Underwood asked on what date YN proposes to release the lamprey. Lampman said, ideally, the fish would be released in the next 2 weeks (April 21 to May 5, 2016). Tonseth suggested YN monitor the hydrograph forecast in case the fishway needs to be shut down for structure protection. Keely Murdoch asked Lampman if Bob Rose (YN) has put this topic on the Coordinating Committees agenda for their April 26, 2016, meeting. She said the Hatchery Committees are not the decision body for this SOW, rather the Coordinating Committees should discuss it, due to its implications for passage of Plan species. She said the Hatchery Committees should discuss it and record any concerns about broodstock collection. Willard said Chelan PUD has collected all of the steelhead broodstock they need for 2016, so they do not have concerns about the proposed actions affecting broodstock collection. Tonseth said the only implications the Hatchery Committees need to consider are to adult management. Tonseth said WDFW could open the trap if adult management for steelhead can justifiably be shut down. Keely Murdoch said it is also important to learn how lamprey navigate the trap, because it is often in operation. Tonseth said lamprey cannot enter the Denil fishway, so it would be best to look at the entire fishway structure first, and later study how lamprey could pass while the trap operates. Underwood suggested lamprey perhaps could find an alternate route through the grates.

Keely Murdoch said lamprey are an important non-target taxon, and PIT-tag detection risks are worth implementing this study. Truscott said PIT-tag detection risks are his main concern, and 30 lamprey would be densely distributed in the short ladder system, if they do stay in the ladder for an extended period. He said if lamprey stick to one of the arrays, it may be impossible to calculate delay, which would affect broodstock collection for plan species. Tonseth said he does not expect to see significant numbers of spring Chinook salmon present at Tumwater Dam until early June, which, if lamprey are released in the fishway before mid-May, provides a relatively long period for the fish to exit the fishway. Truscott asked how YN plans to remove the lamprey from the arrays if one does stick on. Lampman said a pole could be used to nudge the fish off of the array, but he does not expect to see a lamprey stick to an array for very long anyway, from his experience. Lampman said that because lamprey usually spawn in May or June, he does not expect any lamprey to overwinter on the array.

Tonseth said the Hatchery Committees should acknowledge that if a lamprey is stuck on the array, it could inhibit the ability to monitor for spring Chinook salmon delays. Underwood said she agrees, and said fishway attendants could lift grates to potentially access lamprey stuck on arrays, but she would need to run this concept by the safety personnel at Tumwater Dam. Tonseth said he would talk to Andrew Murdoch about foregoing additional steelhead adult management at Tumwater Dam.

IV. Chelan PUD

A. Blackbird Pond acclimation PIT tag data results (Catherine Willard)

Catherine Willard said she presented these results to the Icicle Chapter of Trout Unlimited, and Kirk Truscott requested she share the presentation with the Hatchery Committees. Willard shared a presentation titled, "Blackbird Pond Acclimation PIT Tag Data Results" (Attachment E). *(Note: Sarah Montgomery distributed the presentation to the Hatchery Committees following the meeting on April 20, 2016.)*

Willard said there are structural issues at Blackbird Island, so improvements may be needed if the facility is to continue to be used. A summary of the presentation and questions and comments are included in the following sections.

Background (Slides 1-4)

Willard said, historically, steelhead were reared at Eastbank Hatchery, then Turtle Rock Island Fish Rearing Facility, and then truck-planted in the release locations. She said Chelan PUD worked with Trout Unlimited to start acclimating steelhead at Blackbird Pond to provide a Wenatchee sub-basin acclimation site prior to the Chiwawa Acclimation Site being built. Trout Unlimited provides the water right, and WDFW operates the pond. Currently, approximately 25,000 steelhead are acclimated in Blackbird Pond. Blackbird Pond is a flow-through side channel from the Wenatchee River, and Trout Unlimited's objective was to create more steelhead fishing opportunity in the Wenatchee River in the area near Blackbird Island. Steelhead were first reared in Blackbird Pond in 2010.

Results (Slides 5-8)

Juvenile survival to McNary Dam is compared for Blackbird Pond releases versus combined truck-plant releases in Slide 5. In 2010, the first year of acclimation at Blackbird Pond, juvenile survival was lower compared to the combined truck-plant releases, which Willard attributed to predation and water quality issues in operating the new facility. Mike Tonseth commented that one issue was steelhead aggregating at the outfall area of the intake, causing entrainment. In 2011, survival from the Blackbird Pond releases was significantly greater than the combined truck-plant releases. In 2012, the first year of overwinter acclimation at Chiwawa Acclimation Facility (AF), survival from the truck-plant releases was comparatively low, which could be attributed to new release methods and locations from Chiwawa AF. In 2013, 2014, and 2015, survival from Blackbird Pond releases and combined truck-plant releases were not significantly different.

Date of transfer to the Blackbird Pond AF is significantly associated with juvenile survival to McNary Dam. Juvenile survival is higher for fish that are transferred to the pond at a later date.

There are 3 years of available data for assessing smolt-to-adult returns to Blackbird Pond compared to combined truck-plant releases. In 2010, combined truck-plant releases had a higher smolt-to-adult return rate. In 2011, there was no significant difference in smolt-to-adult return rates between Blackbird Pond releases and the combined truck-plant releases. In 2012, Blackbird Pond had a higher smolt-to-adult return rate. These differences in return rates mimic the differences in juvenile survival to McNary Dam for the same years, and Willard attributed the differences to the same factors.

One of the purposes of acclimating steelhead at Blackbird Pond is to reduce stray rates to non-Wenatchee River sub-basin streams. There is no significant difference in stray rates between Blackbird Pond and combined truck-plant releases for 2010 or 2011. Stray rates were lower for fish released in 2012 for both fish final acclimated in Blackbird Pond and truck releases compared to releases from 2010 and 2011. Tonseth said a shift from in-basin to out-of-basin acclimation affected stray rates from the Chiwawa River in 2012.

<u>Questions and Comments</u>
Tracy Hillman asked how these results affect the future of Blackbird Pond. Willard said there are structural issues with the intake screen, which would take significant investments and a permitting process. She said the Hatchery Committees should begin to consider the costs and benefits associated with Blackbird Pond. She said the facility was built before steelhead were moved to the Chiwawa AF, but it does provide a location to keep potential residual non-migrant fish. Tonseth said Blackbird Pond could also be used to extend the hybrid volitional release currently taking place at Chiwawa AF. He said, if fish have not emigrated by the end of the volitional time period, they could be moved to Blackbird Pond to extend the volitional release period; then, if the fish have still not emigrated by the end of June, the gate would be closed and they would be kept at Blackbird Pond as residualized fish. Kirk Truscott asked how extensive the required modifications would be. Willard replied that the bank is eroding at the location of the intake screen, which would require a major fix. She said major costs will include permitting and fixing the intake, and minor costs would include items such as fixing the pump system.

V. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on May 18, 2016 (Douglas PUD), June 15, 2016, (Chelan PUD), and July 20, 2016 (Douglas PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft Chewuch Homing Study Proposal
Attachment C	Carrying Capacity: Chiwawa Spring Chinook
Attachment D	SOW for Releasing PIT-Tagged Pacific Lamprey within the Tumwater Dam Fish Ladder
Attachment E	Blackbird Pond Acclimation PIT Tag Data Results

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Todd Pearsons†	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Craig Busack*†	National Marine Fisheries Service
Emi Kondo º	National Marine Fisheries Service
Bill Gale*‡	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Ralph Lampman ‡	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined by phone for YN discussion item
º Joined by phone for NMFS Consultation Update

Techniques to improve homing fidelity for Chewuch and Twisp river releases of spring Chinook salmon

Background

Under the Wells Habitat Conservation Plan (HCP), Rocky Reach HCP, and the Priest Rapids Salmon and Steelhead Settlement Agreement, hatchery supplementation is required to mitigate for project losses of migrating salmon and steelhead. As part of this mitigation DCPUD owns and operates spring Chinook acclimation sites on the Chewuch and Twisp rivers. Spring Chinook destined for the acclimation sites are reared at the Methow Fish Hatchery (FH) which is located upstream of both the Chewuch and Twisp rivers. Homing fidelity back to the tributary of acclimation (i.e. Twisp and Chewuch rivers) is low with a proportion of returning fish failing to home and 'straying' to the Methow River, often in the vicinity of the Methow FH. The 5-year analytical report (Murdoch et al. 2012) indicates the mean stray rate for Twisp acclimated spring Chinook is 25%. That is 25% of the Twisp River fish are recovered on spawning grounds outside of the Twisp River or return to Methow Fish Hatchery (Table 1)

Table 1. Stray rates by brood year of Twisp spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012).

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	0	0.00	0	0.00	0.00
1993	3	0.75	1	0.25	0.15
1994	0	0.00	0	0.00	0.00
1996	33	0.66	17	0.34	0.18
1997	6	1.00	0	0.00	0.11
1998	8	0.80	2	0.20	0.45
1999	25	0.56	20	0.44	0.74
2000	12	0.23	40	0.77	0.27
2001	0	0.00	7	1.00	0.13
2002	59	0.47	66	0.53	0.43
2003	2	0.13	13	0.87	0.31
2004	6	0.18	27	0.82	0.18
Mean		0.40		0.43	0.25
SD		0.34		0.35	0.20

Failure to home, and subsequent recovery in non-target locations is a greater problem for Chewuch acclimated fish. The stray rate for Chewuch spring Chinook averages 43% with some years in the 70-80% range (Table 2).

Table 2. Stray rates by brood year of Chewuch spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012)

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	1	1.00	0	0.00	0.03
1993	19	0.86	3	0.14	0.21
1994	0	0.00	0	0.00	0.00
1996	15	0.79	4	0.21	0.46
1997	44	0.62	27	0.38	0.22
2001	46	0.13	321	0.87	0.88
2002	92	0.24	299	0.76	0.74
2003	3	0.12	22	0.88	0.46
2004	35	0.33	70	0.67	0.86
Mean		0.45		0.43	0.43
SD		0.37		0.37	0.34

Since 2014 program size for both the Chewuch and Twisp rivers have been significantly reduced. The program size reduction makes it critical that both programs are performing to standards and achieving the desired goal of supplementing the targeted area. Current release numbers for Chewuch and Twisp Rivers are approximately 61,000 and 30,000, respectively

Sequential Imprinting Method

The sequential imprinting hypothesis as described by Harden-Jones (1968) and Brannon (1982) shows that salmon learn a series of olfactory cues as they migrate through freshwater, retracing the olfactory pattern as they return as adults. Sequential imprinting also occurs in hatchery fish that are transported and released off-site. The sequential imprinting hypothesis predicts that hatchery fish will return to the release site where they initiated their seaward migration, however if the returning hatchery fish can still detect the odors of their rearing site they will continue onward to their rearing hatchery (Dittman et al. 2010). In cases where the acclimation site is located upstream of the rearing hatchery, returning salmon will bypass the rearing facility and continue onto the release site (Dittman et al. 2010). In an evaluation of homing and spawning site selection in the Yakima River, the sequential imprinting hypothesis explains why fish released from Clark Flat and Jack Creek (both downstream of the Cle Elum Hatchery) are often recovered in the vicinity of the Cle Elum Hatchery, while relatively few fish released from the Easton Acclimation Site (upstream of the rearing facility) were recovered in the vicinity of the Hatchery. Fish released from the upstream Easton site had the highest homing fidelity (95.5%; Dittman et al. 2010). Consistent with the sequential imprinting hypothesis, spring Chinook acclimated at the Easton site returned to the vicinity of the acclimation site; being unable to detect any earlier imprint signal, chose to spawn in the vicinity of their last familiar homing cue (Dittman et al. 2010). Sequential imprinting also explains patterns of adult returns for programs where hatchery fish are reared in the lower Columbia and then transported to upper Columbia tributaries, such as the Yakama Nation's coho reintroduction project, and the discontinued White River spring Chinook program. Importantly, the sequential imprinting hypotheses would predict that high stray rates to the Methow FH due to the location upstream of the Chewuch and Twisp Rivers.

In the Methow Basin, fish returning to both the Twisp River and Chewuch River, continue to recognize upstream olfactory cues from Methow Fish Hatchery. The sequential imprinting hypothesis would predict that a proportion of spring Chinook would continue on past the confluences with the Twisp and Chewuch Rivers to return to the vicinity of the Methow Fish Hatchery, which is what is observed in patterns of spawning and carcass recovery (Murdoch et al. 2012).

Embryonic Imprinting Hypothesis

The importance of imprinting at the parr-smolt life stage is commonly known, but embryonic imprinting hypothesis emphasizes the imprinting to the desired 'natal' site earlier during development. Embryonic imprinting for hatchery programs could be tested as either an alternative or complementary method to sequential imprinting (above) to improve homing fidelity to an acclimation site. As suggested by sequential imprinting, adult salmon terminate their spawning migration upon reaching the area associated with olfactory cures learned in the natal redd. Dittman et al. (2015) speculates that hatchery reared salmon returning as adults will seek the earliest detectable imprinted olfactory waypoint as the appropriate location to terminate their spawning migration. If salmon are exposed in the hatchery as embryos to the water derived from the release location, they may spawn in the targeted location.

Methods

Part 1: Embryonic Imprinting Hypothesis

The embryonic Imprinting Hypothesis will be tested at the Chewuch Acclimation site in brood years 2017 and 2018.

Spring Chinook will be spawned and incubated at the Methow Fish Hatchery. All spring Chinook eggs destined for the Chewuch acclimation site will be subjected to the treatment application of Chewuch River water. The treatment will consist of recirculated and chilled Chewuch River water applied continuously between eye-up and first feeding.

Chewuch River water will be transported to Methow Fish Hatchery on a weekly basis via tank truck. Chewuch River water will be UV treated and chilled prior to use. The isolation buckets will be designed to allow for a high level of recirculation (amount to be determined) to limit the amount of Chewuch River water required. Water brought to Methow FH by tank truck will be stored up to a week.

Part 2: Sequential Imprinting Method

The Sequential Imprinting Method will be tested at the Chewuch Acclimation site in brood years 2019 through 2022.

To test the Sequential Imprinting method it is imperative that spring Chinook intended for release at the Chewuch Acclimation Pond are not reared at Methow Fish Hatchery for any part of their life cycle.

After spawning, green gametes will be transported to Wells Fish Hatchery for fertilization and incubation. These fish would remain on station at the Wells Fish Hatchery until transfer to the Chewuch Acclimation Site in the spring prior to release. If necessary to accommodate the rearing space, a similar number of steelhead intended for the Methow Fish Hatchery release could be reared at Methow Fish Hatchery.

All fish used in the evaluation will receive a unique CWT.

Data Analysis:

Upon return as adults CWT recovery on the spawning grounds and at the Methow FH will be used to evaluate the efficacy of embryonic imprinting (brood years 2017 and 2018), and sequential homing (brood years 2019-2022) to improve homing fidelity in the Methow River. The spawning distribution and return rates to the Methow Fish Hatchery will be compared as described for Objective 6 in the M&E plan (Hillman et al, 2013). A fish returning to Methow Fish Hatchery will be considered a 'stray', fish returning to the Chewuch and/or Twisp rivers will have homed successfully.

The study will follow a Before-After Control-Impact (BACI) design. Before (BY2001-2016) and after treatment data will be available for analysis. The Twisp River release, which will not receive any treatment will serve as a control group (both before and after). The proportion of Chewuch acclimated Chinook not homing back to the Chewuch (stray) will be compared with ANOVA before and after treatment relative to the control group (Twisp).

Timeline

May 2016-August 2017: Planning, design and infrastructure modifications to include a chiller and recirc incubation system.

BY 2017: Embryonic Imprinting Treatment

BY 2018: Embryonic Imprinting Treatment

BY 2019: Sequential Imprinting Treatment

BY 2020: Sequential Imprinting Treatment

BY 2021: Sequential Imprinting Treatment

BY 2022: Sequential Imprinting Treatment

2019-2028: Collection and analysis of adult return data

Literature Cited

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Carrying Capacity
Chiwawa Spring Chinook

Outline

Definitions

Population Regulation

Methods

- Evidence of Density Dependence
- Estimation of Carrying Capacity

Results

- Parr Capacity
- Smolt Capacity
- Adult Capacity

Next Steps

Definition

Habitat Capacity (C) = Number of individuals or biomass the resources of a given area can support usually through the most unfavorable period of the year.

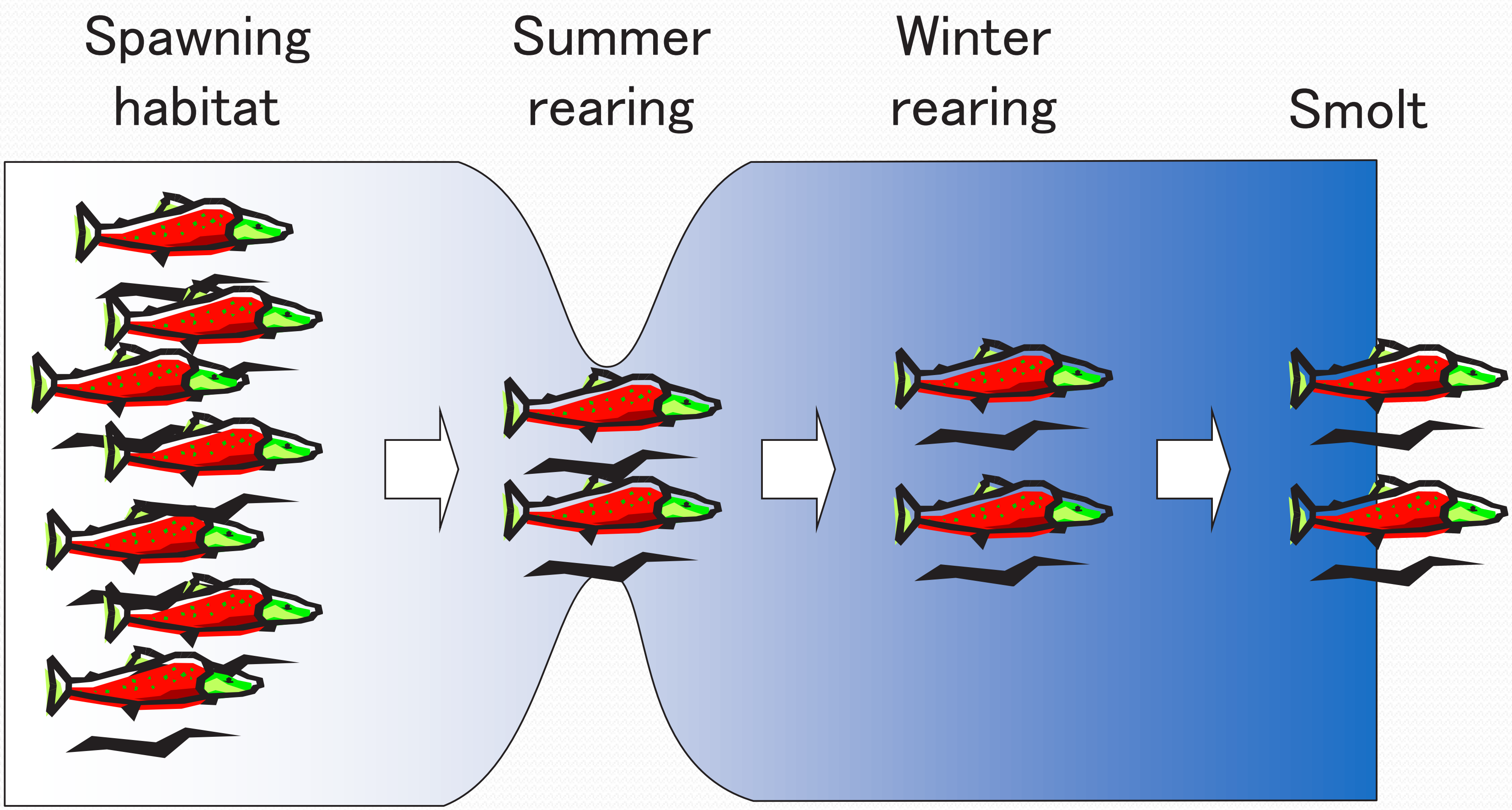
- Maximum Environmental Load
- Linked to Tolerance Limits and Limiting Factors (aka ecological concerns)
- Carrying Capacity

Definition

Population Capacity (K) = Maximum equilibrium population size estimated using population models such as the logistic equation or some stock-recruitment models.

- Defines an upper limit to population growth as density increases.

Bottlenecks

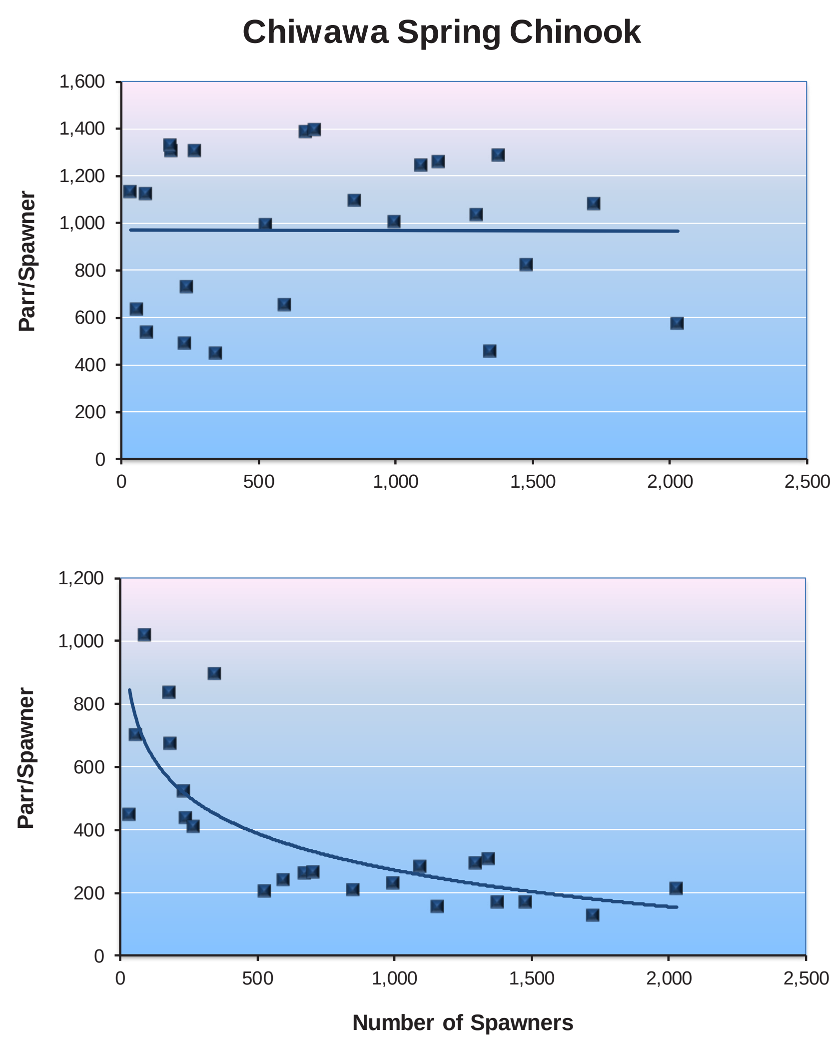


Population Regulation

- **Density Independent Factors** = Population growth is not affected by population density; population persistence is explained by unpredictable environmental variability (Andrewartha and Birch).
- **Density Dependent Regulation** = Population growth is affected by mechanisms whose effectiveness increases as population size increases (Nicholson, Lack, and Elton).

Evidence of Density Dependence

- Plot of population size and population growth rate (or surrogates such as survival rates, natality, productivity, recruits, individual growth rates, movement).
- There is a negative relationship between population size and growth rate.



Methods for Estimating Carrying Capacity

- Time series analysis (Gompertz Model)
- Stock-recruitment modeling
- Habitat modeling

Stock-Recruitment Modeling

- Fit Ricker, Beverton-Holt, and Smooth Hockey Stick models to stock (spawners) and recruitment (parr, smolts, and adult) data.
- Ricker:

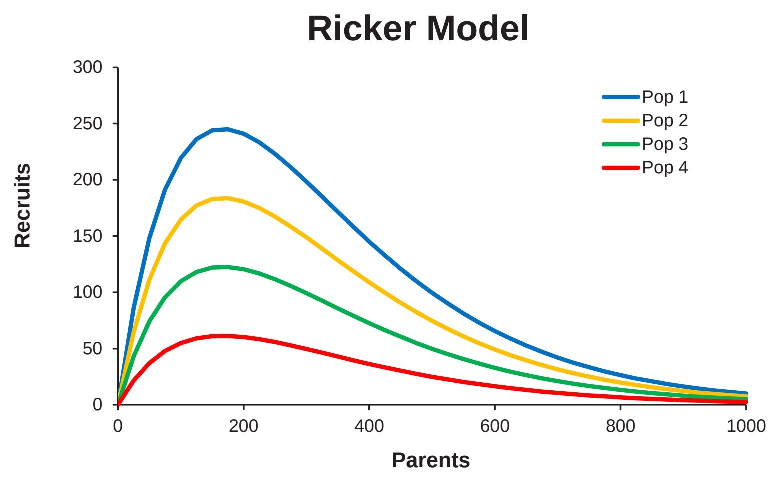
$$E(R) = \alpha S e^{-\beta S}$$
$$K = \left(\frac{\alpha}{\beta}\right) e^{-1}$$

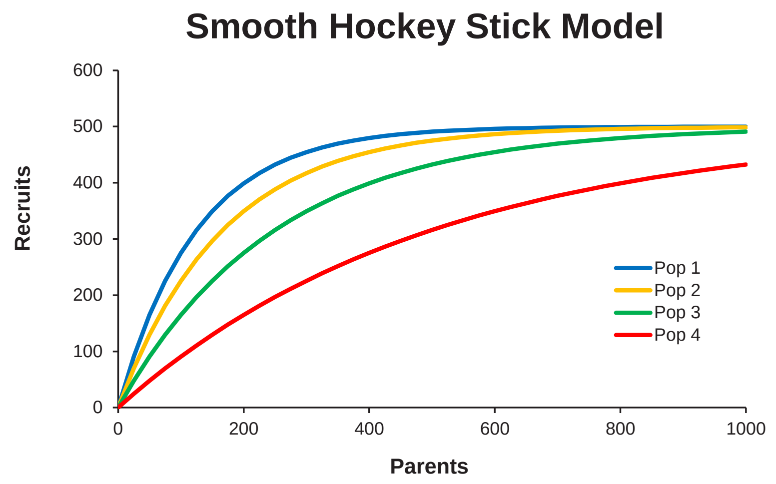
- Beverton-Holt:

$$E(R) = \frac{(\alpha S)}{(\beta + S)}$$
$$\alpha = K$$

- Smooth Hockey Stick:

$$E(R) = R_{\infty}\left(1 - e^{-\left(\frac{\alpha}{R_{\infty}}\right)S}\right)$$
$$R_{\infty} = K$$



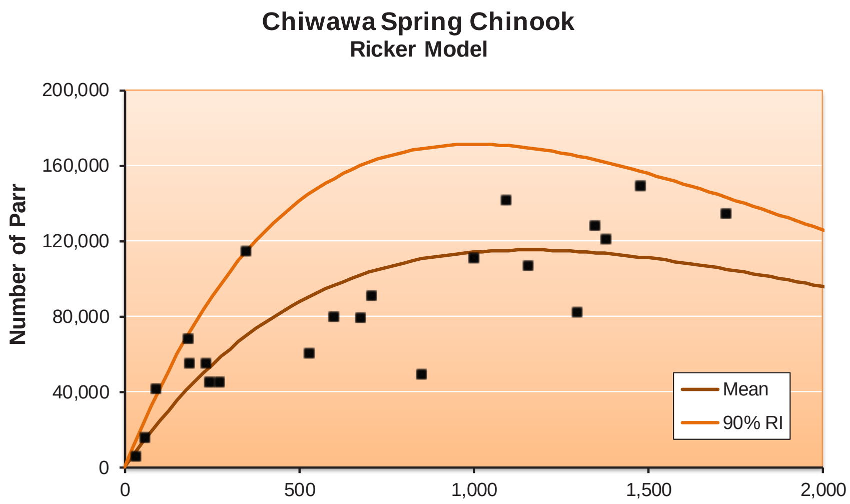


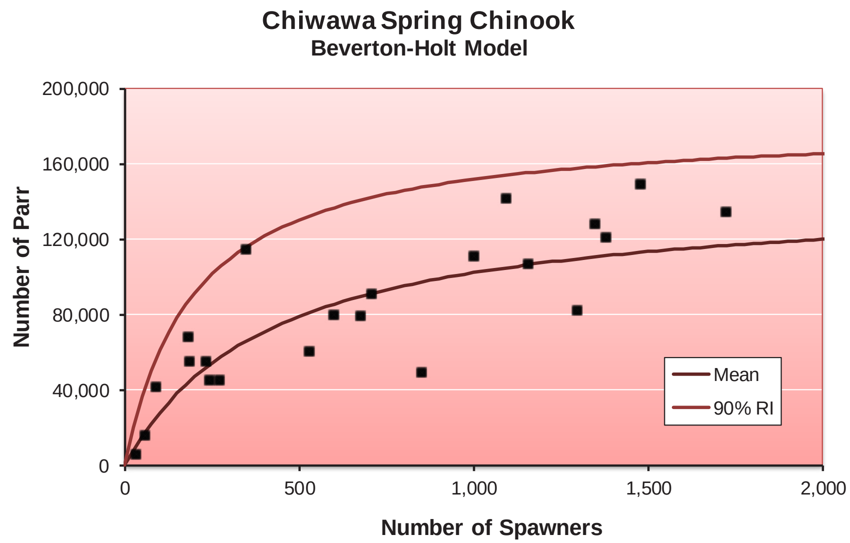
Assumptions

- Assume we can define a population unambiguously.
- Assume that we can measure population size accurately.
- Assume that we have a biologically relevant time-step over which to measure population growth rate.
- Assume a uniformity of nature.

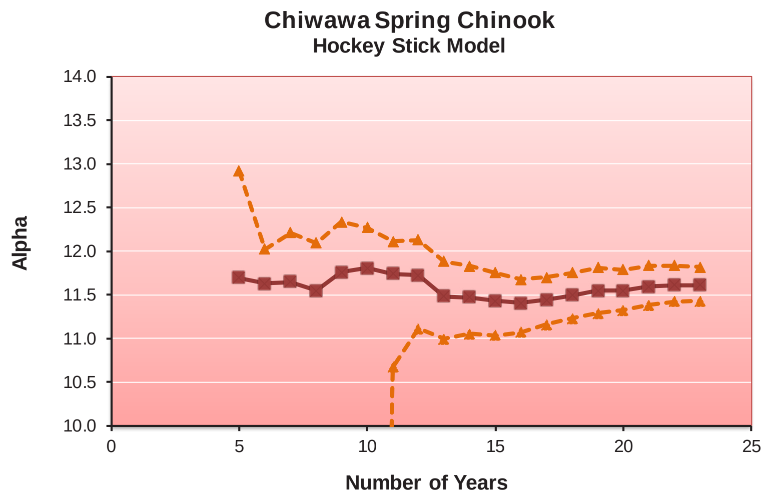
Chiwawa Spring Chinook Parr

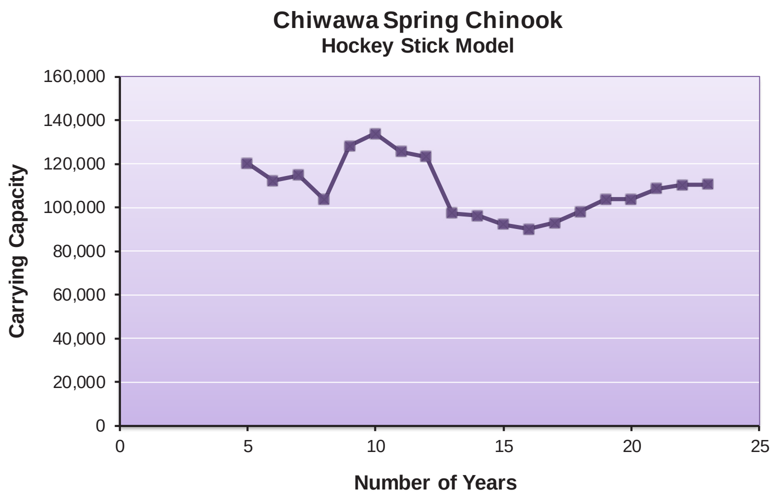
- Population Capacity
  - Ricker = 114,749
  - B-H* = 144,927
  - SHS* = 110,747
- Habitat Capacity
  - Ricker = 171,314
  - B-H = 181,818
  - SHS = ??
  - *QRFM = 164,000*

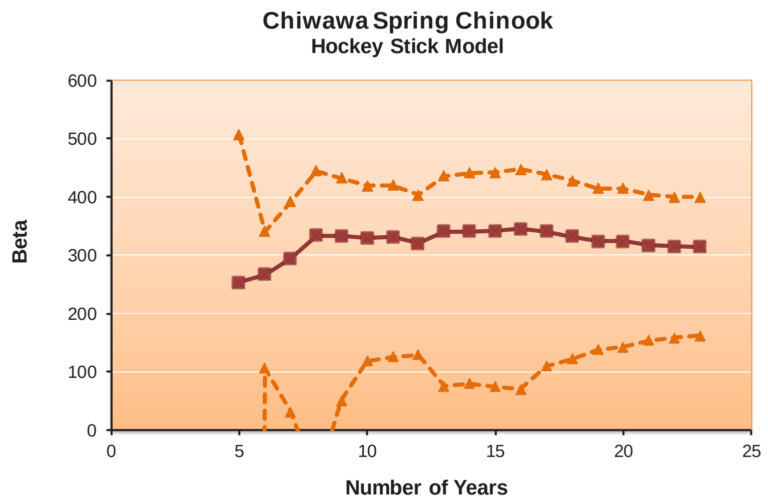


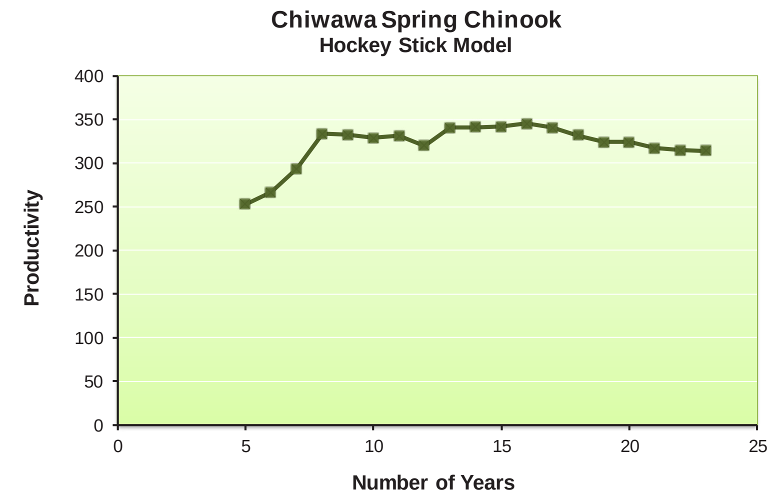


Chiwawa Spring Chinook Parr



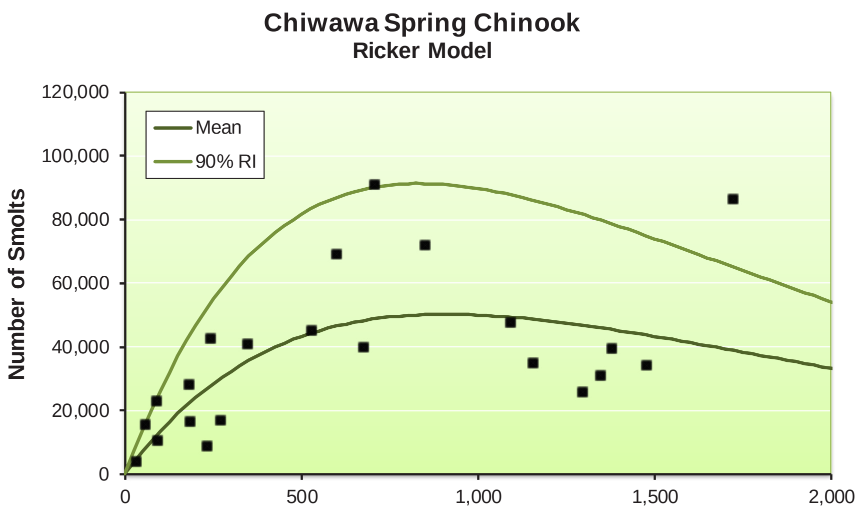


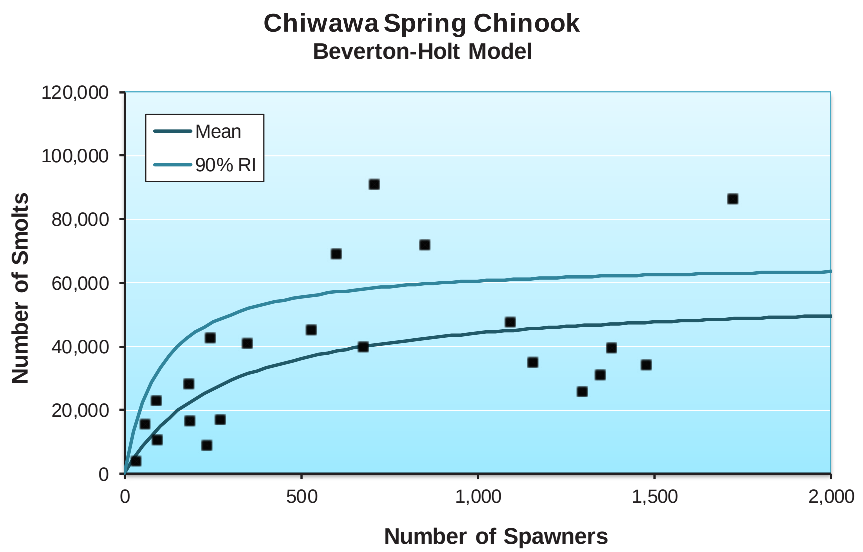




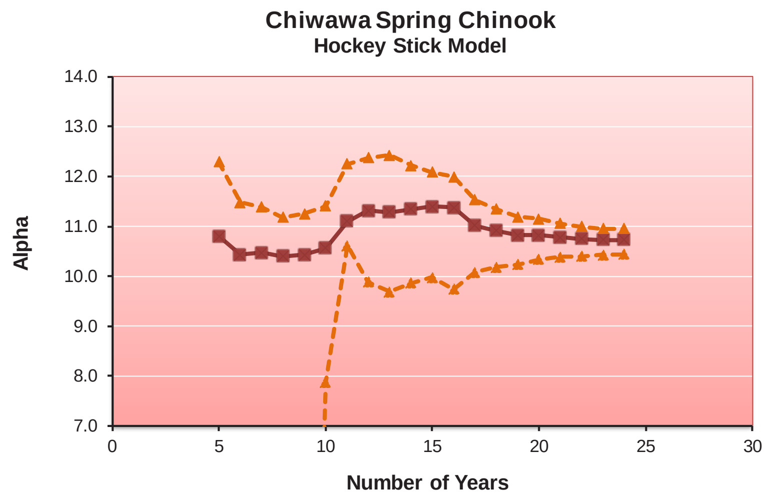
Chiwawa Spring Chinook Smolts

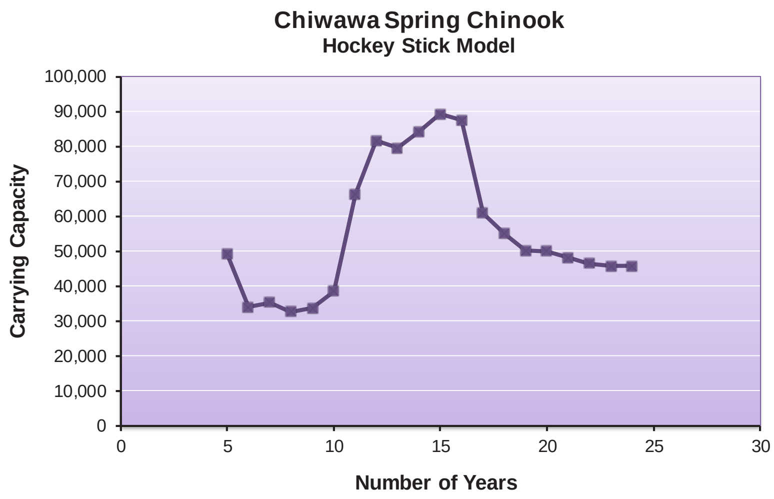
- Population Capacity
  - Ricker* = 50,240
  - B-H* = 56,595
  - SHS* = 45,815
- Habitat Capacity
  - Ricker = 91,348
  - B-H = 66,667
  - SHS = ??

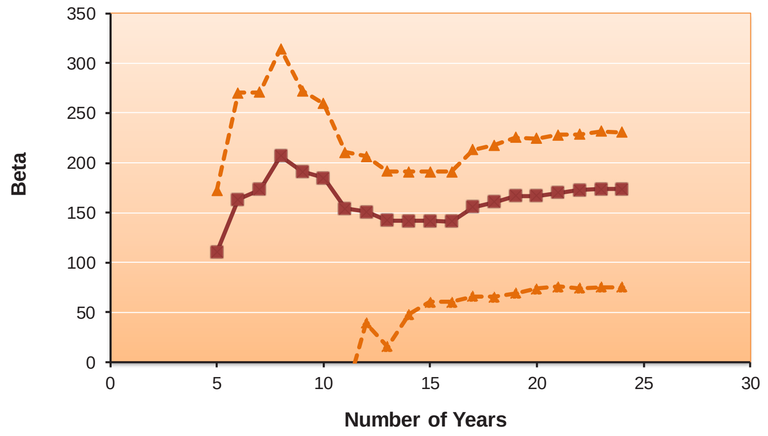


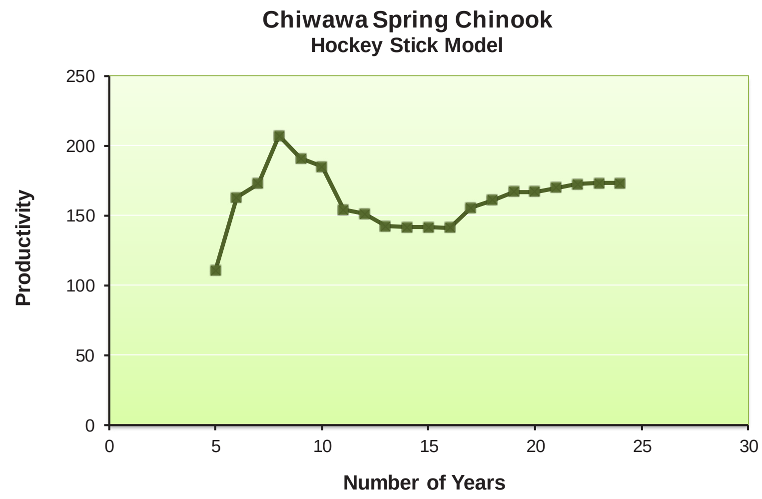


Chiwawa Spring Chinook Smolts



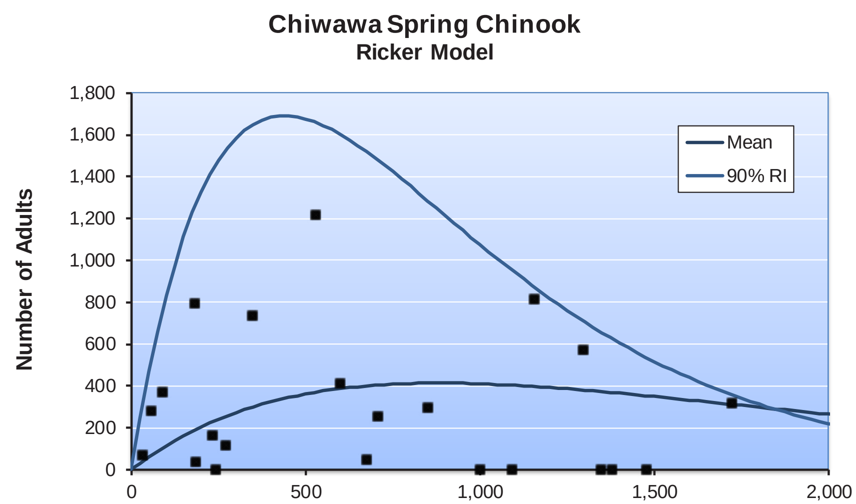


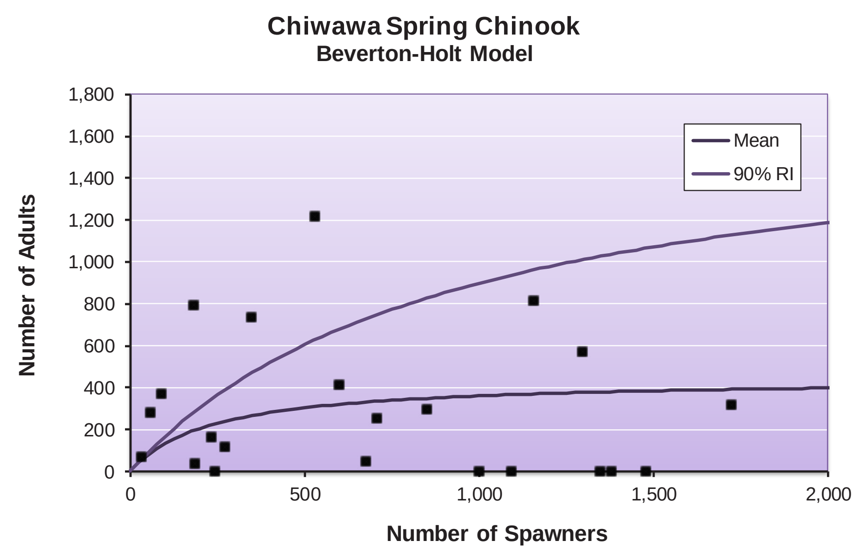




Chiwawa Spring Chinook Adults

- Population Capacity
  - Ricker* = 415
  - B-H* = 444
  - SHS = ??
- Habitat Capacity
  - Ricker = 1,690
  - B-H = 1,743
  - SHS = ??





Chiwawa Spring Chinook

Life Stage	Model	Population Capacity	Habitat Capacity
Parr	Ricker	114,749	171,314
	Beverton-Holt	144,927	181,818
	Hockey Stick	110,747	--
Smolt	Ricker	50,240	91,348
	Beverton-Holt	56,595	66,667
	Hockey Stick	45,815	--
Adult	Ricker	415	1,690
	Beverton-Holt	444	1,743
	Hockey Stick	--	--

So Now What?

- Which populations do we model?
  - Spring Chinook
  - Summer Chinook
  - Steelhead
- What model do we use?
- What data do we use?
- How will the results be used?

SOW for Releasing Adult Pacific Lamprey

within Tumwater Dam Fish Ladder (Wenatchee River)

Ralph Lampman

Yakama Nation FRMP, Pacific Lamprey Project

April 18, 2016

We propose to place 30 adult Pacific Lamprey (all FDX PIT tagged) inside the Tumwater Dam (river km 49.6) fish ladder (lower, mid, and upper pool release) this spring season using open ended tube traps, allowing them to volitionally move out into the fish ladder (see Addendum). By placing some in lower, mid, and upper portions, we can see if lamprey are able to navigate through some parts of the serpentine weirs. Salmonid fish use of the ladder are very low at this particular time of the year (mid-late April); Steelhead counts have wound down to very low levels now and there will be some time (~1 month) before Spring Chinook counts will begin to rise. Hence, it is the best time to experiment with the within ladder lamprey release.

Map 1. Close-up of Tumwater Dam Fish Ladder proposed release locations (yellow arrows; 10 adults in each release, 30 total). Lower ladder release will be in slot #1, mid ladder release will be in slot #12, and upper ladder release will be in slot #17. Of the total 19 slots within the ladder, the two PIT tag arrays (blue circles) are located in slot #15 and #18 of the fish ladder. See Addendum for more details.

Addendum: Release of adult Pacific Lamprey within Tumwater Dam fish ladder

We propose to release adult Pacific Lamprey in three locations within the Tumwater Dam fish ladder (Figure 1). Ten lamprey will be released at each of these locations. Four topics will be pursued from this experimental release: 1) whether lamprey lowered in the fish ladder will stay within the ladder initially or simply move downstream (verification of their behavior and refinement for the release methods), 2) whether lamprey from the two lower release locations can be detected moving upstream through the two PIT tag arrays and fish counting station (despite the lack of larvae presence above the dam), 3) whether lamprey released upstream of the two PIT array locations (uppermost release) will be detected moving upstream through the fish counting station or downstream through the PIT tag arrays, and 4) whether any of the lamprey will be detected multiple times moving upstream and/or downstream. The duration of their detections within the ladder will be of interest as well. Some of the released lamprey may also be detected in PIT tag arrays outside of the fish ladder, either upstream or downstream of Tumwater Dam, after this experiment (indicating their final direction of movement and destination). All of this information will be invaluable for future planning and monitoring of lamprey passage.

Lamprey will be lowered down to the three locations (along the side wall) using PVC tube traps (Figure 2 and Figure 3) to allow lamprey to swim out volitionally once gently lowered to the bottom of the water column. These PVC tube traps are used for lamprey collection in lower Columbia River dams and are known to be effective in providing a refuge within the fish ladders. The traps will have 20 lb. (or heavier) weights on both ends to ensure they sink to the bottom and stay in place (side and edge of the serpentine ladder pools away from any entrances or exits). Once these three PVC tube traps (each holding ten adult lamprey) are lowered in place, one funnel on one end of the trap will be removed using a separately attached rope to allow volitional escapement of lamprey. Each trap will be checked every 15 minutes to monitor the number of lamprey remaining inside the trap. If lamprey still remain inside the tube traps after one hour, the trap will be tilted near the bottom of the water column to gently encourage all lamprey to swim out of the traps, and this process will be repeated until all lamprey successfully swim out. This will be done either earlier in the morning or later in the afternoon/evening when lamprey are more active and have a higher tendency to migrate upstream. This release method is preferred over releasing the adults directly at the water surface as releasing lamprey at the water surface could likely result in lamprey swimming away and displaying evasion immediately after release. Only lamprey that are less sexually mature (interdorsal length of 25 mm or larger) will be used for this experiment to ensure that lamprey still have enough energy reserves to continue upstream migration (prior to reaching their sexual maturity and spawning phase). In the rare case that tagged lamprey are detected continuously in front of one of the PIT arrays, lamprey could be guided away using long poles.

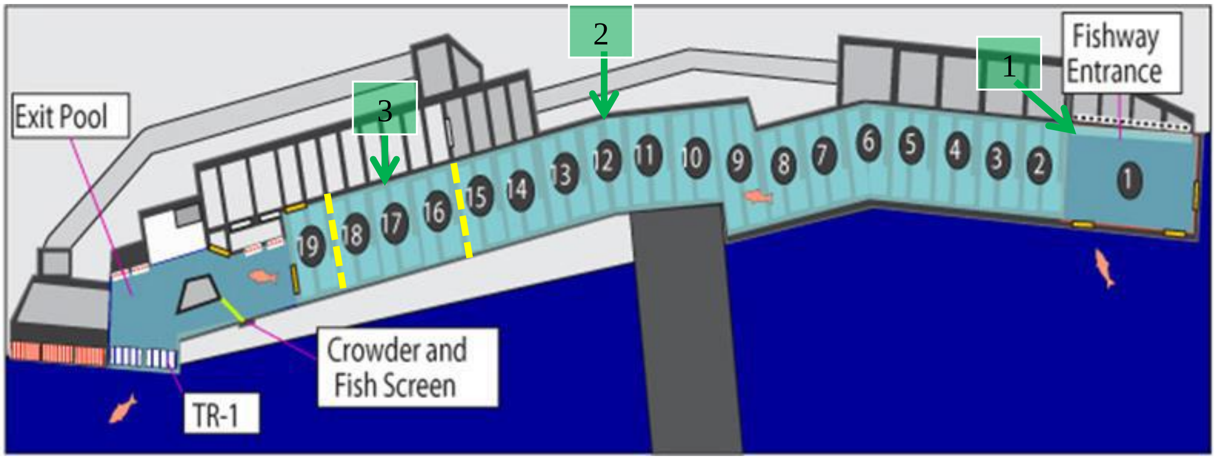


Figure 1. Overview of Tumwater Dam fish ladder, PIT array locations (yellow dotted lines), and adult Pacific Lamprey release locations (green arrows). The three release locations are: slot #1, #12, and #17.

Figure 2. Examples of tube traps proposed to be used for lowering adult Pacific Lamprey in Tumwater Dam fish ladder. Yellow arrows indicate the area where a separate rope will be attached to detach the funnel on one side from the tube trap.

Figure 3. Examples of tube traps used in Lower Columbia River dams for adult Pacific Lamprey collection.

Attachment E

Blackbird Pond Update

Catherine Willard and Alene Underwood

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Background

- District began discussing opportunity to use Blackbird Pond in 2007
  - o Goal was to provide acclimation for steelhead in the Wenatchee Basin while permanent infrastructure was still several years out
- Agreement with TU in 2008 to pay for modifications associated with water intake structure and first year of acclimation 2010
- Current state:
  - o District rears roughly 25,000 fish in the pond annually
  - o District reimburses utility costs while our fish on station and maintains infrastructure
  - o WDFW operates the pond

Attachment E

P.U.D.
CHELAN COUNTY
POWER
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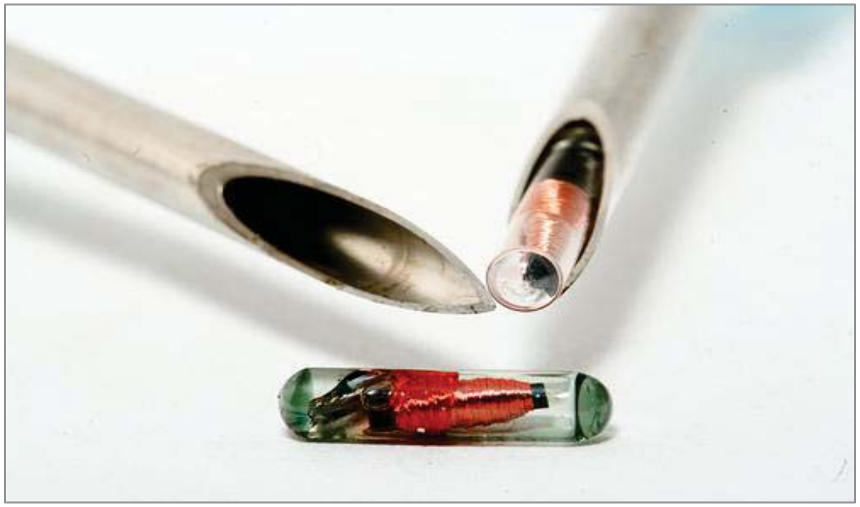

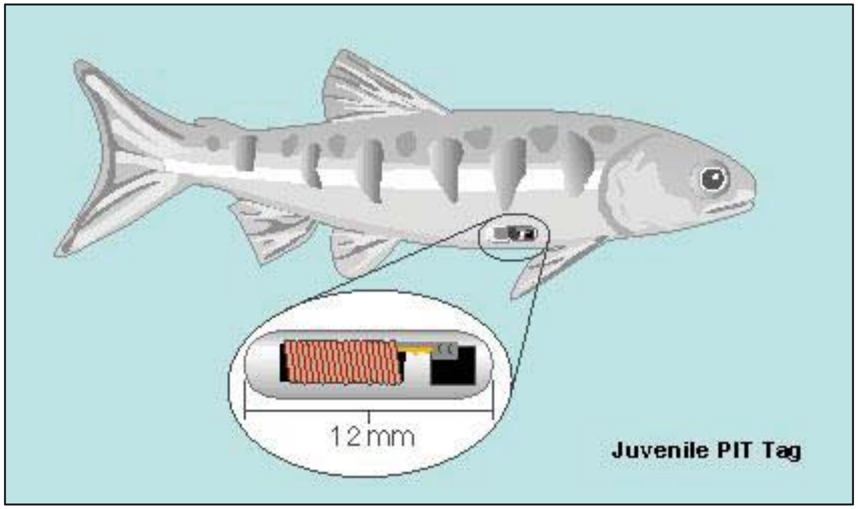

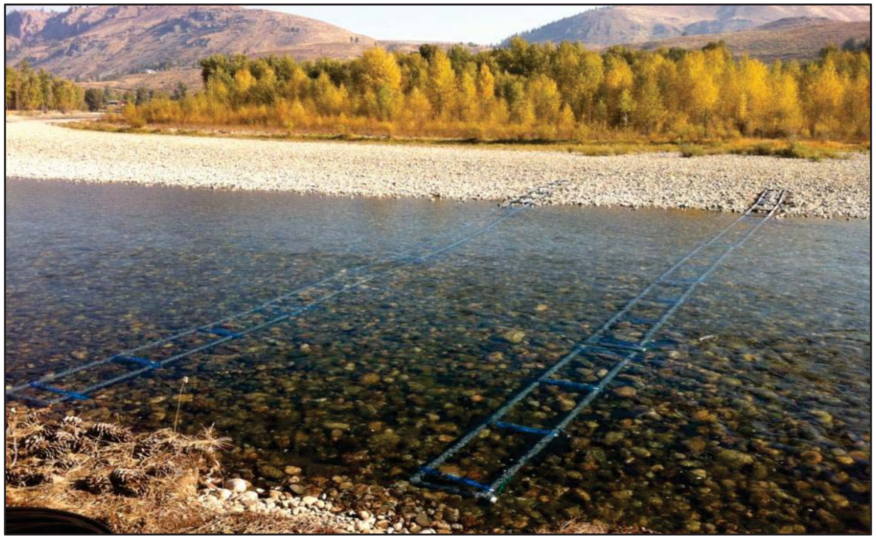

Passive Integrated Transponder (PIT) Tags

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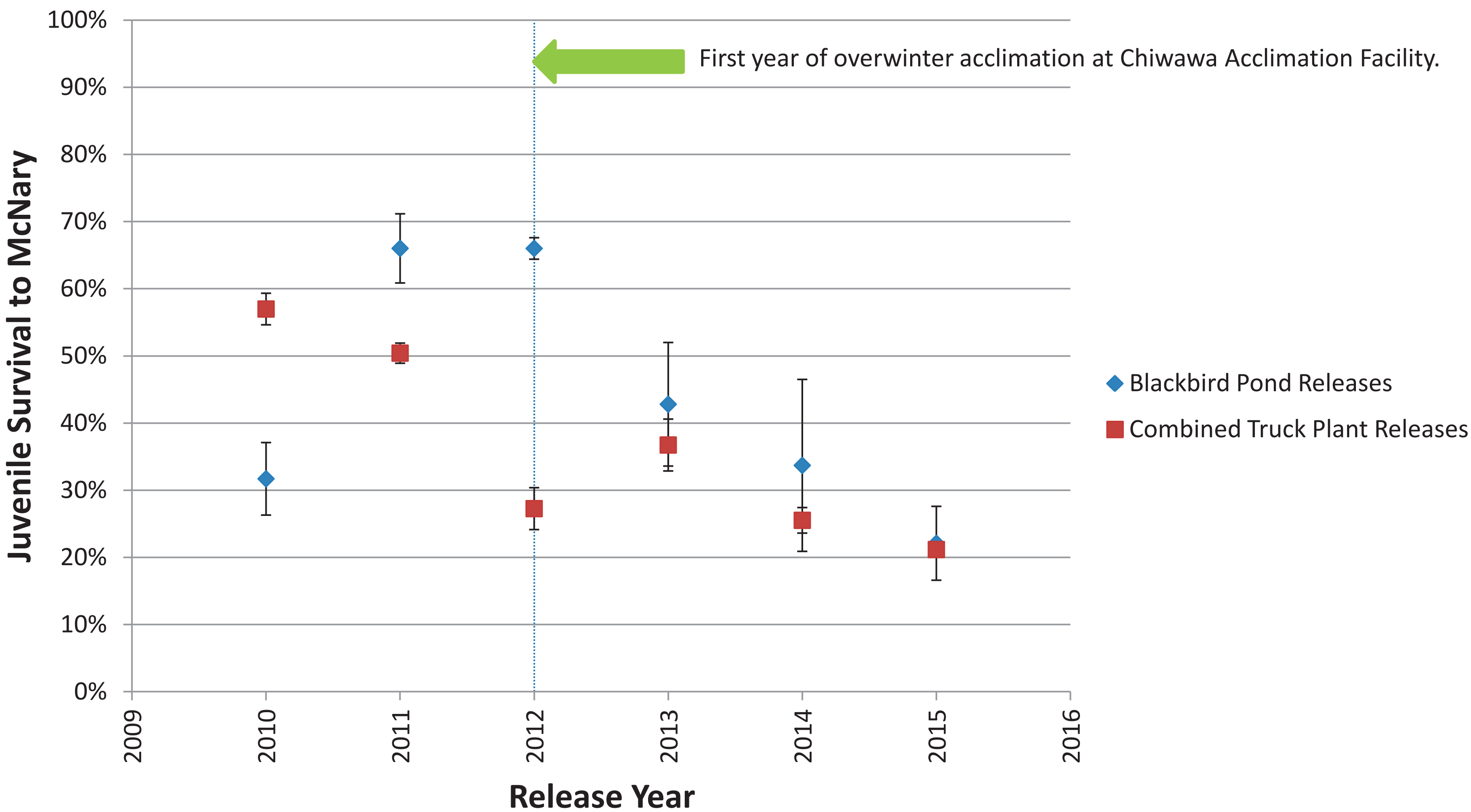
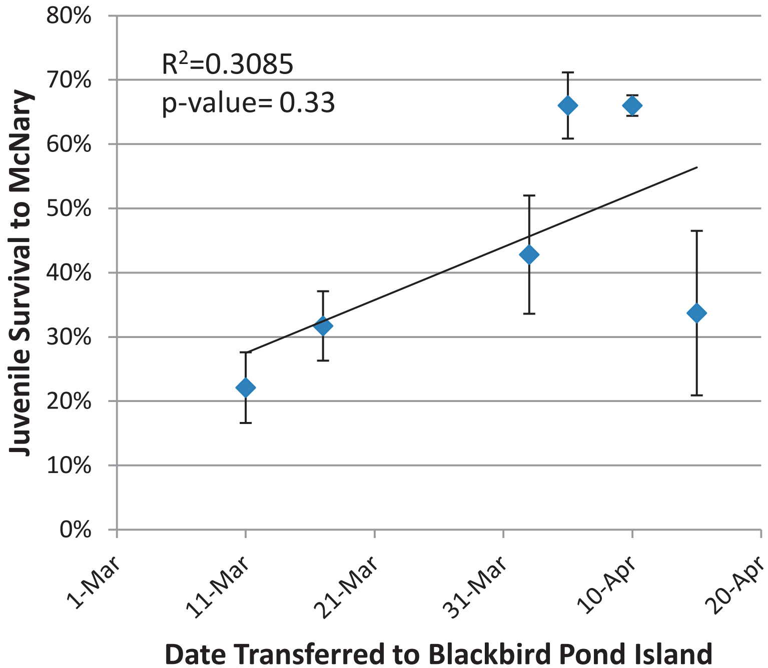
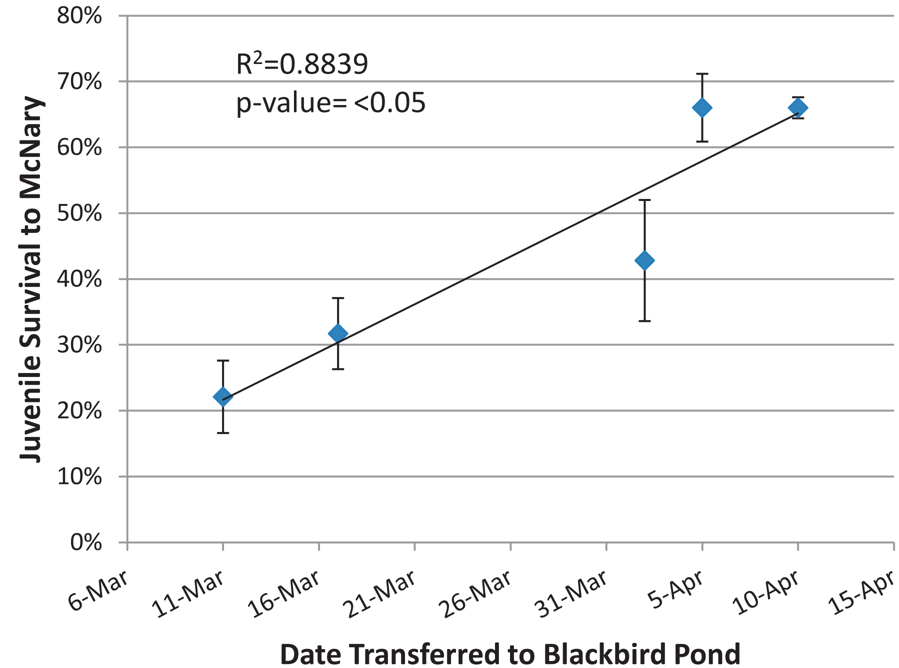
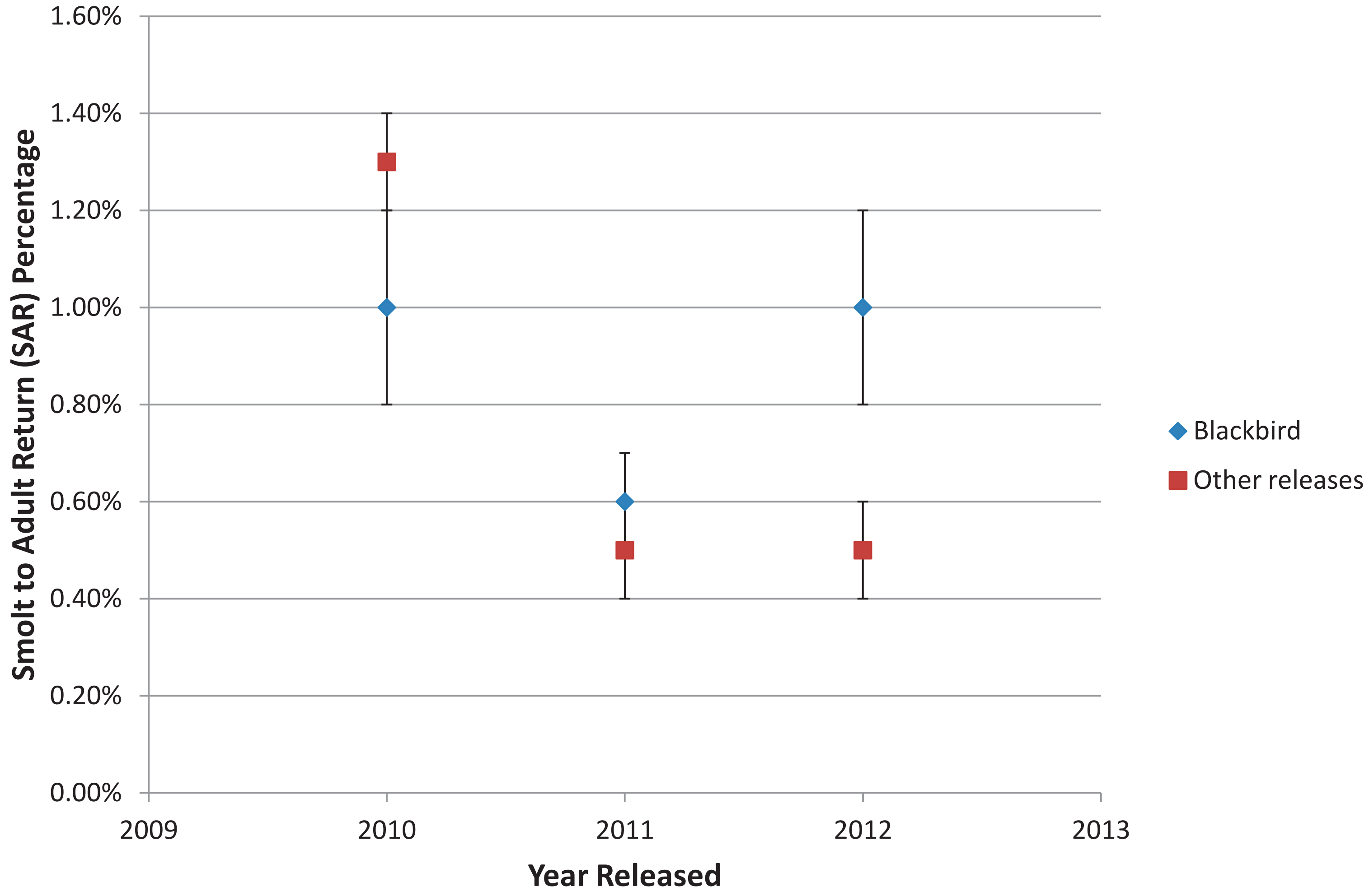
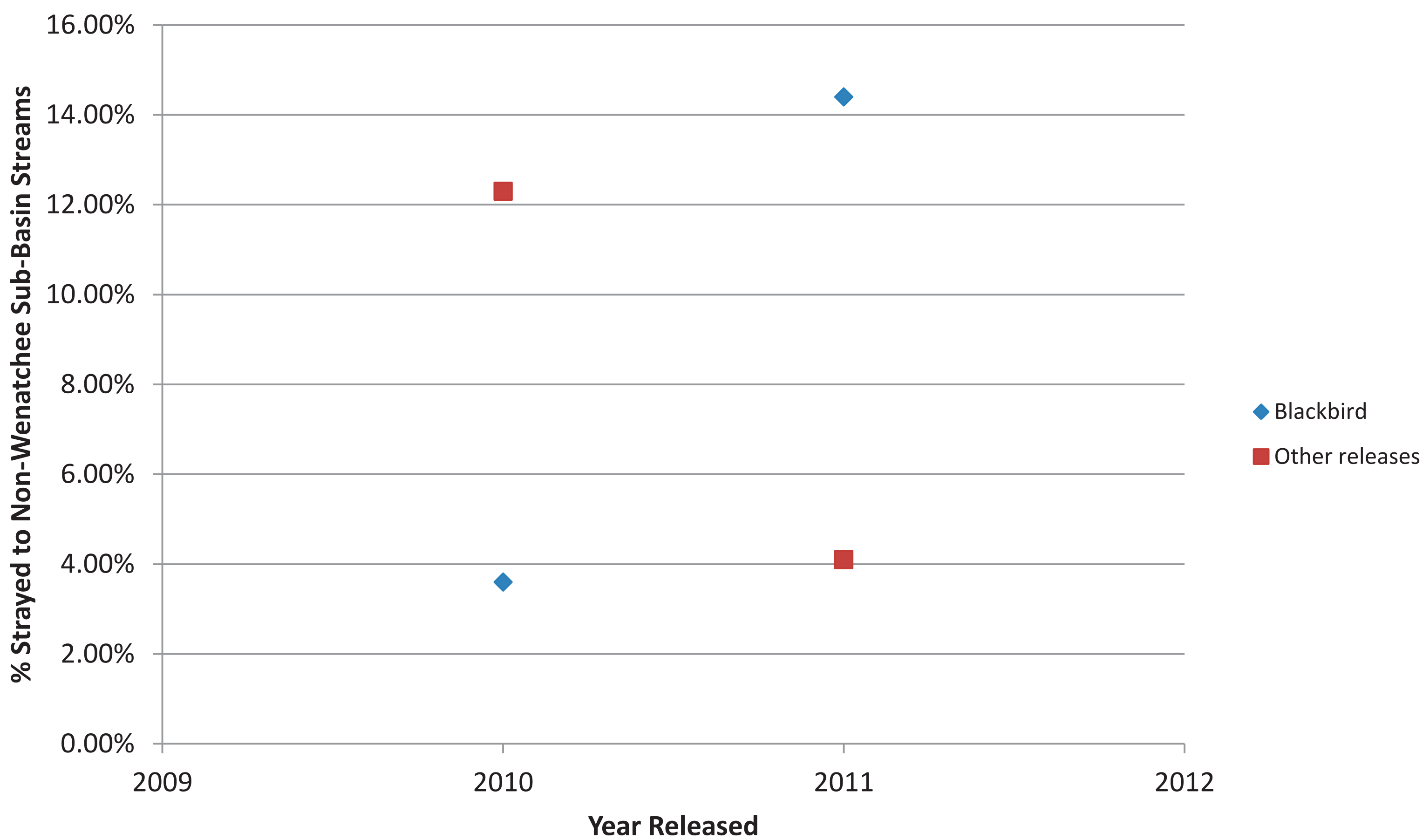

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Juvenile Survival to McNary
First year of overwinter acclimation at Chiwawa Acclimation Facility.
2009
2010
2011
2012
2013
2014
2015
2016
Release Year
Blackbird Pond Releases
Combined Truck Plant Releases





Blackbird Island Pond Steelhead		
Release Year	**Transfer Date**	**Volitional Release Date**
2010	March 17, 2010	April 21, 2010
2011	April 5 2011	May 11, 2011
2012	April 10, 2012	May 1, 2012
2013	April 2, 2013	May 1, 2013
2014	April 15, 2014	April 22, 2014
2015	March 11, 2015	April 21, 2015


1.60%
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
Smolt to Adult Return (SAR) Percentage
2009
2010
2011
2012
2013
Year Released
Blackbird
Other releases



16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
% Strayed to Non-Wenatchee Sub-Basin Streams
2009
2010
2011
2012
Year Released
Blackbird
Other releases

Summary

- Smolt outmigration survival
- Smolt survival relative to transfer date
- Smolt-to-adult survival
- Percent strays

CHELAN COUNTY POWER www.chelanpud.org

Questions?

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	June 16, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the May 18, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held via conference call, on Wednesday, May 18, 2016, from 9:30 to 10:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A). *(Note: this item is ongoing.)*
- The imprinting and homing subgroup will visit the Issaquah Salmon Hatchery on May 26, 2016 (Item I-A). *(Note: the subgroup visited the Issaquah Salmon Hatchery.)*
- Craig Busack will resolve outstanding comments in the National Marine Fisheries Service (NMFS) Consultation Update section of the April 20, 2016, Hatchery Committees meeting minutes and send revisions to Sarah Montgomery, who will distribute the minutes to the Hatchery Committees for approval (Item I-A). *(Note: Busack sent the revised version to Montgomery on May 19, 2016, which she distributed to the Hatchery Committees for approval the same day.)*
- Kirk Truscott will revise Draft Hatchery M&E Plan Appendix 3 to include information for the Okanogan/Chief Joseph programs, and send it to Keely Murdoch (Item I-A). *(Note: Truscott sent the information to Murdoch, and the revised Appendix 3 was distributed to the Hatchery Committees on May 24, 2016.)*
- The Hatchery Committees will discuss Draft Hatchery M&E Plan Appendices 2

through 6 during the June 15, 2016, Hatchery Committees meeting (Item IV-A).

- Chelan PUD and Douglas PUD will research vernacular for straying and homing fidelity, and present definitions that can be used in reports, plans, and minutes at the Hatchery Committees June 15, 2016, meeting (Item V-B).
- Tracy Hillman will demonstrate a tool that processes data from the National Oceanic and Atmospheric Administration (NOAA) Salmon Population Summary database during the Hatchery Committees June 15, 2016, meeting (Item VI-A).
- Kristi Geris (Anchor QEA) will provide support to the Hatchery Committees while Sarah Montgomery is on vacation from May 25 to June 11, 2016. During this time, Hatchery Committees representatives will cc: Geris, Montgomery, and Hillman on all Hatchery Committees communication (Item VI-B). *(Note: Geris provided support from May 25 to June 11, 2016.)*

DECISION SUMMARY

- There were no decisions approved during today's meeting.

AGREEMENTS

Hatchery Committees members present agreed to a 2-day review period for the revised (version 2) April 20, 2016, meeting minutes (Item I-A). (Note: Montgomery sent the revised (version 2) meeting minutes to the Hatchery Committees on May 19, 2016, and the minutes were approved via email on May 23, 2016.)

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on May 16, 2016, notifying them that Draft Hatchery M&E Plan Appendices 2 through 6 are available for review before the Hatchery Committees June 15, 2016, meeting (Item IV-A).

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the April 20, 2016 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Alene Underwood added a discussion about straying and homing fidelity vernacular.

The Hatchery Committees reviewed the revised draft April 20, 2016, meeting minutes. Sarah Montgomery said there are several outstanding comments to be discussed. She said Craig Busack did not attend today's meeting, and outstanding comments in the NMFS Consultation Update section were not resolved during the review period or during today's meeting. Justin Yeager said Busack will address outstanding comments in the NMFS Consultation Update section and then send the revised version to Sarah Montgomery for distribution to the Hatchery Committees. Montgomery asked the Hatchery Committees how much time they need to review Busack's edits to the revised minutes. Alene Underwood said 2 days should be enough time to review his edits, so the minutes can be finalized. Hatchery Committees members present agreed to a 2-day review period for the revised (version 2) April 20, 2016, meeting minutes.

The Hatchery Committees discussed the other outstanding comments and made revisions.

(Note: Hatchery Committees members approved the revised draft April 20, 2016, meeting minutes by email on May 23, 2016.)

Action items from the Hatchery Committees meeting on April 20, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on April 20 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*

  This item is ongoing.

- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A).*
  This item is ongoing.
- *Kirk Truscott will send Okanogan program proportionate natural influence (PNI) and proportion of hatchery-origin spawners (pHOS) goals to Keely Murdoch for use in the Draft Hatchery M&E Plan Appendix 3 (Item II-A).*
  This item is ongoing. Murdoch said she revised Appendix 3 and included a placeholder for the Okanogan/Chief Joseph programs. Truscott said he filled in those sections, and he will send the draft Appendix 3 back to Murdoch. Murdoch also said that much of the information included in Appendix 3 are excerpts from permits and HGMPs. She said she had previously received comments stating that Appendix 3 is too vague; however, she does not want to add meaning or detail to permit language, and for that reason, she maintained the original permit and Hatchery and Genetic Management Plan (HGMP) language.
- *Craig Busack will send the draft Methow spring Chinook Program permits to members of the Hatchery Committees (Item II-A).*
  This item is complete. Hatchery Committees representatives present said they all have a copy of the draft permits; however, the draft permits were not formally distributed to the Hatchery Committees.
- *Keely Murdoch will revise Draft Hatchery M&E Plan Appendix 3 and send it to Sarah Montgomery by Wednesday, May 18, 2016, which she will forward to the Hatchery Committees for review (Item II-B).*
  This item is complete. Murdoch sent Appendix 3 to Montgomery on May 16, 2016, which she forwarded to the Hatchery Committees.
- *The Hatchery Committees will discuss Draft Hatchery M&E Plan Appendices 2 to 6 during the June 15, 2016 Hatchery Committees meeting (Item II-B).*
  This item is ongoing.
- *Catherine Willard will send a Doodle poll to the Hatchery Committees in order to determine a date for visiting the Issaquah Salmon Hatchery (Item II-C).*
  This item is complete. Willard sent the poll to Sarah Montgomery, which she forwarded to the Hatchery Committees on April 25, 2016.

- *The imprinting and homing workgroup will visit the Issaquah Salmon Hatchery on May 26, 2016 (Item II-C).*
  This item is ongoing.
- *Tracy Hillman will send his paper titled, "Assessment of Factors Limiting the Productivity of Summer Chinook Salmon in the Mid-Columbia River" to Craig Busack (Item II-D).*
  This item is complete. Hillman sent the paper to Busack on April 20, 2016.
- *Mike Tonseth will discuss foregoing additional steelhead adult management at Tumwater Dam with Andrew Murdoch (WDFW; Item III-A).*
  This item is complete. Tonseth said additional steelhead adult management at Tumwater Dam was suspended.

II. USFWS

A. USFWS Bull Trout Consultation Update (Matt Cooper)

Matt Cooper said Karl Halupka (United States Fish and Wildlife Service [USFWS]) provided him with an update to share with the Hatchery Committees. Cooper said, regarding the Wenatchee spring Chinook salmon, Wenatchee River steelhead, and Dryden summer Chinook salmon programs, Halupka is incorporating comments from permit applicants and NMFS into the final draft. Cooper said Halupka will provide responses to comments before the permit is finalized.

Regarding permitting for the Methow spring Chinook program consultation, Cooper said Halupka has not made progress on the technical assistance letter stating that the 2012 Wells Relicensing Bull Trout Biological Opinion (BiOp) provides sufficient bull trout coverage. Regarding the Okanogan program consultation, Cooper said Halupka is making progress on extending the Section 10 permit, and is working with Charlene Hurst (NOAA) to develop a Tribal Resource Management Plan (TRMP) consultation approach. Mike Tonseth asked if Halupka indicated a timeline for the Wenatchee River Steelhead BiOp. Cooper replied he is not aware of a timeline for the BiOp.

III. NMFS

A. NMFS Consultation Update (Justin Yeager)

Justin Yeager said NMFS has almost finished the Wenatchee River Steelhead BiOp. Regarding the Methow spring Chinook salmon BiOp, Yeager said NMFS is making progress, and will be drafting an Environmental Assessment (not an Environmental Impact Statement) to complete the National Environmental Policy Act process. He said NMFS is also working on gene-flow guidelines for Methow River steelhead.

Yeager said NMFS and USFWS both plan to modify how they provide monthly updates to the Hatchery Committees, starting at the June 15, 2016, meeting, and the updates will be in bulleted form to better address the consultation status for each program. Alene Underwood asked if and when there will be an opportunity to review the Methow spring Chinook salmon BiOp. Yeager said he is not sure, and suggested that Underwood call Craig Busack or Charlene Hurst for more information. Mike Tonseth recalled that Amilee Wilson (NMFS) was developing a take surrogate for ecological interactions as requested by General Counsel, and asked if the NMFS portion of the Wenatchee River Steelhead BiOp is now complete. Yeager replied the General Counsel has approved the BiOp, but the Section 7 consultation with USFWS is ongoing.

IV. HETT

A. HETT Update (Sarah Montgomery)

Tracy Hillman said Sarah Montgomery distributed Draft Hatchery M&E Plan Appendices 2 through 6 to the Hatchery Committees on May 16, 2016, for review. Montgomery said the Hatchery Committees will review Appendices 2 through 6 during the June 15, 2016, meeting.

V. Chelan PUD

A. Chelan Falls Summer Chinook Salmon Broodstock Collection (Catherine Willard)

Catherine Willard said Chelan, Douglas, and Grant PUDs are discussing different methods for collecting summer Chinook salmon broodstock for the Chelan Falls program at Wells Fish Hatchery. She said she will update the Hatchery Committees when a decision is reached.

B. Straying and Homing Fidelity Vernacular (Alene Underwood)

Alene Underwood said, during the review of the April 20, 2016, Hatchery Committees meeting minutes, representatives present discussed that it would be beneficial to define the terms straying and homing fidelity more clearly. She said, sometimes it is not clear whether people are discussing straying in terms of genetics or straying from a release location. She said defining homing fidelity and straying will help make plans, reports, and minutes more clear and consistent, and will help when discussing NMFS Section 10 permits.
Tracy Hillman asked if Underwood is proposing that "stray" be used to address genetic issues, and "homing fidelity" be used to discuss behavioral movements. Underwood replied yes. Keely Murdoch said definitions should be added to the Hatchery M&E Plan, and to the 5-Year Hatchery M&E Report. Greg Mackey said he thinks it would be most useful, considering the large body of literature addressing straying and homing fidelity, to review how other fisheries biologists have used the terms in the past. He said he would prefer to use terms that other researchers and managers use, so that reports and information produced by the Hatchery Committees make sense to the larger group of scientists in the discipline. Mackey said, for example, Thomas Quinn's (University of Washington) book, *The Behavior and Ecology of Pacific Salmon and Trout*, contains a chapter called "Homing and Patterns of Straying" (Chapter 5)[1]. Mackey said he can help do a literature search and come up with definitions. Underwood agreed that the Hatchery Committees should adopt definitions that are already commonly used, and said Chelan PUD added this discussion to today's agenda, so Chelan PUD will also work with Mackey on developing the definitions. Hillman summarized that Chelan and Douglas PUDs will research vernacular for straying and homing fidelity, and present definitions that can be used in reports, plans, and minutes at the Hatchery Committees June 15, 2016, meeting.

[1] Quinn, Thomas P. *The Behavior and Ecology of Pacific Salmon and Trout*. American Fisheries Society, Bethesda (Maryland), in association with University of Washington Press, Seattle (Washington). 2005.

VI. HCP Administration

A. NOAA Salmon Population Summary Database (Tracy Hillman)

Tracy Hillman asked the Hatchery Committees representatives if they are familiar with the NOAA Salmon Population Summary (SPS) database[2], which contains population data for Columbia River salmon and steelhead populations. He said he and other contractors have been working with Bonneville Power Administration (BPA) on how to display and summarize data in the SPS database. This work is part of the Federal Columbia River Power System BiOp. He said they (BPA and some of their contractors) have developed a tool that processes data from the NOAA SPS database and presents them in easily interpreted formats. He said the tool will be helpful in writing the 5-Year Hatchery M&E Report, because it can plot data, show hatchery and wild fish fractions and age structures, and show recovery and extinction thresholds. Hillman offered to demonstrate this tool, and the Hatchery Committees representatives present accepted. Hillman said he will demonstrate the tool that processes data from the NOAA SPS database during the Hatchery Committees June 15, 2016, meeting.

B. HC Support Coverage During Vacation (Sarah Montgomery)

Sarah Montgomery said Kristi Geris (Anchor QEA, LLC) will perform Montgomery's Hatchery Committees support duties from May 25 to June 11, 2016, while Montgomery is on vacation. Montgomery asked the Hatchery Committees to please cc: Montgomery, Geris, and Tracy Hillman on all Hatchery Committees communication during that time.

C. Next Meetings

The next Hatchery Committees meetings are on June 15, 2016, (Chelan PUD), July 20, 2016 (Douglas PUD), and August 17, 2016 (Chelan PUD).

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[2] National Oceanic and Atmospheric Administration, 2015. NOAA Salmon Population Summary Database. Available from: https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:HOME.

VII. List of Attachments

Attachment A List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Matt Cooper*	U.S. Fish and Wildlife Service
Justin Yeager*	National Marine Fisheries Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	August 20, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the June 15, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, June 15, 2016, from 9:30 a.m. to 1:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will demonstrate a tool that processes data from the National Marine Fisheries Service (NMFS) Salmon Population Summary database during the Hatchery Committees July 20, 2016, meeting (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will incorporate edits from today's meeting into Draft Hatchery M&E Plan Appendices 2, 4, and 6, and send final versions to Sarah Montgomery for distribution to the Hatchery Committees (Item II-C). *(Note: Montgomery distributed final versions on June 24, 2016.)*
- Todd Pearsons (Grant PUD) will revise Draft Hatchery M&E Plan Appendix 3 and send it to Catherine Willard, who will incorporate edits and send the revised version to the Hatchery Committees for review (Item II-C). *(Note: Montgomery distributed the revised version of Appendix 3 for review on July 12, 2016.)*
- Catherine Willard and Tracy Hillman will revise Draft Hatchery M&E Plan Appendix 5 and send it to Sarah Montgomery for distribution to the

Hatchery Committees for review (Item II-C). *(Note: Montgomery distributed the revised Appendix 5 to the Hatchery Committees on July 19, 2016.)*

- The Hatchery Committees will discuss the population structure of Upper Columbia River summer and fall Chinook salmon at the Hatchery Committees August 17, 2016, meeting (Item II-D).
- Keely Murdoch will discuss internally the shortage of natural-origin recruits in the Methow Composite broodstock (Item II-E). *(Note: Murdoch sent an email describing the Yakama Nation's position on this topic, which Sarah Montgomery forwarded to the Hatchery Committees on June 17, 2016.)*
- Todd Pearsons will discuss internally the shortage of natural-origin recruits in the Methow Composite broodstock (Item II-E).
- Mike Tonseth will discuss with Karl Halupka (U.S. Fish and Wildlife Service [USFWS]) and Craig Busack (NMFS) the possibility of using tangle-netting to capture additional natural-origin broodstock for the Methow Composite program (Item II-E). *(Note: Tracy Hillman sent an email to the Hatchery Committees on July 1, 2016, stating that USFWS and NOAA have approved the use of tangle-netting in 2016, and that Tonseth will distribute a plan for broodstock collection.)*

DECISION SUMMARY

- The Hatchery Committees approved Draft Hatchery M&E Plan Appendices 2, 4, and 6.

AGREEMENTS

- There were no agreements during today's meeting.

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on June 15, 2016, notifying them that the Draft 2015 Chelan PUD and Grant PUD Hatchery M&E Annual Report and appendices are available for a 30-day review period, with edits and comments due to Tracy Hillman by Friday, July 15, 2016.
- Sarah Montgomery sent an email to the Hatchery Committees on July 12, 2016, notifying them that Revised Draft Hatchery M&E Plan Appendix 3 is available for review before the Hatchery Committees August 17, 2016, meeting (Item II-C).

- Sarah Montgomery sent an email to the Hatchery Committees on July 19, 2016, notifying them that Revised Draft Hatchery M&E Plan Appendix 5 is available for review before the Hatchery Committees August 17, 2016, meeting (Item II-C).

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on June 24, 2016, notifying them that the Hatchery M&E Plan Appendices 2, 4, and 6 are available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the May 18, 2016 Conference Call Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Sarah Montgomery removed the Hatchery Evaluation Technical Team (HETT) update.
- Catherine Willard removed the Summary of the 5-Year Hatchery M&E Review.
- Tracy Hillman removed his presentation on the National Oceanic and Atmospheric Administration (NOAA) Salmon Population Summary Database Tool, and said it can be added to the Hatchery Committees July 20, 2016, agenda.
- Mike Tonseth added a discussion about broodstock collection for the Methow Conservation Program.

The Hatchery Committees reviewed the revised draft May 18, 2016, conference call minutes. Montgomery said there are no outstanding comments to be discussed.

Hatchery Committees members present approved the draft May 18, 2016, conference call minutes, as revised.

Action items from the Hatchery Committees meeting on May 18, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on May 18, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item is ongoing. Mike Tonseth said the timeline will likely be finished in June 2016.
- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A).*
  This item is ongoing.
- *The imprinting and homing subgroup will visit the Issaquah Salmon Hatchery on May 26, 2016 (Item I-A).*
  This item is complete.
- *Craig Busack will resolve outstanding comments in the National Marine Fisheries Service (NMFS) Consultation Update section of the April 20, 2016, Hatchery Committees meeting minutes and send revisions to Sarah Montgomery, who will distribute the minutes to the Hatchery Committees for approval (Item I-A).*
  This item is complete. Busack sent the revised version to Montgomery on May 19, 2016, which she distributed to the Hatchery Committees for approval the same day.
- *Kirk Truscott will revise Draft Hatchery M&E Plan Appendix 3 to include information for the Okanogan/Chief Joseph programs, and send it to Keely Murdoch (Item I-A).*
  This item is complete and will be reviewed during today's meeting.
- *The Hatchery Committees will discuss Draft Hatchery M&E Plan Appendices 2 through 6 during the June 15, 2016, Hatchery Committees meeting (Item IV-A).*
  This item will be discussed today.
- *Chelan PUD and Douglas PUD will research vernacular for straying and homing fidelity, and present definitions that can be used in reports, plans, and minutes at the Hatchery Committees June 15, 2016, meeting (Item V-B).*
  This item will be discussed today.
- *Tracy Hillman will demonstrate a tool that processes data from the National Oceanic and Atmospheric Administration (NOAA) Salmon Population Summary database during the Hatchery Committees June 15, 2016, meeting (Item VI-A).*

This item will be discussed at the July 20, 2016, Hatchery Committees meeting due to time constraints for today's meeting.

- *Kristi Geris (Anchor QEA) will provide support to the Hatchery Committees while Sarah Montgomery is on vacation from May 25 to June 11, 2016. During this time, Hatchery Committees representatives will cc: Geris, Montgomery, and Hillman on all Hatchery Committees communication (Item VI-B).*

  This item is complete.

II. Joint HCP-HC/PRCC HSC

A. USFWS Bull Trout Consultation Update (Bill Gale)

Bill Gale said he spoke with Karl Halupka, and Halupka said he is revising the Wenatchee River Steelhead Biological Opinion (BiOp) this week, and he plans to circulate a revised draft, which will at least contain the effects analysis, by June 17, 2016.

Additionally, Gale said Winthrop staff provided an update to him, regarding returning spring Chinook salmon to the hatchery, on June 14, 2016. He said there are approximately 1,200 fish in the pond at Winthrop NFH, and staff have excessed more than 1,000 fish. He said Winthrop NFH also received 243 fish transferred from Methow Fish Hatchery (FH). He said Winthrop NFH staff retained 10 fish that were transferred, and set aside 136 adipose-present hatchery fish for broodstock.

Greg Mackey said staff at Wells Dam are 2 weeks delayed in genetic identification because the genetic sequencer needs repair. He said, as of June 14, 2016, staff at Wells Dam had collected 59 wild spring Chinook salmon broodstock for the Methow Composite program, which is roughly half the fish required.

Gale asked if the Methow FH trap is collecting hatchery-origin returning fish efficiently. Mike Tonseth said he does not have an update on the Methow FH trap. Mackey said staff at the Twisp River trap have recently switched the trap to operate through the night. He said many fish are being collected in the trap, including bull trout purposefully collected for a telemetry study. He said staff are optimizing the trap operations based on the time of day that fish move.

B. NMFS Consultation Update (Justin Yeager)

Justin Yeager said Amilee Wilson (NMFS) sent a Doodle poll in May 2016 to schedule a hatchery consultation strategy meeting at the U.S. Forest Service's building in July 2016. Yeager said the Methow spring Chinook salmon BiOp is currently in quality assurance/quality control review, and the revised permits are available for comment, with comments due back to NMFS on June 22, 2016. He said the environmental assessment is being drafted, and NMFS expects the consultation to be complete in July 2016.

Regarding the Methow steelhead consultation, he said NMFS will be contacting permit applicants about gene flow soon. Catherine Willard asked if Yeager has an update on the Wenatchee River steelhead consultation, and Yeager said he does not have an update.

Tracy Hillman asked if the consultation update Yeager just provided is the new format he mentioned during the Hatchery Committees' May 18, 2016, conference call. Yeager said he prepared a bulleted update in advance of the meeting, which is his plan moving forward for consultation updates. Bill Gale asked if Yeager coordinates with Karl Halupka and USFWS regarding a joint consultation update. Yeager said he, Gale, Craig Busack, and Halupka should all discuss the joint consultation updates.

C. Review Draft Hatchery M&E Plan Appendices 2 through 6 (All)

Appendix 2 –HRR Targets

Catherine Willard displayed the document, "draft Hatchery M&E Appendix 2," which Sarah Montgomery most recently distributed to the Hatchery Committees on May 16, 2016 (Attachment B). Questions and comments were discussed, and edits were made to the document. Keely Murdoch asked if the column titled "5-year HRR" is the target or the 5-year data. Tracy Hillman said it is the target Hatchery Replacement Rate (HRR).
Todd Pearsons said the steelhead HRR for the Okanogan conservation program appears very high compared to the Omak program. Hillman reviewed the numbers and said the HRR should be 7.3 (harvest not included) for the Omak steelhead program.

Greg Mackey asked if the HRR for the Wells programs was used for the Twisp River steelhead conservation program, because the time series for the Twisp releases is short.

Hillman said the document will be updated as information becomes available. Mackey also noted that "Eastbank" is the wrong label for Methow basin spring Chinook salmon, which Willard edited.

Hillman noted that some of the numbers in the table do not match the most recent HRR spreadsheet. He checked the numbers and provided updates to Willard, including adding Okanogan summer Chinook salmon to the table.

The Hatchery Committees approved the Draft Hatchery M&E Plan Appendix 2 as revised.

Willard said she would finalize Appendix 2 to include edits discussed today and send it to Montgomery for distribution to the Hatchery Committees.

Appendix 3 – PNI and pHOS Targets and Sliding Scales

Willard displayed the document, "draft Hatchery M&E Appendix 3," which Montgomery most recently distributed to the Hatchery Committees on May 16, 2016 (Attachment C). Questions and comments were discussed, and edits were made to the document.

Murdoch said the summary table is new, and is organized by species, population, management strategy, and section in the document where each is discussed. Todd Pearsons asked if there are proportionate natural influence (PNI) and percent hatchery origin spawn (pHOS) targets for Okanogan summer Chinook salmon. Kirk Truscott replied yes. Mackey asked for clarity that each number be defined as a PNI or pHOS target with a "greater than or less than or equal to" sign, as appropriate.

Hillman asked if Wenatchee spring Chinook salmon will move to a 3-population sliding scale at some point. Murdoch said she is not aware of any planned changes. Pearsons said there are many strays from the Chiwawa River in Nason Creek, so the 3-population model might be a good fit. Murdoch said the 3-population sliding scale was not developed when the permits or Hatchery Genetic Management Plans (HGMPs) were written for Wenatchee spring Chinook salmon, but they could change in the future.

Hillman said he analyzed Wenatchee spring Chinook salmon data using the 3-population model. He said he compared the PNI weighting approach used in the past to the 3-population model approach, and the results were similar, although the 3-population model provides more accurate results.

Bill Gale noted that Methow spring Chinook salmon are listed with a 2-population sliding scale strategy, which should be a 3-population sliding scale. Gale said he wants to make sure that information in Appendix 3 matches the permits. Murdoch said she compiled the appendix based on information directly from the permits, but it should be checked. Mackey said the appendix has extra information that is not included in the permits. Murdoch said when permits are issued, the appendix may need to be updated.

Hatchery Committees members reviewed each section of Appendix 3.

Murdoch said, regarding Wenatchee steelhead, the language in the appendix is from the HGMP and not the draft permit, because the draft permit refers back to the HGMP. Mike Tonseth explained that there is a two-zone management approach, because adult management can be more precise above Tumwater Dam but not below it. Murdoch said the PNI for Wenatchee steelhead above Tumwater Dam can vary and is based on what is occurring in the rest of the Wenatchee basin.

Kirk Truscott said, regarding Okanogan steelhead, the appendix will have to be revised when the permit is issued. Murdoch suggested adding a header to the document stating that it is a "living document" and will therefore change as permits expire and are reissued.

Pearsons said, regarding Priest Rapids fall Chinook salmon, the PNI listed is accurate, but it should be noted that Grant PUD does not have full control of meeting the PNI goal because the U.S. Army Corps of Engineers has a hatchery program in the same area. Pearsons said he will revise Section 13 in Draft Hatchery M&E Plan Appendix 3 and send it to Willard, who will incorporate edits and send the revised version to the Hatchery Committees for review.

Appendix 4 – Spatial Distribution of Spawners

Willard displayed the document, "draft Hatchery M&E Appendix 4," which Montgomery most recently distributed to the Hatchery Committees on May 16, 2016 (Attachment D). Questions and comments were discussed, and edits were made to the document.

Peter Graf said he updated Appendix 4 by adding a column for rationale with text from approved Statements of Agreement (SOAs). Hillman summarized that there are only two programs—Carlton and Dryden summer Chinook salmon—where conservation programs are intended to have a spawning distribution that does not completely overlap with the natural-origin spawning distribution.

Gale said the rationale behind the Carlton management target is that overlap between summer and spring Chinook salmon in the Methow basin should not be increased by the hatchery program. Murdoch said she is not sure if the Hatchery Committees have discussed this management target for the Wenatchee basin, where summer Chinook salmon have expanded their range and now overlap with spring Chinook salmon. Tonseth said the overlap in the upper Wenatchee River is largely driven by wild fish. Murdoch said perhaps the change is driven by climate, and summer Chinook salmon are increasingly seen even in the lower Nason Creek. Gale asked if their expanded distribution is an indication of generally increasing abundances, or a shift in location. Tonseth said he thinks it may be due to an increase in abundance and said high numbers of spawners tend to occur in years when the Wenatchee River is warmer than average, so the fish move into other tributaries.

The Hatchery Committees approved Draft Hatchery M&E Plan Appendix 4.

Willard said she would finalize Appendix 4 to include edits discussed today and send it to Montgomery for distribution to the Hatchery Committees.

Appendix 5 – Stray Rate Objectives

Willard displayed the document, "draft Hatchery M&E Appendix 5," which Montgomery most recently distributed to the Hatchery Committees on May 16, 2016 (Attachment E). Questions and comments were discussed, and edits were made to the document.

Hillman said most of Appendix 5 appears to be taken from the main Hatchery M&E Plan. Pearsons asked if the information should be included in Appendix 5 if it is already located in the main plan. Gale asked if stray rates are annual targets. Willard said stray rates are annual targets. (Note: there are also brood year cohort stray rates that are not an annual target.) Hillman said there is also another stray rate metric to consider, which is that the spawning escapement of the recipient population should not consist of more than 10 percent of strays annually. He said the Technical Recovery Team (TRT) came up with this criterion and uses it for assessing recovery. Gale said these are ambitious metrics, which many hatchery programs probably do not meet all the time. He said Wenatchee steelhead, for example, stray into the Entiat River at high rates, but how programs are managed can affect these stray rates.

Gale said coded wire tags (CWTs) are specific to Chinook salmon programs, and another paragraph should perhaps be added for steelhead. Hillman said in the annual M&E report he uses both CWT and passive integrated transponder (PIT)-tag information to assess straying. With PIT tags, the last detection point is assumed to represent spawning location, which may or may not be true. Gale said he is not certain these stray rate targets can be measured for steelhead. Willard said the objectives included in this appendix are directly from the M&E Plan. Hillman said a lot of steelhead are last detected at Wells Dam, which makes it difficult to analyze straying.

Murdoch suggested that because the information in this appendix is already included in the M&E Plan, which includes additional information and a preamble, perhaps Appendix 5 should focus on the definitions of straying and homing. Willard said Chelan PUD's concern is that they want their programs to be held to stray rates laid out in permits. She said the Wenatchee permit's definition of straying is consistent with the Monitoring and Evaluation Plan for PUD Hatchery Programs-2013 Update (a.k.a. M&E Plan), but the Monitoring and Evaluation of the Wells and Methow Hatchery Programs 2014 Annual Report defines stray rates differently than in the M&E Plan. Murdoch said genetic strays are important to consider for meeting permit conditions, but there are other management goals in the Methow basin that are distinct from genetics, which depend on spatial scales.

Hillman said the original targets in this appendix and plan are for genetic straying within and among populations, and the targets are from the TRT and Upper Columbia River spring Chinook salmon and steelhead Recovery Plan. He said the TRT includes straying as a component of the spatial structure and diversity matrix for assessing recovery. The Methow programs not only include these TRT criteria but discussions have occurred that contemplate extending the stray metrics to assess management objectives. Under this paradigm, the Methow programs would assess straying at a finer spatial scale than did the TRT.

Gale said Nason Creek and Chiwawa River strays have different targets, because the hatchery programs in the Wenatchee use a composited population. Murdoch said a composite is used for Nason Creek, but there is greater genetic risk for Nason fish straying into Chiwawa River than the opposite. Gale said there is higher risk because the composite is not released into Chiwawa River. Hillman said Murdoch's point is interesting, because Chiwawa River fish straying into Nason are considered a within-population stray from a genetic standpoint, but if it is a composite program, there may be less concern. Gale said there would be less concern if the same composite stock was released in both tributaries, but the composite stock is only released in Nason Creek. Hillman said, in the annual M&E report, he treats Nason Creek as an independent spawning aggregate. Straying and PNI are therefore estimated assuming that the Chiwawa River and Nason Creek spawning aggregates are independent genetically. The 3-population gene flow model is also used to estimate PNI.

Murdoch suggested adding a sub-category to the appendix for homing fidelity. She said, in the Chiwawa River, for example, there should be a management goal (not a permit requirement) that fish released return to the Chiwawa River, even though there is not a genetic component to that goal. Gale said he agrees, and out-of-basin straying may even be a greater concern than in-basin straying. He said out-of-basin straying to the Entiat River, and from the Okanogan River to the Methow River are both concerning. He said it is important that Chief Joseph hatchery programs meet their goals because it is a high risk program for genetic straying. Hillman said straying from the Okanogan River into other populations has the lowest acceptable percentile (5 percent) because the TRT recognizes that among-population straying is a greater risk than within-population straying. Gale said if a stray rate reaches a level of concern, the Hatchery Committees should discuss specific steps for a program to solve that concern, rather than just reporting it.

Hillman asked if Appendix 5 is necessary, and if the Hatchery Committees would prefer the HETT revise and discuss the appendix. Willard stated that the HC should revise and discuss the appendix versus the HETT. Murdoch recommended that definitions for straying and homing, also on the agenda for today's meeting, could go in Appendix 5 instead of straying goals, which are already included in the M&E Plan. Mackey said he has reviewed several papers and reports to survey what is used for stray rate terminology and found that many definitions for straying and homing are very wordy and depend on the surrounding text of a report.

Willard brought up Table 2.8 (Figure 1) from the Wells Hatchery and Methow Hatchery M&E 2014 Annual Report, which provides definitions for straying.

Table 2.8. Categories and definitions used to evaluate homing and straying of hatchery fish.

Category	Definition
Donor population	Hatchery population being evaluated; grouped by species, brood, and release location.
Recipient population	Spawning population of species being evaluated; may be at the tributary (e.g., Methow, Twisp, Chewuch), or basin scale (e.g., Entiat, Wenatchee).
In-basin homing	Fish homed to its release stream (population).
In-basin stray	Fish strayed to another population within its release basin.
Out-of-basin stray	Fish strayed to a population in a different release basin.

Figure 1. Table 2.8 of the Douglas PUD 2014 Annual M&E Report

Pearsons asked Mackey if Douglas PUD is comfortable with using the definitions in this table for all programs. Mackey replied yes. Murdoch suggested adding "non-genetic management stray" to the table for Appendix 5. Hillman suggested the Hatchery Committees use TRT definitions for genetic straying and the definitions in the table for management straying. Pearsons asked if this table is going to be the revised Appendix 5. Hillman said it could be, and that someone should provide definitions for genetic and management straying. Gale asked how these definitions apply to summer Chinook salmon, because within-population spawning aggregates are not defined. Hillman said in the annual M&E report, each subbasin is identified as an independent population. The report does not identify separate spawning aggregates within each population. Gale said he thought the subbasins in the Upper Columbia River were a single population. Hillman said in that case, the stray rate would be 10 percent, not 5 percent, which is currently used. Pearsons said the populations may have been grouped geographically, but there were not statistical differences in the population structure. Pearsons said if the summer Chinook salmon in the Upper Columbia River are not genetically distinct from each other, then there would be no genetic strays; however, there could still be management targets. Hillman said according to Utter's work[1], fall and summer Chinook salmon in the Upper Columbia River are not genetically distinct, so the Hanford Reach would be part of the Upper Columbia River summer Chinook salmon population. Hillman added that Appendix M of the annual M&E report also describes genetics of Upper Columbia River summer Chinook salmon. Gale said the proceedings of a workshop about summer Chinook salmon management, held approximately 5 years ago, contained useful information and suggested a management framework, which could be a good resource for future discussions. Gale said this would be a good topic for future discussion. Hillman agreed and suggested it be discussed in August 2016.

The Hatchery Committees will discuss the population structure of Upper Columbia River summer and fall Chinook salmon at the Hatchery Committees August 17, 2016, meeting.

Willard said she and Hillman will revise Draft Hatchery M&E Plan Appendix 5 and send it to Montgomery for distribution to the Hatchery Committees for review.

Appendix 6 – Rearing Targets

Willard displayed the document, "draft Hatchery M&E Appendix 6," which Montgomery most recently distributed to the Hatchery Committees on May 16, 2016 (Attachment F). Questions and comments were discussed, and edits were made to the document.

[1] Utter, F.M., D.W. Chapman, and A.R. Marshall. 1995. Genetic population structure and history of Chinook salmon of the Upper Columbia River. *American Fisheries Society Symposium* 17:149-165.

Willard said Appendix 6 includes rearing targets for Upper Columbia River hatchery programs, and some of the targets are presented as ranges. Hillman asked if the ranges will change in the future. Pearsons said the targets should be a single target eventually. Hillman said if targets vary among years, he can include those in the annual M&E report if Hatchery Committees members let him know during the review process.

Gale suggested that Winthrop NFH steelhead be called "2-years" instead of "yearlings" because they are part of a 2-year program. Willard made that change, and also changed Dryden summer Chinook salmon to 18 fish per pound.

The Hatchery Committees approved Draft Hatchery M&E Plan Appendix 6.

Willard said she would finalize Appendix 6 to include edits discussed today and send it to Montgomery for distribution to the Hatchery Committees.

D. Straying and Homing Fidelity Vernacular (Catherine Willard)

Catherine Willard shared a document titled, "Homing, Straying, and Colonization," (Attachment G) by Thomas Quinn (University of Washington), which is a chapter in a NOAA Technical Memorandum[2]. Sarah Montgomery distributed Quinn's chapter to the Hatchery Committees on June 17, 2016. Willard said the chapter stems from a 1995 workshop.

Willard said, on page 2 of the document, Quinn defines hatchery versus wild homing differently. She said spatial scale is also important to consider. She said for wild fish, "home" is essentially the redd (where they were "born") in the natal stream, but with fish used in homing studies, the definition of "home" is influenced by how and where juvenile fish are

[2] W. Stewart Grant (editor). 1997. Genetic effects of straying of non-native fish hatchery fish into natural populations: proceedings of the workshop. U.S. Dep. Commerce, NOAA Tech Memo. NMFS-NWFSC-30, 130p. Available at: https://www.nwfsc.noaa.gov/publications/scipubs/techmemos/tm30/tm30.html.

collected and marked, and how they are recaptured as adults. For hatchery fish, "home" could either be their ancestral stream, or the hatchery where they are reared, or where they were released.

Greg Mackey said Quinn has also made distinctions about the causes of straying in his book, *The Behavior and Ecology of Pacific Salmon and Trout*[3]. He said one cause of straying is the failure to home and the other is a sort of decision to purposefully return to somewhere other than a natal stream. Kirk Truscott said environmental conditions in natal streams can force or encourage straying. Mackey agreed and said some fish may physically or physiologically not be able to home, and some appear to choose not to home. Tracy Hillman said the TRT discusses homing and straying in many documents from a genetic standpoint, but the M&E Plan should perhaps include discussions about "management strays" that can be defined in Appendix 5. Management straying is defined at a spatial scale finer than genetic straying.

Mackey said, for the Wells and Methow program Annual M&E reports, he would like to present a matrix of recipient and donor populations, which is an easy and effective way to convey the stray data. He said a standard reporting style or summary table for the two to three different kinds of straying would be helpful. He said each report can then provide context about genetics and management for specific programs to help understand the tables.

In regards to the challenges of categorizing "straying" for the undifferentiated summer Chinook salmon aggregates, Mike Tonseth shared a document titled, "Genetic Structure of Upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs." Montgomery distributed it the Hatchery Committees following the meeting on June 15, 2016 (Attachment H). Tonseth said Figure 1 shows the relationship of natural- and hatchery-origin summer Chinook salmon collections from the Upper Columbia River basin. Tonseth said the "MEOK" program is the Methow-Okanogan program operated out of

[3] Quinn, Thomas P. *The Behavior and Ecology of Pacific Salmon and Trout*. American Fisheries Society, Bethesda (Maryland), in association with University of Washington Press, Seattle (Washington). 2005.

Eastbank FH. He said there is not a high degree of differentiation in the basin, but managers choose to manage summer Chinook salmon at a tributary or subbasin level. Hillman said this document will be useful when the Hatchery Committees discuss the population structure of Upper Columbia River summer and fall Chinook salmon at the Hatchery Committees August 17, 2016, meeting.

(Note: the genetic structure of a population can change due to multiple causes. One cause is genetic straying from outside populations. Another cause is a change in the equilibrium between hatchery- and natural-selective forces, determined by gene flow. That equilibrium is approximated by the proportionate natural influence ratio [PNI]. In addition to discussing definitions of straying and the population structure of Upper Columbia River Summer Chinook salmon, the Hatchery Committees discussed the 3-population model, which is used to determine PNI.) Bill Gale asked how the 3-population model fits with the current Wenatchee spring Chinook programs. Keely Murdoch said the permit references the HGMP. Gale said the language in the permit, in annual reports, and in the HGMP should be connected more clearly. Hillman said the PNI target is 0.67, and this is calculated using the 3-population model. Gale said the description of how PNI is calculated in the permit does not agree with the 3-population model, so the permit should clearly state what is being calculated and how. Murdoch agreed and said it would be helpful for Craig Busack to write clear language regarding the 3-population model and calculating PNI so it is clear for anyone else who might work with these permits and plans. Hillman said these are good comments for the draft annual Wenatchee M&E report, which he will incorporate. Tonseth said even though language for the 3-population model is not included in the Wenatchee permit, it can be put in the Broodstock Collection Protocols and monitoring plans, which NOAA approves. In addition, he said the Wenatchee basin spring Chinook salmon management plan is a living document, so that can also be updated.

E. Broodstock Collection for Methow Programs (Mike Tonseth)

Mike Tonseth said he has an update on spring Chinook salmon broodstock collection for the Methow programs, and a discussion topic regarding backfilling the Methow conservation program broodstock. He said, as of June 14, 2016, WDFW has collected 90 adults, which are presumed wild, at Wells Dam. He said 9 percent are unmarked hatchery fish, 22 percent are out-of-basin natural-origin recruits, and the remainder are Methow River-origin fish. He said they are 2 weeks behind on processing genetic data, and he expects some of the fish to assign to out-of-basin sources, leaving approximately 60 natural-origin recruits that can be used as broodstock for the Methow conservation program. He said the run is nearly finished at Wells Dam, and they have not collected enough natural-origin fish to meet this year's target of 122 natural-origin fish. He said most of the spring Chinook salmon passed Wells Dam in a 2-week period, and given trapping constraints, staff have not been able to collect the target number of broodstock. He asked the Hatchery Committees whether they would consider tangle-netting in the Chewuch River or Methow River to acquire natural-origin recruits for the Methow program. He said there would be a lot of coordination work needed with USFWS and NMFS, so he wants to get input from the Hatchery Committees before pursuing this action.

Keely Murdoch asked why they have not collected enough natural-origin broodstock. Tonseth said the run size was smaller, the run period was smaller, there are trapping constraints, and, despite retaining every fish staff thought were wild, there are still not enough. Bill Gale asked how effective tangle-netting in the Chewuch River has been in the past. Tonseth said it has been very effective. Catherine Willard said it has taken 7 to 8 days in the past, with zero bull trout encounters (one was observed but not encountered). She said they collected approximately 35 fish, and some were hatchery-origin.

Murdoch said the Yakama Nation (YN) position on tangle-netting depends on the factors (such as run size) involved in why enough fish were not collected. She said the safety-net program is designed to backfill the conservation program, and she generally does not support tangle-netting. Kirk Truscott said the estimated natural-origin run size over Wells Dam is approximately 580 to 590, which is close to the pre-season projection. Tonseth said collecting the full natural-origin recruit complement of 122 fish would not exceed the permit conditions of 33 percent of the run size. He said there are sufficient natural-origin fish in the population, but not enough have been collected at Wells Dam for the Methow program. Murdoch said tangle-netting could also raise issues with USFWS permitting, which is a process the Hatchery Committees do not want to delay or jeopardize. Tonseth said he hopes that this request would be considered independent of the overall consultation process because it is a special situation, and he will have to discuss this with Karl Halupka and Craig Busack. Tonseth said if this situation is going to be more common in the future, perhaps alternative types of broodstock collection should be built into the permit for flexibility before the permit is issued, but he thinks that is separate from a potential request to tangle-net in the Chewuch River this year.

Todd Pearsons asked if any natural-origin fish returned to Methow trap or Twisp Weir. Tonseth said not a significant number were sampled at Methow Hatchery, and they cannot rely on this trap to collect natural-origin broodstock (note: the Twisp trap is used to trap Twisp-origin natural brood for the Twisp Program). He said they need to request that Methow FH retain sufficient hatchery origin adult returns to satisfy production obligations in the event that no more natural-origin broodstock are collected. Gale asked how many adult returns have already been retained, noting not many have been transferred to Winthrop NFH. Greg Mackey said there are also some hatchery-origin fish at Wells Dam that are waiting genotype results, which could potentially be retained. Mackey said the Methow composite program can use hatchery-origin fish to backfill broodstock up to the full program production size, but the Twisp River program cannot (note: the Twisp would be limited to a minimum pNOB of 0.5 under the current HGMP and pending permit). Therefore, the MetComp program would be commensurately larger if the Twisp River program is brood limited in order to satisfy production obligations.

Gale said he has concerns that using a large proportion of hatchery-origin fish will have a large impact on meeting the 3-population PNI target in the first year the target is used. Murdoch said it would have a greater effect on years when the hatchery-origin fish are returning to the basin. Tonseth said draft permit language recently distributed by Charlene Hurst (NMFS) says that the Methow program will collect natural-origin fish at specific sites, and other Hatchery Committees-approved sites.

Gale said he recalls that Halupka performed a gap analysis for USFWS consultation in the Methow basin, and the only feature not covered under the 2012 Wells Dam Federal Energy Regulatory Commission relicensing Bull Trout BiOp that could have adverse effects would be tangle-netting in the Chewuch River. Tonseth agreed, and said he would discuss this with Halupka and Busack if the Hatchery Committees think it is a viable option for collecting natural-origin broodstock.

Murdoch said YN does not currently support tangle-netting in the Chewuch River despite the desire to use natural-origin fish for broodstock, because there is a back-up plan to use hatchery-origin fish. Murdoch asked what the targets are for proportion of natural-origin broodstock using the sliding scale. Tonseth said the target is 122 wild broodstock, which would be less than 33 percent of the run. Pearsons suggested using the existing natural-origin fish, and putting their descendants into acclimation outside of Methow FH (into the Chewuch River or Goat Wall acclimation sites); fish descended from hatchery-origin fish would be released from Methow FH, then subsequently targeted for removal (increasing the effective proportion of hatchery broodstock [pNOB]). Tonseth said another option would be to live-spawn all natural-origin males at Methow FH and transfer surplus gametes to WNFH, increasing the natural-origin component on spawning grounds, which can be plugged into the 3-population model. Gale said a pNOB of 0.5 is too low, and he wishes they could reach a higher value such as 0.7. Tonseth said the program will likely not achieve a pNOB of greater than 0.5 without tangle-netting.

Gale said he will defer to Halupka on whether the proposed action of tangle netting to ensure adequate collection of natural origin fish is consistent with current permitting considerations.

Tom Kahler asked if enough fish are being collected at the Twisp Weir to populate the Twisp River program. Tonseth said the trapping efficiency at the weir is good, and the problem at the moment is only with MetComp broodstock.

Murdoch said she will discuss internally the shortage of natural-origin recruits in the Methow Composite broodstock. She asked if there was a local response to tangle-netting, and suggested the Hatchery Committees also consider the social implications of collection actions. Tonseth said he is not aware of a local response to tangle-netting when it was performed previously; however, the Methow valley had a large fire that year and people may have been preoccupied.

Kahler asked if the fish trap at Foghorn Dam could be used for broodstock collection. Tonseth said that might be a possibility. Kahler said the trap does not collect Chinook salmon very effectively, and tends to attract bull trout.

Tonseth said a broader discussion can also be had about better flexibility in trapping operations at Wells Dam. He said WDFW is limited to three, 16-hour days per week for a total of 48 hours, and Douglas PUD have been adamant that trapping not exceed 3 days per week. Murdoch asked if it would be beneficial to instead target key times for fish collection on more days, and still not exceed 48 hours per week. Tonseth said there is a narrow period during which fish move through the trap that could be natural or dam-related. He said assurances in the future that annual broodstock collection goals can be met is a necessary discussion.

Pearsons asked how many fish will be released from Goat Wall acclimation site. Murdoch said 25,000 fish will be released.

Truscott said the Colville Confederated Tribes support tangle-netting for the full complement of natural-origin broodstock this year. He said water conditions this year might be more similar to 2015, low and warm, than when tangle-netting last occurred in 2014. He said it would be important to make sure water temperatures are not so high that they expect to see unacceptable mortality.

Tonseth said WDFW supports tangle-netting for the full complement of natural-origin broodstock this year, with conditions. Justin Yeager said NMFS abstains from providing support for tangle-netting until he can discuss this with Busack. Willard said Chelan PUD supports the action with conditions. Mackey said Douglas PUD supports the action with conditions.

Pearsons said he will discuss this internally before providing support or not. He said he might prefer using hatchery-origin fish for a population of on-station releases at Methow FH, and descendants of natural-origin fish could be distributed in release locations away from Methow FH. He said he would want to calculate PNI for that situation. He said he does not have concerns with the effects of tangle-netting on natural resources, because the effects can be managed by snorkeling the system beforehand and by taking precautions. He said he has more concern for the potential effects on consultations and permitting, and for social issues. Gale said Pearsons' idea to remove returning adults would essentially expand the size of the Winthrop NFH program by making a bigger safety-net program. He said that would confuse the relationship between the Winthrop NFH and Methow FH programs. He said he is not opposed to this option if absolutely necessary, but acquiring more natural-origin fish so that the Methow program has a broodstock composition more in line with what is described in the HGMP should be a higher priority. Murdoch said she appreciates Pearsons' input on social and permitting constraints, and said the Hatchery Committees do not want to delay permitting for the Methow programs.

Tonseth said if the Hatchery Committees want to pursue tangle-netting as an option for broodstock collection this year, it will take time to coordinate with USFWS and NMFS and prepare staff for the effort. He said a target start date would be in approximately 30 days.

Truscott said the Hatchery Committees should also consider that with ocean conditions changing, it is possible that in the future they may not want to remove any of the returning hatchery-origin fish, which would result in a high pHOS. Tonseth said to offset some of those genetic concerns, another option would be to live-spawn natural origin males (with natural origin females) and retain them to cross with hatchery females. He said the hatchery-by-wild fish would be released from Methow FH. He said he thinks Methow FH would be able to keep these family groups separate through the rearing stages. Truscott said there are currently about 30 natural-origin males, and using them twice would result in a low effective population size and a pNOB of about 0.8 for the conservation program.

Hillman summarized that some groups need to discuss this matter internally, and Tonseth said he will not pursue tangle-netting without Hatchery Committees support. Mackey said there is a back-up plan to use hatchery-origin fish as broodstock if an agreement is not reached. Truscott said ideally hatchery fish would only be incorporated into broodstock if there are not enough natural fish, which is not the case. He said the run size is large enough, but the trapping period is not sufficient to collect enough of them. Tonseth suggested, in the future, adding a fourth day of trapping to collect more fish at Wells Dam. Kahler said it is important to trap during the crepuscular period, so 16-hour days would still apply. He said he thinks the Coordinating Committees should discuss the trapping schedule. Gale said he agrees with Truscott, and that the program is set up to meet a pNOB of 0.8 at a run size of 500. He said if other tools are available for collecting broodstock to meet these targets, they should be pursued.

III. USFWS

A. Presentation: History of Entiat River Chinook Salmon (Greg Fraser)

Greg Fraser said he is a fisheries biologist with the USFWS, and has been working there for approximately 1 year. Fraser shared a presentation titled, "The unnatural history of the Entiat River and its impact on population trends of Chinook salmon," which Sarah Montgomery distributed to the Hatchery Committees on June 17, 2016 (Attachment I). A summary of the presentation and questions and comments are included in the following sections.

Background (Slides 1 through 12)

In the 1800s and early 1900s, there were many dams and mills blocking anadromous fish access to the Entiat River, extirpating any endemic fish runs. A flood in 1948 destroyed the remaining dams and opened up the river to anadromous fish. A natural barrier to some anadromous fish from 1948 to 1961 was located in the lower Entiat River. Spring Chinook salmon could ascend the natural falls during high-flow conditions, but the falls were likely impassable to summer and fall Chinook salmon due to low flows. Rocky Reach Dam inundated the natural barrier in 1961, and it is now passable to fall and summer Chinook salmon in addition to spring Chinook salmon.

Entiat NFH (Slides 13 through 20)

Entiat NFH was constructed in 1941, initially used for research, and later converted to a production facility in 1961. It was reconstructed in 1979. Entiat NFH has produced Summer Chinook salmon, spring Chinook salmon, sockeye salmon, coho salmon, and rainbow trout sourced from many different populations and hatcheries throughout its period of use. From 1974 to 2007, the hatchery produced spring Chinook salmon (last return in 2010), and from 2009 to present, the hatchery produces summer Chinook salmon (first release in 2011).

Surveys in the Entiat River (Slides 21 through 41)

Historically, WDFW surveyed for spring Chinook salmon redds in middle reaches of the Entiat River, and Chelan PUD surveyed for summer Chinook salmon redds in lower reaches of the river. Most recently, USFWS has conducted weekly redd surveys from late July to late November for spring and summer Chinook salmon throughout areas of the Entiat River with suitable spawning habitat, as well as in the Mad River.

Survey Results (Slides 42 through 47)

The number of spring Chinook salmon redds peaked in mid-August in 2015, and redds were mostly in upstream reaches of the river. Though the distributions overlapped some, summer Chinook salmon redds were concentrated more in downstream reaches. Where the distributions overlap in middle reaches of the Entiat River, superimposition of summer Chinook salmon redds on spring Chinook salmon redds can occur. In areas around river kilometer 30, the area with the most overlap, approximately 60 percent of spring Chinook salmon redds were imposed on by summer Chinook salmon.

Genetics (Slides 48 through 56)

USFWS is also studying the genetic distribution of spring and summer Chinook salmon in the Entiat River, and their hybrids, as well as the proportions of hatchery versus wild carcasses recovered in the river. The proportion of hatchery-origin fish is greater in the lower reaches of the river, and natural-origin fish are in greater abundance in the upper reaches of the river. Overall, natural-origin fish make up a greater proportion of total carcass recoveries for spring and summer Chinook salmon than hatchery-origin fish.

Spring Chinook salmon were last released from Entiat NFH in 2007, and age-5 fish were the last from that release to return to the hatchery in 2010. Unexpectedly, there was an increase in the proportion of hatchery-origin fish compared to wild fish in 2011 and 2012. The proportion of hatchery-origin spring Chinook salmon was relatively lower in 2013, 2014, and 2015. Hatchery-origin spring Chinook salmon in the Entiat River come from many different hatcheries. Most notably, from 2011 to 2013, many hatchery-origin fish released in the Chiwawa River showed up in the Entiat River. Tracy Hillman asked if the number of fish was expanded based on sampling rate. Fraser said yes. Matt Cooper said, in 2014, USFWS had an approximately 10 percent carcass recovery rate.

Summer Chinook salmon were first released from Entiat NFH in 2011. Hatchery-origin summer Chinook salmon returning to the Entiat River come from many different hatchery programs in addition to the Entiat NFH, including mid-Columbia programs, Dryden Ponds, Snake River programs, and Methow-Okanogan programs. After the first release in 2011, there was a large reduction in the number of out-of-basin hatchery fish returning to the Entiat River. Todd Pearsons asked how many summer Chinook salmon are released from Entiat NFH. Fraser said approximately 400,000 fish are released. Overall, there is a much greater proportion of natural-origin summer Chinook salmon upstream of Entiat NFH than downstream.

<u>Ongoing Work and Conclusions (Slides 57 through 58)</u>

Fraser said the USFWS will monitor the spatial distribution of both runs in order to evaluate the impact (superimposition and composition) of Entiat NFH summer Chinook salmon releases on spring Chinook salmon. In addition, this work could help target areas for habitat restoration that would best benefit spring Chinook salmon, which are an ESA-listed species. It will also be important to continue relating the studies to genetic work and consider the impacts of climate change.

Dams extirpated all endemic runs in the Entiat River, and summer Chinook salmon may not be endemic. Hatchery and stray fish colonized the river. Spring and summer Chinook salmon have spatial and temporal differences in spawning, and the composition of both runs differs annually and with production.

Questions and Comments

Hillman asked why there is no surveying in the middle reach of the river—between river kilometers 15 and 25. Fraser said that area is the end of the terminal moraine, and is surveyed periodically. He said the river is faster, steeper, does not have good spawning habitat, and has larger substrate in that area.

Justin Yeager asked what the impetus is for releasing summer Chinook salmon from the Entiat NFH. Bill Gale said it is a hatchery reform measure, used to meet a mitigation goal for Grand Coulee Dam. Under previous conditions, USFWS released Carson Hatchery spring Chinook salmon, but concerns for impacts to wild spring Chinook salmon, and because of ESA concerns in the Upper Columbia River the fish released were not available for local harvest, so the program was converted to summer Chinook. He said shifting to summer Chinook salmon allowed for a program that now contributes to a local fishery. Cooper commented the effects of the program on the number of strays in the Entiat River are interesting. Catherine Willard asked if the genetic stock of the natural-origin fish is from Carson Hatchery. Cooper said genetically identifying the fish to stock was difficult because there are many stocks and low certainty for juveniles. Gale added that the Entiat River does not have a unique stock because salmon in it were extirpated like many others in the region.

Pearsons asked about the numbers (as compared to the percentage) of natural-origin spring Chinook salmon in the Entiat River. Fraser said he did not include the numbers in this presentation. Cooper said USFWS calculates escapement based on the number of redds. Pearsons asked which years would have non-Entiat NFH origin returns of spring Chinook salmon. Fraser said 2010 included a few age-5 Entiat NFH origin fish, but after that, there are no spring Chinook salmon returns from Entiat NFH hatchery releases. Cooper said he expected the proportion of hatchery-origin spring Chinook salmon to decrease after 2010, but it did not, especially due to the strays from the Chiwawa River. Pearsons said there does not seem to be a decrease in natural-origin returning fish after the end of spring Chinook salmon production releases from Entiat NFH. Hillman commented that the NOAA Salmon Population Summary database shows the number of natural-origin recruits returning to the Entiat River. He said there were 254 in 2011, 246 in 2012, and 130 in 2013. Yeager added that the number of recruits per spawner was below 1.0 for those years. Hillman said recruits per spawner was above 1.0 for brood years 2005 and 2006.

IV. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on July 20, 2016 (Douglas PUD), August 17, 2016 (Chelan PUD), and September 21, 2016 (Douglas PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft Hatchery M&E Appendix 2
Attachment C	Draft Hatchery M&E Appendix 3
Attachment D	Draft Hatchery M&E Appendix 4
Attachment E	Draft Hatchery M&E Appendix 5
Attachment F	Draft Hatchery M&E Appendix 6
Attachment G	Homing, Straying, and Colonization
Attachment H	Genetic Structure of Upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs
Attachment I	The unnatural history of the Entiat River and its impact on population trends of Chinook salmon

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*†	Douglas PUD
Todd Pearsons	Grant PUD
Peter Graf ‡	Grant PUD
Deanne Pavlik-Kunkel ‡	Grant PUD
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Greg Fraser	U.S. Fish and Wildlife Service
Justin Yeager*	National Marine Fisheries Service
Mike Tonseth*‡	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
† Joined at 12:00 pm
‡ Joined by phone

Appendix 2. In February of 2016, the HC/HSC agreed to HRR Targets from ideas developed by HETT:

1. Use the estimated 40% HRR Target during 5-year evaluation periods.
2. Use varying degrees of action depending on the numbers of years that annual HRR deviates from Target.
   2a. Green Light (below Target for ≤ 2 years)
   2a. Red Light (below Target for > 2 years)
3. Each program will have its own HRR target (with the following exceptions).
   3a. Nason Creek spring Chinook will use Chiwawa Target (there is no data to calculate its Target)
   3b. Methow and Chewuch spring Chinook will use the greater of their two Targets (they are MetComp stock and evaluated similarly)

Species	**Owner**	**Program (Hatchery)**	**Basin (Purpose)**	**Smolt Release[1]**	**5 YR HRR[2]**	Year 1 HRR	Year 2 HRR	Year 3 HRR	Year 4 HRR	Year 5 HRR	Status	Status
Steelhead	CCPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	123,650	6.9							
Steelhead	CCPUD	Eastbank (Chiwawa)	Wenatchee (Safety Net)	123,650	6.9							
Steelhead	DCPUD	Wells (Wells)	Columbia (Safety Net)	160,000	26.5							
Steelhead	DCPUD	Wells (Wells)	Methow (Safety Net)	100,000	26.5							
Steelhead	DCPUD	Wells (Wells)	Twisp (Conservation)	48,000	26.5							
Steelhead	GCPUD	Wells (Omak)	Okanogan (Conservation)	100,000	21.0 [3]							
SUM Chinook	CCPUD	Eastbank (Chelan Falls)	Chelan (Conservation)	176,000	5.7							
SUM Chinook	CCPUD	Eastbank (Chelan Falls)	Chelan (Harvest)	400,000	5.7							
SUM Chinook	CCPUD, GCPUD	Eastbank (Dryden)	Wenatchee (Conservation)	500,000	5.7							
SUM Chinook	DCPUD	Wells (Wells)	Columbia (Harvest)	320,000	3.0							
SUM Chinook	GCPUD	Eastbank (Carlton)	Methow (Conservation)	200,000	3.0							
SPR Chinook	CCPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	144,026	6.7							
SPR Chinook	CCPUD, DCPUD, GCPUD	Eastbank (Methow)	Methow (Conservation)	193,765	3.8							
SPR Chinook	DCPUD, GCPUD	Eastbank (Twisp)	Methow (Conservation)	30,000	3.8							
SPR Chinook	GCPUD	Eastbank (Nason)	Wenatchee (Conservation)	149,114	6.7							

1 Release goal established by HCP's and adjusted by HC

2 Derived from Annual Reports (McLain Johnson got raw data from Tracy Hillman)

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	None Currently	Details can be found in Section 12.0
Fall Chinook	Hanford Reach	0.67	Details can be found in Section 13.0
Sockeye	Lake Wenatchee	N/A	
	Lake Osoyoos	N/A	

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 prespawn 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 and2008.

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. Two-Population sliding scale of PNI for Methow spring Chinook.

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-introduced 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.

CHJ 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.

	Run Escapement Goal	PNOB Conservation Program	PNOB Safety Net Program	PHOS	PNI
Above TWD	1094	1.0	0.0	Varies	Varies
Below TWD	406	n/a	n/a	< 0.10	< 0.67
Basin Total	1500	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) Summer Chinook

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 Priest Rapids fall Chinook program will be managed to maximize the PNI over time, which may include maximizing pNOB as well as minimizing pHOS. Because efficacy in managing pHOS is unknown, maximizing pNOB may be necessary to achieve appropriate PNI levels (≥0.67) for a primary population. To achieve this goal it is estimated that 10-30% of natural origin fish will be used in the broodstock.

Appendix 4: Management Targets for the 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 A4.1, 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 A4.1. 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

Commented [SM1]: Casey Baldwin via email:
There should be clarification on the implication of positive or negative change. For example, if hatchery fish distribution changes and more hatchery fish are observed in the upper Wenatchee or upper Methow then is that considered a negative change that would require a management action?

Andrew- did we agree that Dryden should be different?
Todd- the SOA was approved in the Methow, and one was drafted for the Wenatchee, but it was never finalized.

Commented [SM2]: Todd Pearsons via email:
Should any other populations be added?
Are there others which should be segregated or different than the natural population? Charlie – Methow safety net steelhead? Is that the intent of a safety net program, zero spawning in case of high abundance?
Greg- that's more related to adult management.
Andrew- steelhead are different.

Peter- instead of listing all, I only included ones where different.

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Commented [CB3]: Seems like it might be worth mentioning why. Biological, financial, feasibility??

In this case it is not clear if the deviation from the normal objective H=W is for biological reasons or feasibility reasons.

Casey- in this case, if hatchery fish expand their distribution, is that a bad thing? Do we want them to stay below a certain area? Expansion beyond a certain point might be considered failure to meet the target.

Matt- perhaps add a column for "rationale".
Todd- in the Wenatchee mngmt plan, you would sometimes use your hatchery in some cases to spawn in those areas (reintroduction).

... [1]

Commented [CB4]: This doesn't tell us if deviation from the baseline is good or bad. Is this deviation about reducing risk to the wild fish or is it about feasibility and cost? If Hatchery fish expand their distribution is that failure to meet the target that would require action?

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Deleted: Peter– based upon language from SOA above.

Page 1: [1] Commented [CB3]	Casey Baldwin	11/2/2015 3:08:00 PM

Seems like it might be worth mentioning why. Biological, financial, feasibility??

In this case it is not clear if the deviation from the normal objective H=W is for biological reasons or feasibility reasons.

Casey- in this case, if hatchery fish expand their distribution, is that a bad thing? Do we want them to stay below a certain area? Expansion beyond a certain point might be considered failure to meet the target.

Matt- perhaps add a column for “rationale”.
Todd- in the Wenatchee mngmt plan, you would sometimes use your hatchery in some cases to spawn in those areas (reintroduction).

Keely- hatchery fish (if conservation and one-gen removed) could be used to expand distribution in cases of new passage.

Appendix 5: **Stray rate objectives for UCR summer steelhead and spring Chinook.**

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., rearing and acclimation water source, release methodology, and location) are the main variables thought to affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater than 10% of the spawning population. The conceptual process for this objective is illustrated in Figure 9. Specific hypothesis for this objective is:

Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return

Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations

Ho: Stray hatchery fish < 10% of spawning escapement of non-target streams within independent populations

Stray rates would be calculated using the estimated number of hatchery fish that spawned in a stream and CWTs were recovered. Recovery of CWT from hatchery traps or broodstock may include "wandering fish" and may not include actual fish the spawned. Special consideration should be given to fish recovered from non-target streams in which the sample rate was very low (i.e., sample rate < 10%). Expansion of strays from spawning ground surveys with low sample rates may overestimate the number of strays (i.e., random encounter). Concurrently, the proportion of strays within target streams (i.e., from other hatchery programs) will also be calculated. Stray hatchery fish from other programs (non-local broodstock) could have a greater influence on the fitness of the target stock and should be monitored.

The rate and trend in strays from hatchery programs will be used to provide recommendations that would lead to a reduction in strays. Depending on the severity, hatchery programs with fish straying out of basin will be given high priority, followed by strays among independent populations, and finally strays within an independent population.

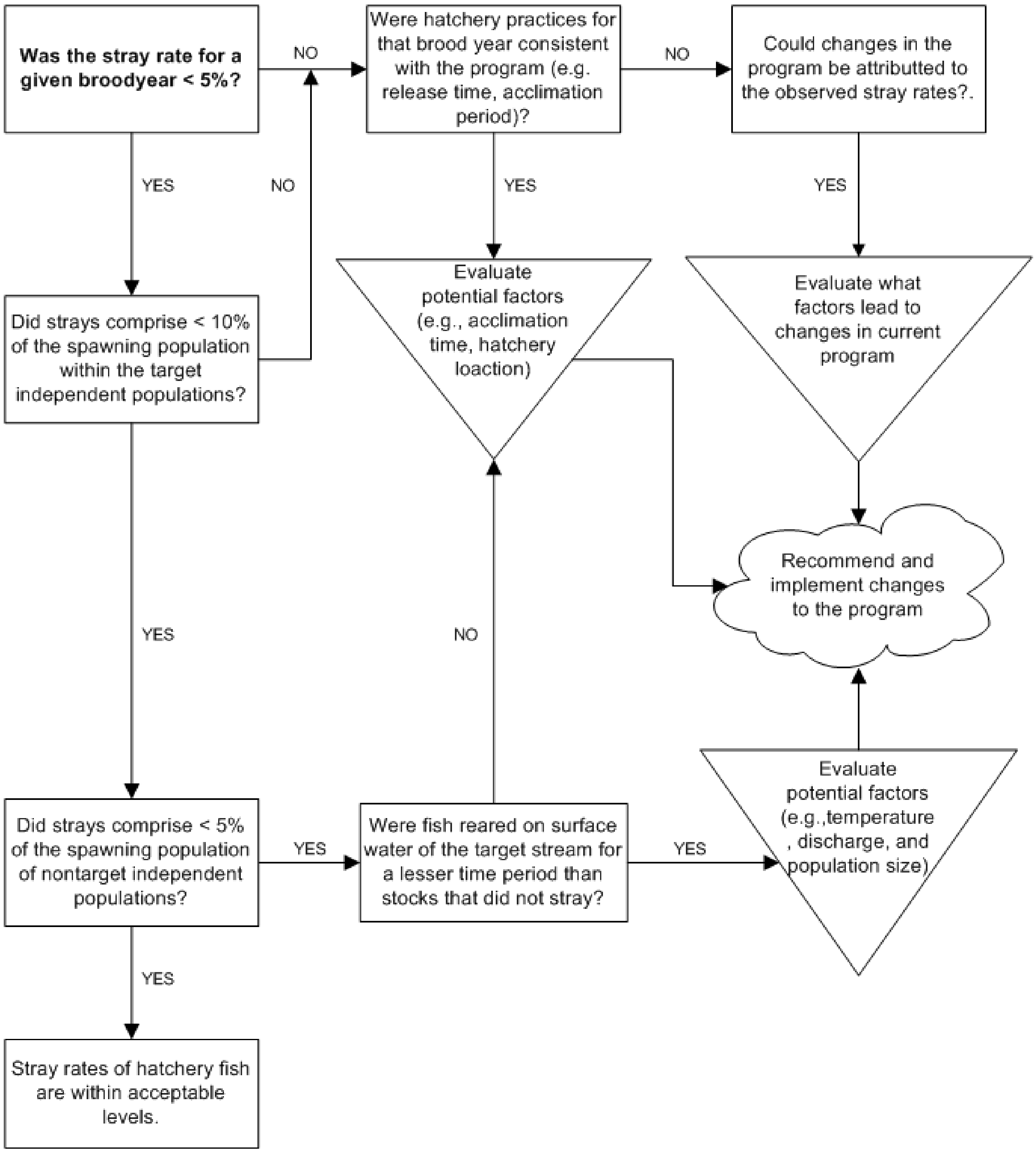

Figure 1. Process for determining if returning hatchery fish have acceptable levels of straying.

Monitoring and Evaluation Plan 5-Year Update – Continuation of developing the appendices that house program targets and reference information

Appendix 6: **Rearing Targets for UCR Hatchery Programs.**

Table A6.1. Size, Coefficient of Variation (CV), and Condition Factor (K) Targets at Release of Hatchery Programs

Hatchery	Species	Life Stage	Basin	FPP	CV	K-factor
Methow	Spring Chinook	Yearling	Methow	15	<10	<1.0
Methow	Spring Chinook	Yearling	Twisp	15	<10	<1.0
Chief Joseph	Spring Chinook	Yearling	Columbia	15	<10	<1.0
Chief Joseph	Spring Chinook	Yearling	Okanogan	15	<10	<1.0
Chiwawa	Spring Chinook	Yearling	Wenatchee	18		1.17
White	Spring Chinook	Yearling	Wenatchee	10-15,18-24		
Nason	Spring Chinook	Yearling	Wenatchee	10-15,18-24		
Winthrop	Spring Chinook	Yearling	Methow	17	<10	<1.0
Leavenworth	Spring Chinook	Yearling	Wenatchee	17	<10	<1.0
Wells	Steelhead	Yearling	Columbia	6	<10	<1.0
Wells	Steelhead	Yearling	Methow	6	<10	<1.0
Wells	Steelhead	Yearling	Twisp	6	<10	<1.0
Wells	Steelhead	Yearling	Omak	5-8	<10	<1.0
Wells	Steelhead	Yearling	Okanogan	5-8	<10	<1.0
Winthrop	Steelhead	Yearling	Methow	4-6	<10	<1.0
Chiwawa	Steelhead	Yearling	Wenatchee	6	9.0	1.25
Wells	Summer Chinook	Subyearling	Columbia	50	<7	1.1
Wells	Summer Chinook	Yearling	Columbia	10	<7	1.1
Chief Joseph	Summer Chinook	Subyearling	Columbia	50	<7	1.1
Chief Joseph	Summer Chinook	Subyearling	Okanogan	50	<7	1.1
Chelan Falls	Summer Chinook	Yearling	Chelan	10-22[a]	9.0	1.25
Entiat	Summer Chinook	Yearling	Entiat	17	<10	<1.1
Carlton	Summer Chinook	Yearling	Methow	13-17	<12	<1.0
Chief Joseph	Summer Chinook	Yearling	Columbia	10	<7	1.1
Chief Joseph	Summer Chinook	Yearling	Okanogan	10	<7	1.1
Dryden	Summer Chinook	Yearling	Wenatchee	10, 15[b]	9.0	1.28
Priest	Fall Chinook	Subyearling	Columbia	50	<10	<1.0
Ringold	Fall Chinook	Subyearling	Columbia	50	<10	<1.0

[a]An experimental release size of 20-45 grams (10-22 FPP) is in place for brood years 2012-2014.
[b]An experimental release size of 30, 45 grams (10, 15 FPP) is in place for brood years 2012-2014.

**NOAA Tech Memo NMFS NWFSC-30:
Genetic Effects of Straying of Non-Native Hatchery Fish into Natural Populations**

HOMING, STRAYING, AND COLONIZATION

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Introduction

The intent of this contribution is to define what is meant by homing and straying, and to describe patterns of homing and straying in salmon populations. I will explore what practices or other factors in hatcheries might encourage straying, and then outline the consequences of straying. By way of historical perspective, it was accepted by about the 1870s that most salmon homed back to their natal streams and rivers to spawn, although some biologists remained unconvinced until the 1930s. A report for the U.S. Commission of Fish and Fisheries stated that ". . . it is an established fact that adult [salmon] will always return to the place where they first made acquaintance with the water, passing directly by the mouths of streams or tributaries better adapted to their purpose, to gain their original home" (U.S. Commission of Fish and Fisheries 1874, p. lxxxii). Biologists also recognized that salmon could swim several hundreds of miles up a river to their natal areas. A later report to the Commission pointed out that a stream near Elko, Nevada "is one of the many that form the headwaters of the Columbia River, and to this point, eighteen hundred miles from its mouth, the salt-water salmon come in myriads to spawn . . ." (U.S. Commission of Fish and Fisheries 1876, p. xxviii-xxix). Milner noted "[t]he generally accepted fact in the habits of anadromous fishes that they are disposed to return to almost the exact locality where they passed their embryonic and earlier stages of growth . . . . Observations of the shad brought to the large markets shows considerable difference in the physiognomy and general contour of those from different rivers. The suggestion is natural that they are distinct and separate colonies of the same species, and thus slight characteristics are perpetuated because they breed in-and-in and do not mix with those of other rivers" (Milner 1876, p. 323).

By the 1930s, a number of biologists were aware of life-history differences among salmon populations (Moulton 1939; e.g., Clemens et al. 1939). In fact, this realization gave the first indication, before tagging studies, that salmon homed to particular localities. Salmon from various populations showed differences in morphology, body size, egg size, fin ray counts, oil content, and so on. In the 1950s to 1970s, knowledge of homing by Pacific salmon was greatly enhanced by the work of Arthur Hasler and his students (reviewed in Hasler and Scholz 1983). Their studies formed the basis for much of what we know about salmon homing. However, straying was not investigated as a behavior pattern in its own right because most salmon homed, and the focus of the research was on the sensory mechanisms of homing. Consequently, the ecological and evolutionary importance of straying from one population to another has received comparatively little attention until recently.

Today, we know that there is extensive variation among populations in many traits and that this variation often has clear adaptive value. Such local adaptations have presumably evolved because homing leads to reduced levels of gene flow between habitats, and because there is genetic control of the traits that adapt the salmon for those habitats. It has been hypothesized (Quinn 1984) that adaptations evolve most rapidly in stable habitats and that homing is likely to be positively associated with the intricacy of adaptations for freshwater habitat, and with variation in age at return. Homing and straying have adaptive value for individuals; the relative advantages may depend on environmental conditions, other life-history traits, and perhaps the relative frequencies of homing/straying (Quinn 1984, Kaitala 1990).

Homing and Straying: Definitions and Qualifications

Just what is meant by homing and straying? For a wild fish, home is the natal stream where it incubated, hatched, and emerged. Home is thus, essentially, the redd. However, when humans study salmon homing, the definition of home is influenced by how and where juvenile fish are collected and marked, and how they are recaptured as adults. These factors also influence the perception of how accurately salmon home. One might think of salmon homing through a hierarchy of spatial scales, including first a river basin, then a major tributary, a stream, and a particular point in the stream. Homing will necessarily be more accurate when measured at broader spatial scales. At the final level, the interaction between homing and spawning site selection (Blair and Quinn 1991, Hendry et al. 1995) or mate choice determines the final destination of the fish. The definitions of straying or homing, therefore, depend on the spatial scale of interest. Most research has not been sufficiently explicit in considering the spatial definition of home, and the transition between homing and spawning site selection.

For transplanted fish, the ancestral locality or the hatchery where they are reared and the locality where they were released could both be considered homes. While there is some tendency to return to the ancestral area (McIsaac and Quinn 1988, Pascual and Quinn 1994), salmon generally return to the site where they were released (Ricker 1972). For salmon released from a hatchery, the incubation, rearing, and release sites may be the same; in this case, home is the hatchery. When planted from the hatchery to a river, salmon tend to return to the point of release (e.g., Donaldson and Allen 1958, reviewed in Quinn 1993). Fish released in the lower portion of a river tend to be caught only in the lower portion of that river, and fish released in the middle or upper portion of a river tend to be caught in all parts of the river downstream from the release site (steelhead trout (*Oncorhynchus mykiss*): Wagner 1969, Cramer 1981, Slaney et al. 1993; Atlantic salmon (*Salmo salar*): Hvidsen et al. 1994, Potter and Russell 1994).

The other side of the homing "coin" is straying. Adult salmon move into non-natal streams for a variety of reasons. We know from radio-tracking data that some fish do not home directly to their natal streams, although these streams may be their final destination (e.g., Berman and Quinn 1991). Upriver migration is characterized by a certain amount of exploratory movement into non-natal streams. If a fish makes an exploratory run up a stream, is caught in a hatchery weir, and is spawned in the hatchery, this constitutes straying from a functional point of view. The fish's genes are incorporated into the hatchery gene pool regardless of whether the fish would have left the hatchery had it been allowed to do so. Consequently, it may be difficult to accurately estimate straying frequencies using data from hatcheries. However, it is clear that some salmon spawn in rivers other than their own and so stray in the truest sense (Quinn et al. 1991).

Estimates of Straying

While many studies have provided data on the proportion of salmon that stray, almost all of these studies have been on single species, and little information exists on comparative straying rates among species. In one of the few such studies, Shapovalov and Taft (1954) reported higher levels of straying by coho salmon (*O. kisutsch*) than by steelhead into two small creeks in California. It has been speculated that pink salmon (*O. gorbuscha*) stray more than other species, but hard evidence is lacking. High levels of intraspecific variability may mask interspecific differences. The available information for coho and chinook salmon (*O. tshawytscha*), for which we have the most data, indicates large amounts of homing variability among populations, even within a small geographical area.

Another problem with the literature on homing is that wild salmon are tagged less frequently than hatchery-produced fish, and when wild salmon are tagged the data are seldom analyzed to produce estimates of straying. Consequently, little is known about straying in wild salmon populations, and most estimates of straying come from hatcheries. Hatchery-produced salmon may not stray with the same frequency as wild salmon, but so few studies have been conducted on hatchery and wild fish in the same areas that we cannot be certain (see below). Many experiments designed to estimate straying are also poorly controlled or are not replicated. In many studies, measuring variability in homing was incidental to other goals, so the data are often confounded with factors besides straying. Most studies also fail to account for straying in and out of a population; in many cases, only the dispersal of strays from the marking site is documented.

As a rough estimate, 90% +/- 10% of salmon home, and this does not include the "pathological" levels of straying that were shown earlier in the workshop for some Snake River hatcheries (Crateau, this volume) and have been documented for some hatcheries on the lower Columbia River (e.g., Grays River chinook salmon: Pascual et al. 1995). However, the overall estimate of 80-100% homing is based largely on data from hatcheries.

Straying in hatchery vs. wild populations

It is difficult to determine from the data at hand whether straying differs between hatchery and wild populations, because studies of hatchery populations greatly outnumber studies of wild populations. Comparisons between wild and hatchery-produced Pacific salmon were conducted by McIsaac (1990) and Labelle (1992). McIsaac (1990) studied fall-run chinook salmon in the Lewis River and found that wild-caught juveniles homed at a higher rate than members of the population that had been incubated and reared in the hatchery. Moreover, short-term rearing of wild fish in a hatchery increased their rate of straying, relative to wild fish not held in the hatchery. On the other hand, Labelle's (1992) study of coho salmon on the east coast of Vancouver Island did not find a significant difference in straying rates between hatchery-produced and wild fish. Studies of Atlantic salmon also did not find differences between the straying rates of hatchery and wild fish (Jonsson et al. 1991, Potter and Russell 1994).

Regional and temporal patterns of straying

Coded wire tagging has provided a large database which can be used for homing studies (van der Haegen and Doty 1995). These data show that spatial patterns of straying vary from one river to another. The proportion of salmon that stray is not the same in all hatcheries in a region such as the lower Columbia River. In addition, the proportion of the total number of straying salmon entering a given river is not simply explained by its distance from the hatchery of origin. For example, Cowlitz River spring-run chinook salmon strayed more often to the Lewis River than to the Kalama River, even though the Kalama River is closer to the Cowlitz River than is the Lewis River (Quinn and Fresh 1984).

It appears that salmon do not stray merely because they are fatigued and cannot reach their natal spawning areas. In many cases, they stray to localities above their river of origin. The proportions of salmon straying into and out of a hatchery can vary considerably. Quinn et al. (1991) found variation from 9.9-27.5% in the proportions of fall-run chinook salmon straying from five lower Columbia River hatcheries. More dramatic, however, was the variation in attractiveness of rivers to strays. Virtually no salmon strayed into the Washougal and Abernathy Hatcheries, but about 30% of the marked salmon entering the Kalama and Lewis Rivers were strays (Quinn et al. 1991). Expanded examination by Pascual and Quinn (1994) confirmed these patterns of variation in straying and found that fish seemed more likely to enter rivers or hatcheries similar to their home than to less similar sites. For example, salmon produced in tributaries of the Columbia River seemed to stray into other tributaries rather than to hatcheries along the mainstream of the river.

In addition to differences in straying among rivers, straying can also differ from year to year. Interannual variability may be associated with catastrophic events such as the eruption of Mount St. Helens (Leider 1989). Less dramatic environmental changes such as variation in flow and temperature may also contribute to temporal variability in straying, but definitive studies do not seem to have been conducted on these subjects. There is some evidence that temporal variation in straying is associated with population size (Quinn and Fresh 1984). In years when many fish returned to the Cowlitz River hatchery, homing was better than in years when fewer fish returned. This suggests that the dynamics of small populations may be different from those of larger populations. This is an important issue and it needs to be evaluated with other data sets. There is also interannual variation in straying from a site, perhaps related to water quality, rearing conditions, or the number of returning salmon. The tendency of hatchery-produced salmon to enter their hatchery, as opposed to spawning in the river, can also vary greatly from year to year (Nicholas and Downey 1983).

Age at return also contributes to variability in straying. Older chinook salmon tend to stray more than younger fish (Quinn and Fresh 1984, Quinn et al. 1991, Unwin and Quinn 1993, Pascual et al. 1995). The difference in the rate of straying by chinook jacks and by 4- or 5-year-old fish may be an order of magnitude (Quinn and Fresh 1984). Age-specific straying rates have also been observed for coho salmon (Labelle 1992), but not for Atlantic salmon (Potter and Russell 1994). Perhaps, the longer a fish is out to sea, the more it forgets the olfactory cues it needs to return to its natal locality. The turnover of sensory epithelial cells associated with odor recognition (Nevitt et al. 1994), changes in the odors of river water, or some unknown evolutionary mechanism may be responsible for this age effect. Hatchery practices can also influence the age structure of the spawning population, which may in turn influence straying.

Straying and colonizing new areas

Little is known about the relationship between straying and the colonizing of unoccupied areas. Although most translocations of salmon have been notoriously unsuccessful, some have succeeded. For example, the inadvertent translocation of pink salmon into the Great Lakes resulted in a rapid colonization of Lake Superior and other Great Lakes (Kwain 1987). The translocation of chinook salmon to one river in New Zealand quickly led to unaided colonization of several other rivers within

15 years, but the present level of straying among rivers is not high enough to account for the widespread colonization that apparently took place after the initial introduction (Unwin and Quinn 1993, Quinn and Unwin 1993).

In addition to translocations, some natural colonization by salmon also occurs. For example, in Glacier Bay, Alaska, new habitat appears as the glacier recedes, and new habitat is colonized as it becomes suitable for spawning (Milner 1987, Milner and Bailey 1989). Straying and the ability to colonize new areas over evolutionary time is important, but little research has been done on this topic. It appears that soon after colonization, and coincident with small population sizes, straying rates may be high; however, after populations become established, only modest rates of straying occur.

Hatchery Practices and Straying

Some hatchery practices might promote straying, the most obvious being the long-standing practice of transporting individuals from one locality to another. Salmon are commonly displaced from hatcheries to "seed" nearby habitat. Most fish reared at one facility through their juvenile stages, but released at another site, return to the site of release and not to the rearing facility (e.g., Donaldson and Allen 1958, Quinn et al. 1989, reviewed by Quinn 1993). Several researchers have studied the details of the timing of imprinting and have found that fish can be imprinted not only at the smolt stage, but also to a lesser extent at earlier stages (Dittman et al. 1994, 1996). Therefore, if a rearing hatchery is in one watershed and the release site is in another watershed, fish tend to return to the release site. As the distance between the rearing facility and the release site gets closer, larger numbers of fish return to the rearing facility, especially if the facility and release site are in the same watershed (Quinn 1993). However, the amount of "straying" from the release site is only roughly correlated with geographical distance. The release site's position within the watershed also affects homing. Johnson et al. (1990) reported that "almost all returning [coho salmon] released as yearlings at a site 23 km upstream from the rearing hatchery returned to the rearing site, whereas only 7-26% of adults originally released in a tributary 11 km downstream from the rearing hatchery returned to the rearing site" (p. 427).

In the Columbia River system, smolts are also displaced to improve their post-release survival. They may be taken from their hatchery ("point of origin" transportation) or captured during their downstream migration, trucked or barged around dams, and then released downriver. Point of origin transportation is usually accomplished by taking the fish by truck, or by truck and then by barge. Coho salmon trucked from the Little White Salmon Hatchery to Youngs Bay returned to Youngs Bay, not to the hatchery (Vreeland et al. 1975). Coho trucked 9 km downstream from Willard Hatchery and then barged to a release point below Bonneville Dam showed improved survival but impaired homing (McCabe et al. 1983). Releases in salt water also tend to increase straying. Solazzi et al. (1991) trucked coho salmon (reared at least in part at Big Creek Hatchery) to release sites below Bonneville Dam (river km 234), and Tongue Point (rkm 29). In addition, smolts were taken by boat in tanks receiving ambient water to the bar of the river (rkm 2), 19 km offshore in the river's plume, 19 km offshore outside the river's plume, and 38 km offshore in non-plume water. These six locations, progressively farther from the rearing site, produced the following proportions of salmon that returned to rivers outside the Columbia River system: <0.1%, 3.4%, 4.1%, 6.1%, 21.0%, and 37.5%. However, salmon captured as migrants and trucked long distances (e.g., from Ice Harbor Dam to Bonneville Dam) may return to the rearing site (Ebel et al. 1973, Slatick et al. 1975). Overall, the displacement studies indicate that maturing salmon tend to reverse the sequence of their outward migration as juveniles. This will lead them to the river or hatchery where they began life. Displaced salmon return first to the odors of their release site and will continue to the rearing site if its odors can be detected. If not, they seem to seek the nearest river or hatchery.

The date of release also influences homing. Fish released too early might be expected to stray more because they have not had time to imprint, or because their endocrine physiology is not synchronized with migration. Studies of Atlantic salmon (Hansen and Jonsson 1991) and of chinook salmon in the lower Columbia River (Pascual et al. 1995) and in New Zealand (Unwin and Quinn 1993) show that fish released after the smolt stage may also stray more frequently than earlier releases. It appears that exposure to site-specific water without migration is not sufficient for imprinting and will not lead to accurate homing, hence salmon held too long stray even though they were given a full opportunity to imprint (Dittman et al. 1996).

Although imprinting is a large component of homing, homing is not entirely a learned behavior. Local populations may home better than transplanted ones (pink: Bams 1976; chinook: McIsaac and Quinn 1988). Salmon may home better to their natal site than to a new site (chinook: McIsaac and Quinn 1988, Pascual and Quinn 1994; coho: Labelle 1992), and transplanted populations may show some tendency to return to their ancestral location (chinook: McIsaac and Quinn 1988, Pascual and Quinn 1994).

Interactions Between Hatchery Strays and Wild Salmon

If a hatchery produces a large number of salmon, straying by even a small percentage of them has the potential to disrupt the genetic composition of nearby wild populations. For example, the proportion of strays from an ocean-ranching facility (Oregon Aqua-Foods) was low, about 6%, but these strays accounted for about 74% of the fish in nearby Yaquina Bay tributaries (Nicholas and Van Dyke 1982). In this case, not only might there be genetic interactions, but simple stock assessment is compromised. A census of natural spawning areas would overestimate the size of wild populations, because the absolute number of strays--a small percentage of the larger hatchery population--was large relative to the local population.

While there is concern that strays from hatcheries will influence wild gene pools, wild salmon may also stray into a hatchery. Nicholas and Van Dyke (1982) estimated that 2,022 (64.7%) of the 3,124 wild coho salmon returning to the Yaquina River watershed in 1981 entered the Oregon Aqua-Foods hatchery. Such decoying of wild salmon into hatcheries both reduces the number of wild fish in the stream and contributes to genetic mixing.

Gene flow from hatchery strays may dilute beneficial genes in populations of locally adapted wild fish, or disrupt adaptive gene complexes. However, salmon mating is non-random. Factors contributing to differential reproductive success include intrasexual competition, some degree of mate choice, differences in aggressiveness between wild and hatchery fish, size effects, different return times, and so on. Differences between homing salmon and strays in distribution within a river system (e.g., Atlantic salmon: Jonsson et al. 1990) might also tend to reduce genetic interactions. Finally, since salmon can discriminate siblings from non-relatives (coho: Quinn and Busack 1985), and can distinguish fish in their own population from those of other populations (sockeye: Groot et al. 1986; coho: Quinn and Tolson 1986), the magnitude of interbreeding may not be equivalent to the proportions of wild and hatchery-produced fish. Wild fish may actively reject siblings and non-native hatchery fish as mates on natural spawning grounds.

Tallman and Healey (1994) studied small chum salmon (*Oncorhynchus keta*) populations on Vancouver Island and indicated that the level of genetic exchange between strays was lower than that inferred by the presence of strays in spawning areas. Simply counting stray hatchery fish on spawning grounds may not provide a reliable estimate of the genetic interaction between hatchery-produced and wild populations. However, genetic consequences may occur if hatchery strays spawn with locally adapted wild fish (Taylor 1991, this volume) because domestication selection and non-native stock in the hatchery might reduce the fitness of wild fish. If hatchery fish have experienced domestication selection or are a non-native stock, then they may reduce the fitness of wild fish with whom they mate (Reisenbichler and McIntyre 1977, Reisenbichler 1988, Leider et al. 1990, Hindar et al. 1991, Johnsson and Abrahams 1991).

Conclusions

Salmon as a group generally home to natal sites to spawn. Homing occurs in diverse groups of salmonids with life-history patterns differing in duration of freshwater residence, anadromy, iteroparity or semelparity, and spawning habitat. Straying between natural populations appears to be an integral part of the evolutionary biology of salmonids and may be important for colonizing new habitats or for avoiding unfavorable habitats. However, intra-specific variation ("local adaptation") presumably results from the scarcity of strays or their high mortality rate, or both, relative to locally adapted salmon. This is consistent with the generally poor survival of transplanted salmon, relative to native populations or to the population in its home environment.

It is unclear whether some species of salmon stray more than other species, but the amount of straying within a species varies considerably among populations, and older salmon tend to stray more than younger fish. It is also not clear whether hatchery-reared salmon generally stray more than wild salmon. The degree of homing in outplanted salmon often differs from that in locally-reared and released salmon, and appears to be determined by complex interactions between rearing location, release site, date, endocrine events, and migration itself. Straying fish tend to enter nearby rivers, although there are many exceptions. Homing, and therefore straying, may be influenced by such factors as water temperature, flow, presence of other salmon, habitat quality, and so on. It is not clear, however, whether fish that stray actively identify their natal breeding grounds, then migrate elsewhere, or whether strays are unable to find their natal site. The propensity to stray itself may be a genetically controlled trait, in addition to genetically based metabolic and physiological traits that make homing possible.

To the extent that there are genetic differences between hatchery and wild salmonids, straying of hatchery-produced salmon to interbreed with wild fish is cause for concern if they are less fit than wild fish. The most obvious and pressing research need is for information linking the straying of adult salmon and the exchange of genes between populations. Thus, data on the relative reproductive success of homing (locally adapted) salmon and strays, whether of wild or hatchery origin, is essential for wise management of salmon populations.

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Discussion

Question: Nils Ryman: Is it possible to select for high rates of straying? Has this been tried?

Answer: Tom Quinn: This has not been tried to my knowledge. However, a study of family-specific differences in several fitness traits such as survival, growth, age composition, fecundity, and so on, was made on Atlantic salmon in Iceland. The researchers did find family-specific differences in homing. These family differences in straying could simply reflect genetic differences among families in memory, sensory ability, swimming performance, and so on, and not differences in the direct genetic control of straying.

Question: Audience: Would it be useful to examine physiological changes in fish to estimate homing ability?

Answer: Tom Quinn: I think the patterns would be complex at best. For example, at the School of Fisheries (University of Washington), coho salmon released as zero age smolts have much lower levels of thyroid hormones than is commonly observed in other hatcheries, yet homing is very good (Dittman et al. 1994). Among adults, salmon populations return at very different states of maturity (e.g., spring- and fall-run chinook, summer- and winter-run steelhead). There seems to be no universal relationship between endocrine changes and homing. This is not to say that there is no relationship, only that it may vary considerably among populations and individuals.

Question: Richard Carmichael: Are you aware of information indicating that rates of straying among natural populations may vary between groups of salmon with different life-history patterns? For example, the Grande Ronde Basin harbors two groups of fish. Fish in one group stay their entire life in the area where they were spawned, and fish in the other group move fairly long distances into main-stem rearing areas in fall, then smolt the following year. Do these different life-history patterns produce different levels of homing?

Answer: Tom Quinn: Yes, there is evidence that stream-type and ocean-type sockeye salmon may stray more, or at least show less genetic differentiation than the conventional lake-type (Wood 1995). In the Cowlitz River Hatchery, spring chinook seemed to home more precisely than fall chinook (Quinn and Fresh 1984, Quinn et al. 1991), but the generality of this pattern among hatcheries and its application to wild populations is unclear.

Question: Mike Lynch: Are you saying that perhaps a straying rate of 2-5% might be fairly normal?

Answer: Tom Quinn: Yes. Straying rates range from almost nothing to a lot, depending on species and region. However, I must emphasize the dearth of information on wild populations.

Question: Mike Lynch: Are these estimates of straying rates compatible with those estimated from molecular data?

Answer: Tom Quinn: We seldom have estimates of straying in wild salmon populations for which we also have genetic data (but see Quinn et al. 1987 for sockeye, and Tallman and Healey 1994 for chum). There is no reason to suspect that straying rates and gene flow must be equivalent because poor survival of the progeny of strays, or non-assortative mating or some other process, may mediate the genetic interactions.

Question: Nils Ryman: Is the straying and the occurrence of jacks related? Is migratory behavior abnormal in both cases?

Answer: Tom Quinn: I am not sure I would be willing to say that jacks display abnormal behavior; they still go to sea, return to fresh water, and spawn. They may have a different marine distribution as a consequence of their younger ages, but they still migrate far enough away so they no longer have contact with their natal rivers. To the extent that there are patterns, jacks seem to stray less often than older salmon.

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Genetic Structure of upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs

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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^{o}C for 3 min, denaturation at 95^{o}C for 15 sec, anneal for 30 sec at the appropriate temperature for each locus (Table 2), extension at 72^{o}C for 1 min, repeat cycle (steps 2-4), final extension at 72^{o}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.

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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

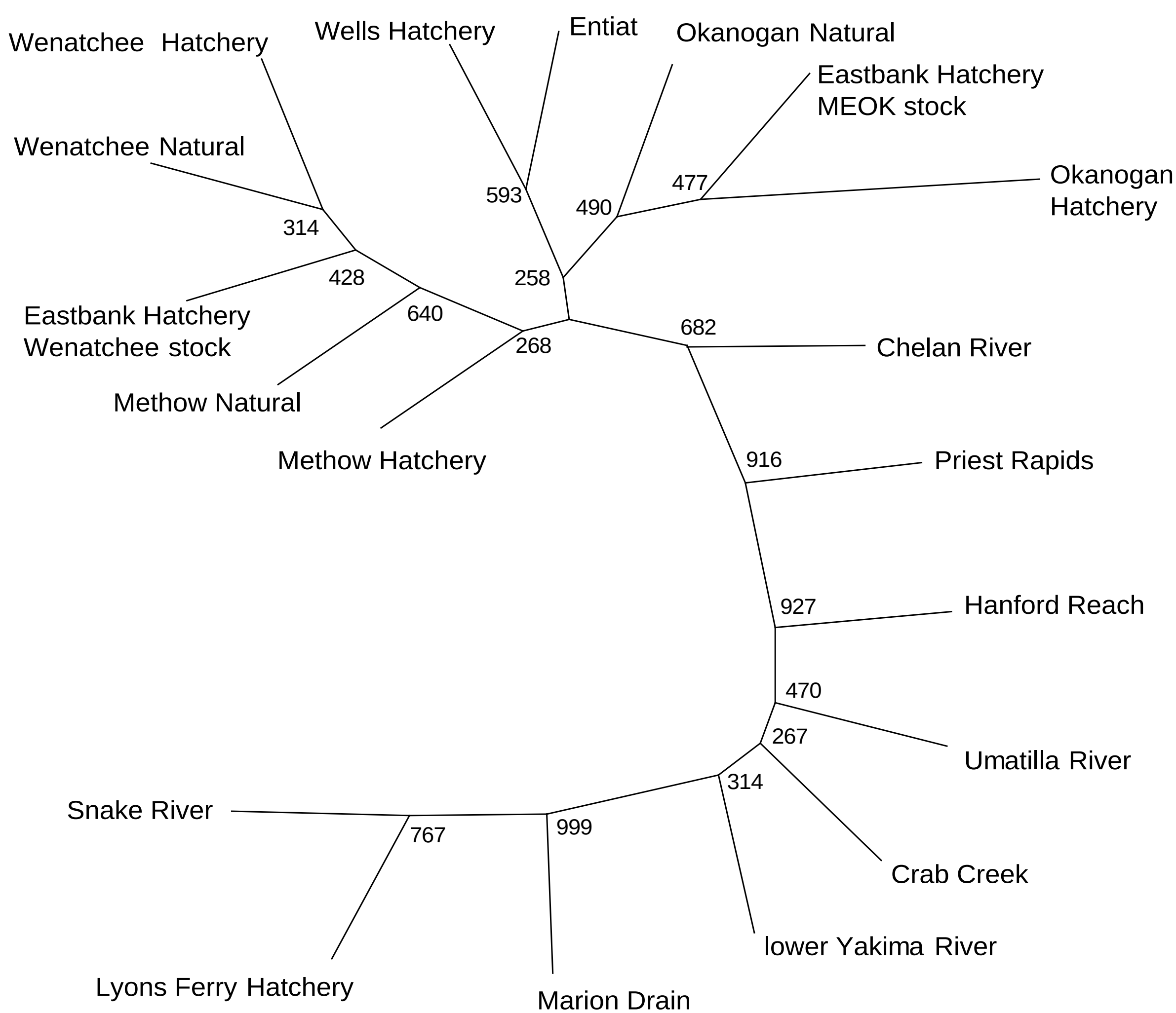
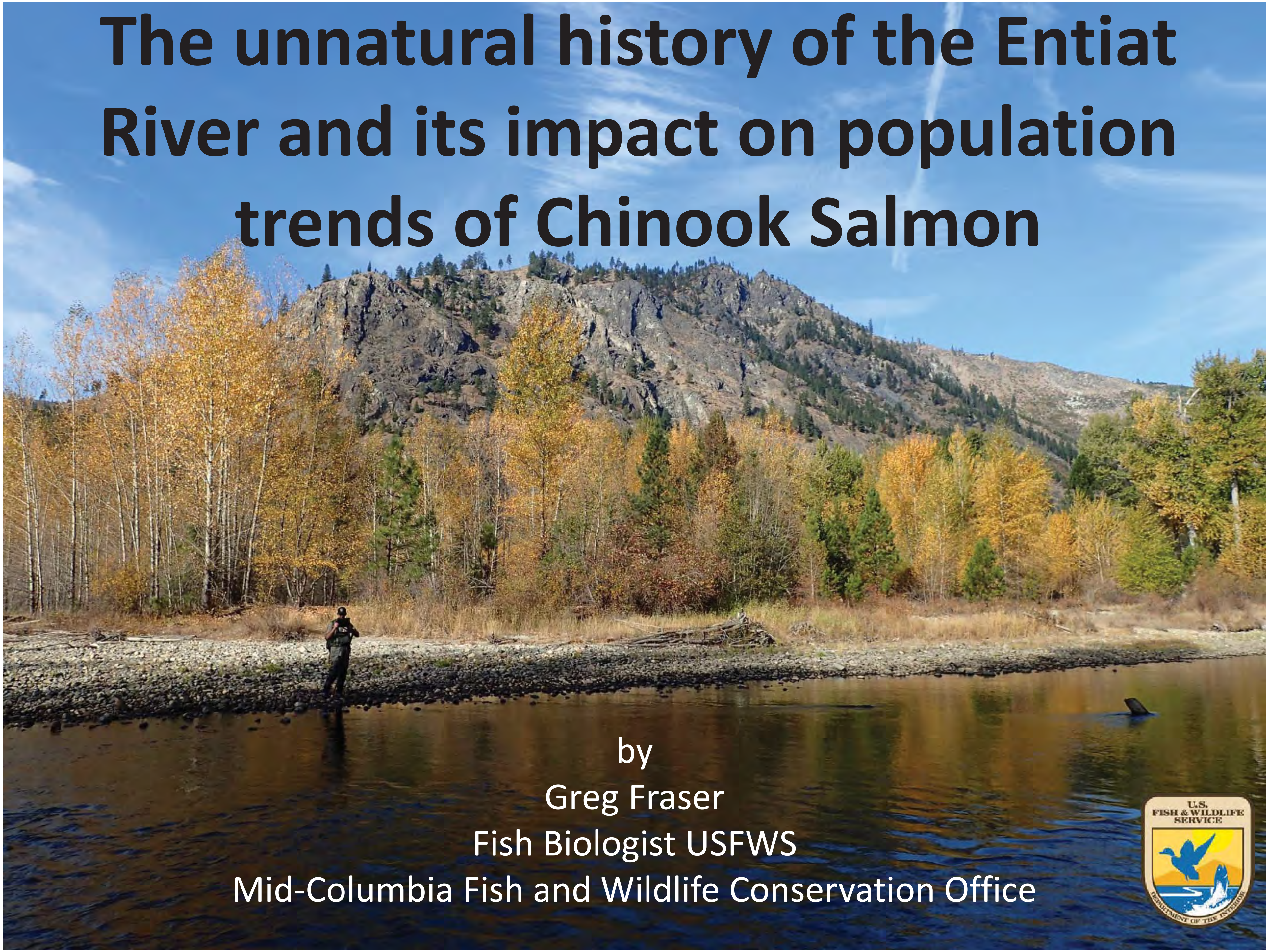


Figure 1. Relationship of natural- and hatchery-origin Chinook collections from the upper Columbia River basin using Cavalli-Sforza and Edwards (1967) chord distance. Bootstrap values are shown at each node.



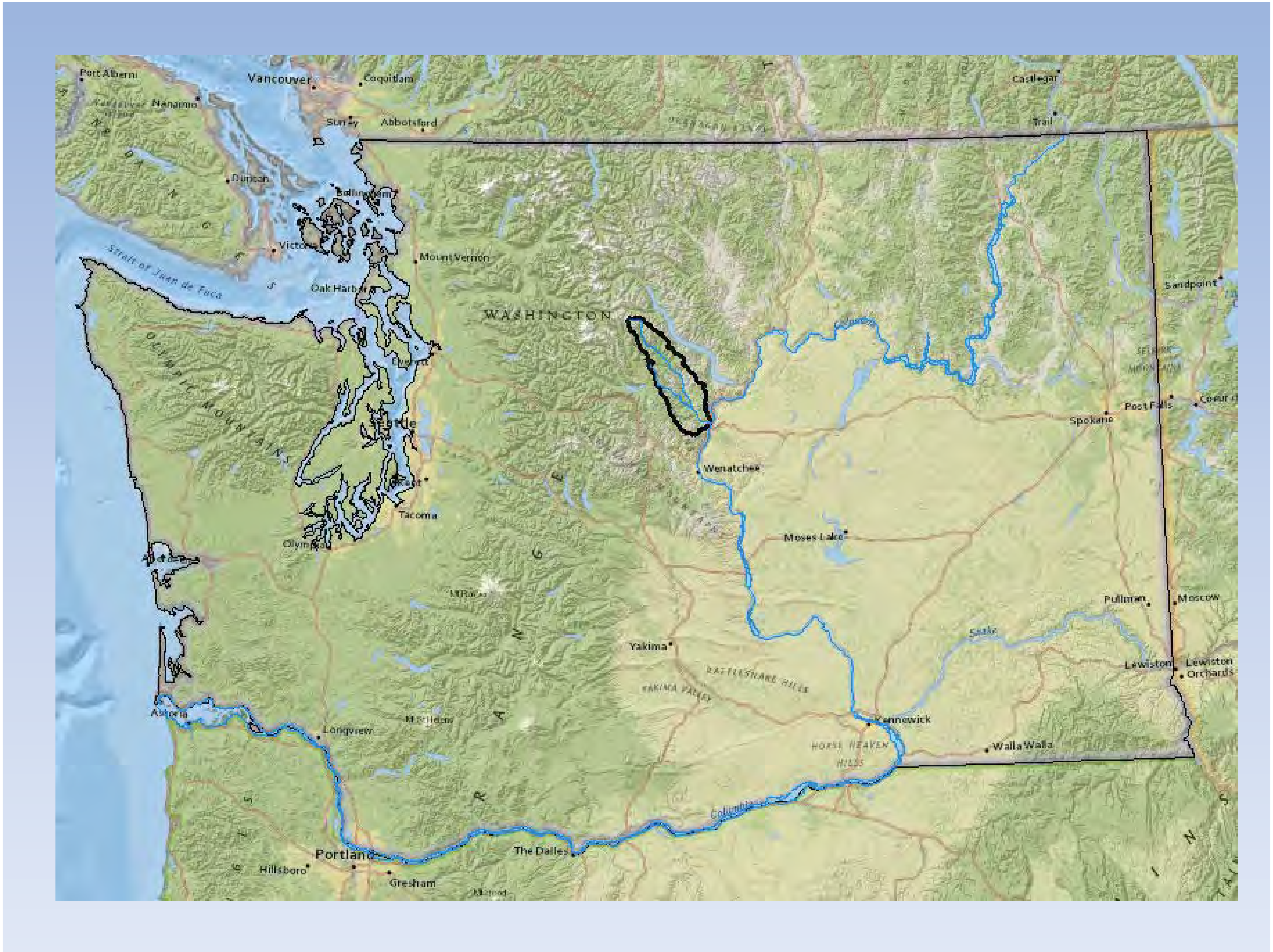
The unnatural history of the Entiat River and its impact on population trends of Chinook Salmon

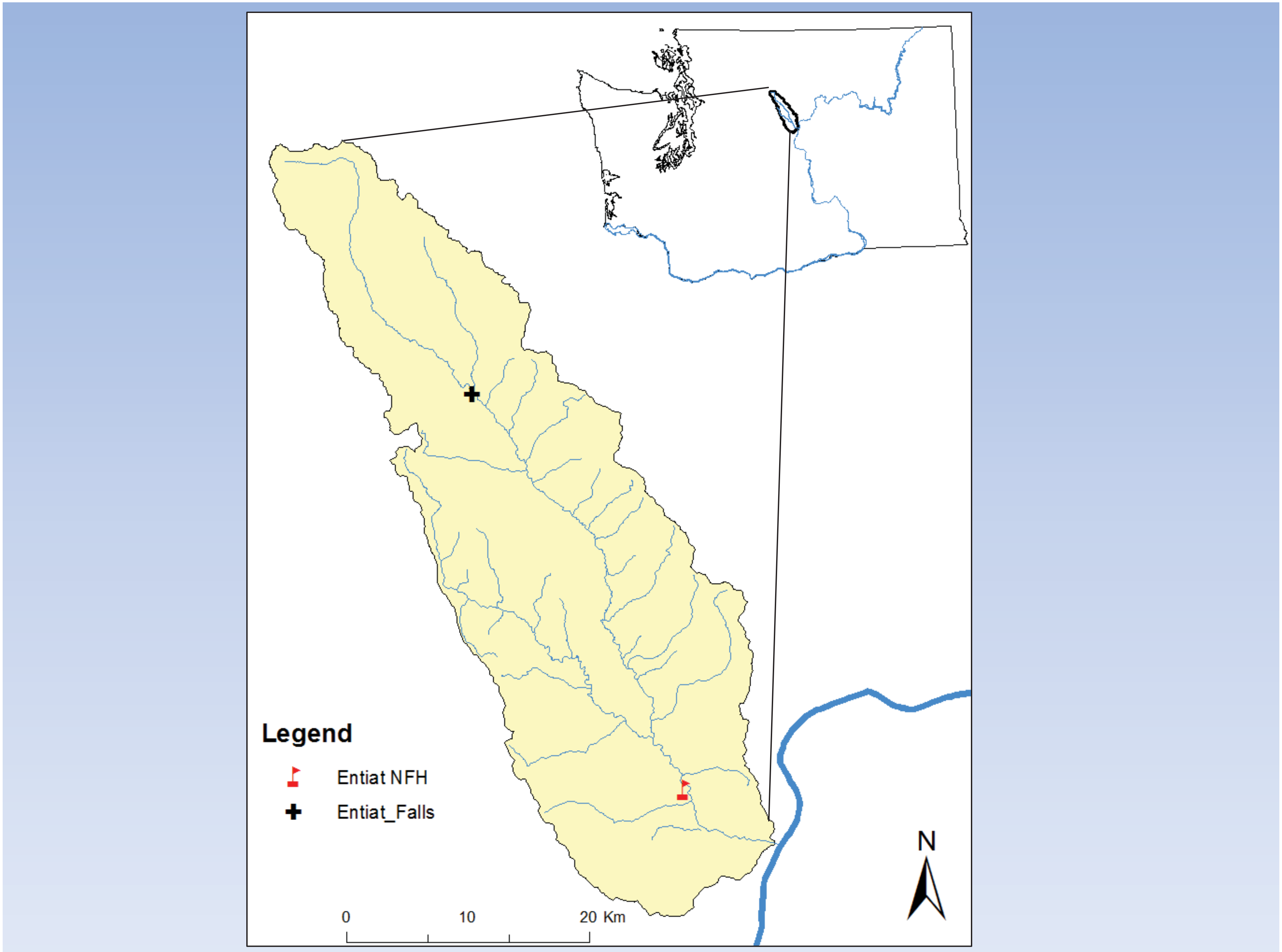
by
Greg Fraser
Fish Biologist USFWS
Mid-Columbia Fish and Wildlife Conservation Office

Outline

- Entiat River History
- Data collection
- 2015 Results
- Population trends 2002-2015

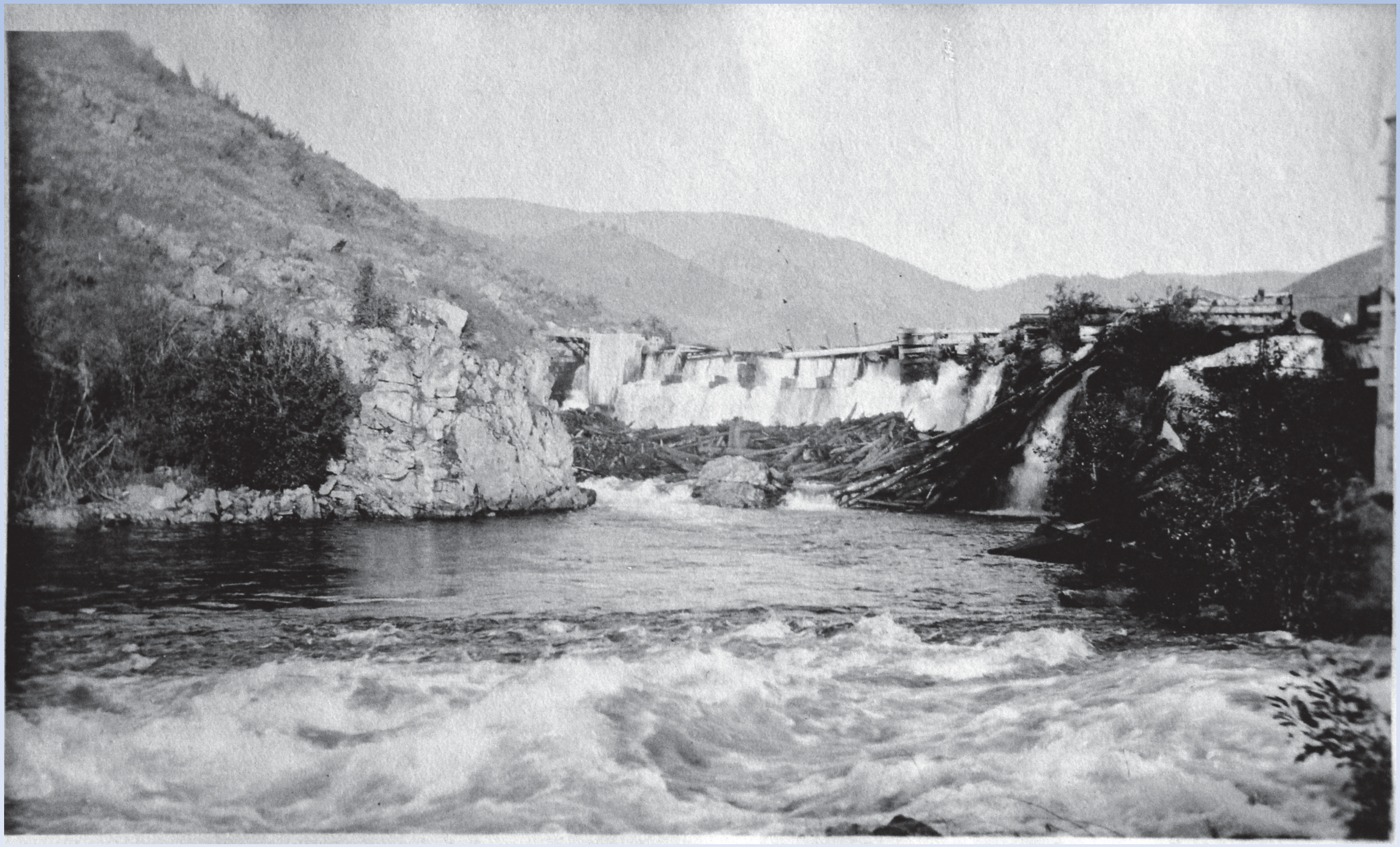
Attachment I

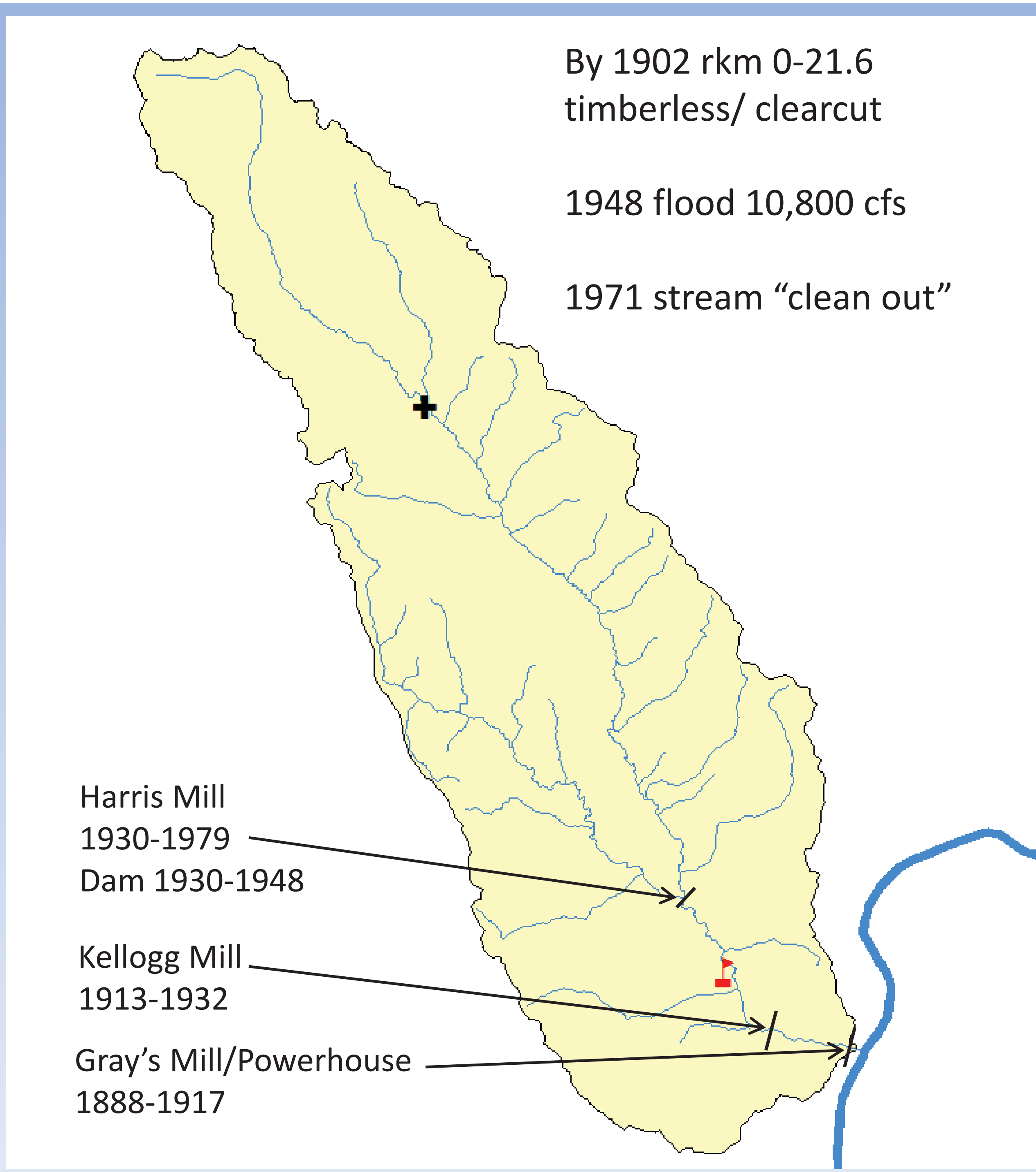



Legend
Entiat NFH
Entiat_Falls
0
10
20 Km
N

Entiat River History: Dams

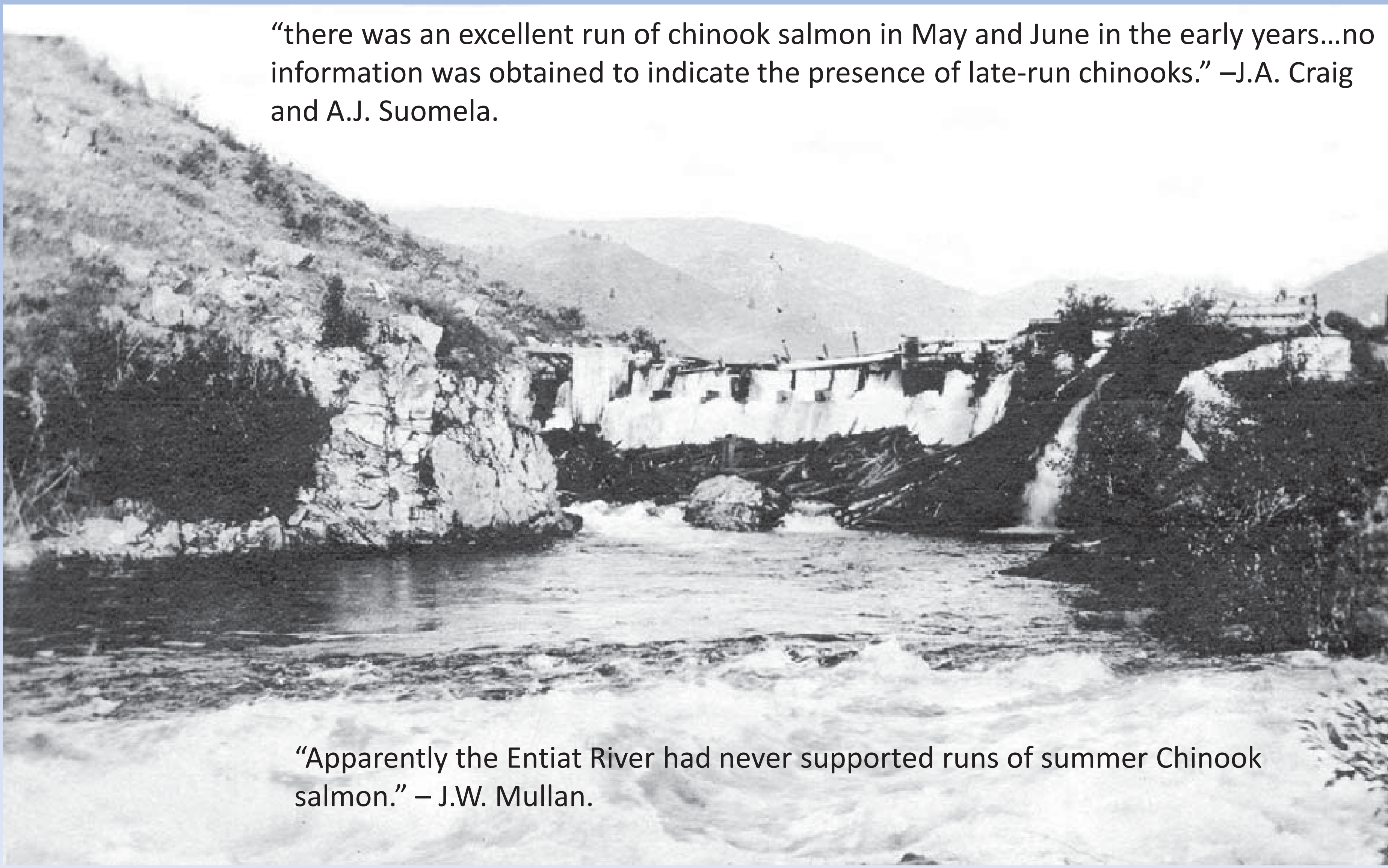
- 1800's multiple dams extirpated salmon runs




By 1902 rkm 0-21.6
timberless/ clearcut
1948 flood 10,800 cfs
1971 stream "clean out"
Harris Mill
1930-1979
Dam 1930-1948
Kellogg Mill
1913-1932
Gray's Mill/Powerhouse
1888-1917

Entiat River History: Springers

“there was an excellent run of chinook salmon in May and June in the early years…no information was obtained to indicate the presence of late-run chinooks.” –J.A. Craig and A.J. Suomela.



“Apparently the Entiat River had never supported runs of summer Chinook salmon.” – J.W. Mullan.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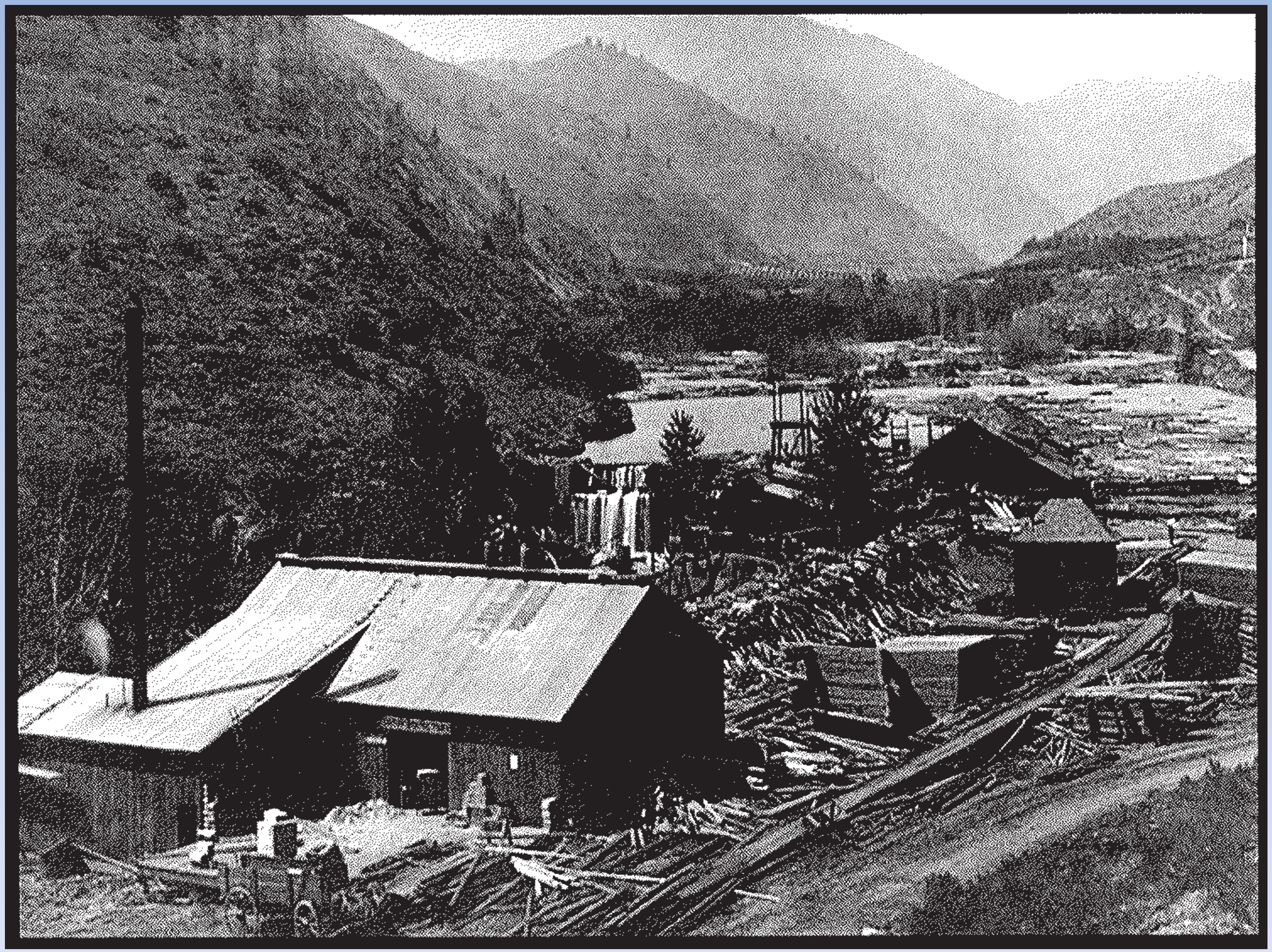
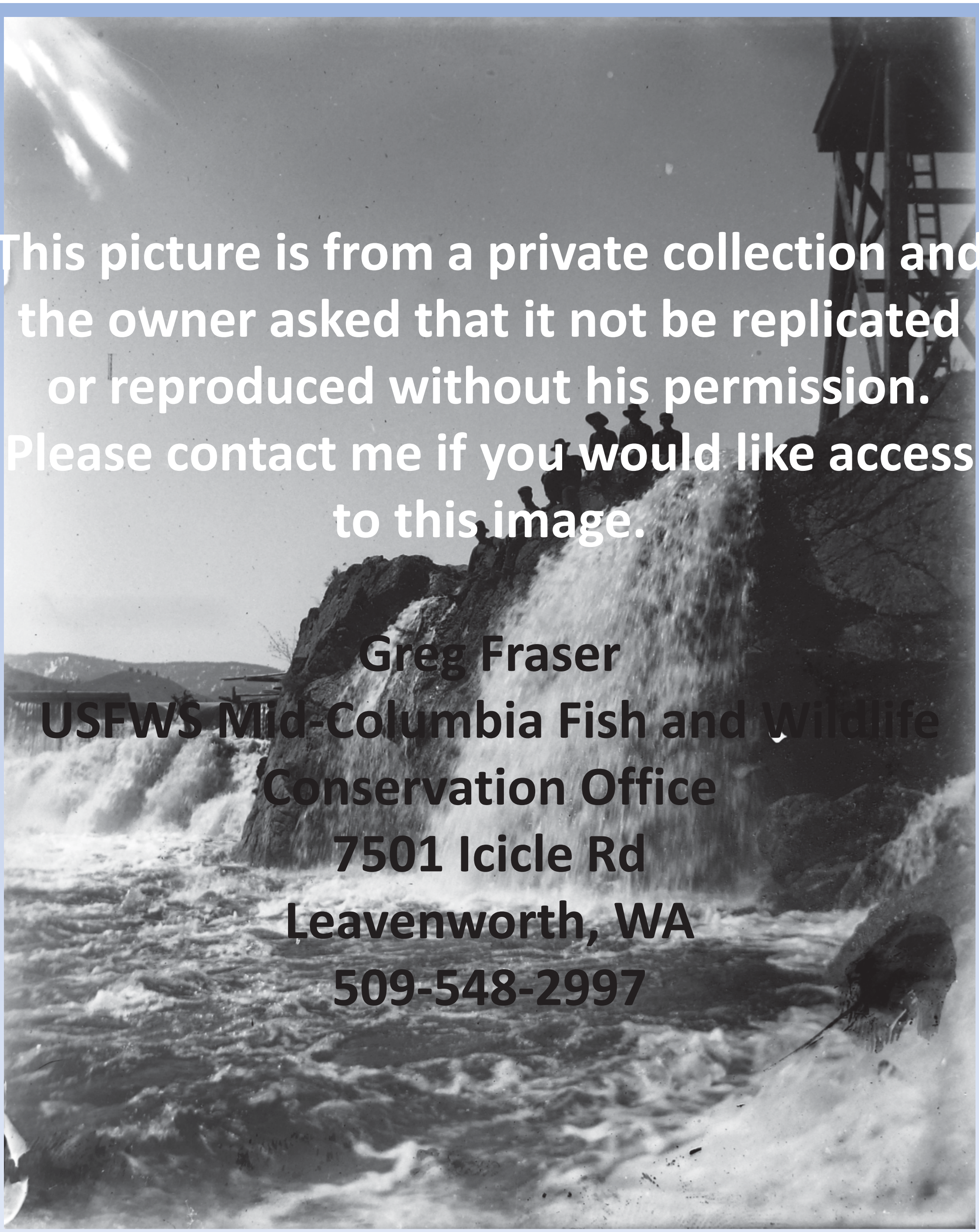
to this image.
Greg Fraser
USFWS Mid-Columbia Fish and Wildlife
Conservation Office
7501 Icicle Rd
Leavenworth, WA
509-548-2997
Spring flows circa 1900





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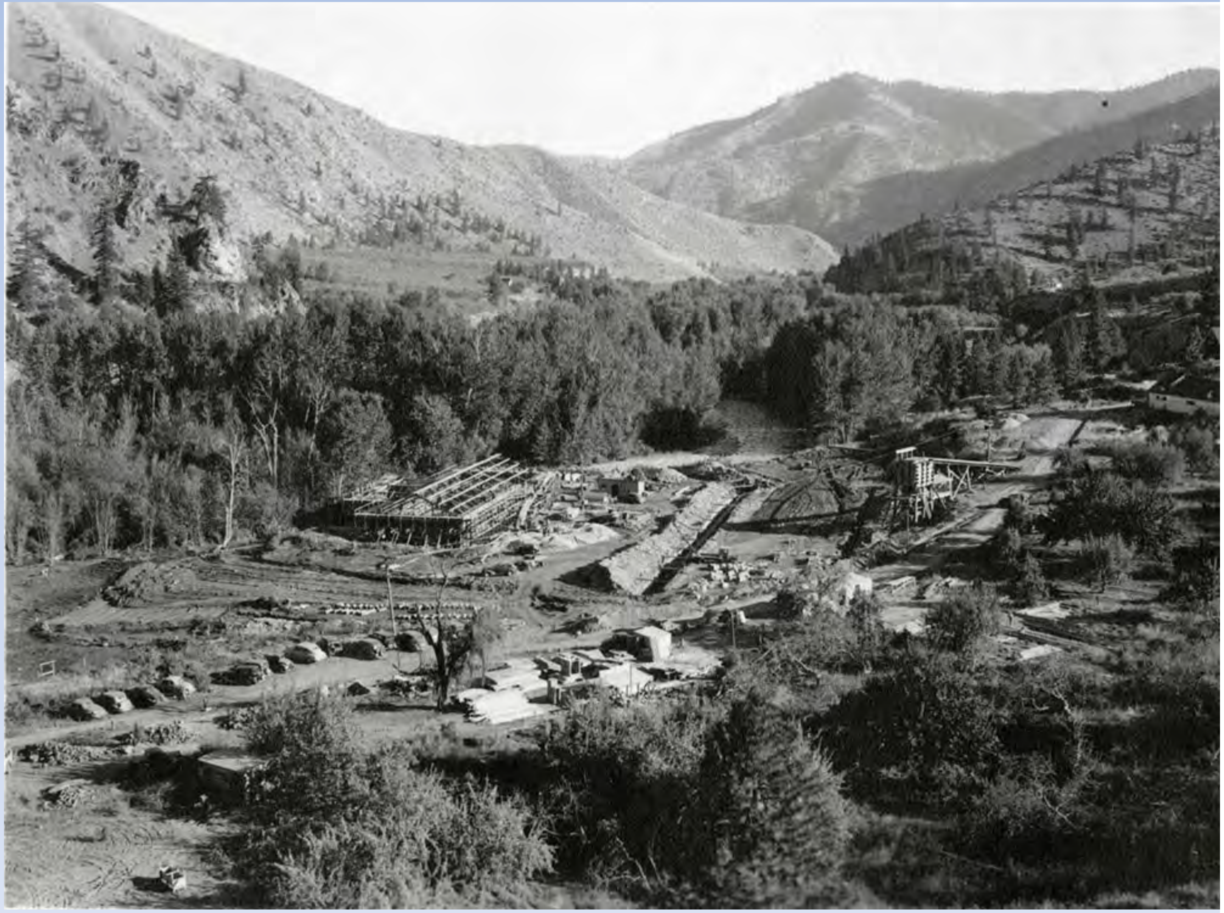
Greg Fraser
USFWS Mid-Columbia Fish and Wildlife Conservation Office
7501 Icicle Rd
Leavenworth, WA
509-548-2997

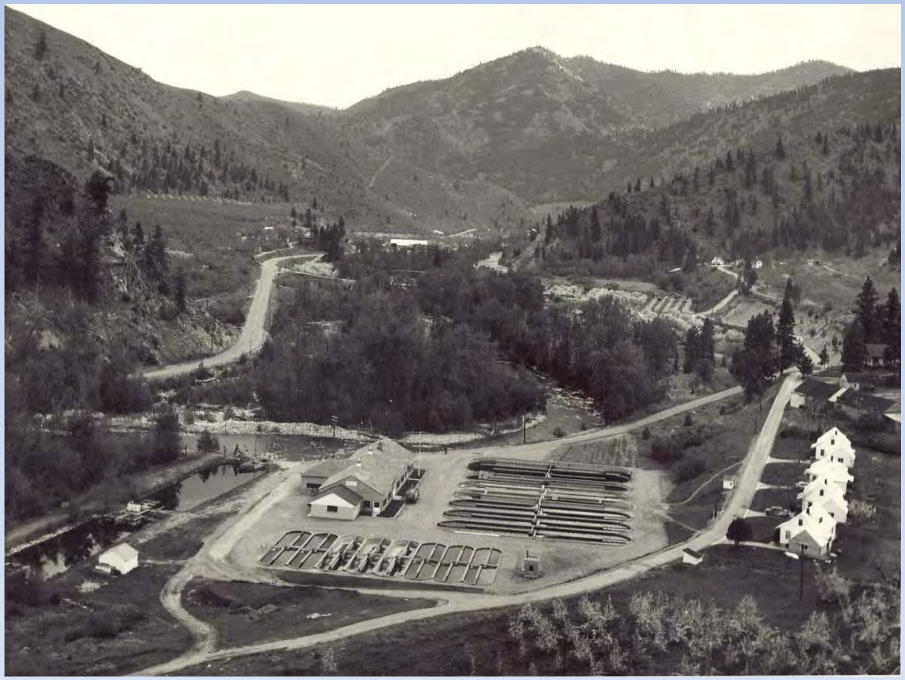
Entiat River History: Entiat NFH

- 1941 constructed
- 1951 research
- 1961 production



Entiat River History: Entiat NFH

- 1979 Entiat NFH reconstructed



Entiat NFH Release Information (1945-1974)

Year	Species	Number	
1945	Summer Chinook	65957	
	Coho	99485	
	Steelhead	16473	Entiat River
	Sockeye	35226	
1946	Summer Chinook	751447	
	Steelhead	7190	EE Eyed eggs shipped to Leavenworth – no Entiat release
	Spring Chinook	176589	EE
1947	Summer Chinook	251438	
	Steelhead	22276	Entiat River
1948	Summer Chinook	396744	
	Steelhead	109502	– Transferred as fingerlings to Chelan State Fish Hatchery
	Sockeye	0	
1949	Summer Chinook	375591	
	Steelhead	0	– Only one female spawned due to new adult pond construction
	Sockeye	9930	
1950	Summer Chinook	526520	
	Steelhead	23570	Released Dec. 11 1950 15 miles above hatchery
	Sockeye	45800	
1951	Summer Chinook	625358	
	Steelhead	7474	Released as fry into Entiat River
	Sockeye	27775	
1952	Summer Chinook	321727	
	Steelhead	0	
	Sockeye	154148	
1953	Summer Chinook	659076	
	Steelhead	0	
	Sockeye	458642	
1954	Summer Chinook	498323	
	Steelhead	0	
	Sockeye	260727	Eggs to Leav.
1955	Summer Chinook	463393	
	Steelhead	0	
	Sockeye	488953	
1956	Summer Chinook	250472	
	Steelhead		
	Sockeye	240452	Eggs to Leav.
1957	Summer Chinook	309380	
	Steelhead	0	
	Sockeye	396794	
1958	Summer Chinook	522504	
	Steelhead		
	Sockeye	726970	
1959	Summer Chinook	143847	
	Steelhead		
	Sockeye	396128	
1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

* Entiat NFH became "Salmon Cultural Laboratory" in 1951 and Steelhead were no longer a species of interest for the station. Due to a WDFW policy that stated fingerlings must be reared for 18 months or longer prior to release, the steelhead program was discontinued.

Entiat NFH Release Information (1945-1974)

Year	Species	Number	
1945	Summer Chinook	65957	
	Coho	99485	
	Steelhead	16473	Enti
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1946	Summer Chinook	751447	
	Steelhead	7190 EE	E
	Spring Chinook	176589 EE	
1947	Summer Chinook	251438	
	Steelhead	22276	Ent
1948	Summer Chinook	396744	
	Steelhead	109502	- Trans
	Sockeye	0	
1949	Summer Chinook	375591	
	Steelhead	0	- Only
	Sockeye	9930	
1950	Summer Chinook	526520	
	Steelhead	23570	Rele
	Sockeye	45800	
1951	Summer Chinook	625358	
	Steelhead	7474	Releas
	Sockeye	27775	
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	Steelhead	0	
	Sockeye	154148	
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	Sockeye	458642	
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	Steelhead	0	
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	Steelhead	0	
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	Steelhead		
	Sockeye	396128	
1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

Year	Species	Number	
	Rainbow Trout	80315	
1962	Summer Chinook	229828	
	Steelhead	59,334 eggs	- Taken from adults trapped at Rocky Reach Dam
	Sockeye	None	
	Rainbow Trout	182783	
	Cutthroat Trout	eggs	
1963	Summer Chinook	230593	
	Steelhead	377591	- Eyed eggs shipped to Winthrop NFH and Chelan SFH
	Sockeye	0	
	Cutthroat Trout	8106	
	Coho	eggs	
1964	Summer Chinook	2100 to Leav	
	Steelhead	36101	- Fingerlings transferred to "Washington State Game" for distribution - unknown sites
	Sockeye	0	
	Rainbow Trout	95496	
	Cutthroat Trout	0	
	Coho	0	
1965	Summer Chinook	990898	
	Steelhead	22503	- No record of release site.
	Sockeye	0	
	Rainbow Trout	716482	
	Coho	473882	
1966	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	252475	
	Coho	275000	
1967	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	1053364	
	Coho	299855	
1968	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	304380	
	Coho	2805816	
1969	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	510148	
	Coho	452929	
1970	Summer Chinook	0	
	Coho	588745	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	456549	
	Cutthroat Trout	0	
	Brook Trout	0	
1971	Summer Chinook	0	
	Coho	0	
	Steelhead	0	

Entiat NFH Release Information (1945-1974)

Year	Species	Number	
1945	Summer Chinook	65957	
	Coho	99485	
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	Sockeye	35226	
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	Steelhead	0	
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1960	Summer Chinook	152282	
	Steelhead		
	Sockeye	550154	
1961	Summer Chinook	316545	
	Steelhead		
	Sockeye	245334	

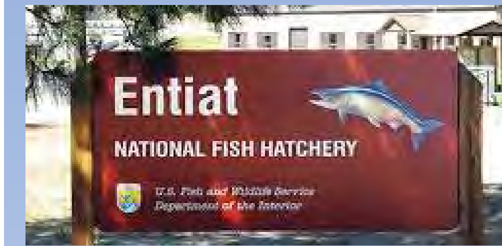
	Rainbow Trout	80315	
1962	Summer Chinook	229828	
	Steelhead	59,334 eggs	- Taken from adults trapped at Rocky Reach Dam
	Sockeye	None	
	Rainbow Trout	182783	
	Cutthroat Trout	eggs	
1963	Summer Chinook	230593	
	Steelhead	377591	- Eyed eggs shipped to Winthrop NFH and Chelan SFH
	Sockeye	0	
	Cutthroat Trout	8106	
	Coho	eggs	
1964	Summer Chinook	2100 to Leav	
	Steelhead	36101	- Fingerlings transferred to "Washington State Game" for distribution - unknown sites
	Sockeye	0	
	Rainbow Trout	95496	
	Cutthroat Trout	0	
	Coho	0	
1965	Summer Chinook	990898	
	Steelhead	22503	- No record of release site.
	Sockeye	0	
	Rainbow Trout	716482	
	Coho	473882	
1966	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	252475	
	Coho	275000	
1967	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	1053364	
	Coho	299855	
1968	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	304380	
	Coho	2805816	
1969	Summer Chinook	0	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	510148	
	Coho	452929	
1970	Summer Chinook	0	
	Coho	588745	
	Steelhead	0	
	Sockeye	0	
	Rainbow Trout	456549	
	Cutthroat Trout	0	
	Brook Trout	0	
1971	Summer Chinook	0	
	Coho	0	
	Steelhead	0	

	Sockeye	0
	Rainbow Trout	761456
	Cutthroat Trout	3230
	Brook Trout	11410
1972	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	754523
	Cutthroat Trout	0
	Brook Trout	26000
1973	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	764802
	Cutthroat Trout	0
	Brook Trout	19768
1974	Summer Chinook	0
	Steelhead	0
	Sockeye	0
	Rainbow Trout	317207
	Brook Trout	24921

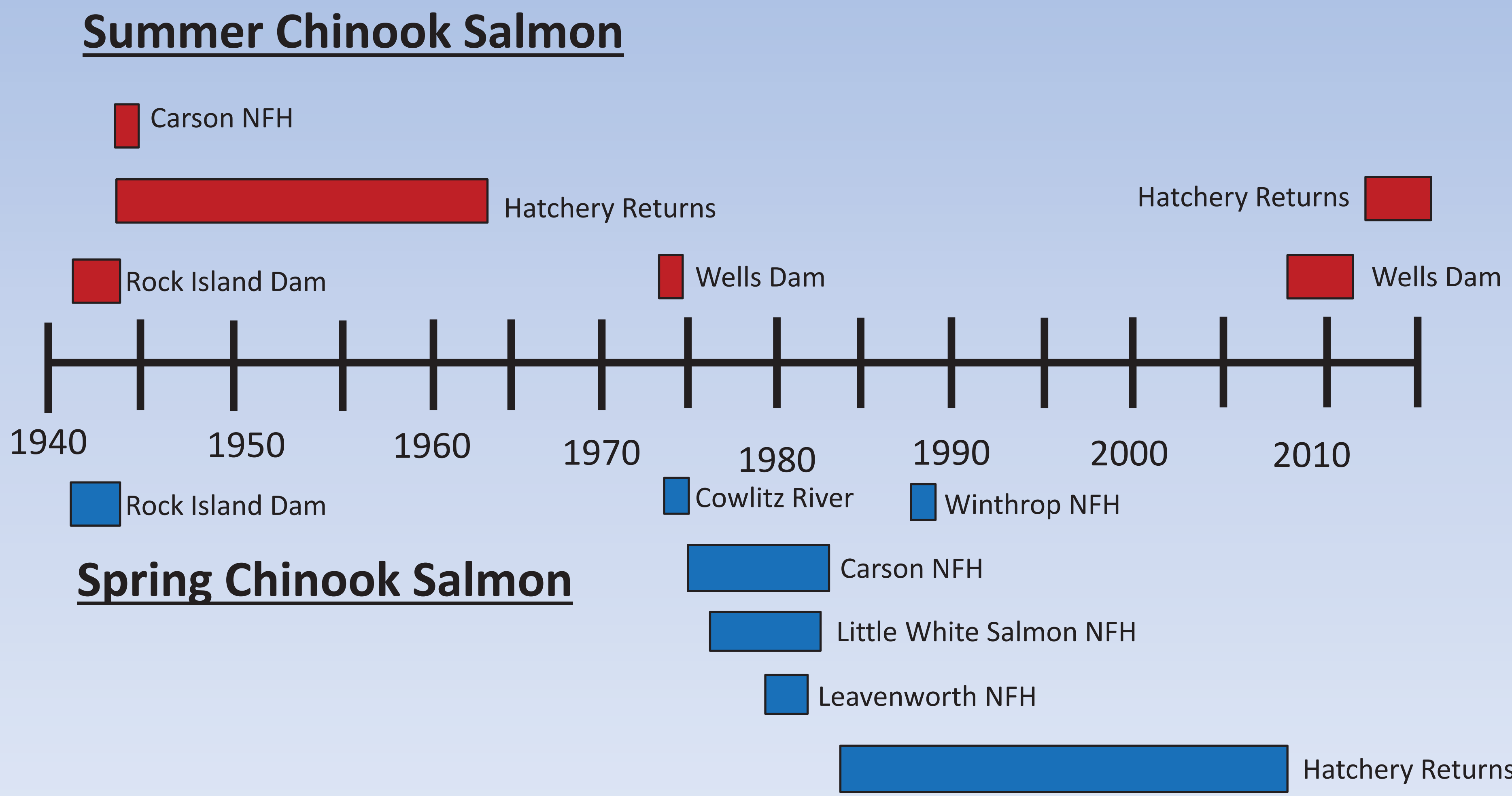
1943 "Spring" steelhead 7,974 into Entiat River at hatchery in May.
"Land Locked" steelhead 21,667 into Entiat River at hatchery in July.
"Spring" steelhead 619,245 fry into Entiat River at hatchery in September.
"Fall" steelhead 599,778 fry into Entiat River at hatchery in September.

Entiat River History: Entiat NFH

- 1939-1940 Summer Chinook placed in river
- 1942-1944 Spring Chinook
- 1945-1961 Sockeye
- 1941-1965 Summer Chinook
- 1966-1973 Coho and Rainbow Trout
- 1974-2007 Spring Chinook
- 2009-present Summer Chinook



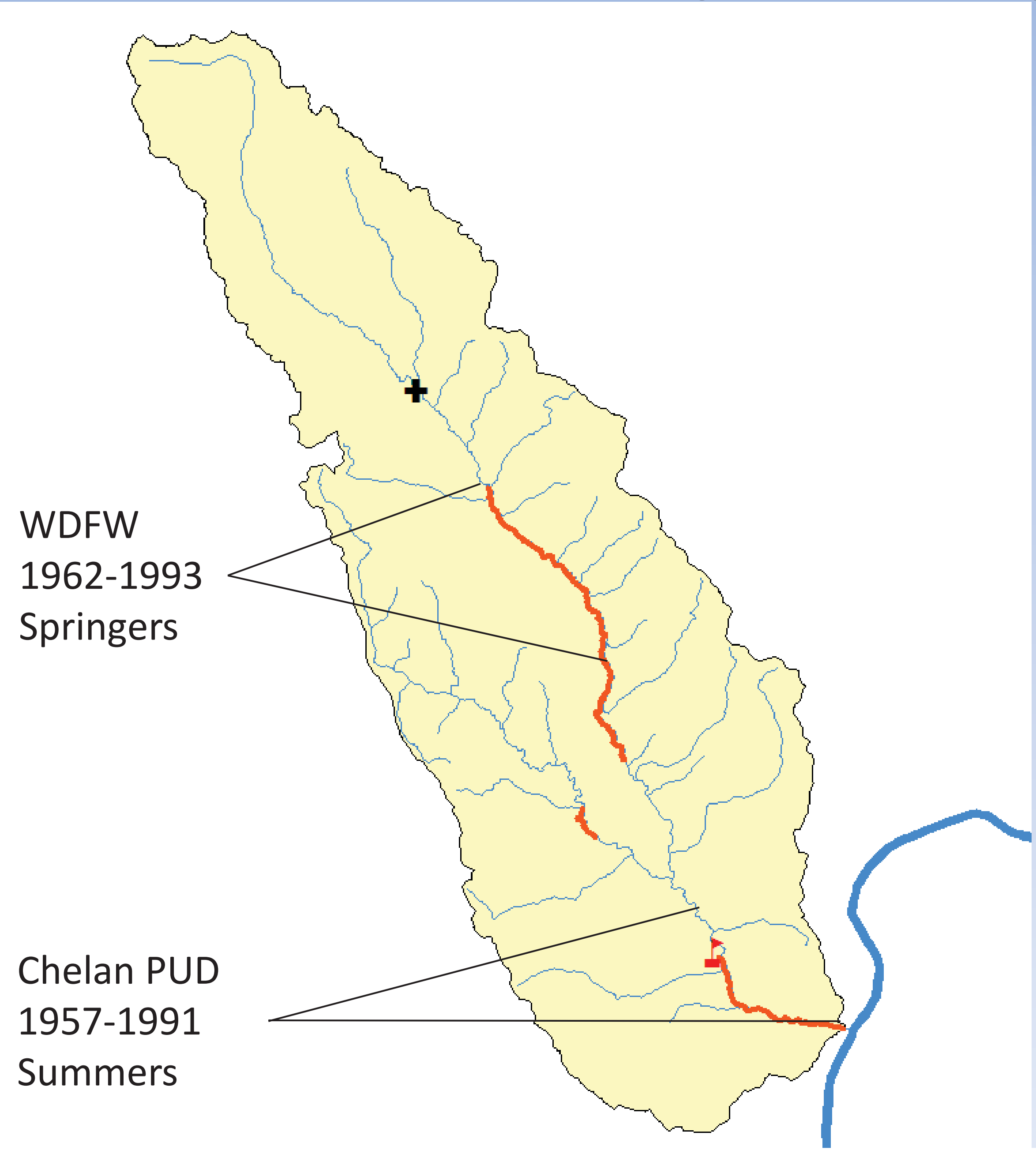
Broodstock History



Entiat River History

- 1974-2007 Entiat NFH raised spring Chinook
  - Last spring Chinook release 2007, last return 2010
- 2009-present raise summer Chinook
  - First release 2011
  - First full production release 2013

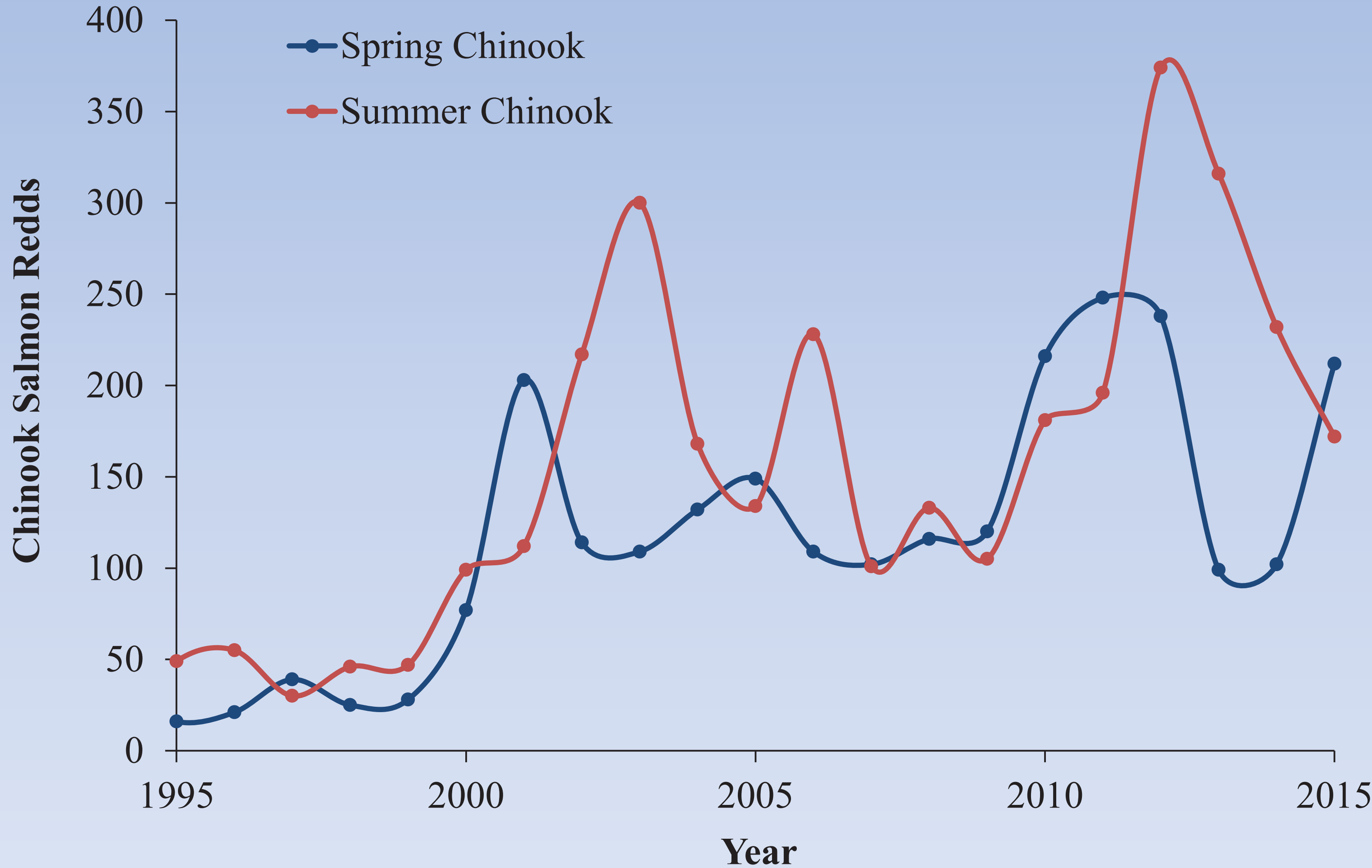
Entiat River History: Surveys



Spawning Ground Surveys

- Groups of 2-4 observers per survey
- One observer per bank minimum
- Weekly surveys began late-July
- Redd Data: spatial, temporal, abundance
- Carcass Data: age, sex, origin

Abundance Trends



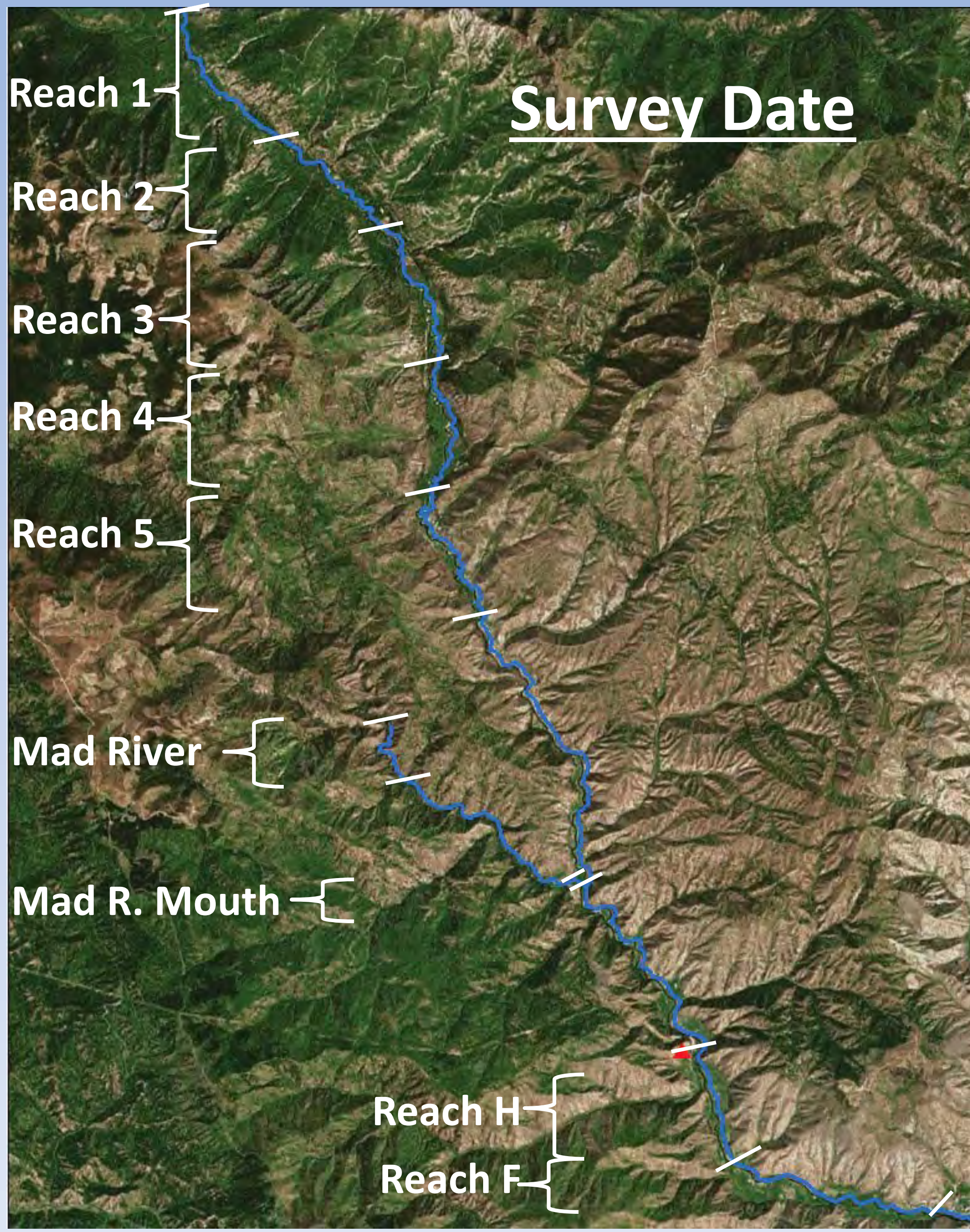
Attachment I

Attachment I

Total
0

Spring

0
0
0
0
0
0
0



Summer

0
0
0
0
0
0
0
0
0

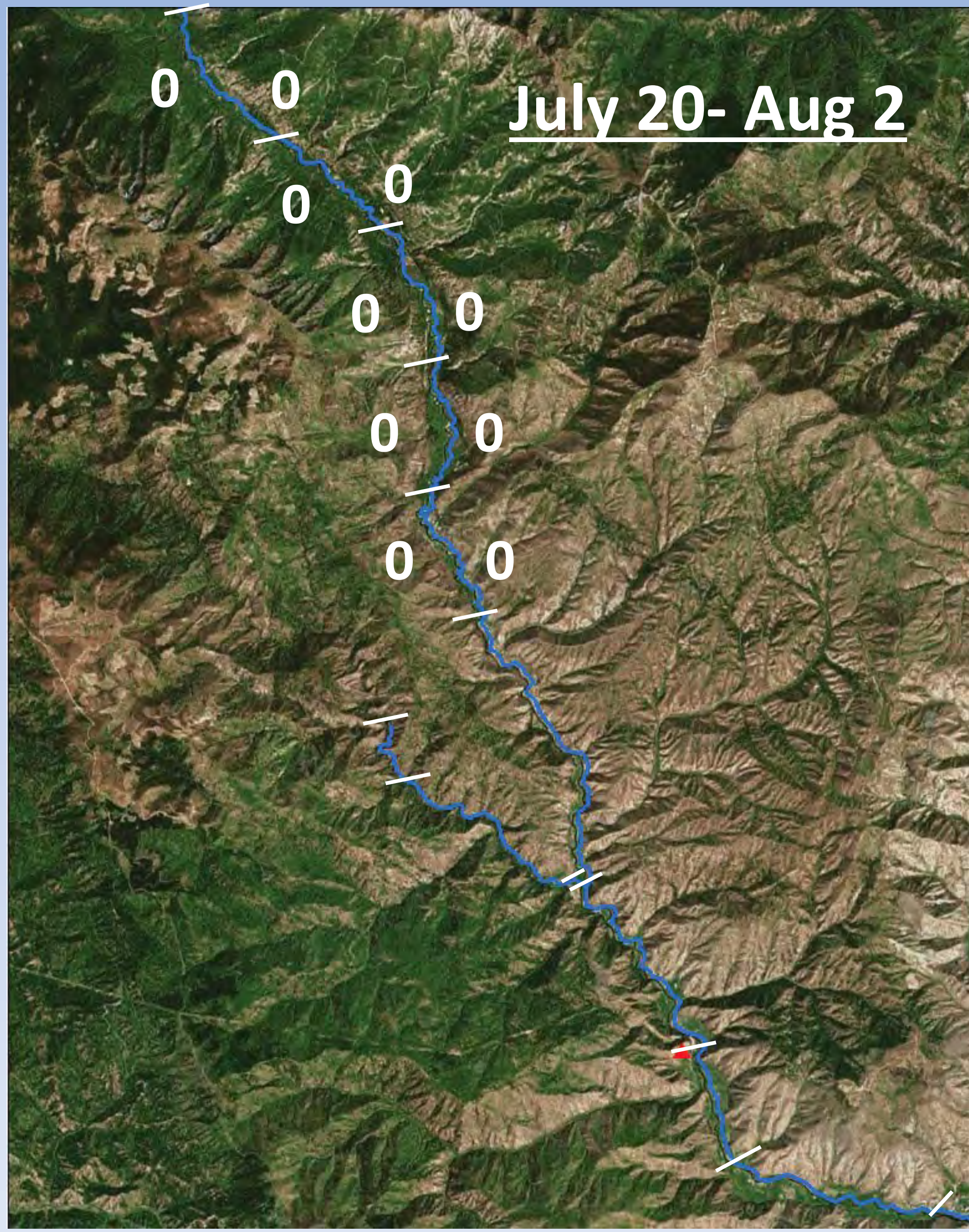
Total
0

Attachment I

Total
0

Spring

0
0
0
0
0
0
0



Summer

0
0
0
0
0
0
0
0
0

Total
0

Attachment I

Total
0

Spring

0

0

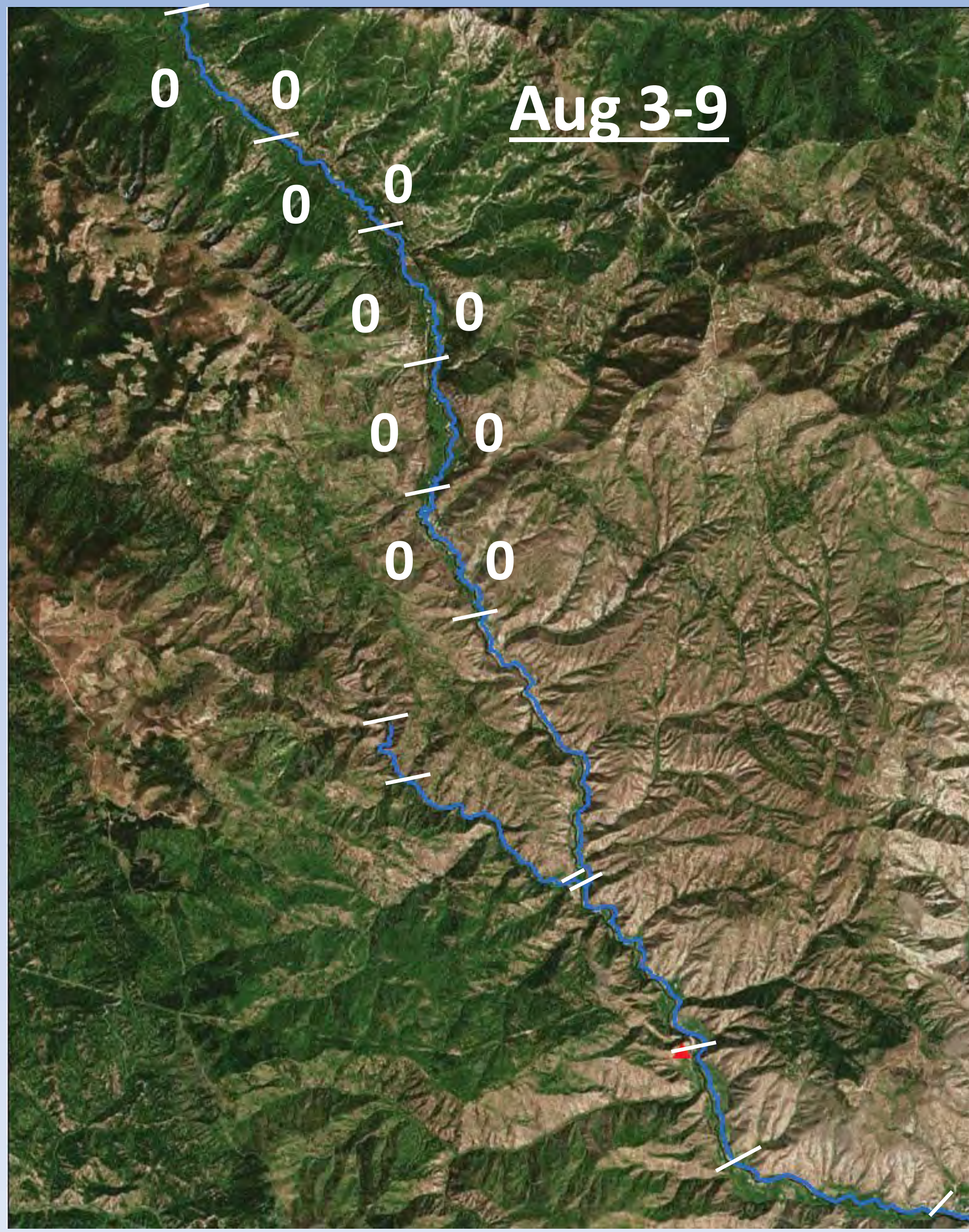
0

0

0

0

0



Summer

0

0

0

0

0

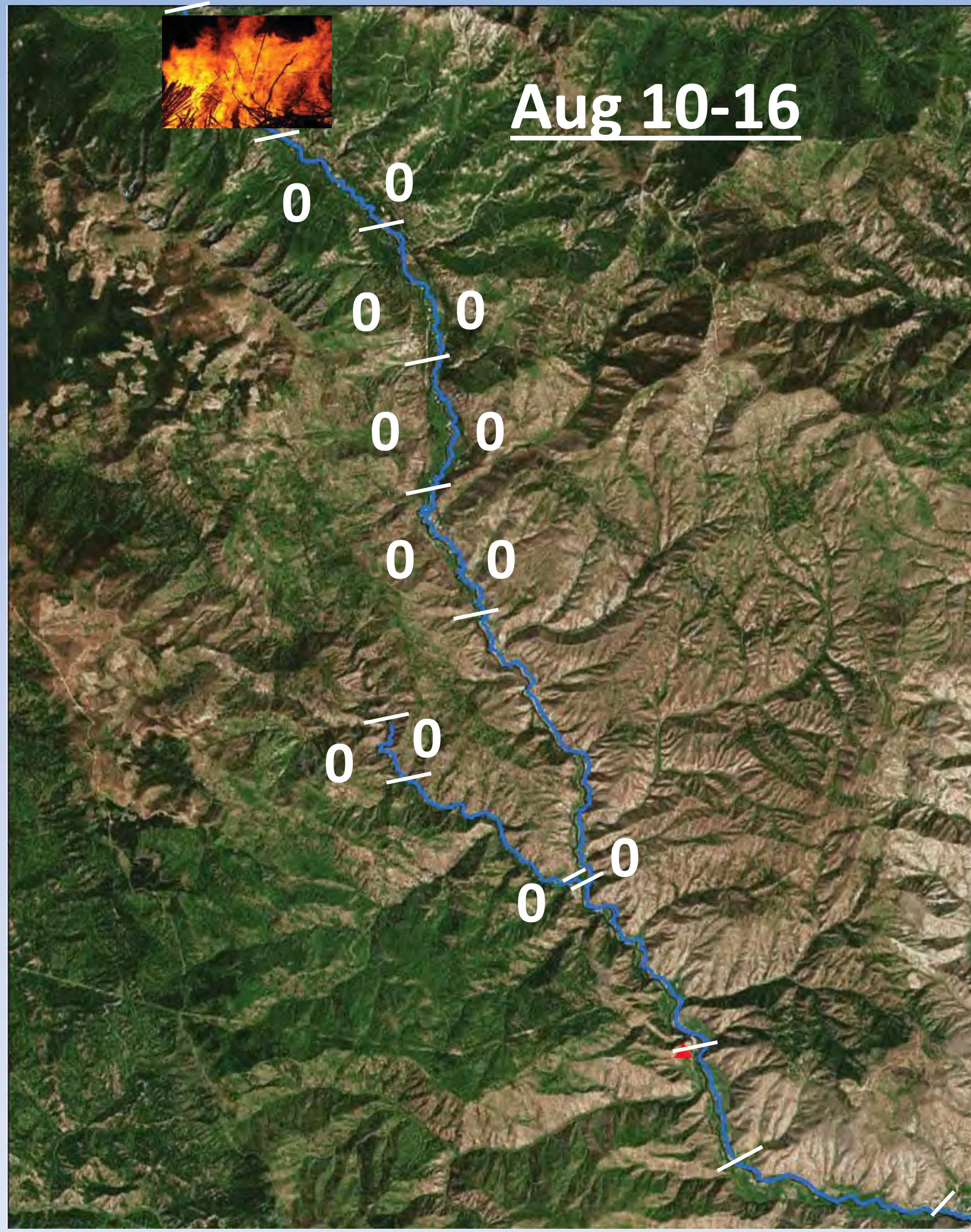
0

0

0

0

Total
0

Total	Spring		Summer	Total
0	0		0	0
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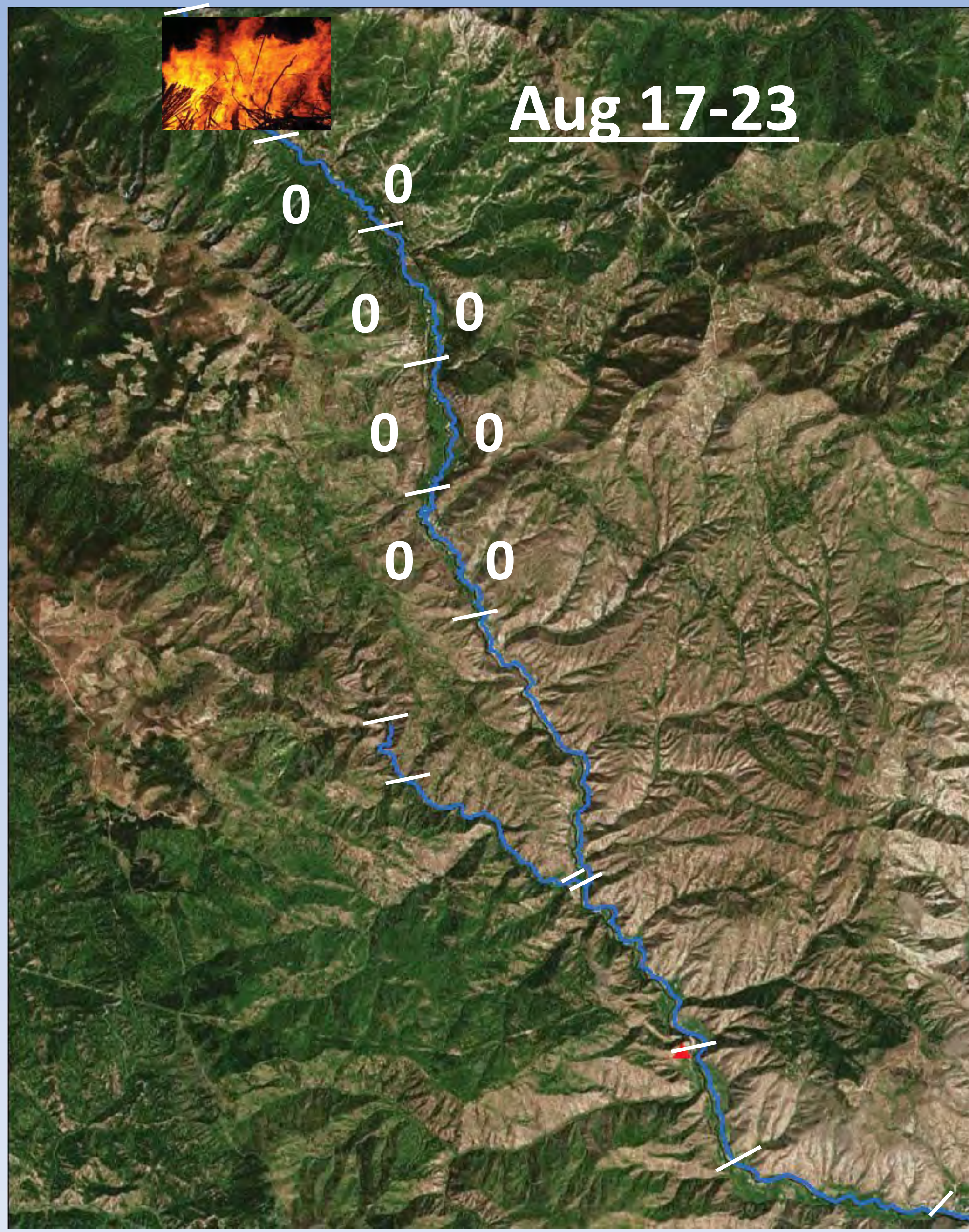
	0		0	
	0		0	
	0		0	
	0		0	
	0		0	
			0	
			0	

Attachment I

Total	Spring		Summer	Total
0	0		0	0
	0		0	
	0		0	
	0		0	
	0		0	
	0		0	
	0		0	
			0	
			0	



Total
4

Spring

0

0

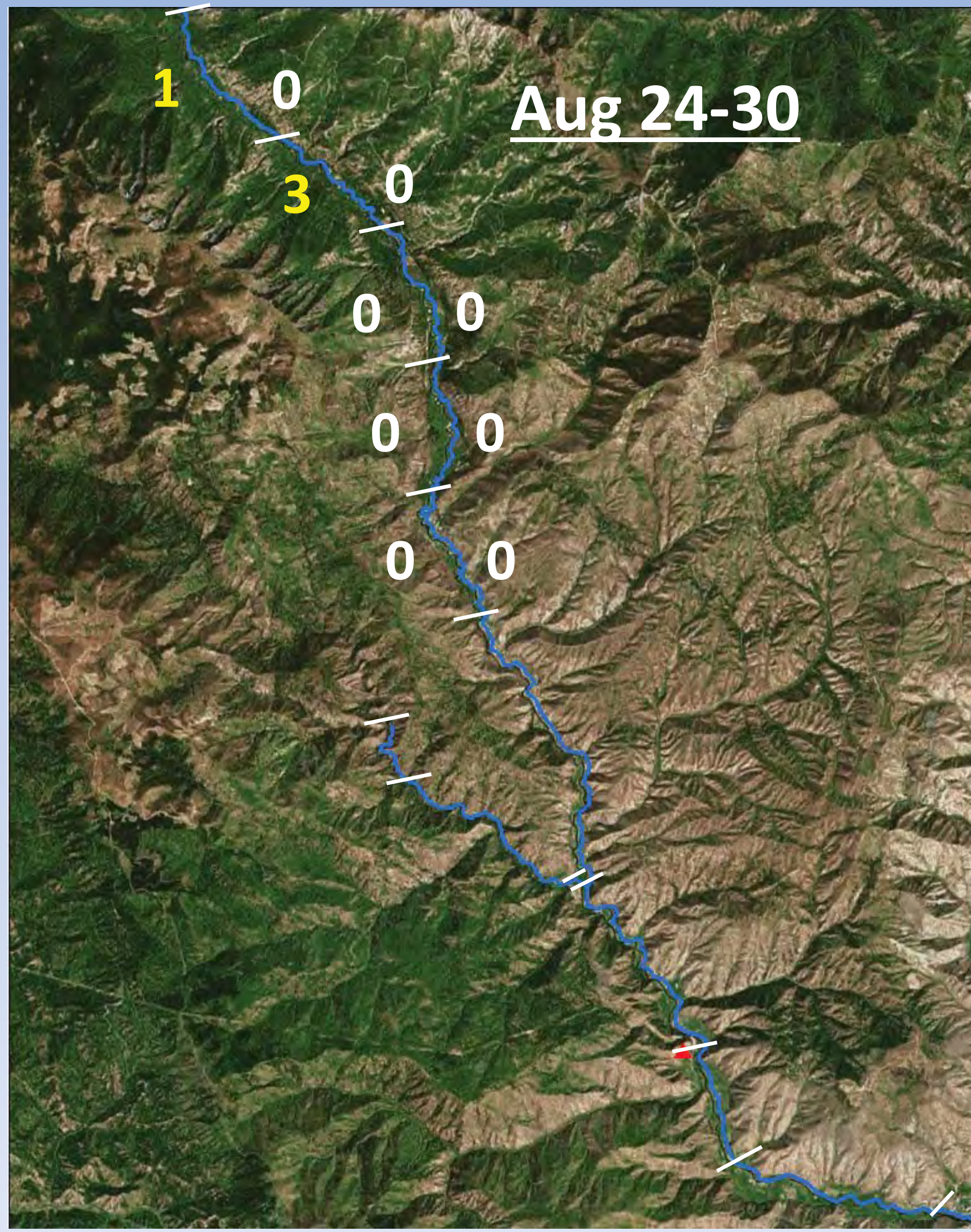
0

0

0

0

0



Summer

0

0

0

0

0

0

0

0

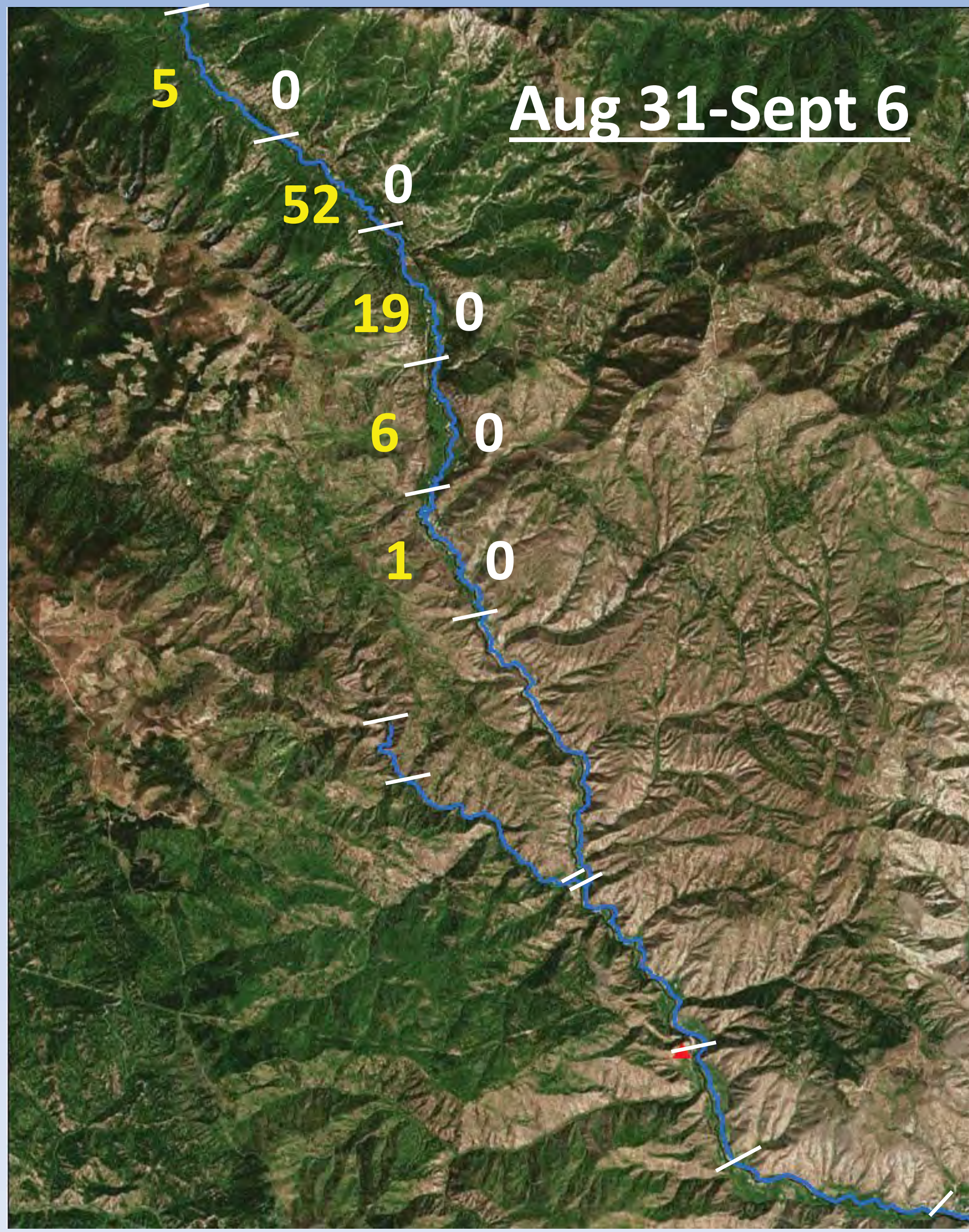
0

Total
0

Total
87

Spring

1
3
0
0
0
0
0



Summer

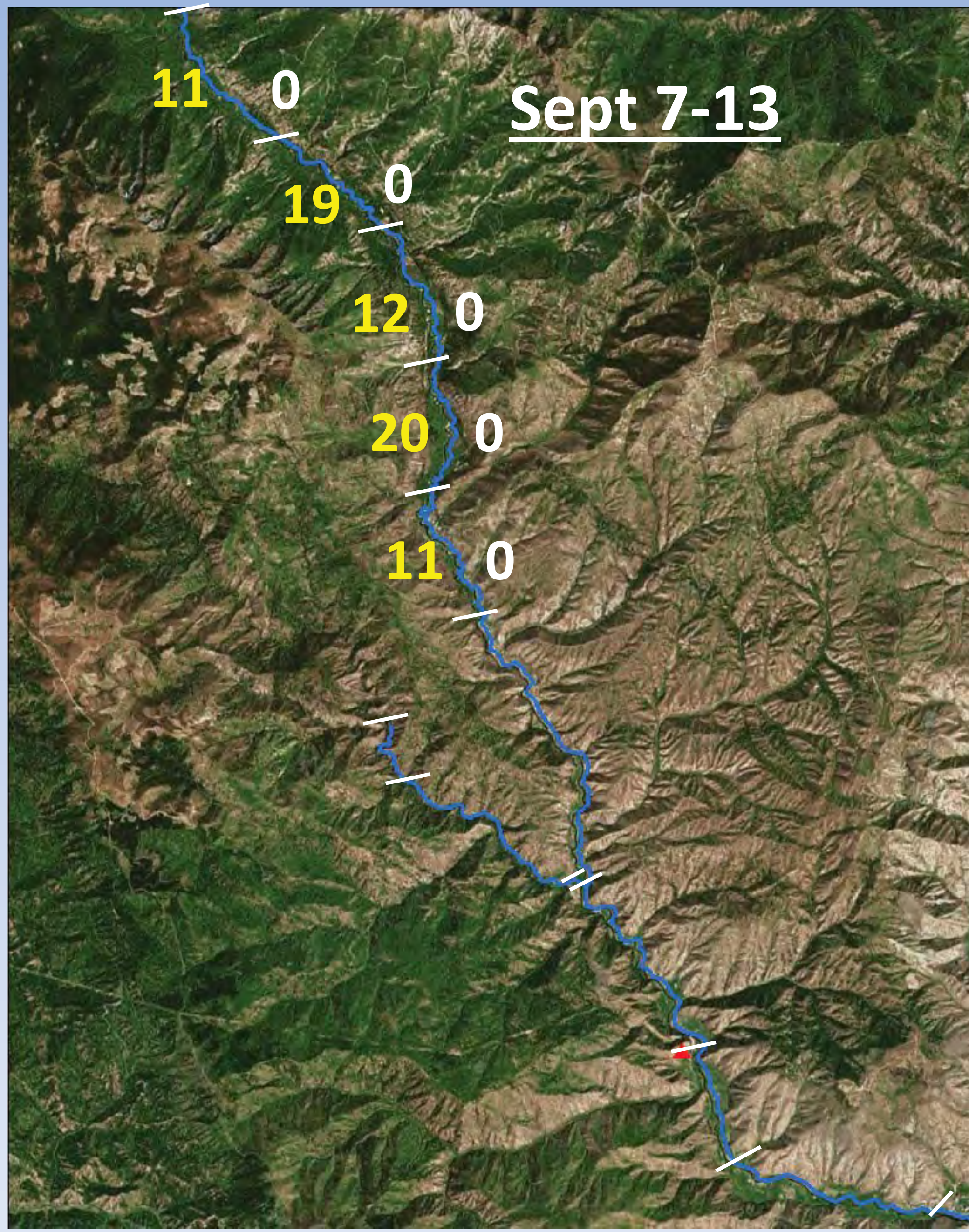
0
0
0
0
0
0
0
0
0

Total
0

Attachment I

Total
160

Spring	Summer
6	0
55	0
19	0
6	0
1	0
0	0
0	0
	0
	0

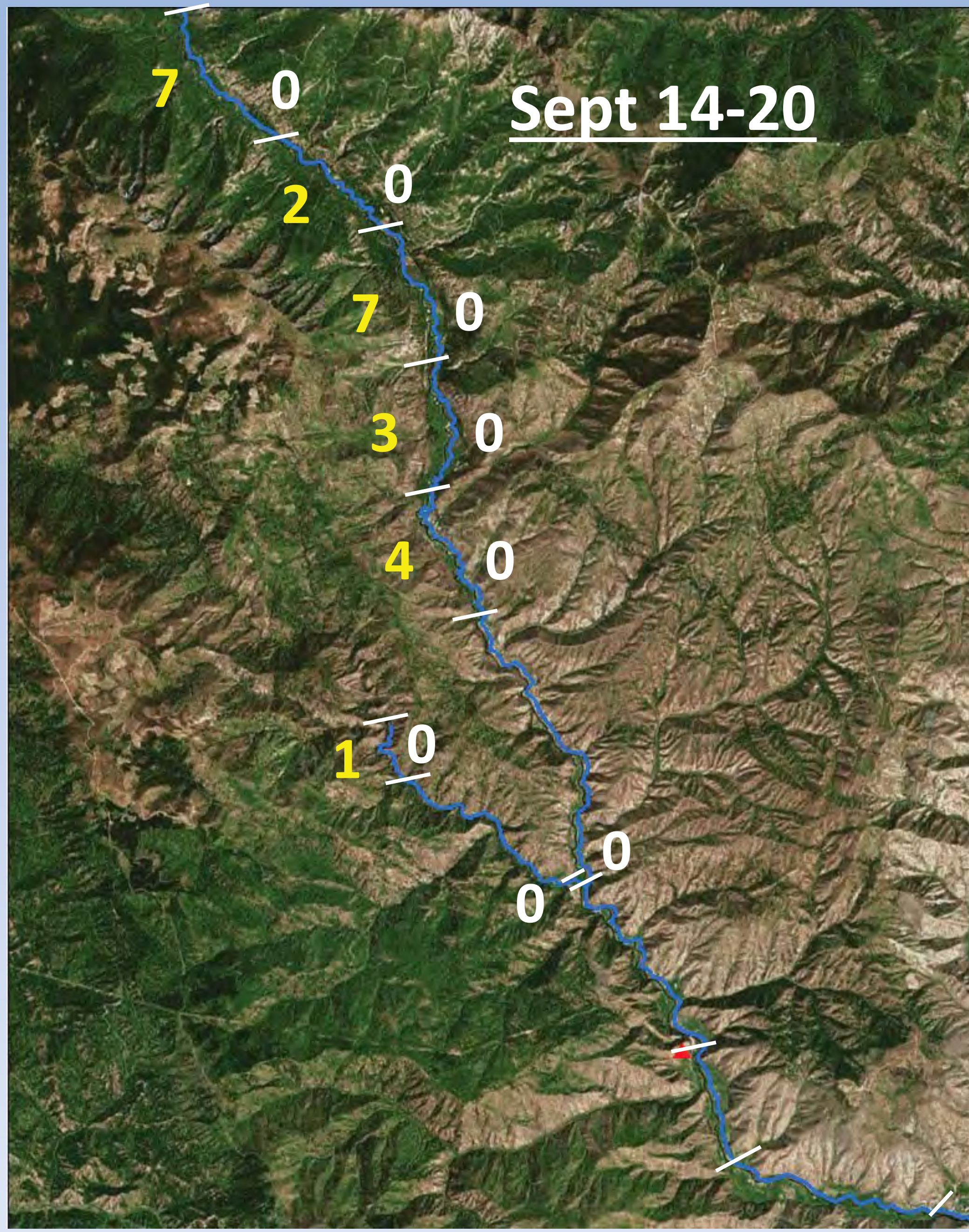


Total
0

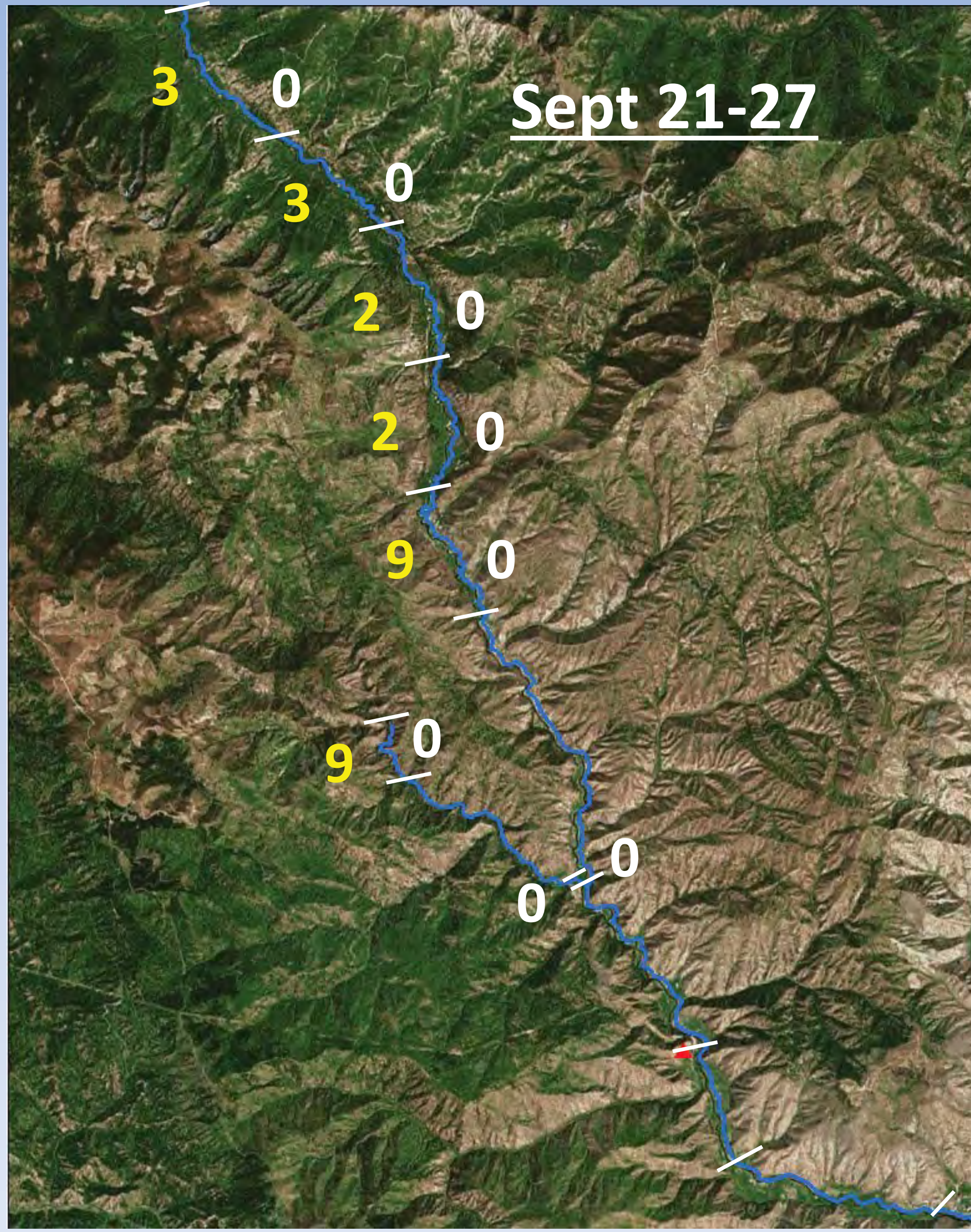
Total
184

Spring	Summer
17	0
74	0
31	0
26	0
12	0
0	0
0	0
	0
	0

Total
0



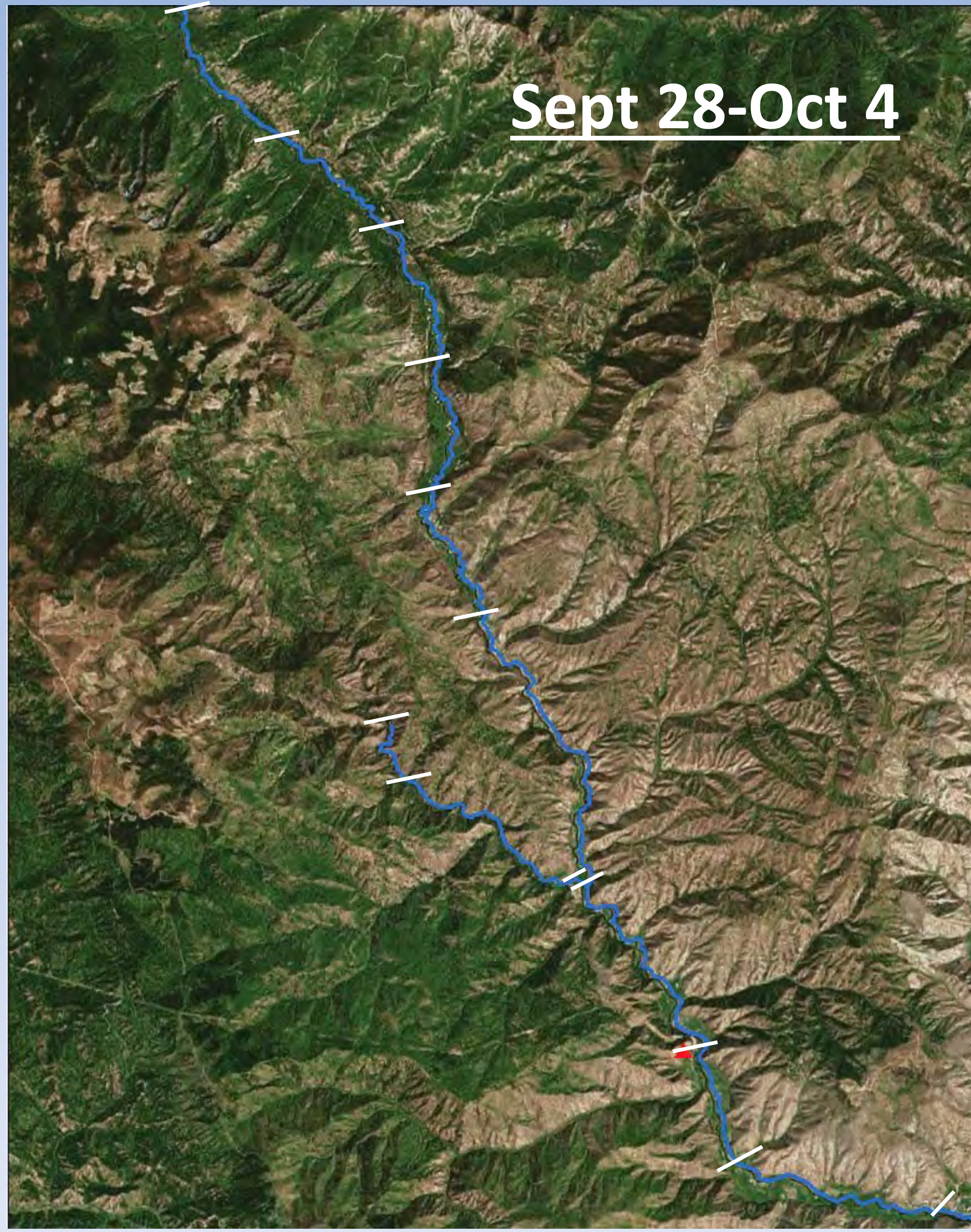
Total
212



Spring	Summer
24	0
76	0
38	0
29	0
16	0
1	0
0	0
	0
	0

Total
0

Attachment I

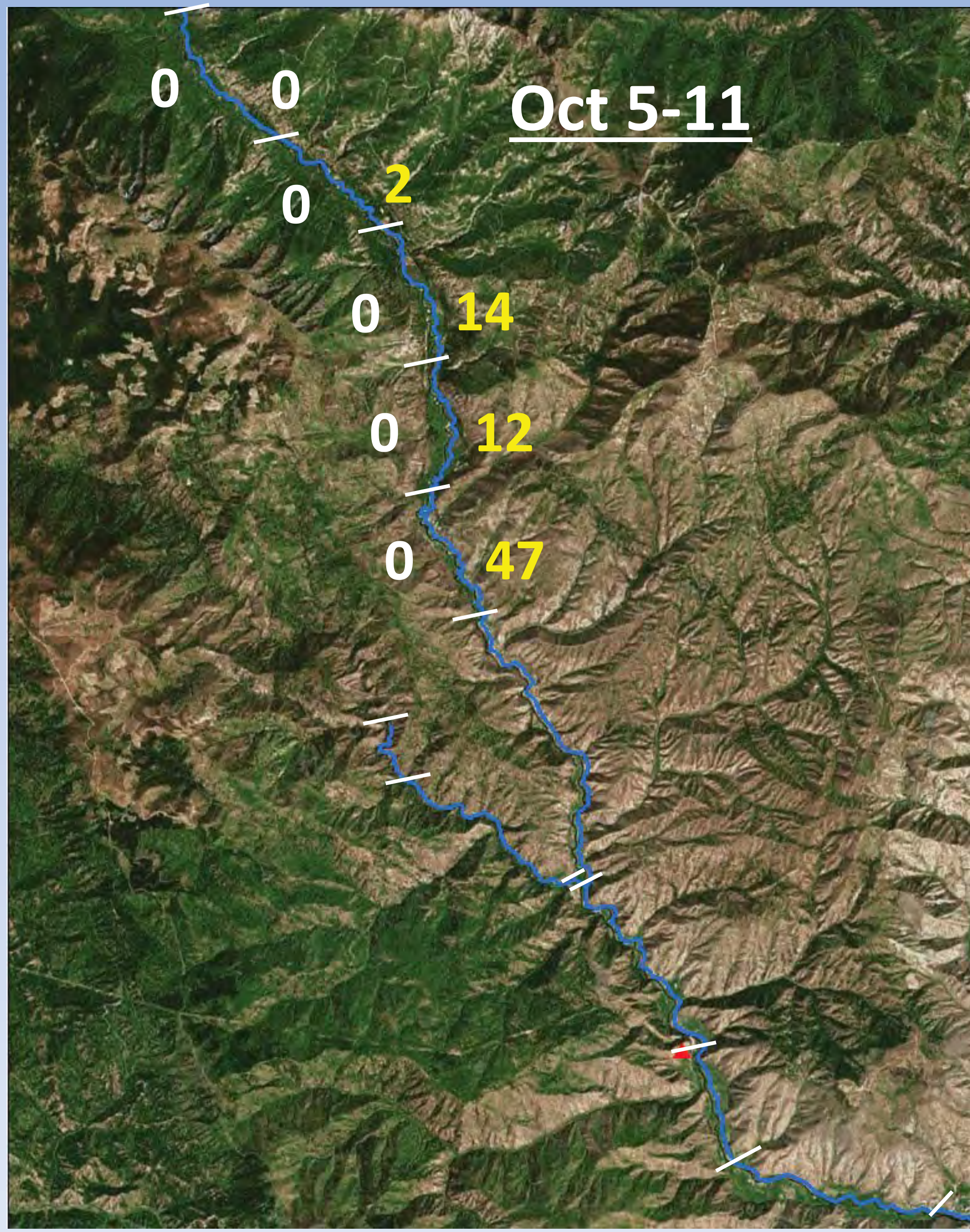


Spring	Summer
27	0
79	0
40	0
31	0
25	0
10	0
0	0
	0
	0

	Spring	Summer
Total	212	0

Attachment I

Total	Spring	Summer	Total
212	27	0	75
	79	0	
	40	0	
	31	0	
	25	0	
	10	0	
	0	0	
		0	
		0	



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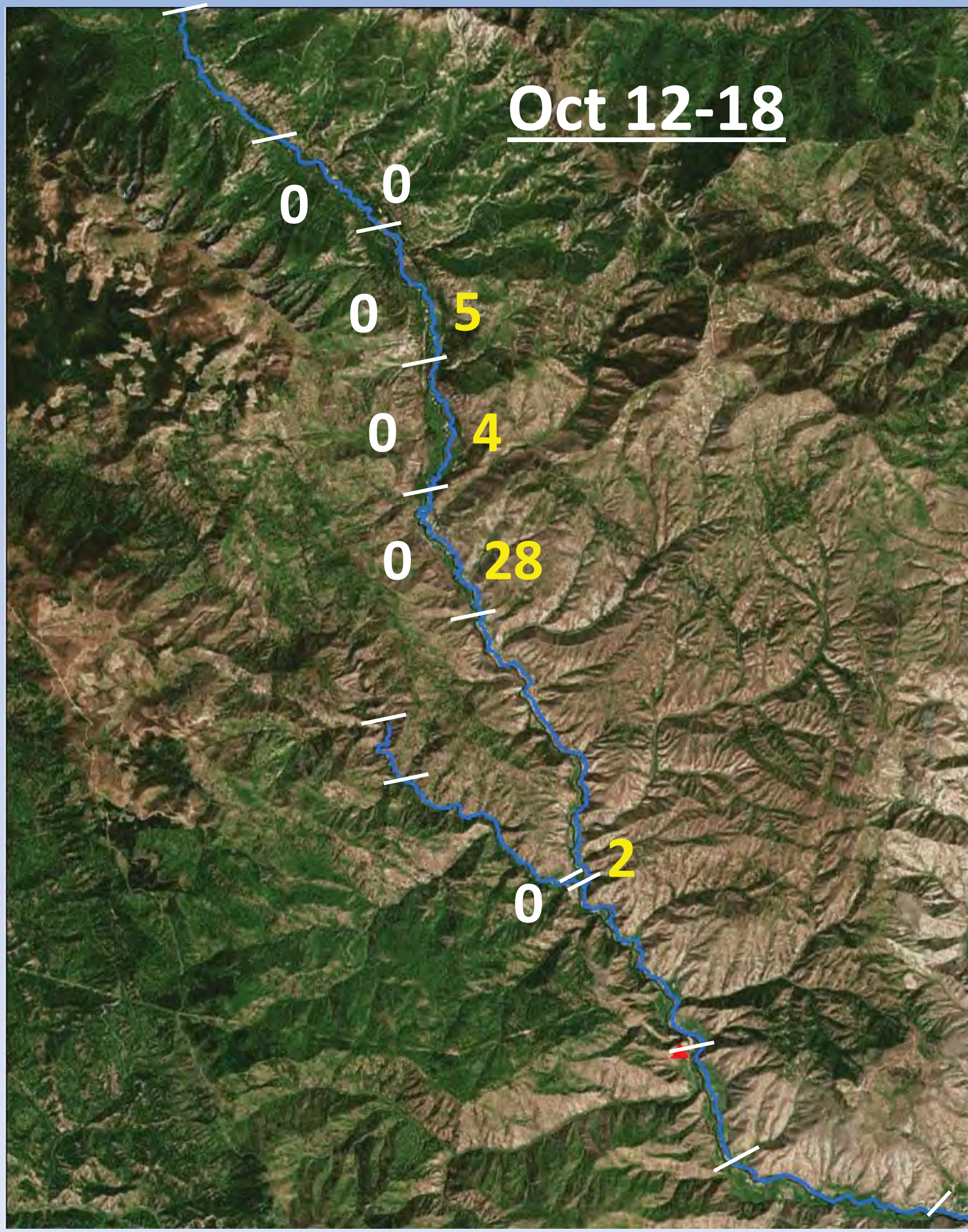
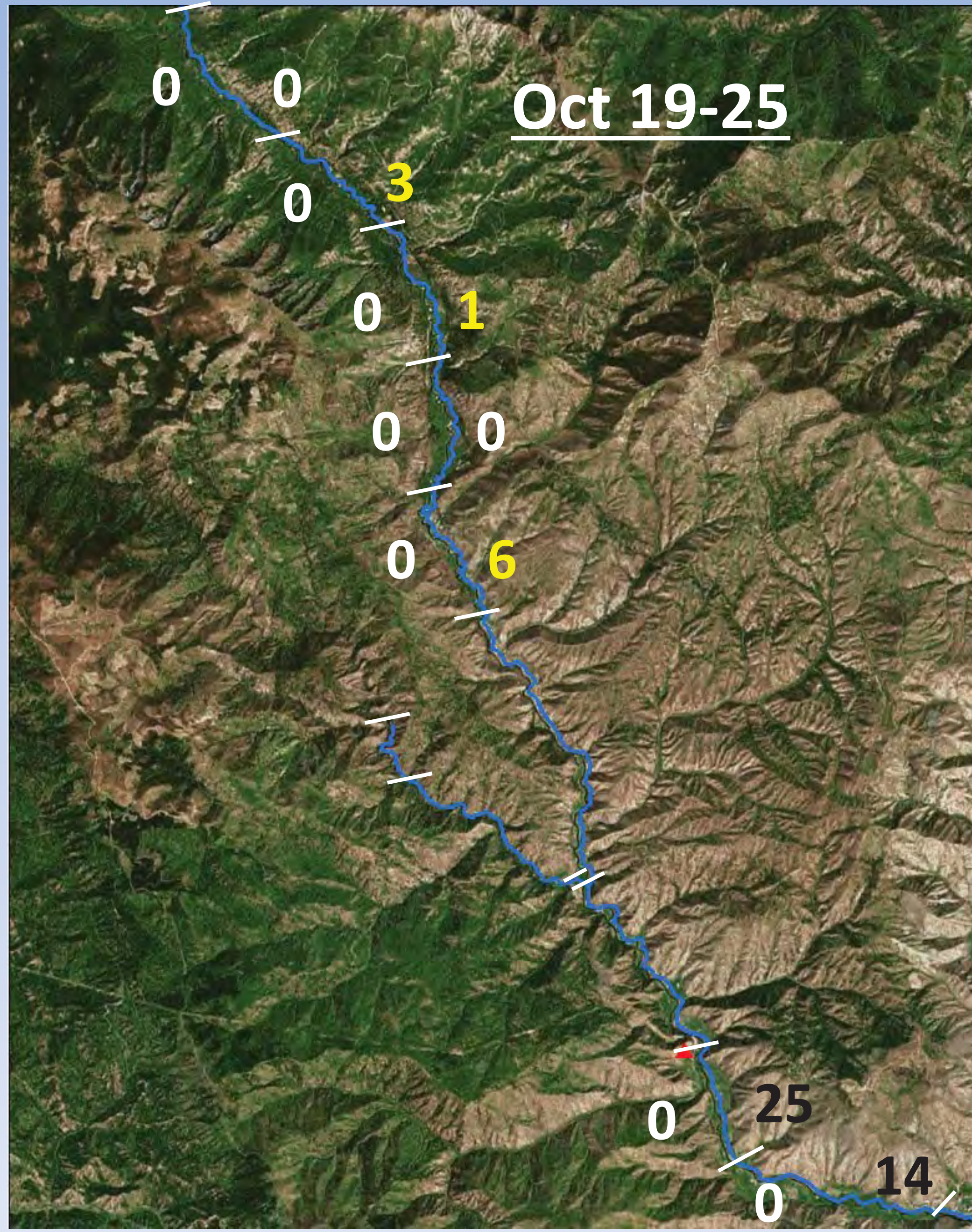


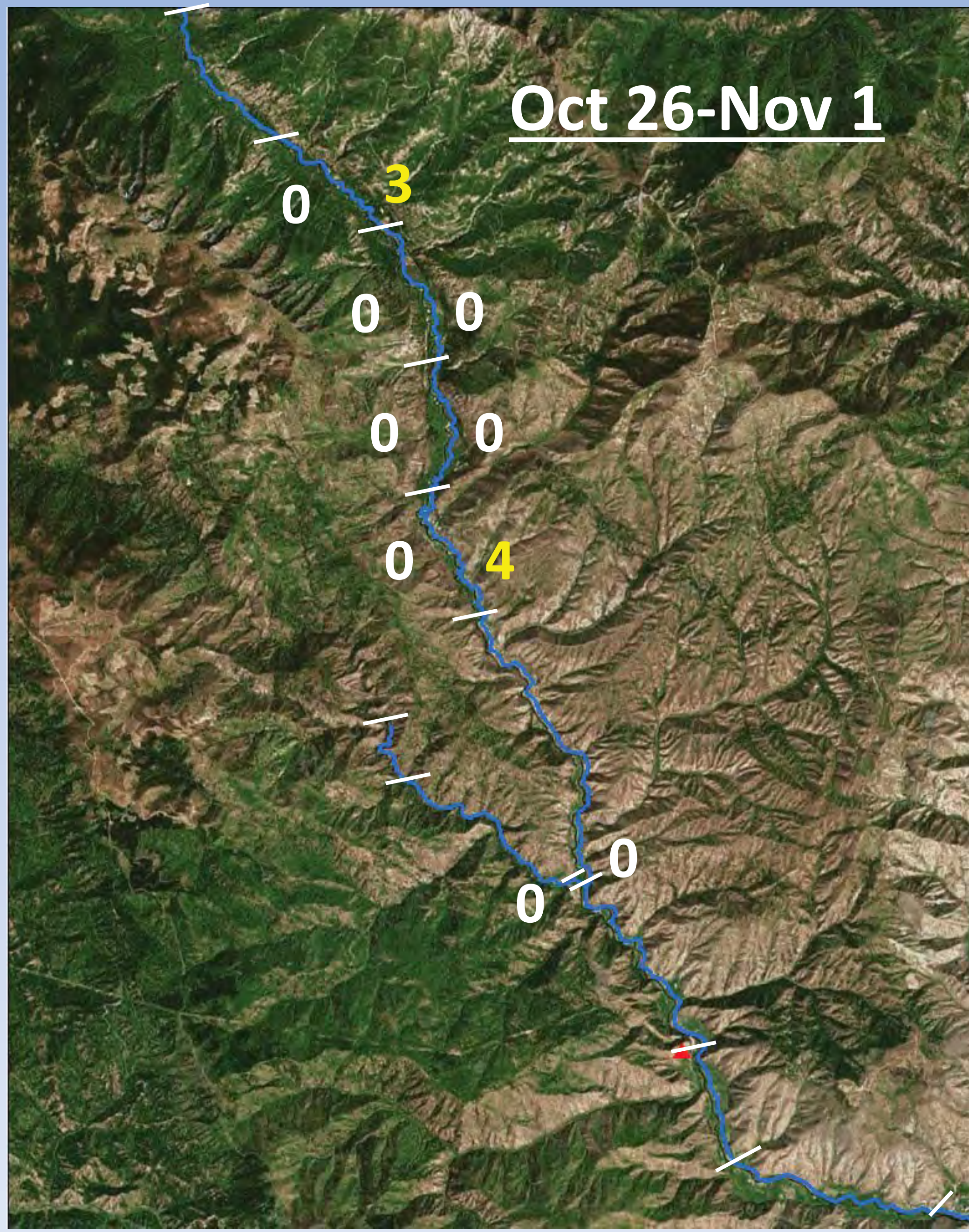
Total	Spring	Summer	Total
212	27	0	114
	79	2	
	40	14	
	31	12	
	25	47	
	10	0	
	0	0	
		0	
		0	

Total	Spring		Summer	Total
212	27		0	163
	79		2	
	40		19	
	31		16	
	25		75	
	10		0	
	0		2	
			0	
			0	



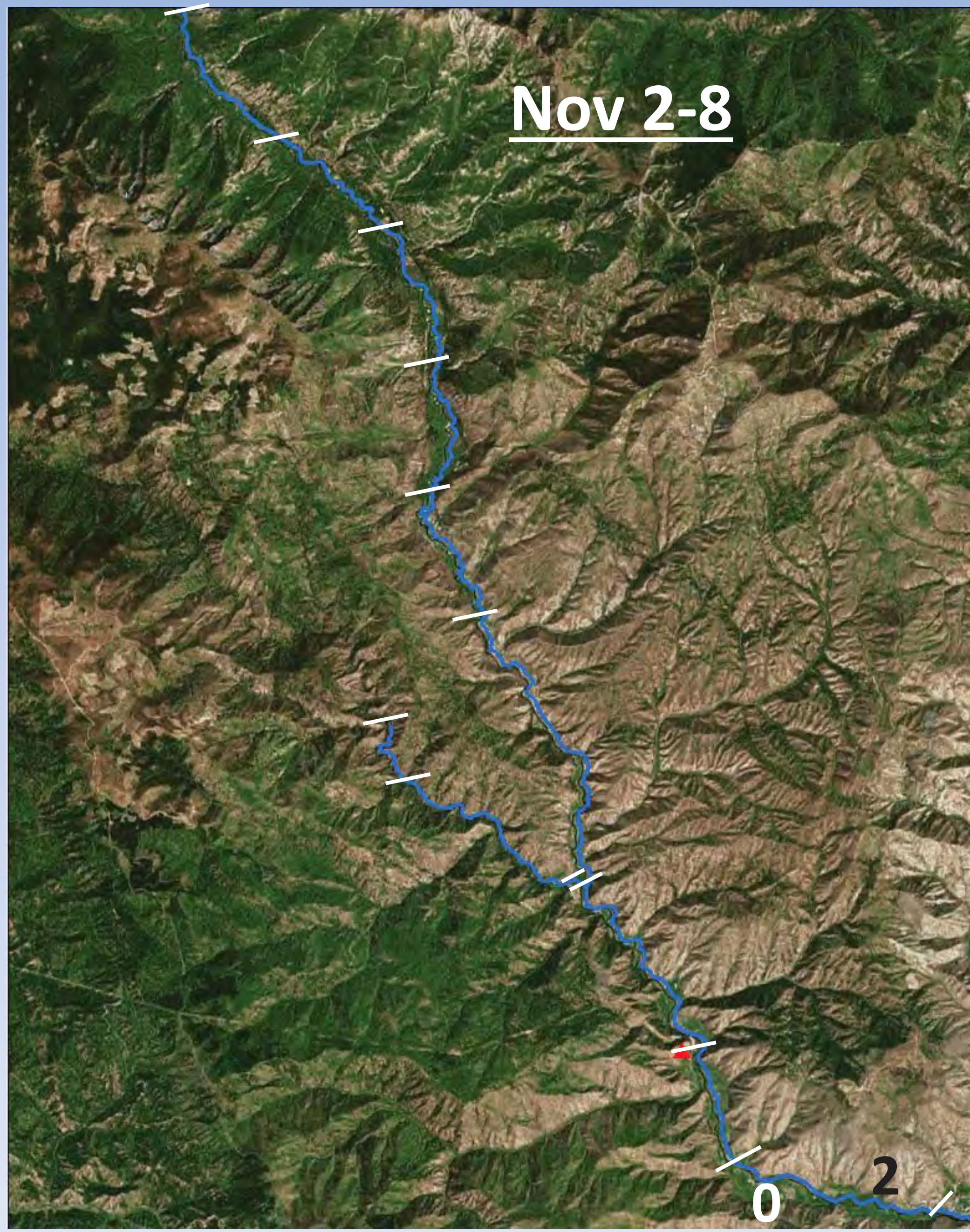
Attachment I

	Spring	Summer	
Total 212	27	0	**Total** 170
	79	5	
	40	20	
	31	16	
	25	81	
	10	0	
	0	2	
		25	
		14	



Attachment I

Total
212



Spring	Summer
27	0
79	8
40	20
31	16
25	85
10	0
0	2
	25
	14

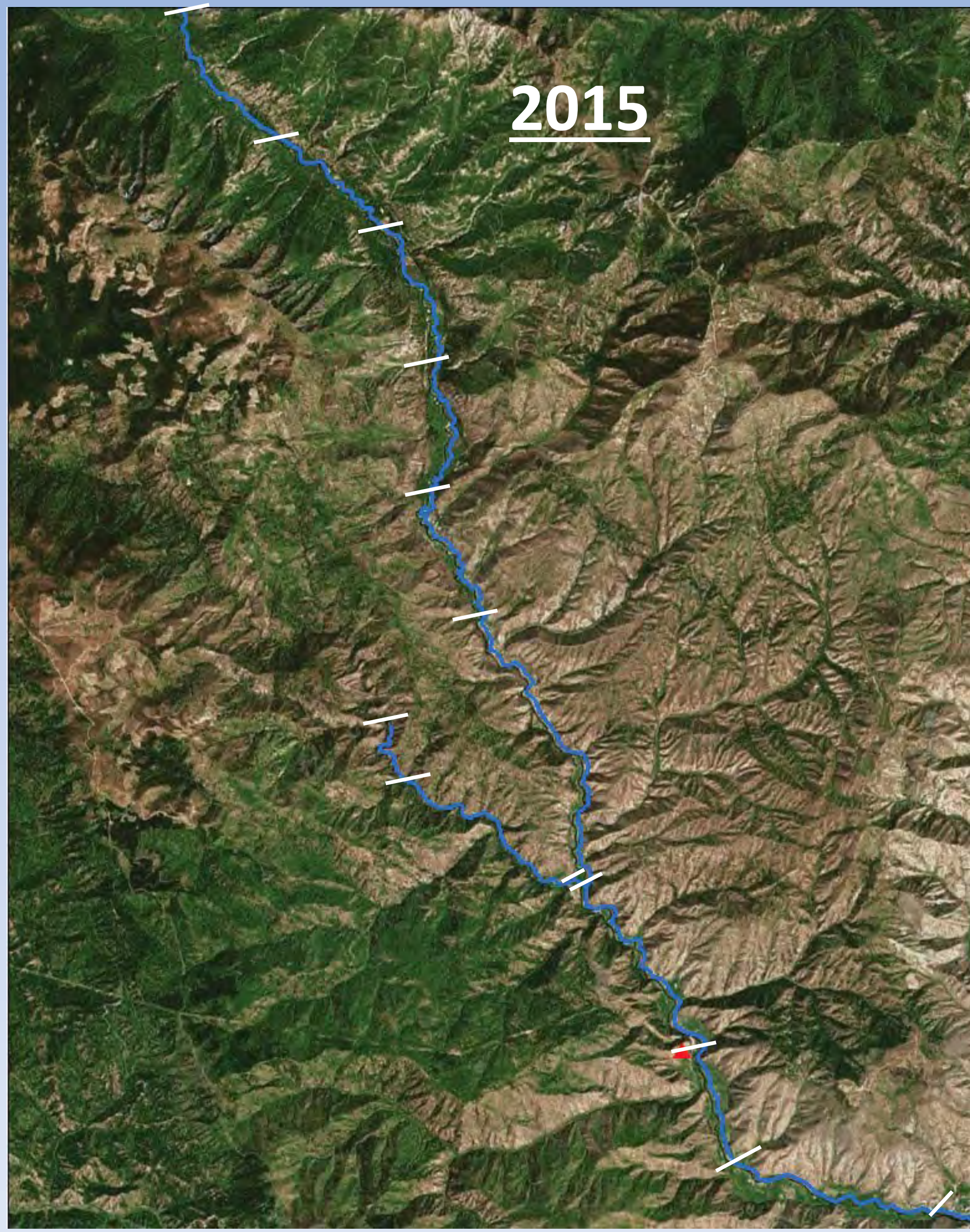
Total
172

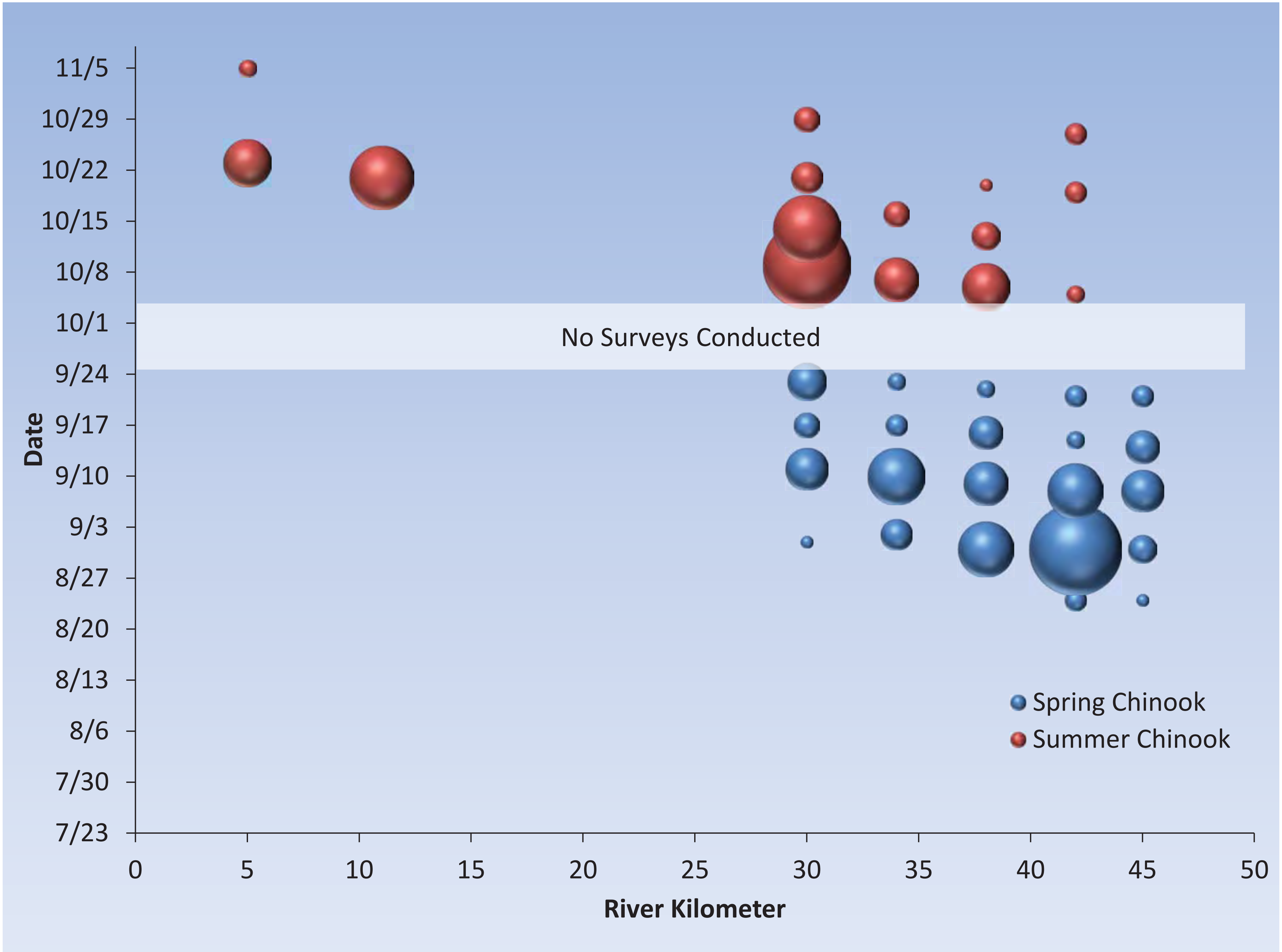
Attachment I

Total 212 (Spring)

Total 172 (Summer)

Spring	Summer
27	0
79	8
40	20
31	16
25	85
10	0
0	2
	25
	16




11/5
10/29
10/22
10/15
10/8
10/1
9/24
9/17
9/10
9/3
8/27
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Date
No Surveys Conducted
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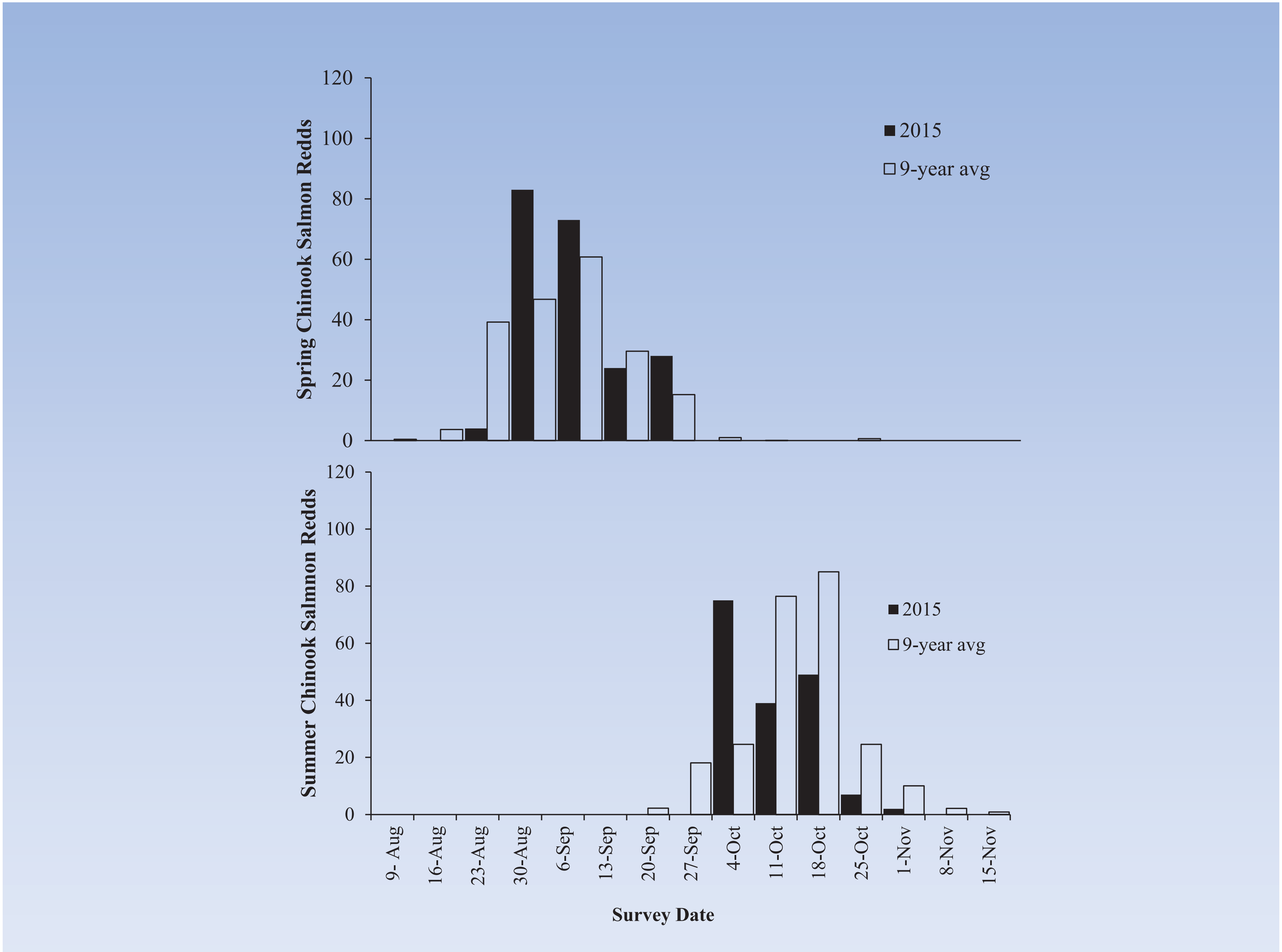
5
10
15
20
25
30
35
40
45
50
River Kilometer
Spring Chinook
Summer Chinook


120
100
80
60
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0
Spring Chinook Salmon Redds
2015
9-year avg
120
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Summer Chinook Salmnon Redds
2015
9-year avg
9- Aug
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23-Aug
30-Aug
6-Sep
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20-Sep
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4-Oct
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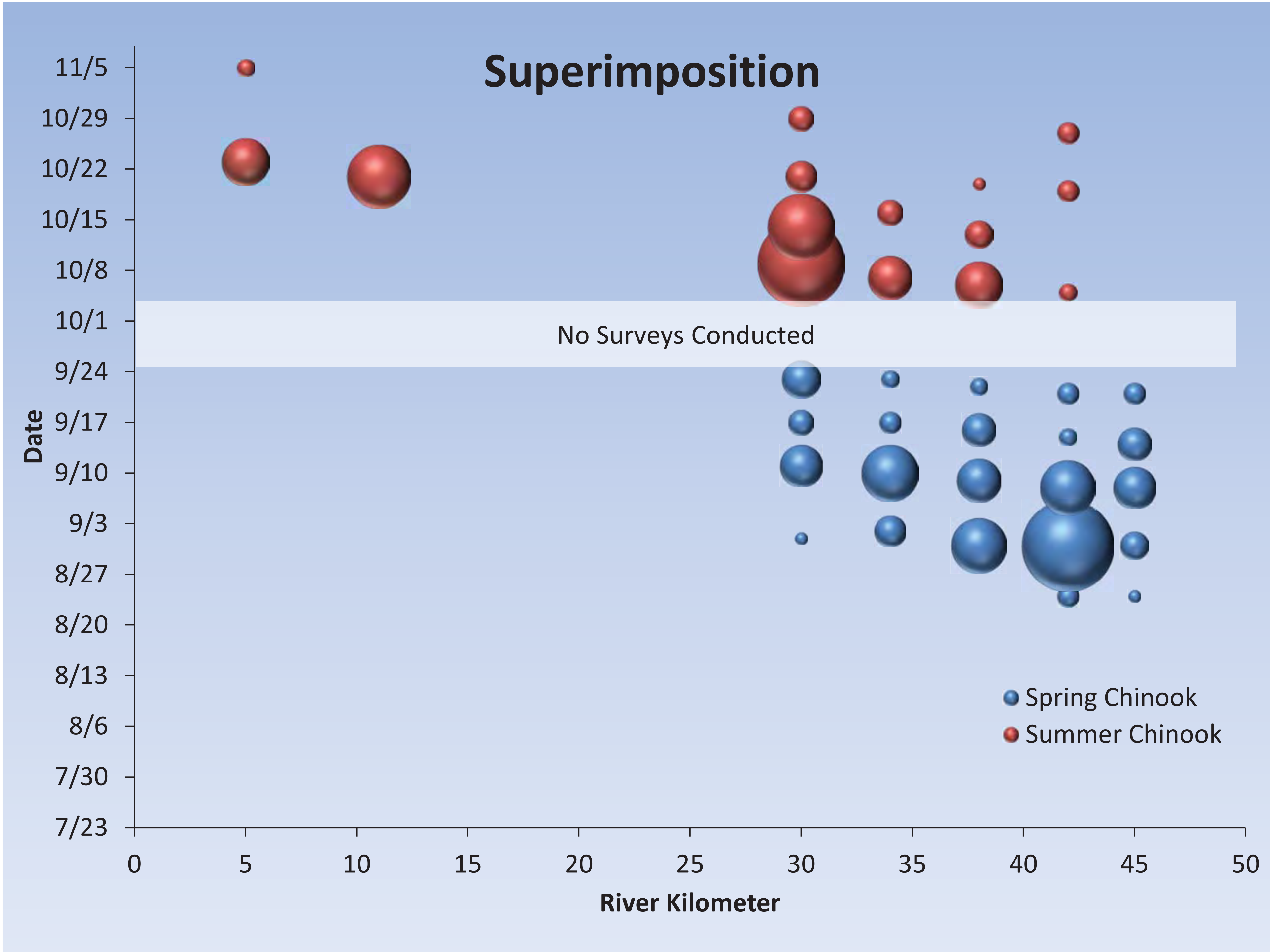
8-Nov
15-Nov
Survey Date


Superimposition
11/5
10/29
10/22
10/15
10/8
10/1
9/24
9/17
9/10
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Date
No Surveys Conducted
0
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10
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20
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40
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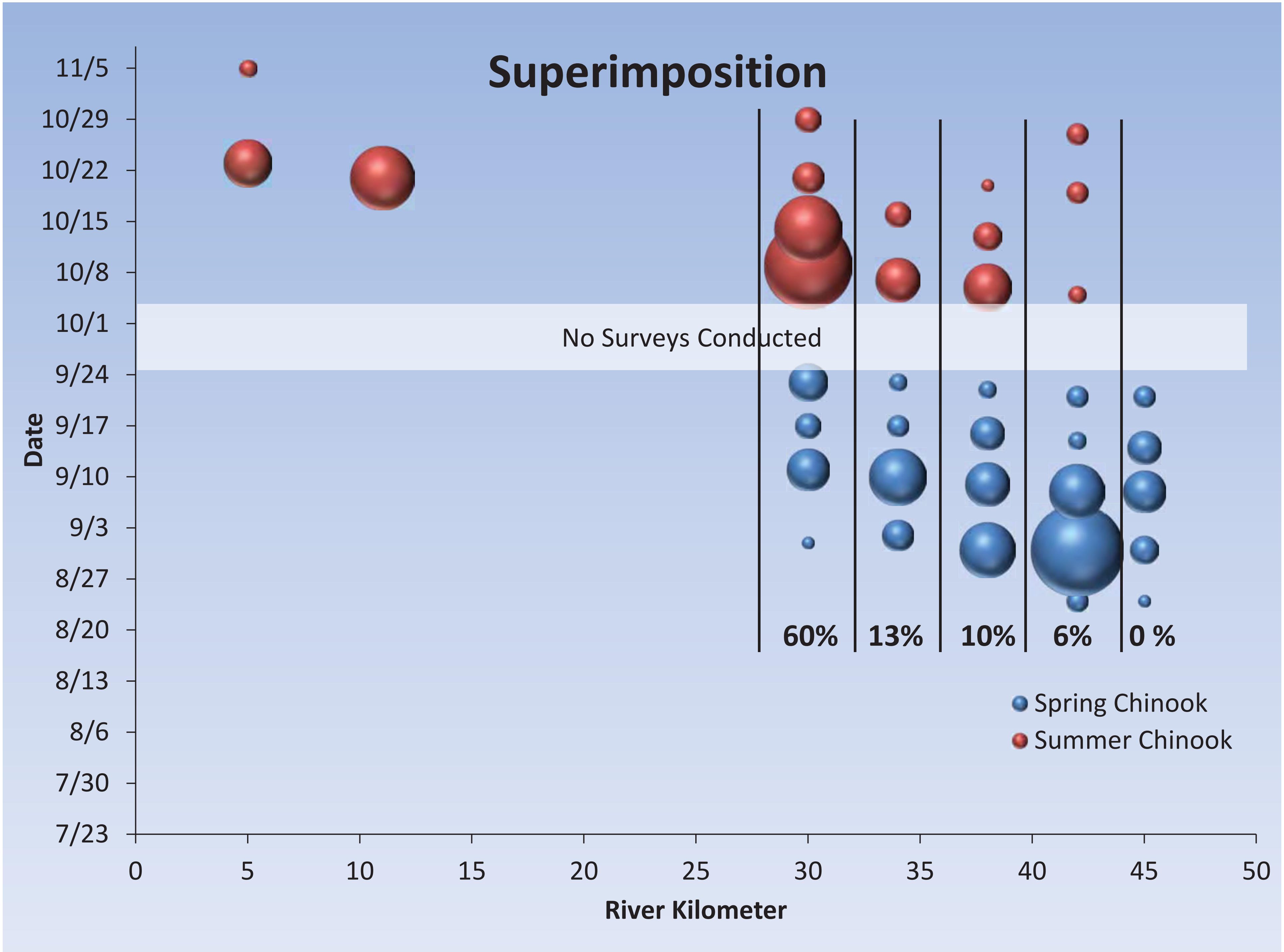
50
River Kilometer
Spring Chinook
Summer Chinook

Attachment I



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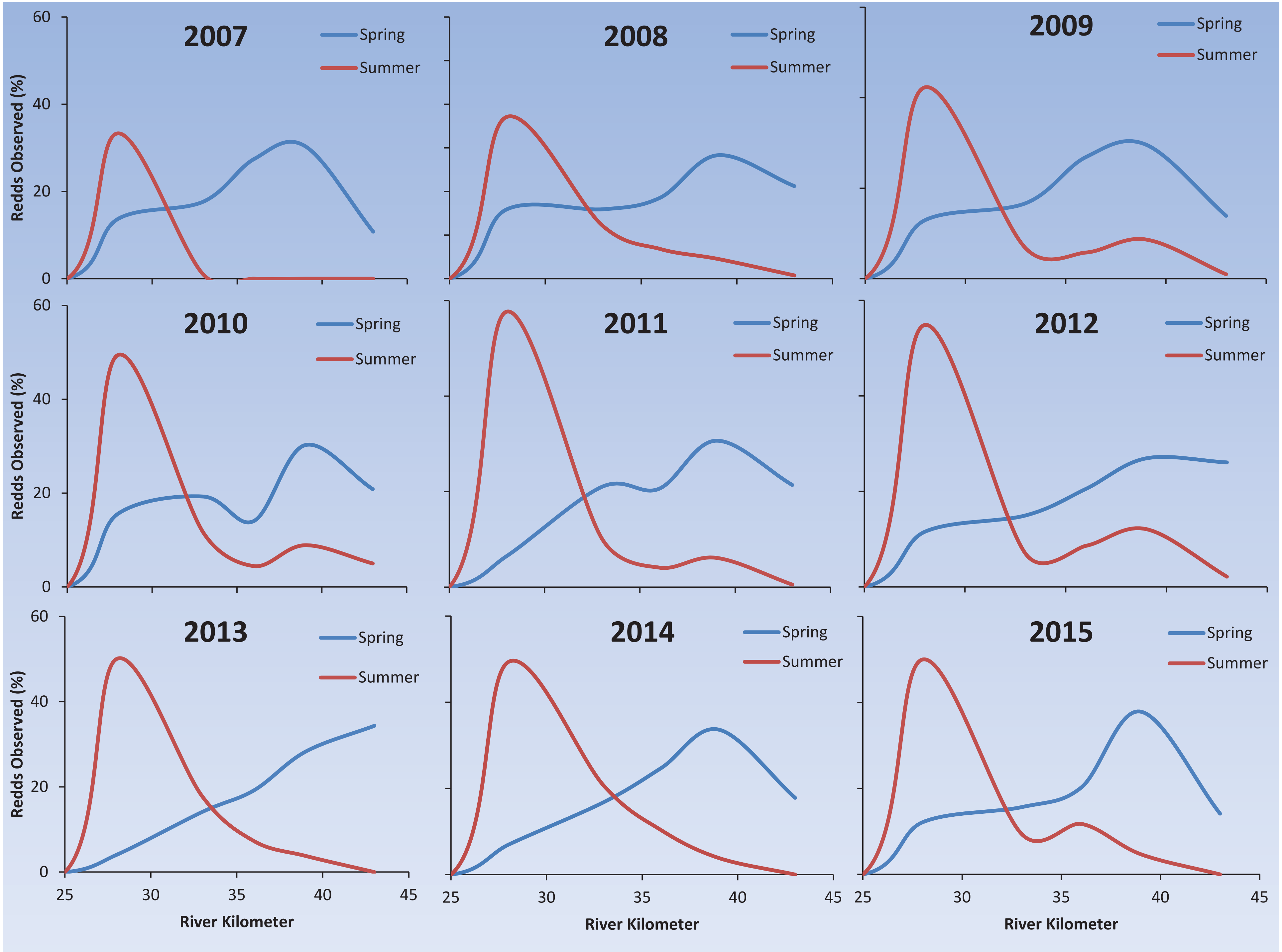
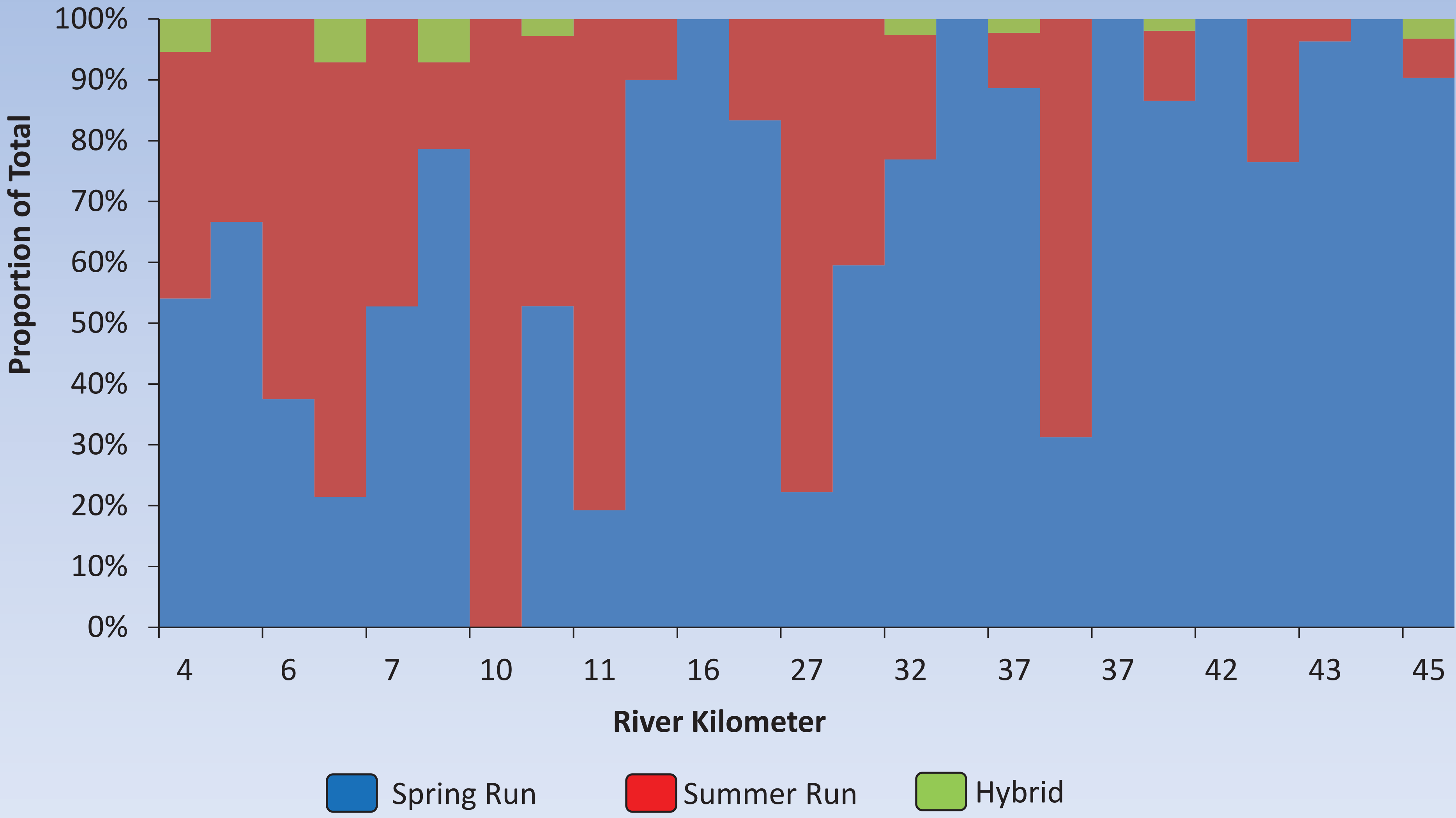



2007
2008
2009
2010
2011
2012
2013
2014
2015
Summer
Spring
Redd Abundance
0
50
100
150
200
250
30
34
38
42
45
River Kilometer

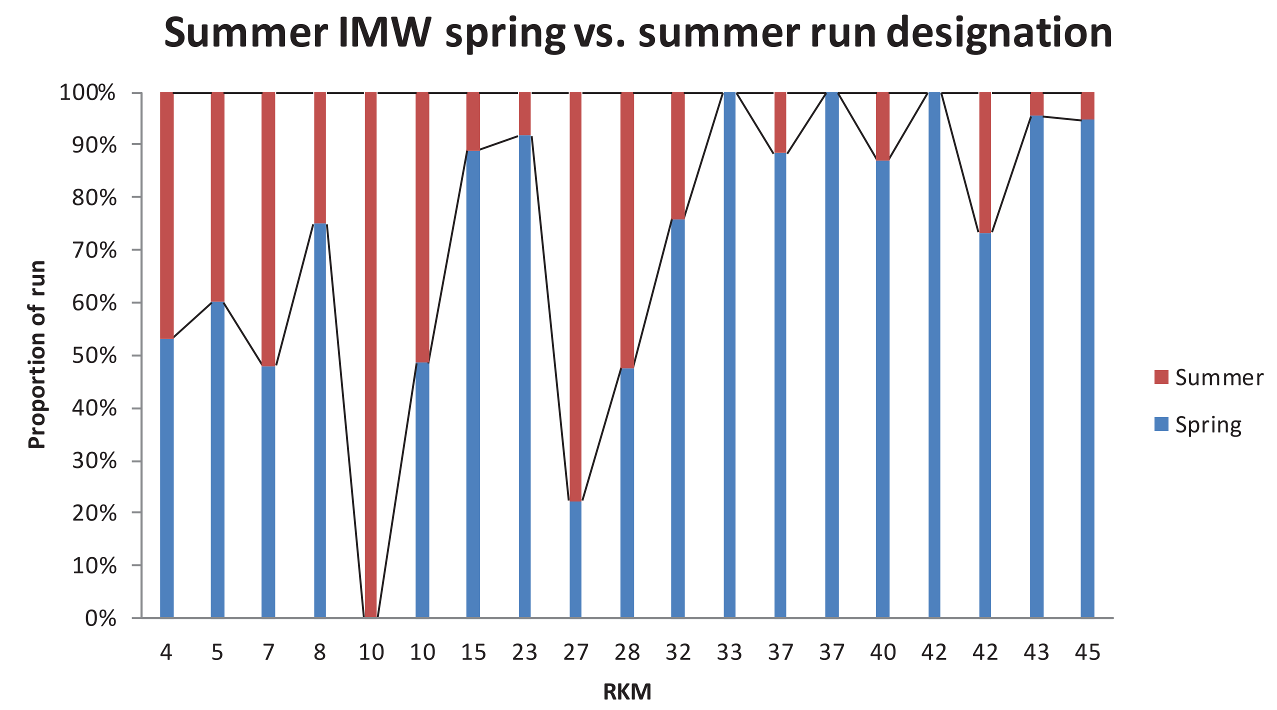
Attachment I

Genetic Spatial Distribution



Chinook Life Histories

- Spring Chinook migrate as yearlings
- Summer Chinook migrate as sub-yearlings


Summer IMW spring vs. summer run designation
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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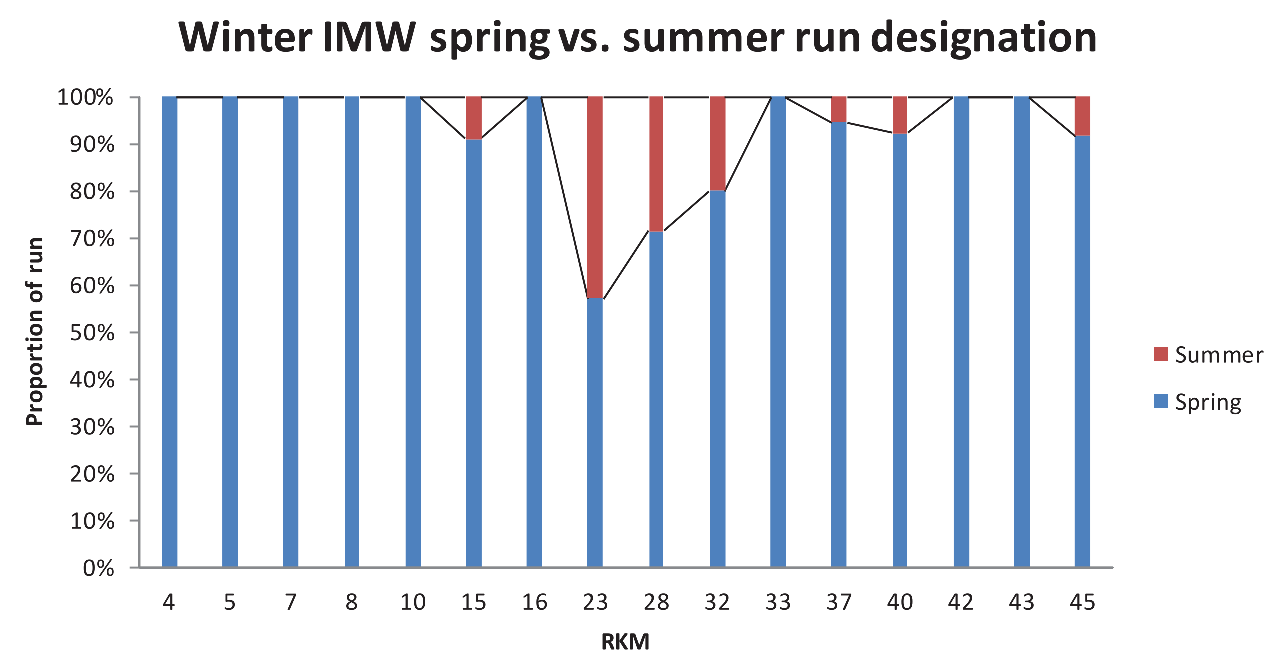
Proportion of run
4 5 7 8 10 10 15 23 27 28 32 33 37 37 40 42 42 43 45
RKM
Summer
Spring


Winter IMW spring vs. summer run designation
100%
90%
80%
70%
60%
50%
40%
30%
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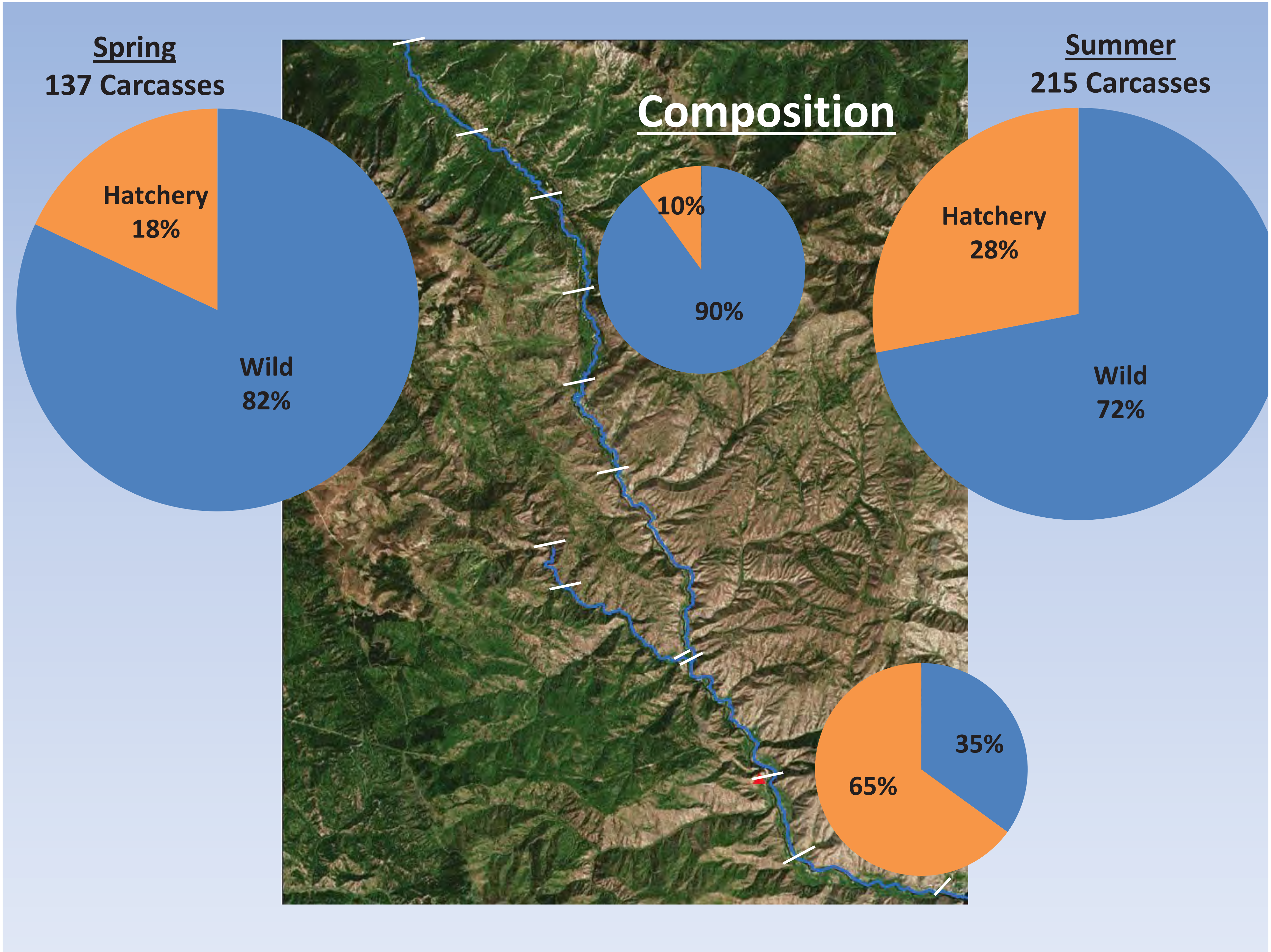
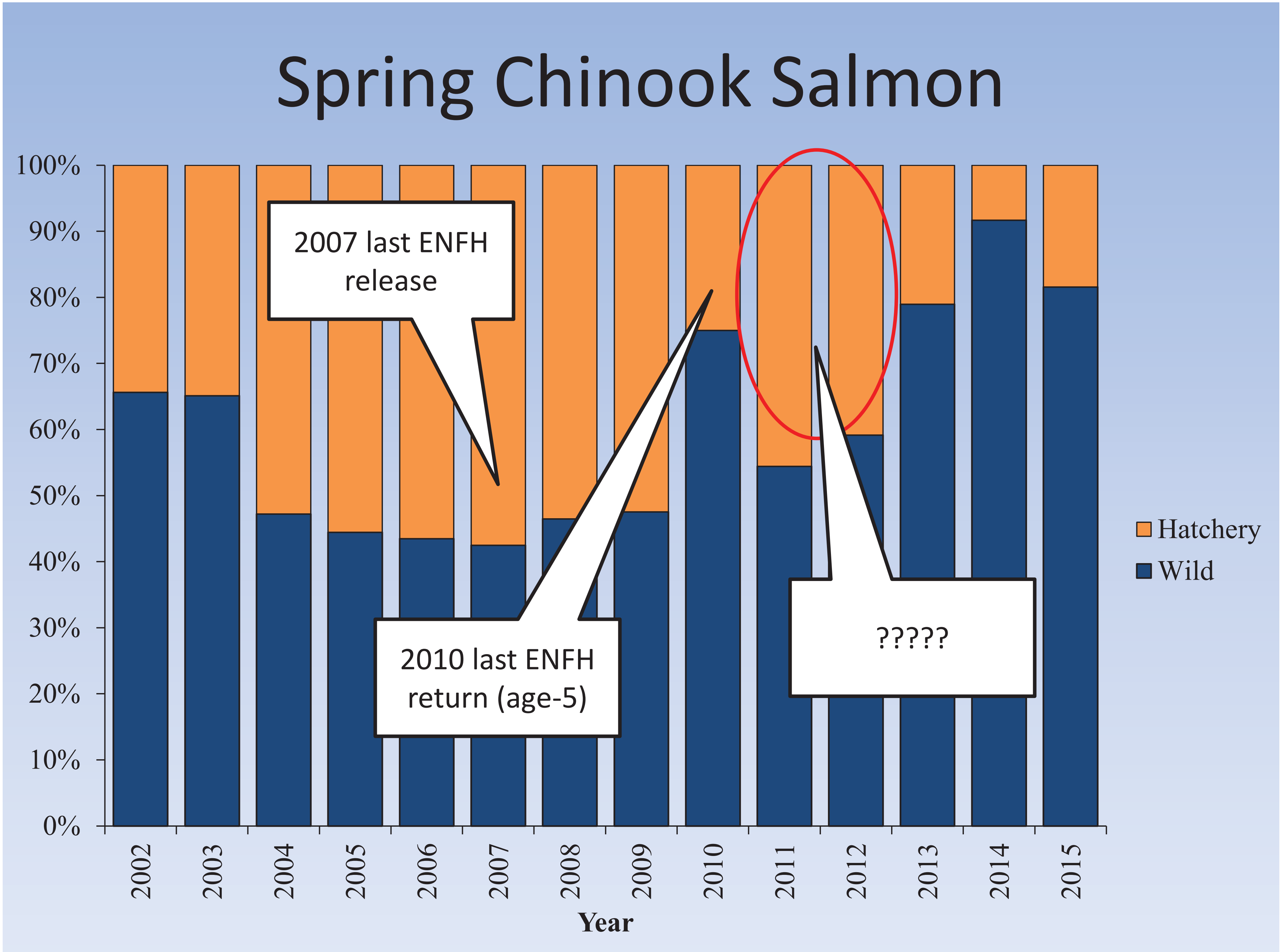
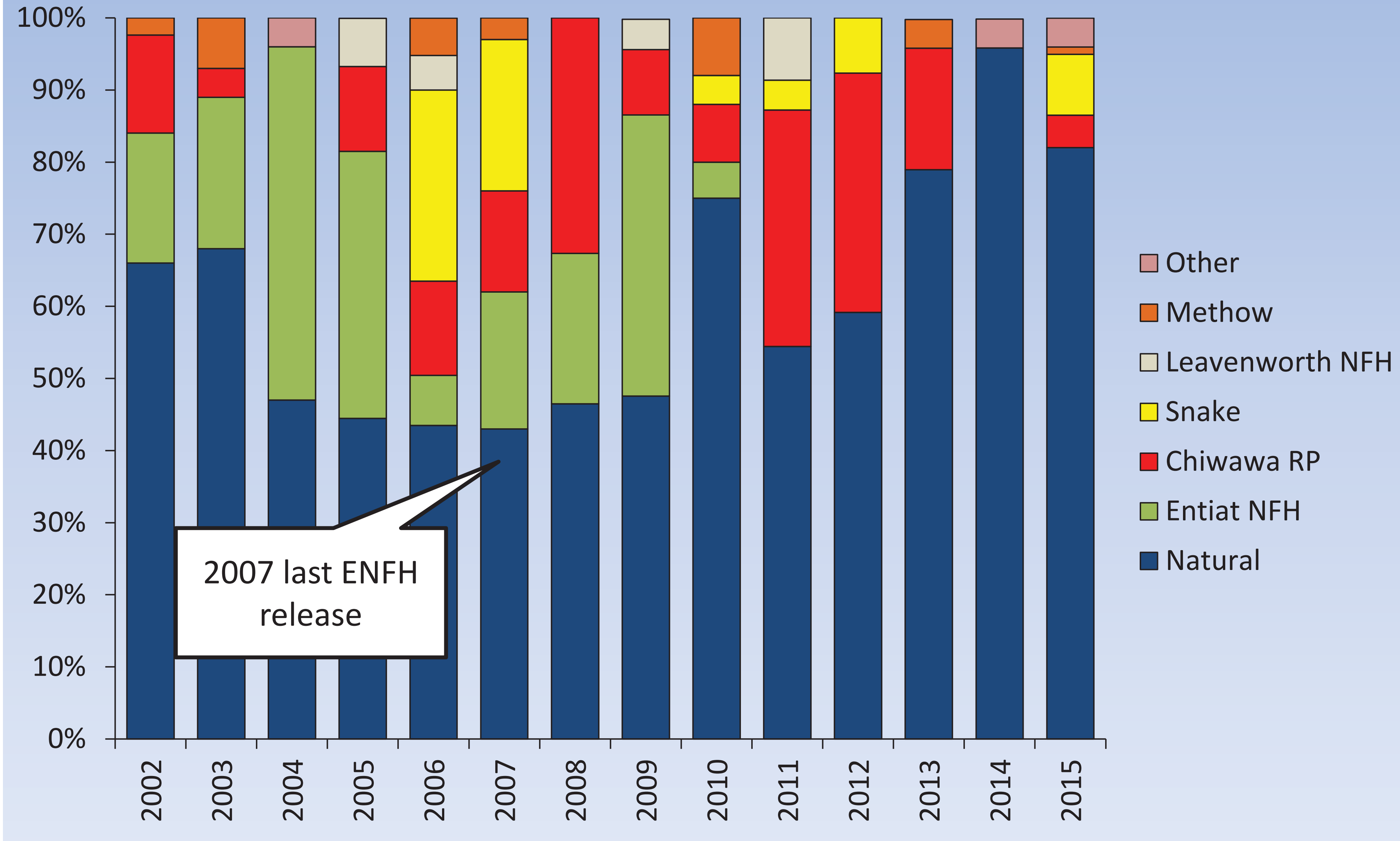
0%
Proportion of run
4 5 7 8 10 15 16 23 28 32 33 37 40 42 43 45
RKM
Summer
Spring

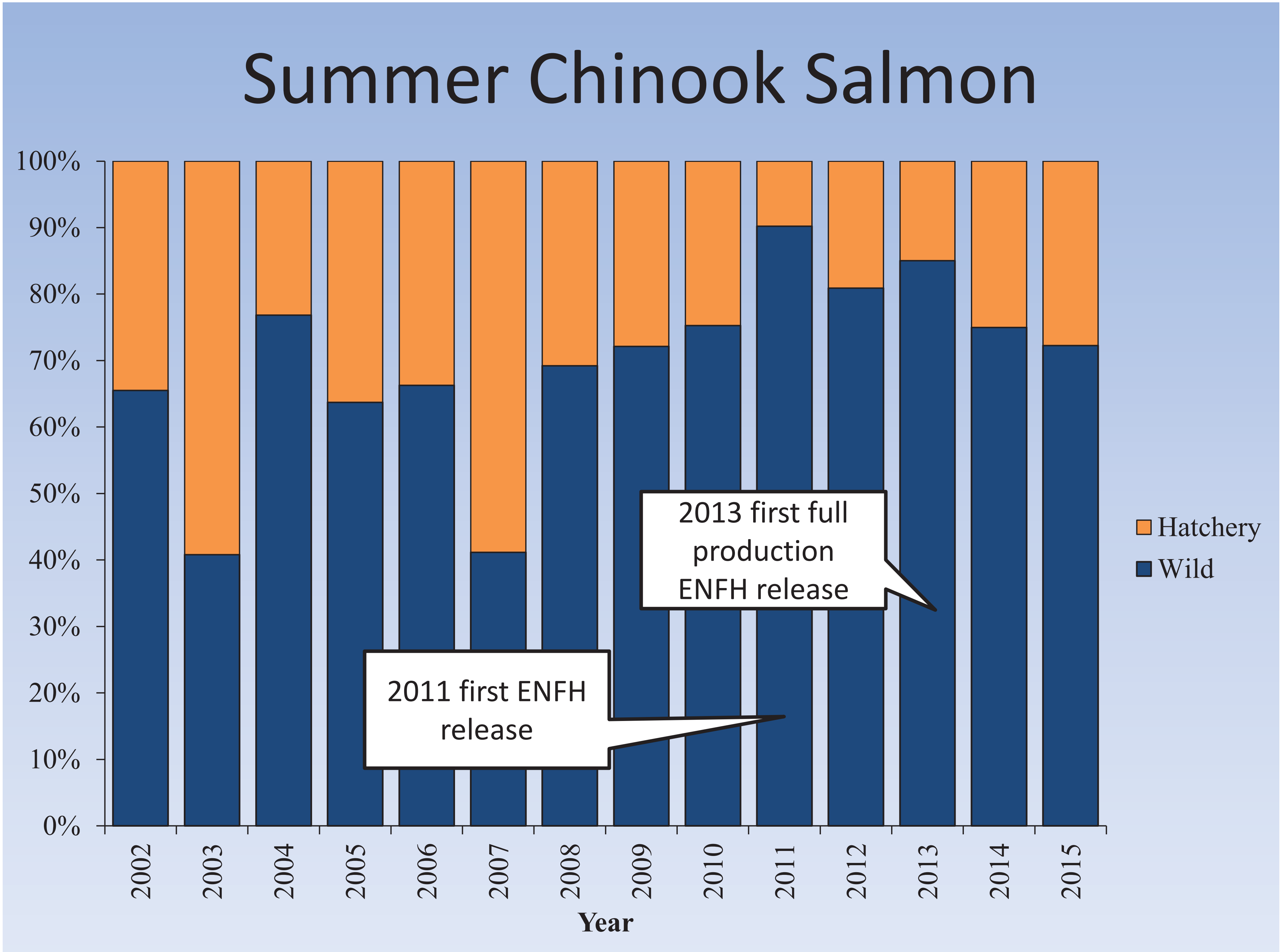

Spring
137 Carcasses
Hatchery
18%
Wild
82%
Composition
10%
90%
Summer
215 Carcasses
Hatchery
28%
Wild
72%
35%
65%

Attachment I



Spring Chinook Salmon




Summer Chinook Salmon
100%
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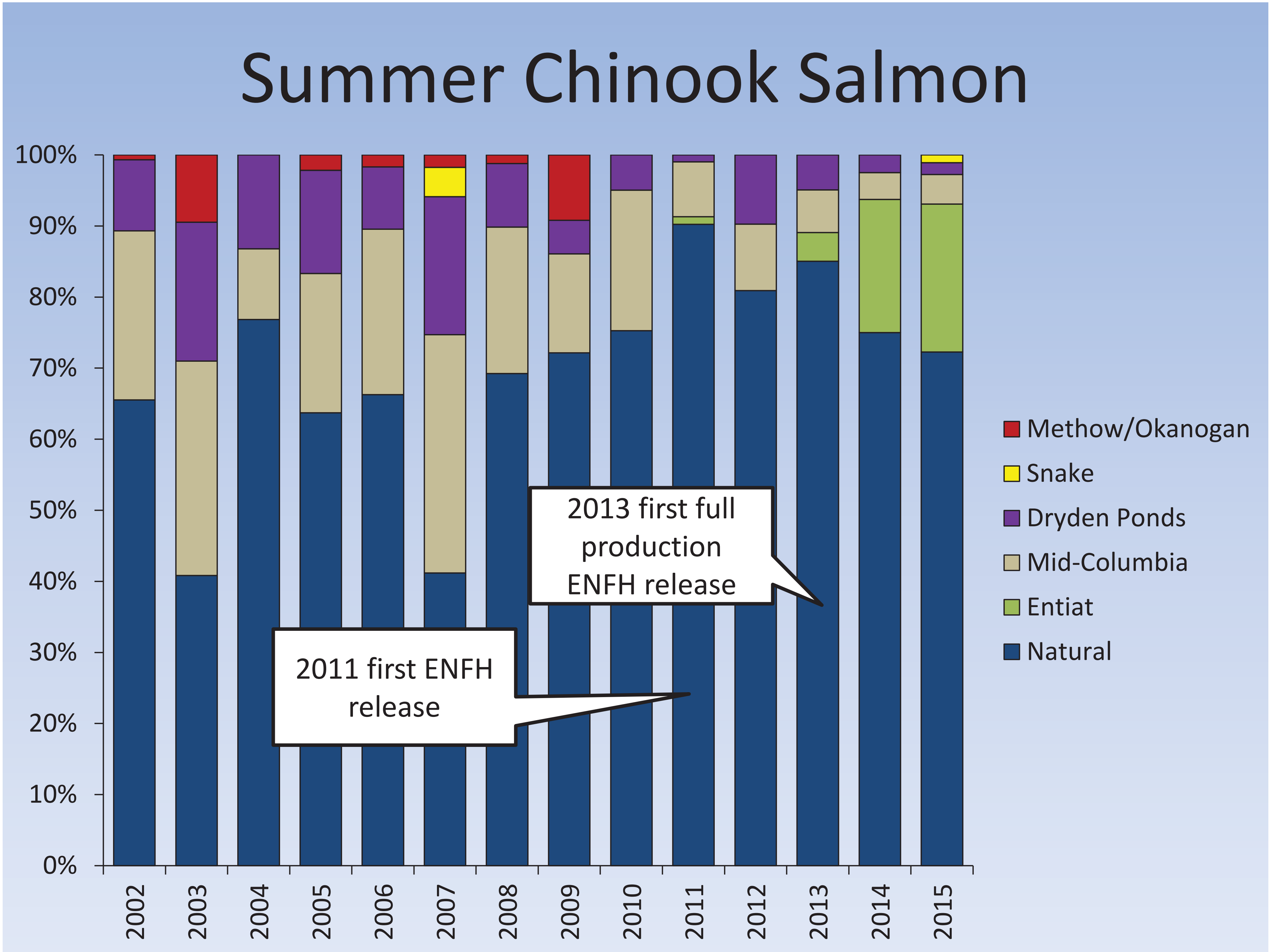
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year
Hatchery
Wild
2013 first full production ENFH release
2011 first ENFH release



Summer Chinook Salmon
100%
90%
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10%
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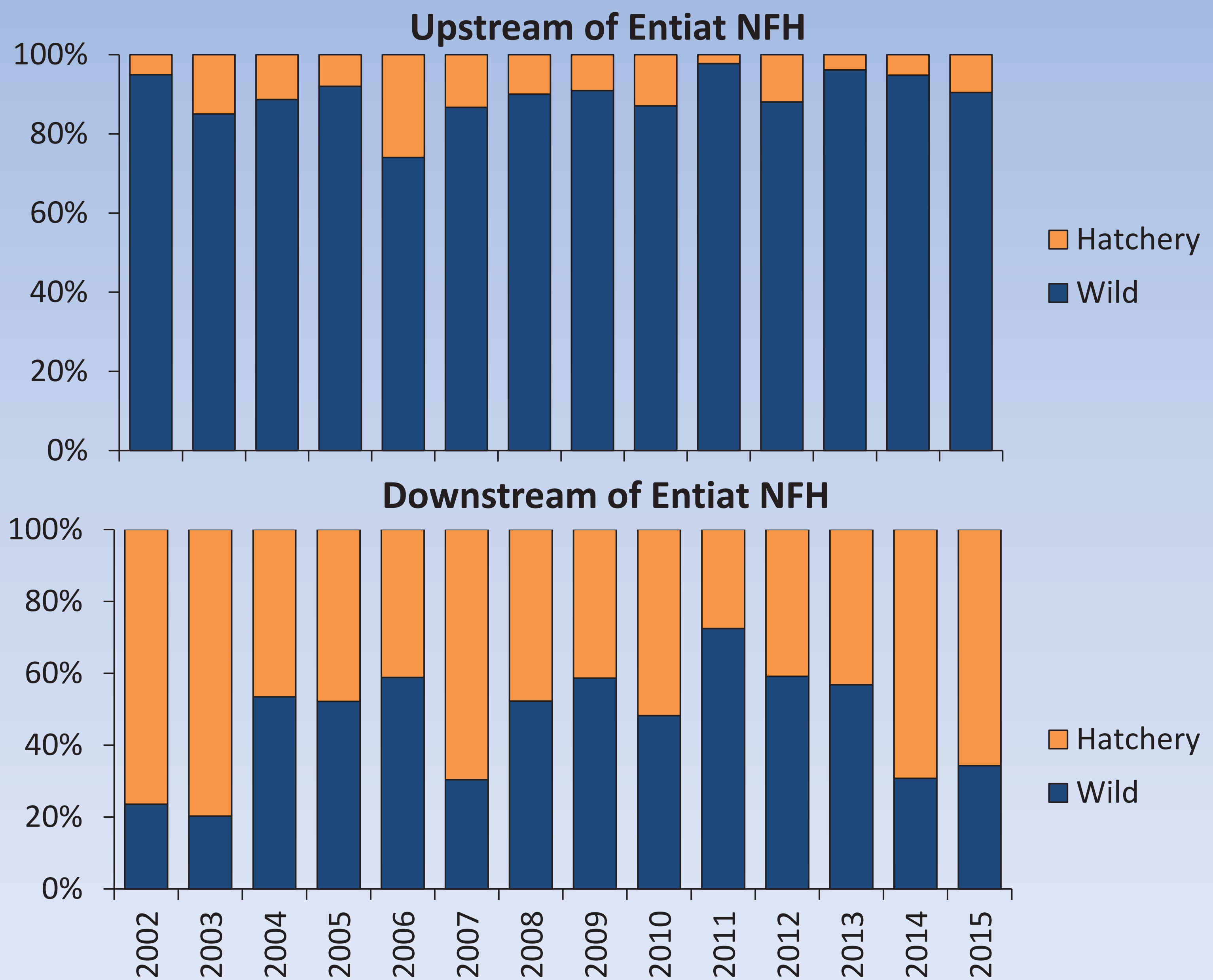
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2013 first full production ENFH release
2011 first ENFH release
Methow/Okanogan
Snake
Dryden Ponds
Mid-Columbia
Entiat
Natural

Spatial Distribution of Summer Chinook Origin



The Future

- Monitor spatial distribution of both runs
- Evaluate the impact of Entiat NFH summer Chinook releases: superimposition and composition
- Habitat improvements to the Entiat River may alter distribution and abundance
- Relate to genetic work
- Climate change impacts?

Conclusion

- Summers may not be endemic to Entiat River
- Dams extirpated all endemic runs
- Hatchery and strays colonized the Entiat River
- Spatial and temporal difference in spawning
- Production change altered run compositions
- Composition of runs differs annually
- Reliable stray component to both runs

Acknowledgements

Supervisor:

Matt Cooper

Geneticist:

Pat DeHaan

Technicians:

Charles Hamstreet

Katy Pfannenstein

Jakub Bednarek

Entiat Historians:

Phyllis Griffith

L. Wayne Long

Jim and Barbara Small

Conard Peterson


Questions?

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	September 21, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the August 17, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, August 17, 2016, from 9:30 a.m. to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: Johnson provided an update to the Hatchery Committees on September 20, 2016.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A). *(Note: this item is ongoing.)*
- Bill Gale will review the revised June 15, 2016, Hatchery Committees meeting minutes and provide edits to Sarah Montgomery by Friday, August 19, 2016 (Item I-A). *(Note: Gale provided edits, which Montgomery finalized on Saturday August 20, 2016.)*
- Justin Yeager will check when the Yakama Nation (YN) most recently reviewed the Wenatchee steelhead draft Biological Opinion (BiOp) and provide that date to Keely Murdoch (Item II-B).
- The Hatchery Committees will review revised Hatchery M&E Plan Appendix 5 and provide approval or further edits to Sarah Montgomery by Friday, August 26, 2016 (Item II-C). *(Note: further edits to Appendix 5 will be discussed during the Hatchery Committees September 21, 2016, conference call.)*

- Mike Tonseth will ask McLain Johnson (WDFW) when the timeline for conducting genetic sampling for HCP program species will be complete (Item II-D).
- Kirk Truscott will discuss internally stray rate targets for upper Columbia River summer Chinook salmon (Item II-D).
- Mike Tonseth will provide the Hatchery Committees with an update on tangle-netting for Methow spring Chinook salmon broodstock (Item II-E). *(Note: Tonseth provided an update on September 7, 2016).*
- Tracy Hillman will respond to Greer Maier's (upper Columbia Salmon Recovery Board [UCSRB]) request for the Hatchery Committees to review the Draft Hatchery Report, stating the Hatchery Committees want to review the report. He will also invite Maier to discuss comments in person at an upcoming Hatchery Committees meeting (Item II-F).
- Sarah Montgomery will update the Hatchery Committees meeting protocols document to reflect agreements during today's meeting (Item IV-A).

DECISION SUMMARY

- The Hatchery Committees approved Draft Hatchery M&E Plan Appendices 3 and 6 as edited during the meeting. *(Note: Appendix 6 was previously approved at the Hatchery Committees June 15, 2016, meeting. This approval is for a revised final version, [Item II-C.])*
- The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's Draft 2017 Hatchery Monitoring and Evaluation Implementation Plan (Item III-A).

AGREEMENTS

- The Rocky Reach and Rock Island Hatchery Committees agreed via email on July 19, 2016, that Chelan PUD can use surplus summer Chinook salmon from Entiat National Fish Hatchery (ENFH) as a back-up source of broodstock for the Chelan Falls program in 2016.
- The Hatchery Committees representatives present agreed to change their meeting starting time to 9:00 a.m. at all future meetings, starting with the September 21, 2016, meeting (Item IV-A).

- The Hatchery Committees representatives present agreed to hold back-to-back meetings with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC) at Grant PUD's Wenatchee, Washington, office when the HCP Hatchery Committees and PRCC HSC facilitators think the agendas are short enough to hold both meetings in 1 day. Grant PUD (PRCC HSC) also voiced agreement with this arrangement (Item IV-A).

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on August 17, 2016, notifying them Revised Hatchery M&E Plan Appendix 5 is available for review, with approval or comments requested by August 26, 2016 (Item II-C). *(Note: Montgomery distributed a revised version with Tracy Hillman's edits on August 22, 2016, and another revised version with Mike Tonseth's edits on August 22, 2016.)*
- Sarah Montgomery sent an email to the Hatchery Committees on September 14, 2016, notifying them the Draft 2015 Douglas PUD and Grant PUD Monitoring and Evaluation Annual Report is available for a 30-day review, with edits and comments due to Greg Mackey by October 14, 2016. *(Note: Montgomery sent a follow-up email on September 21, 2016, stating that the review is for 60 days, as discussed during the Hatchery Committees September 21, 2016, meeting.)*

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on August 17, 2016, notifying them the Final Hatchery M&E Plan Appendices 3 and 6 are available for download from the Hatchery Committees Extranet site (Item II-C).
- Sarah Montgomery sent an email to the Hatchery Committees on August 18, 2016, notifying them the Final 2015 Chelan PUD and Grant PUD Hatchery M&E Annual Report and appendices are available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on August 18, 2016, notifying them the Final 2017 Chelan PUD Hatchery Monitoring and Evaluation Implementation Plan is available for download from the Hatchery Committees Extranet site (Item III-A).

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the June 15, 2016 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Sarah Montgomery removed the Hatchery Evaluation Technical Team (HETT) update.
- Catherine Willard added a Chelan PUD broodstock collection update.
- Sarah Montgomery added the revision of Hatchery M&E Appendix 6.
- Mike Tonseth added an update on Methow spring Chinook salmon broodstock collection.
- Tracy Hillman added discussing a request from the UCSRB to review their Draft Hatchery Report.
- Montgomery added an administrative item regarding back-to-back meetings with the PRCC HSC.

The Hatchery Committees reviewed the revised draft June 15, 2016, meeting minutes. Montgomery said there are several outstanding comments to be discussed, which the Hatchery Committees reviewed and addressed.

Bill Gale asked if he could have until Friday, August 19, 2016, to review the meeting minutes again. The Hatchery Committees agreed, and all others present approved the draft June 15, 2016, meeting minutes, as revised. (Note: Gale provided further edits and approved the draft June 15, 2016, meeting minutes on August 19, 2016.)

Action items from the Hatchery Committees meeting on June 15, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on June 15, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*

This item is ongoing.

- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A).*
  This item is ongoing.
- *Tracy Hillman will demonstrate a tool that processes data from the National Marine Fisheries Service (NMFS) Salmon Population Summary database during the Hatchery Committees July 20, 2016, meeting (Item I-A).*
  This item will be discussed today.
- *Catherine Willard will incorporate edits from today's meeting into Draft Hatchery M&E Plan Appendices 2, 4, and 6, and send final versions to Sarah Montgomery for distribution to the Hatchery Committees (Item II-C).*
  This item is complete. Montgomery distributed final versions on June 24, 2016.
- *Todd Pearsons (Grant PUD) will revise Draft Hatchery M&E Plan Appendix 3 and send it to Catherine Willard, who will incorporate edits and send the revised version to the Hatchery Committees for review (Item II-C).*
  This item is complete. Montgomery distributed the revised version of Appendix 3 for review on July 12, 2016.
- *Catherine Willard and Tracy Hillman will revise Draft Hatchery M&E Plan Appendix 5 and send it to Sarah Montgomery for distribution to the Hatchery Committees for review (Item II-C).*
  This item is complete. Montgomery distributed the revised Appendix 5 to the Hatchery Committees on July 19, 2016, which will be discussed today.
- *The Hatchery Committees will discuss the population structure of Upper Columbia River summer and fall Chinook salmon at the Hatchery Committees August 17, 2016, meeting (Item II-D).*
  This item will be discussed today.
- *Keely Murdoch will discuss internally the shortage of natural-origin recruits in the Methow Composite broodstock (Item II-E).*
  This item is complete.
- *Todd Pearsons will discuss internally the shortage of natural-origin recruits in the Methow Composite broodstock (Item II-E).*
  This item is complete.

- *Mike Tonseth will discuss with Karl Halupka (U.S. Fish and Wildlife Service [USFWS]) and Craig Busack (NMFS) the possibility of using tangle-netting to capture additional natural-origin broodstock for the Methow Composite program (Item II-E).* This item is complete. Tracy Hillman sent an email to the Hatchery Committees on July 1, 2016, stating that USFWS and the National Oceanic and Atmospheric Administration (NOAA) have approved the use of tangle-netting in 2016, and Tonseth will distribute a plan for broodstock collection.

II. Joint HCP-HC/PRCC HSC

A. USFWS Bull Trout Consultation Update (Bill Gale)

Bill Gale said the BiOp covering hatchery programs in the Wenatchee basin will be distributed to the applicants for review next week (August 22 to 26, 2016). He said the draft memorandum regarding the Methow spring Chinook salmon program consultation will undergo internal review next week.

B. NMFS Consultation Update (Justin Yeager)

Justin Yeager said the Wenatchee River Steelhead BiOp was signed on July 20, 2016, and distributed to the applicants. He said NMFS will issue related Section 10 permits. Regarding the Methow River steelhead consultation, Yeager said NMFS has been working with WDFW on gene flow guidelines, and NMFS and WDFW are meeting on September 14, 2016, to discuss these further. Yeager said NMFS is also working with WDFW to develop a Methow steelhead adult management plan. Keely Murdoch asked to whom the Wenatchee River Steelhead BiOp was distributed on July 20, 2016. Mike Tonseth said the BiOp was distributed to the permit holders. Murdoch asked when the YN reviewed the BiOp. Yeager said he is not sure, because the BiOp was undergoing quality assurance/quality control review and internal review for several months. Yeager said he will check when YN reviewed the BiOp and let Murdoch know the date. Murdoch said NMFS has been working with WDFW on the Methow steelhead management plan and asked if the Hatchery Committees will have the opportunity to review the plan. Tonseth said yes.

Regarding the Methow spring Chinook salmon BiOp, Yeager said NMFS will send the draft to the permit applicants soon for a 2-week review. Yeager said, as part of the National

Environmental Policy Act process, the draft Environmental Assessment is currently undergoing internal review. Todd Pearsons asked which documents have been distributed regarding the Methow spring Chinook salmon consultation. Tonseth said only the Draft Terms and Conditions have been distributed.

Kirk Truscott asked if Yeager has an update on the Tribal Resource Management Plan (TRMP) program or on the Okanogan steelhead Hatchery Genetic Management Plan. Yeager said he does not have an update on either plan.

C. Review Draft Hatchery M&E Plan Appendices 3, 5, and 6(All)

Appendix 3 – Proportionate Natural Influence (PNI) and Proportion of Hatchery-origin spawners (pHOS) Targets and Sliding Scales

Catherine Willard displayed the document, "Revised Hatchery M&E Appendix 3," which Sarah Montgomery distributed to the Hatchery Committees on July 12, 2016. Tracy Hillman said Todd Pearsons provided edits to Section 13, "Priest Rapids Fall Chinook," which the Hatchery Committees reviewed.

The Hatchery Committees approved the Revised Hatchery M&E Plan Appendix 3. *(Note: Montgomery distributed the Final Hatchery M&E Plan Appendix 3 to the Hatchery Committees following the meeting on August 17, 2016 [Attachment B].)*

Appendix 5 – Stray Rate Objectives

Willard displayed the document, "Revised Hatchery M&E Plan Appendix 5," which Montgomery distributed to the Hatchery Committees on July 19, 2016. Questions and comments were discussed, and edits were made to the document.

Hillman said this appendix now defines three types of stray rates: 1) management strays; 2) genetic out-of-population strays; and 3) genetic within-population strays. Pearsons asked if programs designed with the goal that fish stray, such as reintroduction programs, are considered management strays under this definition. Mike Tonseth said that in the upper Columbia River, all current hatchery programs intend that fish return to their release location. Hillman said reintroduction programs would be considered an exception to the management stray definition.

Keely Murdoch said the footnote regarding Wenatchee steelhead that are acclimated at the Chiwawa Acclimation Facility and truck-planted at various locations is confusing. She said the goal of truck-planting steelhead in Nason Creek is that they return to Nason Creek. She said the Hatchery Committees had discussed developing overwinter acclimation facilities in both Nason Creek and the Chiwawa River; however, the Chiwawa River facility (on Wenatchee River water) alone was chosen with truck planting and short-term acclimation in YN's Rolfing's Pond in Nason Creek. She said if data later indicated that Nason Creek-released steelhead do not return to Nason Creek, an overwinter acclimation facility in Nason Creek would be revisited. Hillman asked if steelhead released in Nason Creek are differentially marked. Willard responded that they are not differentiated by external marks; however, it is known where passive integrated transponder (PIT) tagged fish are released. Murdoch said PIT-tag data and other technology regarding where steelhead are escaping are becoming available and will help determine if steelhead released in Nason Creek return to Nason Creek. She said, at the time acclimation facility decisions were made, those data were not available. Tonseth said before steelhead were acclimated in-basin at the Chiwawa Acclimation Facility, the stray rates were 70 to 80% for fish reared at Turtle Rock Island. Willard deleted the footnote.

Kirk Truscott suggested mentioning the Okanogan spring Chinook salmon 10(j) "non-essential experimental" program. He said that program would be considered an exception to the definition of management stray, because fish released into the Okanogan River are expected to colonize smaller tributaries instead of homing back to the mainstem. Bill Gale suggested adding the text "reintroduction programs may be excluded," which Willard added.

Truscott asked what the difference is between management strays and genetic within-population strays. Hillman used the Chewuch and Methow rivers spawning aggregate as an example. He said there is no genetic difference between fish in the Chewuch and Methow rivers, but from a management perspective, we want Chewuch-released fish to return to the Chewuch River. From a genetics perspective, it does not matter if Chewuch-released fish spawn in the Methow River. However, from a management perspective, it does matter. Truscott said it would be beneficial to add that example to the definition and state the difference between Methow Composite MetComp fish straying to the Twisp River, versus MetComp fish released in the Chewuch River spawning in the Methow River. Tonseth said the definition references "spawning aggregates," such as in Hillman's example. Hillman suggested adding the phrase "discrete sub-populations" to make the definition more clear.

Justin Yeager asked if these definitions are from the 2007 Technical Recovery Team Report, and said the TRT update these reports occasionally. Hillman said that the Upper Columbia Spring Chinook and Steelhead Recovery Plan is based on the 2007 TRT report. Because the Hatchery M&E Plan cites the Recovery Plan, which cites the 2007 TRT report, we could cite both the Recovery Plan and TRT document. Yeager requested that the Hatchery Committees have until Friday August 26, 2016, to review Appendix 5. The Hatchery Committees will review revised Hatchery M&E Plan Appendix 5 and provide approval or further edits to Montgomery by Friday, August 26, 2016. *(Note: Montgomery sent an email to the Hatchery Committees on August 17, 2016, notifying them Revised Hatchery M&E Plan Appendix 5 [Attachment C] is available for review, with approval or comments requested by August 26, 2016. Montgomery distributed a revised version with Hillman's edits to the Hatchery Committees on August 22, 2016, and a revised version with Tonseth's edits on August 22, 2016. Further edits to Appendix 5 will be discussed during the Hatchery Committees September 21, 2016, conference call.)*

Appendix 6 – Rearing Targets

Willard displayed the document, "Final Hatchery M&E Appendix 6," which Montgomery distributed to the Hatchery Committees on July 24, 2016 (Attachment D). Hillman recalled that Tom Kahler had sent an email to the Hatchery Committees regarding many of the condition factor (also known as K-factor) targets in the appendix being less than 1.0. Hillman suggested making the target less than or equal to 1.0. Tonseth said it would be very difficult to produce a hatchery fish with a condition factor less than 1.0. He asked if a low condition factor correlates with high survival. Todd Pearsons asked what the source of the condition factor targets is. Matt Cooper said facility managers reviewed the targets. Hillman said the condition factor targets are from Piper et al., 1982[1]. Tonseth said the tables in Piper et al. are not particularly reflective of the body profile of fish produced in hatcheries in the upper Columbia River basin. Cooper said one facility manager who reviewed Appendix 6 said a reasonable condition factor could be one plus or minus 10%, which would be considered an "ideal" condition factor. Pearsons said setting an unreachable target may be unreasonable, and said there are two ways to think about targets: 1) the target is considered an ideal; and 2) the target is an attainable goal, and when it is not met, changes are instituted. Pearsons suggested connecting the condition factor target to survival. He said the condition factor target should be good for the fish, and should be achievable. Tonseth said the word "target" implies that it is a hard and fast rule, and that a program should not be considered a failure if it does not meet an unrealistic target. Yeager asked if these condition factor targets are new. Hillman said before the 5-Year Hatchery M&E Report was completed, the condition factor target for programs was less than 1.0, which is nearly impossible for a program to reach. Therefore, instead of using less than 1.0, the average condition factor for some programs was used to represent a realistic value. He said an alternative to using less than 1.0 or the average condition factor, would be to perform quantile regression on length-weight relationships and use the 90th percentile as a target range. Gale said, if there is a biological reason, like higher survival, for the target to be set at less than 1.0, then it would be a reasonable target. Yeager said it is unknown how condition factor at release and survival are related. Tonseth said condition factor is a function of length and weight, and for stream-type fish, relatively skinny (higher length to weight ratio) fish generally have higher survival. Gale said it would be difficult to assess an individual covariate such as condition factor and survival, and studying it would require many PIT tags and a large monitoring effort. He said Piper et al. provides generally accepted anecdotal goals. Tom Kahler said the Methow programs stopped using condition factor targets from Piper et al. in 2006. Hillman said there is a correlation between size (length) and survival, but he is unaware of a correlation between condition factor and survival in the upper Columbia River basin. Gale stated that circular tanks produce leaner hatchery fish compared to raceways, and Willard

[1] Piper, R., I. McElwain, L. Orme, J. McCraren, L. Fowler, and J. Leonard, 1982. Fish hatchery management. U.S. Department of the Interior Fish and Wildlife Service, Washington D.C.

agreed. Pearsons emphasized that the Hatchery Committees and PRCC HSC do not want to set targets that would hurt a program. Pearsons suggested using the language “suggestions to hatchery staff” instead of “target” for condition factors in the table in Appendix 6.

Hillman said in the 5-year Hatchery M&E Report, the length and weight targets do not match the condition factor targets. If the length and weight targets are set, the condition factor is greater than 1.0, because it is a function of the length and weight targets. He said, during preparation of the 5-year Hatchery M&E Report, they found it impossible to meet both the length and weight targets. You can meet one but not the other. Kahler said, for the Methow programs, it was also impossible to reach the length and weight target at the same time. Tonseth said the strongest known correlation is between length and survival, so the target for condition factor should be linked to the length target. Willard said although some of the hatchery programs are currently PIT-tagging in the spring, which is closer to the time of release, not all programs are currently PIT tagging in the spring and historically fish were PIT-tagged in the fall. It is not feasible to study the survival of fish at varying lengths unless they are PIT-tagged in the spring. Tonseth said PIT-tagging in the spring could be considered for future evaluations. Truscott said the fish are fed based on fish-per-pound targets, not on length targets. Hillman said the target could then be set based on weight, and length could be calculated from the length-weight relationship.

Hillman asked if the HETT should discuss condition factor targets. Pearsons said, if the hatchery managers manage the fish based on weight (FPP), then the committees should set a weight target and report length and condition factor instead of having a target. Gale said managing solely for weight is insufficient, and a target for length at least should be included. Pearsons said the point of these targets is to have a fish with good survival; in order to assess that, a survival target should be set and reported on in the 5-year Hatchery M&E Report. Gale asked what would be considered “good” survival, and Pearsons replied that good survival could be determined relative to past survival and to other programs. Gale said NMFS has released a set of goals for fish length; therefore, the programs should have length targets. Kahler said, in the history of the Methow program, there has never been a condition factor less than 1.0. Hillman said the Chiwawa spring Chinook salmon program has never met its length target, but it has met its weight target. He said, based on the growth of the fish, the length and weight targets do not match. He said, if reasonable length and weight targets are set, a condition factor target is not needed. Right now, however, it appears the length target is not appropriate for some programs and should be adjusted.

Tonseth said the programs have length, weight, and condition factor targets because past permits have required the progeny to be released at similar length, weight, and condition factor to natural fish. He said it is an appropriate time to determine what size of fish optimizes survival and minimizes negative ecological interactions, and set that as the operational goal specific to each stock, program, and facility. He said the Hatchery Committees should discuss this during the next 5-year M&E update to see if a correlation can be determined between survival and size of fish. Hillman suggested removing the condition factor column. Gale said it should be noted that the condition factor or fork length targets will be determined based on data from the pending 5-Year Hatchery M&E Report. Willard made that edit. Tonseth said there are some programs for which size and survival cannot be correlated currently. Gale said there are some data from the Winthrop program that could be used to inform management of the Methow programs, because Winthrop National Fish Hatchery (NFH) has been PIT-tagging many fish and studying the length, weight, and condition factor at the time of release.

The Hatchery Committees approved Appendix 6 as revised during the meeting.
(Note: Montgomery distributed the Revised Final Appendix 6 to the Hatchery Committees on August 17, 2016.)

D. Population Structure of Upper Columbia River Summer and Fall Chinook Salmon (All)

Tracy Hillman said there has been a lot of discussion about upper Columbia River summer/fall Chinook salmon and straying. He said the monitoring program currently considers straying among subbasins (e.g., Wenatchee, Entiat, Chelan, Methow, and Okanogan) as "out-of-population strays." However, there are data suggesting that upper Columbia River summer/fall Chinook salmon are one population, which would mean that any straying among subpopulations should be considered "within-population strays." He said the Hatchery Committees will discuss today the current available information on population structure of upper Columbia River summer/fall Chinook salmon and stray rate targets.

Bill Gale suggested reviewing a document with population structure and management targets that was produced by a group of upper Columbia River co-managers after they met to discuss summer Chinook salmon. Mike Tonseth said those discussions took place in 2009 to 2011, and the document, "Genetic Structure of upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs" was distributed to the Hatchery Committees by Sarah Montgomery on June 16, 2016. Hillman said the conclusions from the 2011 genetics report were there is no genetic difference between subbasins of summer/fall Chinook salmon in the upper Columbia River. He said, according to the 2011 report, the entire Columbia basin is one homogenized population, which may be a result of management. Todd Pearsons said it is not known whether the homogenization is a result of management or not. Hillman stated that Chinook salmon tend to home, so there would likely be natural differences among subbasins; however, because summer/fall Chinook salmon also spawn in the mainstem Columbia River, there may be considerable gene flow among tributaries and the mainstem. Tonseth said, even though there is little differentiation between tributaries, WDFW still manages the Wenatchee, Okanogan, and Methow populations separately (but not the Entiat or Chelan rivers). Gale said the populations should be managed as primary populations using localized broodstock, and the Entiat and Chelan rivers are identified as stabilizing populations. Gale asked if there are mainstem spawning areas for summer and fall Chinook salmon populations from different tributaries that overlap. Tonseth said there is natural-origin spawning in various areas of the mainstem Columbia River, and spawning between Rock Island Dam and Rocky Reach is unknown. Tonseth said he does not think the spawning areas allow for very much genetic overlap of populations. He said radio telemetry and coded wire tag results from the Methow and Okanogan basins show some years with a high degree of mixing. When mainstem Columbia River broodstock is used for the programs, there is likely to be little genetic differentiation, which has led to the continued homogenization of upper Columbia River summer/fall programs.

Hillman said there are two types of stray rates to discuss: 1) management strays; and 2) genetic strays. He said the Wenatchee program, using a genetic within-population stray rate target of 10%, nearly meets the target in most years. That program does not meet the genetic out-of-population stray rates. Gale said there is a higher proportion of hatchery-origin strays that spawn in the lower Entiat River than in the upper Entiat River, and these might be fish from Eastbank Fish Hatchery (FH). Gale said these three populations—Methow, Wenatchee, Okanogan—should be managed as primary populations with a 5% stray rate target instead of 10%. Tonseth suggested calling these populations "management strays" and using a 5% stray rate target because the programs are managed independently; genetically, they are not distinct, but they are managed in a way that treats them distinctly.

Pearsons asked when the next genetic sampling would take place. Tonseth said he will ask Mclain Johnson about the timeline for genetic sampling.

Hillman summarized that Hatchery Committees representatives present think the upper Columbia River summer/fall Chinook salmon programs are managed as different populations despite being genetically homogenized; therefore, a management stray rate target of 5% should be used. Kirk Truscott said he wants to confer with Casey Baldwin (Colville Confederated Tribes) about the stray rate targets before agreeing to set a target. Truscott mentioned approximately 40% of the PIT-tagged, natural-origin fish that pass Wells Dam go to the Okanogan River. Tonseth said many of the fish also return to the Wenatchee River (they drop back over the dam). He said the previous Okanogan summer Chinook program broodstock collection at Wells Dam incorporated a lot of natural-origin fish from areas below Wells Dam.

E. Update on Methow spring Chinook Broodstock Collection (All)

Tracy Hillman said the HCP Coordinating Committees and Hatchery Committees discussed constraints for tangle-netting for Methow spring Chinook salmon broodstock in the Chewuch River and modifying the trapping schedule at Wells Dam. Tom Kahler said the permit allows the Hatchery Committees to make adjustments to the trapping schedule for spring Chinook salmon, which is at the discretion of NMFS and therefore can be approved as part of the Coordinating Committees approval of the annual broodstock collection protocols. Mike Tonseth said he would provide an update on tangle-netting progress in the Chewuch River next week. He said there were some weather issues during field work. Todd Pearsons asked if any more wild fish had been encountered at Wells Dam since Tonseth's last update on June 15, 2016. Tonseth said some genetic results were still pending (which came back as natural-origin) at the time of the tangle-netting request, so the tangle-netting target is lower than initially anticipated. Tonseth said there will be no issue of meeting the production obligation. Pearsons said these numbers would likely result in a relatively high percent natural-origin broodstock (pNOB).

F. Request from Upper Columbia Board to Review Hatchery Report (Hillman)

Tracy Hillman said he received an email from Greer Maier requesting that the Hatchery Committees review the UCSRB's draft Hatchery Report. He said the Hatchery Report is a summary of the hatchery programs in the upper Columbia River basin and is part of an effort to integrate understanding of actions affecting salmon and steelhead (the 4 H's, which are harvest, hatcheries, hydropower, and habitat). Hillman asked the Hatchery Committees if they would like to review the report and invite Maier to a Hatchery Committees meeting to discuss the report. Keely Murdoch said she is on the committee that has been providing data for the report. She said she has not been asked to provide much input on the report itself and has not reviewed a draft yet, so she thinks the Hatchery Committees should definitely review a draft and discuss with Maier how she plans to incorporate comments and suggestions. Todd Pearsons asked what the function of the report is and if it will include recommendations to hatchery programs. Mike Tonseth said it is mostly an update to the UCSRB on each of the 4 H's. Murdoch said the habitat report has already been finalized, and in looking at that report, she expects there will not be many recommendations due to the sensitivity of hatcheries; rather, it will be a status update with many data. Tom Kahler said the UCSRB wants a status update on the 4 H's because they are concerned that no matter how much habitat restoration work is completed, the other H's (i.e., hydropower, hatcheries, and harvest) may preclude recovery of listed species. Hillman said he will respond to Maier's request for the Hatchery Committees to review the Draft Hatchery Report, stating that the Hatchery Committees want to review the report and then invite Maier to discuss comments in person at an upcoming Hatchery Committees meeting.

G. NOAA Salmon Population Summary Database (Tracy Hillman)

Tracy Hillman said the NOAA Salmon Population Summary (SPS) database[2] contains population data for Columbia River salmon and steelhead populations. He said the database can be queried by recovery domain, evolutionary significant unit (ESU), MPG, populations, years, and attributes, and those results can be exported into a spreadsheet. He said he and other contractors have been working with Bonneville Power Administration (BPA) on how to display and summarize data in the SPS database so users do not have to process a spreadsheet of the data each time they have a question. He said BPA and some of their contractors have developed a tool that processes data from the NOAA SPS database and presents them in easily interpreted formats. Hillman displayed the NOAA SPS Data Browser[3]. He said it can show features such as spawner abundance, proportion of natural-origin fish, age structure, and harvest. Justin Yeager said the tool is particularly useful because it is updated more frequently than every 5 years. Hillman said the upper Columbia River data series are some of the best in the basin. Todd Pearsons said the most recent data included in the browser are from return year 2013. He asked how to export figures. Hillman said you can take a screenshot of the browser. Hillman demonstrated an example with Snake River fall Chinook salmon, and showed that even though the geometric mean of spawner abundance has increased above the minimum recovery threshold, the spatial structure and diversity of the population is still low, which is why they have not been delisted.

III. Chelan PUD

A. Rock Island/Rocky Reach M&E 2017 Implementation Plan (Willard)

Catherine Willard shared a document titled, Draft 2017 Chelan PUD Hatchery Monitoring and Evaluation Implementation Plan (Attachment E), which Sarah Montgomery distributed to the Hatchery Committees on August 1, 2016. Willard said the document has only changed slightly from the 2016 version. She said the number of PIT-tagged

[2] National Oceanic and Atmospheric Administration, 2015. NOAA Salmon Population Summary Database. Available from: https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:HOME.

[3] National Oceanic and Atmospheric Administration, 2016. NOAA Salmon Population Summary Data Browser. Available from: http://www.onefishtwofish.net/sps/SPS3h.html.

hatchery-released Methow spring Chinook salmon has changed from 10,000 to 5,000 due to a sharing agreement with Douglas PUD. Willard said none of the methods have changed.

The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's Draft 2017 Hatchery Monitoring and Evaluation Implementation Plan.

B. Broodstock Collection Update

Catherine Willard said, for the Chiwawa spring Chinook salmon conservation program, Chelan PUD has collected 30 males and 31 females at the Chiwawa Weir. She said, on July 25, 2016, Chelan PUD stopped trapping at the weir because they reached the maximum allowable number of bull trout encounters (110 fish). Willard said Chelan PUD collected a few additional natural-origin PIT-tagged spring Chinook salmon at Tumwater Dam, and the remainder of the program will be made up of hatchery-origin fish. Mike Tonseth said 18 hatchery-origin females will be used to ensure the Chiwawa program production goal is met if insufficient natural-origin adults are collected. He said WDFW and Chelan PUD will know exactly how much of the program will be made up of hatchery-by-hatchery origin fish once they know the fecundities of fish collected.

Willard said, for the Chelan Falls summer Chinook salmon program, Chelan PUD have collected 70 adult fish from the Eastbank Outfall so far, and additional surplus fish (40 so far) have been acquired from Entiat NFH. She said the pilot project to trap summer Chinook salmon at the Chelan River Habitat Channel Water Conveyance Canal Outlet structure has been very successful so far. She said they have collected their target of 100 fish, and trapped the most in 1 day (60 fish) when both pumps were operating. She said, in accordance with the pilot study, they stopped collecting at 100 fish, and will evaluate gamete quality in order to determine the potential long-term success of using this location to meet broodstock needs of the Chelan Falls summer Chinook salmon program. Bill Gale asked if the program will still use broodstock from Entiat NFH in 2016. Tonseth said WDFW and Chelan PUD are still moving forward with the original plan of prioritizing summer Chinook salmon collected at the Eastbank Outfall for the program, using surplus fish from Entiat NFH to meet any shortfalls in broodstock, and evaluating the use of the Chelan Falls pilot trap for broodstock collection in 2017 and future years. *(Note that July 19, 2016, the Rocky Reach* *and Rock Island Hatchery Committees agreed via email that Chelan PUD can use surplus summer Chinook salmon from ENFH as a back-up source of broodstock for the Chelan Falls program in 2016.)*

IV. HCP Administration

A. Back-to-back Meetings with the PRCC HSC (Montgomery)

Sarah Montgomery said she, Tracy Hillman, Elizabeth McManus (Ross Strategic; PRCC HSC Chair), and Andy Chinn (Ross Strategic) have been discussing the logistics of holding back-to-back meetings with the HCP Hatchery Committees and PRCC HSC. Hillman said, in months when both committees have short agendas, it would make sense to meet at one location and hold the HCP Hatchery Committees meeting in the morning, and the PRCC HSC meeting afterwards, with joint items being discussed during the HCP Hatchery Committees meeting. He said the location would be Grant PUD's Wenatchee, Washington, office because it is easy access and preferred by many attendees. Gale suggested the Hatchery Committees meeting start at 9:00 am instead of 9:30 am on these days. The Hatchery Committees discussed the time change and agreed to meet at 9:00 am instead of 9:30 am for all future meetings, starting with the September 21, 2016 meeting.

The Hatchery Committees agreed to hold back-to-back meetings with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC) at Grant PUD's Wenatchee, Washington, office when the HCP Hatchery Committees and PRCC HSC facilitators think the agendas are short enough to hold both meetings in 1 day. Grant PUD (PRCC HSC) also voiced agreement with this arrangement.

Montgomery said she will update the Hatchery Committees meeting protocols document with the meeting time and location changes.

B. Next Meetings

The next Hatchery Committees meetings are September 21, 2016 (conference call), October 19, 2016 (Chelan PUD), and November 16, 2016 (Douglas PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Final Hatchery M&E Plan Appendix 3
Attachment C	Revised Hatchery M&E Plan Appendix 5
Attachment D	Final Hatchery M&E Appendix 6
Attachment E	Draft 2017 Chelan PUD Hatchery Monitoring and Evaluation Implementation Plan

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons ‡	Grant PUD
Peter Graf†‡	Grant PUD
Deanne Pavlik-Kunkel†‡	Grant PUD
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Justin Yeager*	National Marine Fisheries Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

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	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 prespawn 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-introduced 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.

	Run Escapement Goal	PNOB Conservation Program	PNOB Safety Net Program	PHOS	PNI
Above TWD	1094	1.0	0.0	Varies	Varies
Below TWD	406	n/a	n/a	< 0.10	< 0.67
Basin Total	1500	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) Summer Chinook

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.

<u>Appendix 5:</u> Defining strays for hatchery programs

- **Management Stray** = Any hatchery fish that spawn in streams other than the stream in which they were released. An example would be hatchery spring Chinook released from the Chewuch Acclimation Facility that return and spawn in the Methow River. Reintroduction programs may be excluded from this metric.
- **Genetic Out-of-Population Stray** = Any hatchery fish that spawn in populations other than the one from which they were released. An example would be hatchery steelhead from the Wenatchee that spawn in the Methow River. Out-of-population strays should make up no more than 5% of the recipient population spawning escapement (ICBTRT 2007).
- **Genetic Within-Population Stray** = Any hatchery fish that spawn within spawning aggregates (i.e., discrete, genetic sub-population) other than the one from which they were released. An example would be a MetComp hatchery spring Chinook spawning in the Twisp River. Within-population strays should make up no more than 10% of the recipient spawning aggregate (ICBTRT 2007).

References:

Interior Columbia Basin Technical Recovery Team (ICTRT). 2007. Viability criteria for application to interior Columbia basin salmonid ESUs. ICTRT Report to NOAA Fisheries, Portland, Oregon.

Deleted: [1]

Deleted: (i.e., major or minor spawning areas)

Deleted: [1]This definition does not apply to Wenatchee steelhead which are acclimated at the Chiwawa Acclimation Facility and truck-planted at various release locations in the Wenatchee sub-basin; a steelhead released in Nason Creek that returns to the Chiwawa River is not considered a management stray.

Appendix 6.

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 A6.1. Size, Coefficient of Variation (CV), and Condition Factor (K) Targets at Release of Upper Columbia River Hatchery Programs.

Hatchery	Species	Life Stage	Basin	FPP	CV	K-factor
Methow	Spring Chinook	Yearling	Methow	15	<10	TBD
Methow	Spring Chinook	Yearling	Twisp	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Columbia	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Okanogan	15	<10	TBD
Chiwawa	Spring Chinook	Yearling	Wenatchee	18	<10	TBD
Nason	Spring Chinook	Yearling	Wenatchee	18-24	<10	TBD
Winthrop	Spring Chinook	Yearling	Methow	17	<10	TBD
Leavenworth	Spring Chinook	Yearling	Wenatchee	17	<10	TBD
Wells	Steelhead	Yearling	Columbia	6	<10	TBD
Wells	Steelhead	Yearling	Methow	6	<10	TBD
Wells	Steelhead	Yearling	Twisp	6	<10	TBD
Wells	Steelhead	Yearling	Omak	5-8	<10	TBD
Wells	Steelhead	Yearling	Okanogan	5-8	<10	TBD
Winthrop	Steelhead	Two year	Methow	4-6	<10	TBD
Chiwawa	Steelhead	Yearling	Wenatchee	6	9.0	TBD
Wells	Summer Chinook	Subyearling	Columbia	50	<7	TBD
Wells	Summer Chinook	Yearling	Columbia	10	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Columbia	50	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Okanogan	50	<7	TBD
Chelan Falls	Summer Chinook	Yearling	Chelan	10-22	9.0	TBD
Entiat	Summer Chinook	Yearling	Entiat	17	<10	TBD
Carlton	Summer Chinook	Yearling	Methow	13-17	<12	TBD
Chief Joseph	Summer Chinook	Yearling	Columbia	10	<7	TBD
Chief Joseph	Summer Chinook	Yearling	Okanogan	10	<7	TBD
Dryden	Summer Chinook	Yearling	Wenatchee	18	9.0	TBD
Priest	Fall Chinook	Subyearling	Columbia	50	<10	TBD
Ringold	Fall Chinook	Subyearling	Columbia	50	<10	TBD

Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2017

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Prepared by:

Alene Underwood and Catherine Willard

July 2016

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Contents

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: 2013 Update"* (Hillman et al. 2013) and the "*Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Programs*" (Murdoch and Peven 2005).

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 2017. Additionally, monitoring and evaluation activities for Lake Wenatchee sockeye in 2017 are included in this document. As monitoring tasks are completed in 2016 and are evaluated for their efficacy, methodologies to accomplish the tasks defined in the 2017 Implementation Plan may be modified [with Habitat Conservation Plan's Hatchery Committee (HCP-HC) approval].

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The work described in this plan has Endangered Species Act (ESA) coverage provided by NFMS Section 10(a)(1)(A) permits 18121 and 1395 and Section 10(a)(1)(B) permit 1347. All activities conducted under this Implementation Plan shall adhere to all terms and conditions as specified in the referenced permits. 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. 2013. 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.

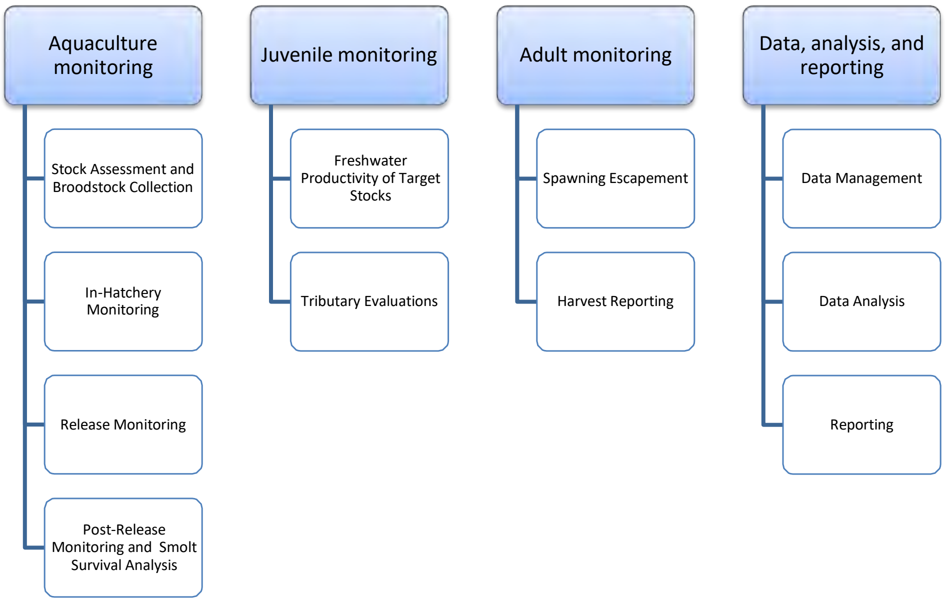

Figure 1. The four components of the hatchery monitoring and evaluation program and the study design elements within each component.

Table 1. Study design elements performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2013.

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	WDFW	WDFW
	5, 8	In-hatchery monitoring	WDFW CPUD[2]	WDFW CPUD[2]	WDFW Biomark3	WDFW CPUD[2]	WDFW CPUD[2]
	9	Release monitoring	WDFW	WDFW	WDFW	WDFW	WDFW
	9	Post-release monitoring and smolt survival analysis	WDFW	WDFW	WDFW	WDFW	WDFW
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
	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 addressed at the next 10 year HCP check-in.
[2] CPUD crews will PIT tag in-hatchery fish.
[3] Biomark will PIT tag in-hatchery fish.
[4] In 2017, 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.

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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. 2013). Table 2 below provides a summary of the variables to be measured in 2017 under the aquaculture monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

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Table 2. Monitoring and Evaluation Plan (Hillman et al. 2013) objectives and the associated measured variables for the aquaculture monitoring component.

Objectives	Measured Variables *(Applicable Study Component(s))*
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 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*)
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.	• 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*)
Objective 8: 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*)
Objective 9: 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 Broodstock Collection Protocol approved annually by the HCP-HC and relevant permits. Data collection during broodstock collection will be consistent with Murdoch and Peven (2005). A representative sample of fish trapped throughout the entire run, either collected for broodstock or released back to the river, will be sampled for origin, age, sex, size, and migration timing. Biological sampling of all fish trapped will include presence of internal (CWT or PIT) and external (VIE) tags or marks, scales, length, and sex (determined by ultrasound). PIT tags will be injected into all target species (Chinook and steelhead), whether collected for broodstock or released back to the river to monitor for potential fallbacks. All non-target species will be enumerated daily. Measures of central tendency and spread will be calculated and reported for each metric.

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. Life stage specific in-hatchery survival and growth rates, disease monitoring, and an estimate of the number of fish released will be collected and analyzed according to Murdoch and Peven (2005). Additional data to be collected includes individual lengths and weights of juveniles during monthly sampling, and the weight of gonadal mass and body of spawned broodstock. Measures of the central tendency and spread will be calculated and reported for each metric.

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 as an Addendum to this Plan. 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 (Table 3) at Eastbank Hatchery approximately two to four weeks before the fish are transferred to acclimation ponds or in the spring prior to release. 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.

Program	Release goals	Number of fish PIT tagged[1]	PIT tag rate (%)
Chiwawa spring Chinook	144,026	10,000	3.5
Wenatchee steelhead	247,300	20,000	8.0
Wenatchee summer Chinook	318,816 (CPUD Program) 181,184 (GPUD Program)	20,600[2]	4.1
Methow spring Chinook	60,516	5,000	8.3
Chelan Falls summer Chinook	576,000	10,000	1.7

[1] Additional PIT tagging may take place for Chelan PUD approved studies and/or comparisons.

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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 Murdoch and Peven (2005), 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. 2013). 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 Murdoch and Peven (2005), 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. Monitoring of steelhead released in the Wenatchee River sub-basin will occur during loading of fish into transport trucks, unless fish are released directly into the Chiwawa River. Steelhead will pass through a series of PIT-tag antennas, each connected to a data logger, thereby allowing the creation of a PIT-tag observation file for each truckload of steelhead consisting of unique tag records. The release location (stream and rkm), release type (volitional or forced), and hatchery group (HxH or WxW) will be recorded for each tag file created. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. However, because PIT-detection efficiency during loading will not be 100%, 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 Murdoch and Peven (2005), 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. Should PIT tagging occur, a monitored release strategy consistent with other Chinook stocks (i.e., Chiwawa Spring Chinook) will be implemented. 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 (Murdoch and Peven 2005). 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 Murdoch and Peven (2005). 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. 2013). Table 4 below provides a summary of the variables to be measured in 2017 under the juvenile monitoring component and what objective the measure supports. The text that follows in this section further describes the activities.

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Table 4. Monitoring and Evaluation Plan (Hillman et al. 2013) 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, parr [where appropriate], 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 newly 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.

Specific actions to monitor the freshwater productivity of supplemented spring Chinook salmon in the Methow sub-basin have yet to be determined. As these become available, the plan will be amended and presented to the HC by December.

3.2 Tributary Evaluations

Chiwawa River

Snorkel surveys will be utilized to estimate parr abundance within the Chiwawa subwatershed during the summer. This approach has been used in the Chiwawa subwatershed since 1992. In parallel to addressing Objective 2, additional juvenile data can help to assess the habitat carrying capacity in each tributary. This information can add value to the overall M&E plans and help inform management decisions.

Sampling will follow a stratified random sampling design. Landscape classification will be used to stratify streams in the Chiwawa subwatershed that support juvenile Chinook salmon. In the Chiwawa subwatershed, WDFW found that classification "explained" most of the variability in fish numbers caused by geology, land type, valley bottom type, stream state condition, and habitat type (Hillman 2013). The same classification method was used to identify sections of the Little Wenatchee River (reference area) that corresponded to discrete reaches in the supplemented subwatersheds, but that had no release of hatchery Chinook. Consistent with previous efforts, habitat types within each land-class or reach will be identified and quantified annually. At least three units of each habitat type within each reach will be randomly selected for estimating densities of salmon and trout. Thus, overall sampling consists of a stratified-random sampling design, which increases the accuracy and precision of population estimates.

Densities of salmon and trout will be estimated in August and September by direct underwater observation within the randomly-selected habitat units. Underwater methods will follow those described by Thurow (1994), Dolloff et al. (1996), and O'Neal (2007). Habitat surface areas and volumes will be estimated during fish sampling. Numbers of fish counted will be adjusted for detection probabilities using the models published in Hillman et al. (1992). For each habitat type within a state type and reach stratum, the mean density of salmon and trout will be calculated as the ratio of mean numbers to mean area or volume sampled (Cochran 1977). Total numbers of fish will be estimated per habitat type within a state type and reach stratum as the product of mean density of fish in a given habitat type, times total area or volume of that habitat type within the stratum (Cochran 1977). Total numbers of fish within the supplemented subwatershed will be estimated as the sum of all population numbers per habitat type in state type/reach strata. Bootstrapping methods will be utilized to estimate variance and percent errors (based on 95% confidence interval) for total numbers of fish.

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 2017under the adult monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

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Table 5. Monitoring and Evaluation Plan (Hillman et al. 2013) 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 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 Murdoch and Peven (2005). 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 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.

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 in Murdoch and Peven (2005). 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. In addition, all

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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 last 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 Murdoch and Peven (2005). 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. Weekly ground-based estimates and the true number of redds determined via intensive surveys will be compared in order to determine observer efficiency. Weekly river characteristics (e.g., channel width, water depth, discharge, visibility, and habitat complexity), observer experience, and survey effort will be incorporated into a model to predict observer efficiency in all river reaches. Predicted redd observer efficiency for each river reach will be used to expand ground-based redd counts to estimate the total reach redd count. Ground-based surveys will also be used to estimate redd life for each river reach. The estimated spawner abundance in the Wenatchee River and an associated level of precision will be calculated using the estimated total redd count for each reach, mean redd life, and the sex ratio of the population similar to methods described in Millar et al. (2012). Salmon carcass data collected during spawning ground surveys will be consistent with Murdoch and Peven (2005). 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 (Murdoch and Peven 2005). 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: 2013 Update (Hillman et al. 2013). 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 2017(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.

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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 proposed 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

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	October 20, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the September 21, 2016, HCP Hatchery Committees Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees met via conference call on Wednesday, September 21, 2016, from 9:00 to 10:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A). *(Note: this item is ongoing.)*
- Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A). *(Note: this item is ongoing.)*
- Justin Yeager will check when the Yakama Nation (YN) most recently reviewed the Wenatchee steelhead draft Biological Opinion (BiOp) and provide that date to Keely Murdoch (Item I-A). *(Note: this item is ongoing.)*
- Justin Yeager will check with Emi Kondo (National Marine Fisheries Service [NMFS]) to make sure the Methow spring Chinook Environmental Assessment is distributed to applicants and the Colville Confederated Tribes (CCT) on September 21, 2016 (Item II-B).
- Sarah Montgomery will distribute the revised Hatchery M&E Plan Appendix 5, as edited during the September 21, 2016, conference call, to the Hatchery Committees for review (Item II-C). *(Note: Montgomery distributed the revised Appendix 5 on September 21, 2016.)*
- The Hatchery Committees will review revised Hatchery M&E Plan Appendix 5 and provide approval or further edits to Sarah Montgomery by Wednesday,

October 5, 2016 (Item II-C). *(Note: Appendix 5 has been added to the October 19, 2016 Hatchery Committees meeting agenda for further discussion.)*

- Todd Pearsons will follow up with Jeff Grimm (WDFW) regarding the third year of Issaquah Hatchery embryonic imprinting data (Item II-D).
- Bill Gale will invite Roger Tabor (U.S. Fish and Wildlife Service [USFWS]) to the October 19, 2016, Hatchery Committees meeting to discuss embryonic imprinting (Item II-D).
- Sarah Montgomery will send a clarification email regarding the 60-day review period for the Douglas PUD Draft Hatchery M&E Annual Report to the Hatchery Committees (Item III-A). *(Note: Montgomery sent a clarification email to the Hatchery Committees on September 21, 2016.)*
- Bill Gale will invite Katy Pfannenstein (USFWS) to the November 16, 2016, Hatchery Committees meeting to discuss juvenile sampling and early male maturation (Item IV-A).

DECISION SUMMARY

- There were no decisions approved during today's meeting.

AGREEMENTS

- There were no agreements during today's meeting.

REVIEW ITEMS

- Sarah Montgomery sent an email to the Hatchery Committees on September 21, 2016, notifying them the revised Hatchery M&E Plan Appendix 5 is available for review, with approval or comments requested by October 5, 2016 (Item II-C).
- Sarah Montgomery sent an email to the Hatchery Committees on September 14, 2016, notifying them the Draft 2015 Douglas PUD and Grant PUD M&E Annual Report is available for a 60-day review, with edits and comments due to Greg Mackey by November 14, 2016 (Item III-A).
- Sarah Montgomery sent an email to the Hatchery Committees on October 7, 2016, notifying them that the Draft 2017 Methow M&E Implementation Plan is available

for a 30-day review, with edits and comments due to Greg Mackey by November 7, 2016. *(Note: review period pending Hatchery Committees agreement.)*

FINALIZED DOCUMENTS

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the August 17, 2016 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Sarah Montgomery removed the Hatchery Evaluation Technical Team (HETT) update.
- Tracy Hillman added the review period for the Draft Douglas PUD Hatchery M&E Annual Report.
- Keely Murdoch added a joint Hatchery Committees/Priest Rapids Coordinating Committee Hatchery Sub-Committee regarding embryonic imprinting and homing fidelity.

The Hatchery Committees reviewed the revised draft August 17, 2016, meeting minutes. Montgomery said there are several outstanding comments to be discussed, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft August 17, 2016, meeting minutes, as revised.

Action items from the Hatchery Committees meeting on August 17, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on August 17, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item is ongoing. Johnson provided an update to the Hatchery Committees on September 20, 2016 and will provide another update at the Hatchery Committees

October 19, 2016, meeting. Mike Tonseth said the genetics laboratory will likely provide a list of recommendations for genetic sampling.

- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A).*
  This item is ongoing. Willard said completing this document depends on whether continued discussions of embryonic imprinting should be included in the Objective 5 section of the summary. She said she would finish drafting the document for review by the October 19, 2016, Hatchery Committees meeting, and it can be revised later with additional Objective 5 information.
- *Bill Gale will review the revised June 15, 2016, Hatchery Committees meeting minutes and provide edits to Sarah Montgomery by Friday, August 19, 2016 (Item I-A).*
  This item is complete.
- *Justin Yeager will check when the Yakama Nation (YN) most recently reviewed the Wenatchee steelhead draft Biological Opinion (BiOp) and provide that date to Keely Murdoch (Item II-B).*
  This item is ongoing. Yeager said he did not find the date, but will try again. Murdoch also did not find the date.
- *The Hatchery Committees will review revised Hatchery M&E Plan Appendix 5 and provide approval or further edits to Sarah Montgomery by Friday, August 26, 2016 (Item II-C).*
  This item will be discussed today.
- *Mike Tonseth will ask McLain Johnson (WDFW) when the timeline for conducting genetic sampling for HCP program species will be complete (Item II-D).*
  This item is complete.
- *Kirk Truscott will discuss internally stray rate targets for upper Columbia River summer Chinook salmon (Item II-D).*
  Truscott said Casey Baldwin (CCT) has been working on genetics information for upper Columbia River summer Chinook salmon and will be able to provide more information in October, 2016.
- *Mike Tonseth will provide the Hatchery Committees with an update on tangle-netting for Methow spring Chinook salmon broodstock (Item II-E).*

This item is complete. Hillman said Tonseth sent an email to the Hatchery Committees on September 7, 2016, stating that broodstock for the Methow spring Chinook salmon program totals 85 females and 58 males this year.

- *Tracy Hillman will respond to Greer Maier's (upper Columbia Salmon Recovery Board [UCSRB]) request for the Hatchery Committees to review the Draft Hatchery Report, stating the Hatchery Committees want to review the report. He will also invite Maier to discuss comments in person at an upcoming Hatchery Committees meeting (Item II-F).*
  This item is complete. Hillman said he discussed this with Maier, and Maier said the document should be available for review in October, 2016.
- *Sarah Montgomery will update the Hatchery Committees meeting protocols document to reflect agreements during today's meeting (Item IV-A).*
  This item is complete. Montgomery said the protocols have flexibility in meeting time and location and therefore do not need to be updated.

II. Joint HCP-HC/PRCC HSC

A. USFWS Bull Trout Consultation Update (Bill Gale)

Bill Gale said Karl Halupka (USFWS) distributed a draft of the BiOp covering hatchery programs in the Wenatchee basin to the applicants for a 3-week review, with comments due on September 29, 2016. Gale said the draft memorandum regarding the Methow spring Chinook salmon consultation is in internal review.

Todd Pearsons said he has not reviewed the entire 300-page Wenatchee basin BiOp, but has at least one item to discuss. He said there are some situations or measures that would have a positive effect for one listed species, and a potential negative effect for another listed species. He gave an example related to the Wenatchee basin Adult Management Plan specifically related to Wenatchee spring Chinook salmon. He said there is an element of the plan that allows for carcass outplanting in nutrient-poor areas, with the intent to place carcasses during periods in which they would be naturally occurring. In contrast, an element of the draft BiOp is not performing nutrient-restoration activities during periods when bull trout are holding or spawning, which corresponds with the same period (approximately September 1 to November 1) during which Chinook salmon carcasses would be outplanted based on the

Adult Management Plan. Pearsons said concurrence from USFWS is necessary to determine where, when, and with which carcasses, nutrient-restoration activities could occur. He said, if USFWS included the measure in response to concerns about disease, perhaps carcass analogs could be used. Mike Tonseth said disease concerns from carcasses are already mitigated for from the perspective of WDFW, because when WDFW distributes carcasses they remove the point sources for pathogens (head and all internal organs) in accordance with fish-health protocols.

Pearsons summarized that more clarification is necessary regarding the risks of carcass analog or whole-carcass distribution related to any potential nutrient enhancement activity identified in the Wenatchee basin Adult Management Plan and in the draft Wenatchee basin BiOp currently under review. Bill Gale said he supports the idea of carcass enhancement and it is a viable use of excess fish. He said fisheries enhancement groups perform most carcass enhancement activities and their permits and consultation for enhancement activities are a separate responsibility from the draft BiOp being discussed. Pearsons asked why the BiOp would restrict nutrient-restoration activities by the hatchery programs. Gale replied that the location, area, and handling of fish are not addressed in the Wenatchee basin Adult Management Plan; therefore, the restoration action cannot be consulted on by USFWS. Pearsons asked which details about nutrient-restoration activities are included in the Adult Management Plan. Keely Murdoch said nutrient-enhancement activities are identified as a viable use of surplus fish in the Adult Management Plan; however, she thinks the details about location, area, and handling of fish are not addressed. Murdoch agreed with Pearsons that there may be items in the draft BiOp that contrast with the intent of some programs, specifically in regards to Endangered Species Act-listed species, and it might help to have more time to review the draft BiOp than is currently provided. Gale suggested that those who would like a longer review period contact Karl Halupka and said the purpose of this agenda item is to provide an update on the status of consultation, and not necessarily to discuss details of the draft BiOp, which he said would be beneficial to do in another forum. Alene Underwood said there is a meeting on October 11, 2016, which may be a good forum to discuss some of these topics.

B. NMFS Consultation Update (Justin Yeager)

Justin Yeager said, regarding the Methow spring Chinook salmon consultation, a draft Environmental Assessment will be distributed to the applicants today by Emi Kondo. Kirk Truscott asked that it also be sent to him, because the Okanogan and Methow programs are related; Yeager said he would make sure it is sent to CCT. Yeager clarified that the Environmental Assessment is part of the National Environmental Policy Act process.

Yeager said, regarding the draft Methow Steelhead Adult Management Plan, NMFS and WDFW are working to develop gene flow guidelines, and most recently met on September 15, 2016.

Yeager said NMFS expects to complete the Okanogan steelhead Tribal Resource Management Plan (TRMP) by the end of 2016.

Tracy Hillman summarized that the Wenatchee steelhead and Wenatchee spring Chinook BiOps have been issued, the Methow spring Chinook EA will be distributed today for review, the Methow Steelhead Adult Management Plan is being worked on, and the Okanogan steelhead TRMP can be expected by the end of 2016. Mike Tonseth clarified that the Wenatchee steelhead BiOp has been issued to applicants, but the Section 10 permit has not been issued and is pending the completion of Section 7 consultation with USFWS.

C. Review Draft Hatchery M&E Plan Appendix 5 (All)

Appendix 5 – Stray Rate Objectives

Sarah Montgomery displayed the document, "Revised Hatchery M&E Plan Appendix 5 (Hillman and WDFW edits)," which Montgomery distributed to the Hatchery Committees on August 22, 2016. Montgomery also displayed an email from Craig Busack, sent on August 23, 2016, providing feedback on the revised appendix. Questions and comments were discussed, and edits were made to the document.

Tracy Hillman summarized Busack's comments. Busack questioned whether the Hatchery Committees should set a general standard for management strays, and recommended the title of the appendix be changed. Greg Mackey said management strays pose a different level of risk, and applying a strict standard to management strays does not make sense, especially one as strict as 5%. Hillman said the concern is about how much (as a target, say, 90% or more) of the spawning escapement spawned in the stream in which they were released as juveniles, and suggested adding a similar explanation in the appendix, with the caveat that each program can be addressed on a case-by-case basis depending on percent hatchery-origin spawners (pHOS) and proportionate natural influence (PNI) targets. Mackey said stating and comparing to a general guideline could be beneficial, but overall, it is more important to discuss qualitatively what the stray rate represents from a risks and benefits standpoint. Keely Murdoch agreed that setting a guideline is a good idea, especially because pHOS changes frequently for some programs (that are managed under pHOS or PNI sliding scales). Murdoch said she is confused about the purpose of Appendix 5, because its initial purpose was to provide definitions of strays, and it currently is setting targets for evaluation, which perhaps should be in the body of the Monitoring Plan itself. Hillman said the standards for genetic strays are already set, and choosing management stray rate targets for each program is necessary to help guide data analysis. Murdoch said she prefers to agree on a standard and say that it can be adjusted. She said the YN wants fish to return to the location where they are released. Mike Tonseth said 90% could be the minimum acceptable level. Mackey said it is important to take a more integrated approach to management decisions; so, for example, in any report, the authors should explain why a program is not meeting the 90% threshold within the context of straying and not exacerbating other management problems. Tonseth agreed and said, for some programs, 85% or 95% may be an optimal target. Hillman suggested adding "and can be adjusted up or down" to the target definition. Mackey said that will work, but he is apprehensive about setting a target and focusing a lot of effort on stray rates because stray rates may not be very important for recovering the populations.

Todd Pearsons said one of the reasons the Hatchery Committees may be having trouble setting a management stray target is that there is not a generally acceptable target across other hatchery programs as there is for genetic strays (5 or 10%). He asked if anyone has a region-wide understanding of standards for management strays, or knows of targets other programs have used. He said management strays are a newer concept, and asked if setting a management stray "percentage" target is even the appropriate metric for achieving program goals. He said the goal is that a certain number of fish return to specific locations and asked if this is better measured as a percent of the release or as numbers of fish. Hillman said the target stated in the draft Appendix 5 is based on a percentage of spawning escapement and not a percent of the numbers of fish released. Murdoch said setting the number of returning fish as a target is a difficult metric to measure and would change from year to year based on the sliding scale of natural-origin fish returning. She said a 90% target is a simpler metric that provides a guideline and can illustrate how reliably hatchery releases home to their release site. She said homing fidelity is a key metric and understanding it will help programs to adjust the number of fish that should be release from each site. Bill Gale said, if the 10% stray rate criterion becomes the accepted standard, the metric applies to integrated and segregated programs. He said, within the Leavenworth National Fish Hatchery permit, for example, stray rate criteria are set stricter than 5%. He said he thinks setting a 10% guideline for management stray rates and adjusting it up or down for program-specific factors is consistent with how NMFS sets stray rate levels in permits. Hillman said it would be helpful for reporting purposes to set a guideline for comparison. He said it seems representatives present are in concurrence with setting a minimum acceptable level of 90% of the spawning escapement will spawn in the stream in which they were released as juveniles, unless the Hatchery Committees adjust it up or down based on stock-specific pHOS and PNI. He said edits made to Appendix 5 today will be sent to the Hatchery Committees for a 2-week review.

Sarah Montgomery said she will distribute the revised Appendix 5, as edited during the September 21, 2016, conference call, to the Hatchery Committees for review. The Hatchery Committees will review the revised Appendix 5 and provide approval or further edits to Montgomery by Wednesday, October 5, 2016.

D. Embryonic Imprinting (Keely Murdoch)

Keely Murdoch said she added the embryonic imprinting discussion to the agenda because Hatchery Committees members visited the Issaquah Salmon Hatchery in May, 2016, and should begin revisiting discussions about embryonic imprinting. She said the Hatchery Committees can discuss whether to test embryonic imprinting or sequential imprinting, and next steps.

Todd Pearsons said he has been trying to find data related to the Issaquah Hatchery embryonic imprinting study. He said Roger Tabor is the technical lead, and from his understanding, there are only 2 reliable years of data. He said, in the first year of the Issaquah Hatchery study, 85% of fish returned to their natal stream. In the second year of the study, 42% of fish returned, and in the third year, there was an issue with the otolith thermal marking. Pearsons said he will follow up with Jeff Grimm regarding the third year of data. Bill Gale asked if Pearsons thinks Tabor would be willing to discuss embryonic imprinting with the Hatchery Committees, and said he could reach out to Tabor and ask him to come to a meeting. Pearsons said it would be useful to have Tabor attend a meeting so the Hatchery Committees can ask him questions. Gale said he will invite Tabor to the Hatchery Committees October 19, 2016, meeting to discuss embryonic imprinting.

III. Douglas PUD

A. Review Period for Draft Hatchery M&E Annual Report (Greg Mackey)

Tracy Hillman said Douglas PUD distributed their Draft Hatchery M&E Annual Report for review on September 14, 2016. He said Douglas PUD is requesting a 30-day review period instead of a 60-day period, which is consistent with 2015 and with Chelan PUD's annual report review periods. Gale asked why the review period should be shortened.

Mike Tonseth said, regardless of whether the period is 30 or 60 days, most people wait until the week of the due date to provide edits. Alene Underwood said the reason Chelan PUD requested a shorter review time in 2015 was to include more data in the report and stagger review times with other reports. Greg Mackey said the reason Douglas PUD wants to use a 30-day review period is to deliver the report to NMFS sooner. However, if NMFS is okay with a 60-day review period and receiving the report in December 2016, then the 60-day review period will allow more time for Hatchery Committees members to review the report in addition to other items that are out for review (such as the draft Methow spring Chinook Environmental Assessment and Wenatchee basin BiOp). Tonseth said Section C, Terms and Conditions, of the 1196 permit states that the report is due when the Hatchery Committees decide it is due; therefore, it is up to the Hatchery Committees to set a reasonable and appropriate review timeline. Hillman summarized that the Hatchery Committees decided not to shorten the review period for Douglas PUD's draft Hatchery M&E Annual Report, so comments on the draft are due back to Mackey by November 14, 2016. Sarah Montgomery said she would remind the Hatchery Committees, by email, of the 60-day review timeline.

IV. HCP Administration

A. Upcoming Agenda Items

Bill Gale said Katy Pfannenstein has been working on juvenile sampling and male maturation studies. He asked the Hatchery Committees if they would like to invite her to present a summary of her analysis at the November 16, 2016, meeting. Hatchery Committees members present said that would be interesting, and Gale said he would invite Pfannenstein to attend the November 16, 2016, Hatchery Committees meeting.

B. Next Meetings

The next Hatchery Committees meetings are October 19, 2016 (Chelan PUD), November 16, 2016 (Douglas PUD), and December 21, 2016 (Chelan PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Revised Hatchery M&E Plan Appendix 5 (Hillman and WDFW edits)

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons†	Grant PUD
Peter Graf†	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Bill Gale*	U.S. Fish and Wildlife Service
Justin Yeager*	National Marine Fisheries Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
† Joined for the joint HCP-HC/PRCC HSC discussion

Appendix 5: Defining strays for hatchery programs

- **Management Stray** = Any hatchery fish that spawn in streams other than the stream in which they were released. An example would be hatchery spring Chinook released from the Chewuch Acclimation Facility that return and spawn in the Methow River. This metric may not apply to reintroduction programs where fish are encouraged to recolonize new or reconnected habitat. Management strays should make up no more than 5% of the recipient tributary escapement.
- **Genetic Out-of-Population Stray** = Any hatchery fish that spawn in populations other than the one from which they were released. An example would be hatchery steelhead from the Wenatchee that spawn in the Methow River. Out-of-population strays should make up no more than 5% of the recipient population spawning escapement (ICBTRT 2007).
- **Genetic Within-Population Stray** = Any hatchery fish that spawn within spawning aggregates (i.e., discrete, genetic sub-populations) other than the one from which they were released. An example would be a MetComp hatchery spring Chinook spawning in the Twisp River. Within-population strays should make up no more than 10% of the recipient spawning aggregate (ICBTRT 2007).

References:

Interior Columbia Basin Technical Recovery Team (ICTRT). 2007. Viability criteria for application to interior Columbia basin salmonid ESUs. ICTRT Report to NOAA Fisheries, Portland, Oregon.

Deleted: [1]

Commented [MT1]: The management stray definition is meaningless unless there is a level to which we are managing for. The committees had briefly touched on this but I don't believe we fully agreed on an acceptable level.

From the States perspective, we would like to see a management stray make up no more than 5% of the recipient tributary escapement.

Deleted: Reintroduction programs may be excluded from this metric.

Deleted: (i.e., major or minor spawning areas)

Deleted: [1]This definition does not apply to Wenatchee steelhead which are acclimated at the Chiwawa Acclimation Facility and truck-planted at various release locations in the Wenatchee sub-basin; a steelhead released in Nason Creek that returns to the Chiwawa River is not considered a management stray.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	January 18, 2016
From:	Tracy Hillman, HCP Hatchery Committees Chairman		
Cc:	Sarah Montgomery, Anchor QEA, LLC		
Re:	Final Minutes of the October 19, 2016, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees met at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, October 21, 2016, from 9:00 am to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Justin Yeager will check when the Yakama Nation (YN) most recently reviewed the Wenatchee steelhead draft Biological Opinion and provide that date to Keely Murdoch (Item I-A). *(Note: this item is ongoing.)*
- The U.S. Fish and Wildlife Service (USFWS) will send a letter to the HCP Coordinating Committees describing changes in USFWS representation on the Hatchery Committees (Item II-A). *(Note: Jim Craig [USFWS] emailed a letter to Tracy Hillman describing this change on October 21, 2016.)*
- Sarah Montgomery will assist USFWS in acquiring Hatchery Committees cc: email access for Michael Humling (USFWS; Item II-A). *(Note: Montgomery added Humling to the Hatchery Committees email cc: distribution list on October 20, 2016.)*
- A subgroup led by Catherine Willard will convene to prepare a plan to outplant adult spring Chinook salmon in the Chewuch River (Item II-C). *(Note: the subgroup met on January 9, 2017.)*
- Keely Murdoch will research who is leading the Columbia River Inter-Tribal Fish Commission's (CRITFC) parentage-based tagging effort in order to coordinate with Mclain Johnson about genetic sampling (Item II-D).

- Mclain Johnson (Washington Department of Fish and Wildlife [WDFW]) will revise the timeline for conducting genetic sampling for HCP program species and send it to Sarah Montgomery for distribution to the Hatchery Committees (Item II-D).
- The Hatchery Committees will review the timeline for conducting genetic sampling for HCP program species and provide additional questions to Johnson (Item II-D).
- Mike Tonseth will ask WDFW geneticists about a technical methodology for deciding sampling intervals (Item II-D).
- Sarah Montgomery and Tracy Hillman will renumber the Hatchery Monitoring and Evaluation (M&E) Plan appendices and append them to the Hatchery M&E Plan (Item II-E).
- Todd Pearsons (Grant PUD) will distribute the paper by Ford et al. (2015) regarding brood year stray rates to the Hatchery Committees for review (Item II-E).
  (Note: Pearsons sent the paper to Montgomery, which she forwarded to the Hatchery Committees on October 20, 2016.)
- Catherine Willard will add a summary table to the draft summary of the 5-Year Hatchery M&E Review process (Item II-F).
- Craig Busack will discuss proportion of hatchery-origin spawners (pHOS) targets for Methow steelhead with Amilee Wilson (National Marine Fisheries Service [NMFS]), and follow up with the Hatchery Committees by October 21, 2016 (Item III-A).
  (Note: Busack emailed Hatchery Committees representatives on October 21, 2016, stating the consultation has been transferred to Charlene Hurst [NMFS], and Hurst and Busack will further discuss pHOS targets.)
- Sarah Montgomery will provide the WebEx phone number on the agenda for future Hatchery Committees meetings (Item V-B). *(Note: Montgomery added the WebEx phone number to the January 18, 2017, agenda.)*

DECISION SUMMARY

- There were no decisions approved during today's meeting.

AGREEMENTS

- Hatchery Committees representatives present agreed to Douglas PUD's proposed 30-day review period for the Draft 2017 Methow M&E Implementation Plan, with edits and comments due to Greg Mackey by November 7, 2016 (Item IV-B).
- Hatchery Committees representatives present agreed to delete draft Appendix 5 from the Hatchery M&E Plan because its contents are included in the plan itself (Item II-E).

REVIEW ITEMS

- There are no items currently out for review.

FINALIZED DOCUMENTS

- Sarah Montgomery sent an email to the Hatchery Committees on November 18, 2016, notifying them that the Final 2015 Douglas PUD Hatchery M&E Annual Report is now available for download from the Hatchery Committees Extranet site.
- Sarah Montgomery sent an email to the Hatchery Committees on November 9, 2016, notifying them that the Final 2017 Douglas PUD, Chelan PUD, and Grant PUD Hatchery M&E Implementation Plan is now available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the September 21, 2016 Conference Call Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following revisions were requested:

- Sarah Montgomery added the Draft Summary of Hatchery M&E Report Review.

The Hatchery Committees reviewed the revised draft September 21, 2016, meeting minutes. Montgomery said there are several outstanding comments to be discussed, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft September 21, 2016, conference call minutes, as revised.

Action items from the Hatchery Committees meeting on September 21, 2016, and follow-up discussions, were addressed *(note: italicized text below corresponds to agenda items from the meeting on August 17, 2016)*:

- *McLain Johnson (Washington Department of Fish and Wildlife [WDFW]) will develop a timeline for conducting genetic sampling for HCP program species (Item I-A).*
  This item will be discussed today.
- *Catherine Willard will draft a summary of the 5-Year Hatchery Monitoring and Evaluation (M&E) Review process (Item I-A).*
  This item will be discussed today.
- *Justin Yeager will check when the Yakama Nation (YN) most recently reviewed the Wenatchee steelhead draft Biological Opinion (BiOp) and provide that date to Keely Murdoch (Item I-A).*
  This item is ongoing. Yeager said Amilee Wilson will provide an answer to Murdoch.
- *Justin Yeager will check with Emi Kondo (NMFS) to make sure the Methow spring Chinook Environmental Assessment is distributed to applicants and the Colville Confederated Tribes (CCT) on September 21, 2016 (Item II-B).*
  This item is complete.
- *Sarah Montgomery will distribute the revised Hatchery M&E Plan Appendix 5, as edited during the September 21, 2016, conference call, to the Hatchery Committees for review (Item II-C).*
  Montgomery said she distributed the revised Appendix 5 on September 21, 2016, and this item will be discussed further today.
- *The Hatchery Committees will review revised Hatchery M&E Plan Appendix 5 and provide approval or further edits to Sarah Montgomery by Wednesday, October 5, 2016 (Item II-C).*
  This item will be discussed today.
- *Todd Pearsons will follow up with Jeff Grimm (WDFW) regarding the third year of Issaquah Hatchery embryonic imprinting data (Item II-D).*
  This item is ongoing.

- *Bill Gale will invite Roger Tabor (U.S. Fish and Wildlife Service [USFWS]) to the October 19, 2016, Hatchery Committees meeting to discuss embryonic imprinting (Item II-D).*
  Gale said he was not able to discuss embryonic imprinting with Roger Tabor.
- *Sarah Montgomery will send a clarification email regarding the 60-day review period for the Douglas PUD Draft Hatchery M&E Annual Report to the Hatchery Committees (Item III-A).*
  This item is complete.
- *Bill Gale will invite Katy Pfannenstein (USFWS) to the November 16, 2016, Hatchery Committees meeting to present findings on juvenile sampling and early male maturation (Item IV-A).*
  Cooper said Pfannenstein is very busy and plans to make her presentation to the Hatchery Committees in either November or December 2016.

II. Joint HCP-HC/PRCC HSC

A. USFWS Consultation Update (Bill Gale)

Bill Gale said he does not have any updates specific to USFWS consultation. He said he has an update on USFWS Hatchery Committees representation. Gale said regional USFWS leadership has asked him to be available to work on a 10-year implementation plan. For that reason, he and Matt Cooper are switching roles on the Hatchery Committees for approximately 6 months. He said he will be the alternate and Cooper will now be the representative. This change will be recorded in a letter from USFWS to the HCP Hatchery and Coordinating Committees.

Gale asked Tracy Hillman and Sarah Montgomery to add Michael Humling to the Hatchery Committees cc: email distribution list. Montgomery said she will check on the requirements for providing access to Humling and follow up with Gale and Humling.

Gale asked the Hatchery Committees if the USFWS Consultation Update should continue to be a standing agenda item for Hatchery Committees meetings. Hatchery Committees representatives present responded yes. Hillman added he provides updates to the

Coordinating Committees regarding Hatchery Committees discussions, and he believes the consultation updates are helpful to the Coordinating Committees.

B. NMFS Consultation Update (Justin Yeager)

Regarding the Methow spring Chinook salmon consultation, Justin Yeager said NMFS received comments on the draft Environmental Assessment, and Yeager thanked the Hatchery Committees for their input.

C. Embryonic Imprinting (Keely Murdoch)

Todd Pearsons said he is still working to confirm why the third year of data for the Issaquah Fish Hatchery (FH) embryonic imprinting study were not reliable, and he suspects it is related to unclear otolith signatures. Keely Murdoch said representatives should discuss today whether to move forward with a plan to test embryonic imprinting, or develop a plan to test sequential imprinting, which may depend on the Wells Fish Hatchery rebuilding. She said having the full dataset from the Issaquah FH study would be helpful, but the Hatchery Committees can still move forward with what they know. Pearsons said he did find a short draft progress report for the Issaquah FH study; however, no interpretation of the third year of results was offered in the report.

Pearsons recalled that Murdoch had drafted a pre-proposal that Hatchery Committees members provided feedback on, and said that document might be useful to look at for this discussion. Catherine Willard shared the latest version of Murdoch's proposal "Draft Chewuch Homing Study Proposal (Grant PUD comments)," which Montgomery distributed to the Hatchery Committees on April 20, 2016 (Attachment B). Pearsons said the Hatchery Committees already have a version of a homing study —the Goat Wall Acclimation Study. Greg Mackey said it would take a minimum of 5 brood years to see results from a homing study, and a power analysis would be required to see how large a sample size would be required to produce meaningful results. He said, because the best means of monitoring homing is through coded-wire tags, results will also depend on rates of carcass recovery. In addition, many years of data are necessary because stray rates vary annually and studies must wait for entire cohorts to return. Pearsons asked if there are enough available fish to perform the Goat Wall Acclimation Study and a second imprinting study for a long enough time period for both studies. Murdoch said the Goat Wall Acclimation Study includes only

25,000 fish from the Methow FH release, and the study would be consistent with the sequential imprinting theory in that fish spawned and reared at Methow FH are final acclimated further upstream in the same tributary and released. She said she also thinks a group of fish outplanted in the Chewuch River would make sense for studying embryonic imprinting. Bill Gale said the Goat Wall release is only 25,000 fish, which may be too small of a release to return enough adults to assess a level of difference between groups.

Willard asked if the Goat Wall study was designed to specifically address spawning distribution and not homing fidelity. Mackey said they could be studied simultaneously because both metrics are about fish seeking natal areas, as long as the cutoff point for homing is defined. Murdoch said incorporating the Goat Wall study into assessing homing fidelity has potential. Tracy Hillman said some of the earlier discussions Hatchery Committees members had in 2016 focused on embryonic or sequential imprinting, the equipment needed to conduct a study, which fish to use, and the timeline related to the Wells FH remodel. Mike Tonseth added that Hatchery Committees members should also consider statistical and biological meaningfulness and whether appropriate escapement objectives should be considered. Mackey said, regarding biological significance, there is always a chance of type II error, which is failing to reject the null hypothesis when it is in fact false. Having a large enough sample size will help avoid type II errors. Hillman said Mackey has previously conducted power analyses and found the sample size or sampling intensity must be high.

Pearsons asked the Hatchery Committees what their objectives are for studying homing and straying. He said the embryonic imprinting results from the Issaquah FH study are not very satisfying (note: Issaquah results from year 1: 85% homing, year 2: 42% homing, and year 3: no results); therefore, it is necessary to consider program objectives and desired homing rates, or the desired number of fish spawning in the Chewuch River. Mackey said the defined straying and homing objectives are merely a way to ensure sufficient fish return to spawning grounds. Justin Yeager said the recovery plan defines the number of fish that should return to spawning grounds for each major spawning group. Based on the recovery standards, there should be a minimum of 20 redds from natural-origin crosses in the Chewuch River, or there should be at least 5% of the total number of redds in the population. Hillman read the Methow spring Chinook salmon criteria from the recovery plan stating, "Naturally produced spring Chinook salmon spawning will occur within the Twisp, Chewuch, and Upper Methow major spawning areas. The minimum number of naturally produced spring Chinook salmon redds within each major spawning area will be either 5% of the total number of redds within the Methow subbasin or at least 20 redds within each major area, whichever is greater." Mackey asked if there is a spawner escapement target for the Methow population. Yeager responded the target is 2,000 natural-origin spawners for the Methow population, and Tonseth pointed out that 20 redds or 5% of the total number of redds does not match up well with 2,000 total spawners in the basin. Pearsons said 20 redds or 5% of the total number of redds is a minimum threshold, which contributes to the spatial distribution of the population, not a threshold for abundance and accounting for recovery at the basin-scale. Kahler added that the probability of natural-origin fish spawning with hatchery-origin fish is high when pHOS is high, and asked whether the redds are called "natural-origin" if they only have a natural-origin female spawner rather than both parents of natural origin.

Gale said the Hatchery Committees know the number of natural-origin spawners in the population in previous years and expected number in a current year. He said combining that information with the allowable number of hatchery fish derived from pHOS targets would drive calculations of the number of adult hatchery fish to release and proportionate natural influence (PNI). He said it is important to start calculations at known values instead of back-calculating from goals. Murdoch said YN wishes to see conservation fish spawning in areas where they will be productive and return natural-origin fish. She said releasing fish directly from hatcheries does not help to reach abundance goals for natural-origin spawners. She said the first step should be determining how many hatchery-origin fish can be put in areas such as the Chewuch River, then using the best available science to acclimate those fish. She said she suspects the number of allowable hatchery-origin fish in spawning areas such as the Chewuch River based on PNI and pHOS goals will not be high enough to perform an analysis using imprinting technology.

Mackey said another option that might achieve the same goal reliably would be to truck-plant hatchery origin adults removed during gene flow management into the Chewuch River. He said fish behavior could be studied with radio tags, and this study would produce results faster, with greater control and reliability, than other methods proposed. He said Douglas PUD is interested in the scientific concept of improving homing by imprinting on natal water, but conducting basic science is not in the mission of the PUDs and prefers to implement established science instead of testing it. Murdoch recalled that Andrew Dittman (National Oceanic and Atmospheric Administration [NOAA]) doubted how well embryonic imprinting would work with the Methow program because of its geography. She said she thinks testing sequential imprinting is more likely to produce meaningful results.

Tonseth said Mackey's idea of adult outplanting in the Chewuch River instead of acclimating juveniles is an easy and relatively inexpensive way to put hatchery spawners on spawning grounds. Murdoch said, in 2010, YN tested adult outplanting of coho salmon in Nason Creek and took genetic samples of juveniles. She said 35% of coho salmon juveniles in Nason Creek from that brood year genotyped back to the outplanted adults, which was higher than they expected. She said it appeared the outplanted adults spawned in Nason Creek. Hillman asked where adults for outplanting in the Chewuch River would be captured. Mackey said these fish could be adults that swim into the Methow FH and would otherwise be adult-managed. Murdoch suggested adding a genetic analysis component to the study. Mackey said a visible tag, such as a Floy tag, could also be used because M&E staff conduct spawner surveys in these areas on a weekly (or more frequent) basis. Willard said there are also passive integrated transponder (PIT)-tag arrays in the Chewuch River. Murdoch advised that spring Chinook salmon hold longer than other fish before spawning, so they should not be placed on the spawning grounds too early in case they return to the hatchery instead of staying to spawn.

Gale asked if this group of fish would have to be held separately at the Methow FH. Tonseth said he thinks staff are able to keep the fish separate, which may be necessary in order to perform broodstock checks. He cautioned there are limits to tagging, drugging, and releasing fish, so those factors must be considered.

Willard volunteered to convene a subgroup made up of interested representatives to draft a study plan in November. Kahler said the draft study plan will be modulated by the pHOS issue Gale described earlier; therefore, the plan will change in-season with information about the number of natural-origin fish returning to the Chewuch River.

Kirk Truscott said the homing fidelity of Chewuch-released fish returning to the Chewuch River is highly variable. He said staff cannot genetically differentiate natural-origin returns between the Chewuch and Methow rivers. He asked how they plan to calculate the number of fish to outplant in order to still meet pHOS targets. Tonseth said the number of PIT-tagged hatchery-origin fish from the Chewuch River returning is known starting at Priest Rapids Dam. In addition, PIT-tag arrays in the Chewuch River mean that they can calculate the number of fish to outplant very close to spawning time. He said, for natural-origin fish, proportions change frequently, but historical numbers can be referenced. Kahler added that the study plan could also involve waiting until spawning starts, and outplanting in areas that are not being utilized.

D. Genetic Sampling for HCP Program Species Timeline (Mclain Johnson)

Mclain Johnson said Objective 7 of the 2013 M&E Plan for PUD Hatchery Programs lists three monitoring questions that ask if hatchery programs have genetic impacts on natural stocks. He said he was tasked with locating and comparing samples that will help address these questions. He said his team inventoried the WDFW and NOAA genetics laboratories, then compiled all data into a spreadsheet, which he displayed on screen and said he will later distribute to the Hatchery Committees. He said the spreadsheet he developed starts with data from 1979 when some of the hatchery programs began. He showed Hatchery Committees members the contents of the spreadsheet, and they provided feedback and asked questions.

Todd Pearsons asked if fall Chinook salmon would be included in the spreadsheets. Tonseth said fall Chinook salmon samples are collected as part of the CRITFC sampling. Keely Murdoch volunteered to research who is leading CRITFC's parentage-based tagging effort and coordinate with Johnson. Mike Tonseth added that for any WDFW-operated programs, samples are stored at the WDFW laboratory and shared with the CRITFC laboratory by splitting the sample in most cases.

Johnson said they also assembled available genetic reports for each stock. He said the purpose of making this spreadsheet was to organize available data and to identify where different programs are in the 10-year genetic analysis cycle. He said this will help coordinate analysis efforts, help decide whether to upgrade some microsatellite marker analysis methods to single nucleotide polymorphisms (SNP) analysis methods, and help stagger analyses and reporting years within the 10-year framework.

Greg Mackey said genetic analyses were scheduled for every 5 years in the original M&E Plan. The Hatchery Committee decided to extend this interval to every 10 years during the updated of the M&E plan in 2013 because the 5-year interval was thought to be too short to detect any meaningful changes in population genetics metrics. Tonseth said it has also been discussed that three generations (approximately 15 years) may be a more appropriate analysis interval, but it would likely depend on the size of the program. He said, for small programs such as Endangered Species Act (ESA)-listed stocks and recovery programs, genetic change could occur more frequently. Regarding the analysis methodology, Tonseth said a lot of baseline genetic information for these programs is based on microsatellite analyses. The options are to continue running microsatellite analyses, switch to SNP analysis, or switch to SNP analyses and also rerun old samples with SNP analyses. Johnson said SNP analyses produce panels with a lot of information, and would be more likely to finding small genetic effects. Pearsons asked about the abundance of past tissue samples. Tonseth replied there is plenty of fish tissue to perform many analyses on older samples. Mackey added that the DNA can also be saved between analyses. Johnson said rerunning past samples with SNP analyses may change the timeline for conducting genetic analysis, so he will revise the timeline before distributing it to the Hatchery Committees for review. Bill Gale said he is interested in aligning these sampling efforts with genetic monitoring work at Winthrop FH, and he would also like to include the USFWS Abernathy Fish Technology Center so the same panels can be run in the same years.

Johnson summarized that in relation to the M&E Plan; one genetic analysis panel answers all three questions under Objective 7. Mackey said regional coordination is also required by Question 7.2.1. He said, in order to estimate genetic distance among populations, analyses are conducted on a set of populations within a region. In addition, an outgroup is also normally used to anchor the genetic distances within the region. He said it would make sense to perform sampling and analyses regionally to address populations that are potentially affected by the various hatchery programs.

Tom Kahler said Okanagan Nation Alliance has genetic samples for Okanogan sockeye salmon related to the Skaha Lake reintroduction program. Kirk Truscott said Okanogan summer Chinook salmon broodstock samples from 2013 are available from CRITFC.

Pearsons asked how the coordination between WDFW and CRITFC works with sampling and analysis. Johnson said WDFW and CRITFC share the same panel analysis structure.

Pearsons asked if there is a technical way to determine sampling intervals based on population size, the observed level of variation, the desired detection level, and the concern for potential genetic change. Johnson said all of the sampling intervals are currently set at 10 years. Pearsons said perhaps geneticists can provide technically defensible reasons for sampling intervals, similar to a power analysis; and requested that Johnson ask the geneticists to provide a biologically based sampling interval based upon variation in historic data. Gale said the interval would depend on the minimum genetic distance intended for measurement. Tonseth said he would ask WDFW geneticists about rationale behind 10-year sampling intervals.

Sarah Montgomery said she will send Johnson's revised timeline to the Hatchery Committees for review when she receives it. Hatchery Committees members will review the timeline and send feedback or additional questions to Johnson.

E. Review Draft Hatchery M&E Plan Appendix 5 (All)

Appendix 5 – Stray Rate Objectives

Tracy Hillman said Keely Murdoch, during the last meeting, brought up the idea that definitions and criteria stated in Appendix 5 are already included in the M&E Plan for PUD Hatchery Programs (2013 Update). He said he checked the M&E Plan, and it indeed contains criteria and definitions. He said the background for material currently included in the draft Appendix 5 stems from a table (showing allowable stray percentages) Greg Mackey put together, which was discussed in the Hatchery Evaluation Technical Team (HETT). He said it was decided in the HETT that not every program can make up 5% of strays in a population because the recipient population could then have a large percentage of stray hatchery fish. Murdoch said the purpose of the draft Appendix 5 then switched to defining management versus genetic strays, which Willard stated is defined in the M&E Plan and also in the Wenatchee annual report. Hillman said it is important to be clear about recipient populations and management strays, but he thinks this is adequately discussed in the M&E Plan. Hatchery Committees members present agreed that Appendix 5 is redundant and should be removed from the plan. Hillman said he and Sarah Montgomery will renumber the other appendices and append the final versions to the final M&E Plan.

Todd Pearsons said there is also a statement in the M&E Plan about revising brood year stray rates (currently set at 5% for strays into an independent [non-target] population, 5% brood stray rate, and 10% strays to non-target areas within a population) when new information becomes available. Pearsons said a 2015 paper by Mike Ford and others indicates a natural stray rate of up to 17.5% for Chinook salmon, and the Hatchery Committees should discuss this paper and target stray rates at an upcoming meeting.[1] Pearsons said he would send the Ford et al. paper to Montgomery for distribution to the Hatchery Committees.

Hillman summarized that the Hatchery Committees have completed reviewing all Hatchery M&E Plan appendices except for Appendix 1, and he and Montgomery will leave a placeholder for it when appending the other final appendices.

F. Draft Summary of Hatchery M&E Report Review (Catherine Willard)

Catherine Willard shared a document titled "Draft Summary of Hatchery M&E Report Review," which Sarah Montgomery distributed to the Hatchery Committees on October 13, 2016 (Attachment C).

[1] Ford, M., A. Murdoch, and M. Hughes, 2015. Using parentage analysis to estimate rates of straying and homing in Chinook salmon (*Oncorhynchus tshawytcha*). *Molecular Ecology* 24:1109-1121.

Willard said she and Sarah Montgomery compiled meetings notes applicable to the review of the Hatchery M&E Report, including all relevant documents, presentations, or other materials as attachments, organized by objective and by date. Hillman suggested adding a summary table, which Willard said she and Montgomery will add to the document. Willard summarized that the document consists only of approved Hatchery Committees meeting minutes and related documents and summaries, which may be useful as a tool for the Hatchery Committees in the future. Murdoch said it will also be important to document that Hatchery Committees responsibilities have been fulfilled in regards to the Hatchery Committees Statement of Agreement "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-Year Report 2006-2010" (approved March 27, 2015).

III. Douglas PUD and USFWS

A. Methow Steelhead Gene Flow (Greg Mackey)

Greg Mackey shared a document titled, "Draft Methow Steelhead Programs PNI Model for ESA Permits," which Montgomery distributed to the Hatchery Committees on October 13, 2016 (Attachment D). Mackey said Douglas PUD and USFWS recently received a request from NMFS to develop a proposal under the Methow steelhead ESA consultations thatshould target a pHOS of 0.3. He said Douglas PUD used the 4-population model developed by Craig Busack in 2016 where the combined Winthrop and Douglas PUD steelhead programs in the Methow basin would achieve a pHOS of 0.3. Busack updated the 3-population gene flow model to be a 4-population gene flow model so the Twisp program, Methow safety-net program, Winthrop program, and wild population can all be assessed together. Mackey said the document presented today starts with an approximation of current conditions, with an overall pHOS of 0.72 and an overall PNI of 0.16.

The next step in using the model was manipulating it to force pHOS to 0.5, which was the initial input from NMFS that USFWS and Douglas PUD had been working on (before pHOS = 0.3). The resulting PNI with pHOS of 0.5 would be 0.63. He said forcing pHOS to be 0.3 in the model resulted in a PNI of 0.68. He said to reach a pHOS this low, adult removal rates would be 70% for Twisp-origin fish, 90% for Methow safety-net program fish, and 90% of Winthrop program fish in addition to broodstock removals and fishery removals. He said the takeaway from this exercise is that almost all fish would have to be removed from most programs in order to get a pHOS of 0.3. He said the modeling work is still in progress, but Douglas PUD and USFWS are concerned that these removal rates would be impossible to achieve.

Keely Murdoch said, following discussions regarding spring Chinook salmon with the Hatchery Committees during 2013, NMFS released a document to the Hatchery Committees about the management framework for Methow spring Chinook salmon for Section 10 consultation. She said it was an outline written by Craig Busack that outlined his expectations for consultation. In that document, Methow steelhead had a target pHOS of 0.5 calculated over the entire Methow basin for all years through 2020. She said the timeline was divided into phases and with different percentages upstream and downstream of the Methow FH, but the general point is that the pHOS target was 0.5, which YN has been using as a guideline since then. She said, for this reason, YN will not be able to agree to a more restrictive pHOS value than 0.5.

Busack said many factors affecting how pHOS targets are determined have changed since 2013. He said, for example, the Methow spring Chinook salmon consultation hinged on developing the three-population model for determining pHOS values. He said the pHOS target of 0.3 requested by NMFS was not directly from him, and the Methow basin is a complicated basin for deciding on a target for pHOS. He said he would discuss pHOS values with Amilee Wilson and email the Hatchery Committees by October 21, 2016, with an update. He said the Hatchery Scientific Review Group (HSRG) criteria set pHOS at 0.3 for ecological reasons, but that does not necessarily mean it is an appropriate target for the basin.

Murdoch said that changes from final frameworks documents have been occurring, which have not been more restrictive from YN's perspective. She said YN would rather see the targets move to a PNI and sliding scale approach, similar to the approach taken for spring Chinook salmon; however, they have already agreed to a pHOS of 0.5 so that would be acceptable to YN as well. She said, in particular, she thought the phased approach to pHOS management was interesting and encouraged revisiting that approach.

Busack mentioned that the Methow steelhead consultation may be transferred from Wilson to Charlene Hurst.

Mike Tonseth said any pHOS value lower than 0.5 would certainly pose significant adult management challenges because of the uncertainty of removal at Winthrop National FH and Methow FH. Tonseth said he hopes there can be open discussion regarding moving production around facilities in case it is necessary to retain a fishery component. He said, for example, having pHOS and PNI vary or float between the lower and upper areas of the Methow River could help manage tributaries from Gold Creek upstream, and the hatchery could be relegated to the lower part of the river.

Kirk Truscott asked how the different iterations of pHOS and PNI described by Mackey affect the overall abundance of Methow steelhead over time. Tonseth said, under a pHOS of 0.5, there would be roughly 1,900 hatchery-origin fish on spawning grounds.

Mackey added that the Twisp steelhead program has been operated at a pHOS of 0.5 successfully since 2010 under the relative reproductive success study plan. He said 2016 is the last parental brood year included in the Douglas PUD HCP study, so determining what the pHOS in the Twisp River can also be discussed. He said releasing a different proportion(s) of hatchery-origin fish above the Twisp Weir could be considered. Tonseth said WDFW is working on a proposal regarding hatchery releases above the Twisp Weir.

IV. Douglas PUD

A. 3-Year Hatchery Committees Chair Review Results (Greg Mackey)

Greg Mackey said the Hatchery Committees review the Chairperson every 3 years. He said this process involves an email correspondence to the Hatchery Committees asking for their review of the Chair's performance. Mackey then collates the feedback and provides it to the Hatchery Committees, Chairperson (Tracy Hillman) and support personnel (Sarah Montgomery). Montgomery distributed the Hatchery Committees Chair Review Results to the Hatchery Committees representatives and alternates on October 7, 2016. Mackey summarized that the results of the review are a some suggestions for operating the meetings and a confirmation by the Hatchery Committees to retain the Chairperson and support personnel for 3 more years. Hillman thanked the Hatchery Committees for their constructive feedback and asked that they please provide feedback to him at any time. Montgomery agreed and said she welcomes feedback at any time as well.

B. Draft Methow M&E Implementation Plan 2017 (Greg Mackey)

Greg Mackey said Douglas PUD's Draft Methow M&E Implementation Plan is available for review, which Sarah Montgomery distributed to the Hatchery Committees on October 8, 2016 (Attachment E). Mackey said the majority of the plan is the same as in 2016. He noted that in the juvenile population sections for spring Chinook salmon and steelhead he has indicated that rotary screw trapping and population estimates conducted by electrofishing and PIT tagging are both under consideration for implementation and are both under technical review to ascertain if one approach is technically superior to the other for providing the type of data needed for the M&E plan assessments. He said they also added a table of due dates for draft and final documents in accordance with expected ESA permit conditions. For the Methow programs, he said Douglas PUD will be working on the 5-Year Hatchery M&E Summary Report, and they set December 31, 2017 as the due that for this report.

Mackey said Douglas PUD requests a 30-day review for the draft because Douglas PUD cannot execute a contract with WDFW until the plan is approved, and they aim to begin the contracting process with WDFW a soon as possible in order to approve a contract in December in order to have a contract in place by January 1, 2017. Montgomery said the Hatchery Committees need to approve any review period less than 60 days for plans and reports. Hatchery Committees representatives present agreed to Douglas PUD's requested 30-day review period for the Draft 2017 Methow M&E Implementation Plan.

V. HCP Administration

A. Recent Report on Adult Spring and Summer Chinook Salmon Passage Timing

Tracy Hillman said he recently read a report regarding the migration patterns of spring and summer Chinook salmon in the upper Columbia River[2]. He said, in particular, the report states that hatchery fish from the upper Columbia River have a strong tendency to arrive at Bonneville Dam before wild fish. He compared this to monitoring data at Tumwater Dam, which show wild fish reach Tumwater Dam before hatchery fish. Keely Murdoch suggested that a high-flow barrier in Tumwater Canyon may affect timing. Mike Tonseth said results for Wenatchee River hatchery fish may be partially driven by the Leavenworth FH program, which has earlier run timing than endemic hatchery programs. Bill Gale said the difference described in the analysis is skewed with hatchery fish from the Leavenworth program, which are not in the same Evolutionarily Significant Unit (ESU) as other fish analyzed.

B. Next Meetings

The next Hatchery Committees meetings are November 16, 2016 (Douglas PUD), December 21, 2016 (Chelan PUD), and January 18, 2017 (Douglas PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft Chewuch Homing Study Proposal (Grant PUD comments)
Attachment C	Draft Summary of Hatchery M&E Report Review
Attachment D	Draft Methow Steelhead Programs PNI Model for ESA Permits
Attachment E	Draft Methow M&E Implementation Plan 2017

[2] Crozier, L., E. Dorfmeier, T. Marsh, B. Sandford, and D. Widener, 2016. *Refining our understanding of early and late migration of adult Upper Columbia spring and Snake River spring/summer Chinook salmon: passage timing, travel time, and survival.* Report of research by Fish Ecology Division, Northwest Fisheries Science Center, Seattle, Washington.

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Alene Underwood*	Chelan PUD
Catherine Willard*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons†	Grant PUD
Peter Graf†	Grant PUD
Deanne Pavlik-Kunkel†	Grant PUD
Bill Gale*	U.S. Fish and Wildlife Service
Matt Cooper*	U.S. Fish and Wildlife Service
Michael Humling	U.S. Fish and Wildlife Service
Justin Yeager*	National Marine Fisheries Service
Craig Busack*††	National Marine Fisheries Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Mclain Johnson	Washington Department of Fish and Wildlife
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
† Joined for the joint HCP-HC/PRCC HSC discussion
†† Joined for Methow Steelhead Gene Flow discussion

Techniques to improve homing fidelity for Chewuch and Twisp river releases of spring Chinook salmon

Background

Under the Wells Habitat Conservation Plan (HCP), Rocky Reach HCP, and the Priest Rapids Salmon and Steelhead Settlement Agreement, hatchery supplementation is required to mitigate for project losses of migrating salmon and steelhead. As part of this mitigation DCPUD owns and operates spring Chinook acclimation sites on the Chewuch and Twisp rivers. Spring Chinook destined for the acclimation sites are reared at the Methow Fish Hatchery (FH) which is located upstream of both the Chewuch and Twisp rivers. Homing fidelity back to the tributary of acclimation (i.e. Twisp and Chewuch rivers) is low with a proportion of returning fish failing to home and 'straying' to the Methow River, often in the vicinity of the Methow FH. The 5-year analytical report (Murdoch et al. 2012) indicates the mean stray rate for Twisp acclimated spring Chinook is 25%. That is 25% of the Twisp River fish are recovered on spawning grounds outside of the Twisp River or return to Methow Fish Hatchery (Table 1)

Table 1. Stray rates by brood year of Twisp spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012).

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	0	0.00	0	0.00	0.00
1993	3	0.75	1	0.25	0.15
1994	0	0.00	0	0.00	0.00
1996	33	0.66	17	0.34	0.18
1997	6	1.00	0	0.00	0.11
1998	8	0.80	2	0.20	0.45
1999	25	0.56	20	0.44	0.74
2000	12	0.23	40	0.77	0.27
2001	0	0.00	7	1.00	0.13
2002	59	0.47	66	0.53	0.43
2003	2	0.13	13	0.87	0.31
2004	6	0.18	27	0.82	0.18
Mean		0.40		0.43	0.25
SD		0.34		0.35	0.20

Failure to home, and subsequent recovery in non-target locations is a greater problem for Chewuch acclimated fish. The stray rate for Chewuch spring Chinook averages 43% with some years in the 70-80% range (Table 2).

Table 2. Stray rates by brood year of Chewuch spring Chinook and the number and proportion based on non-target recovery location (Murdoch et al. 2012)

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	1	1.00	0	0.00	0.03
1993	19	0.86	3	0.14	0.21
1994	0	0.00	0	0.00	0.00
1996	15	0.79	4	0.21	0.46
1997	44	0.62	27	0.38	0.22
2001	46	0.13	321	0.87	0.88
2002	92	0.24	299	0.76	0.74
2003	3	0.12	22	0.88	0.46
2004	35	0.33	70	0.67	0.86
Mean		0.45		0.43	0.43
SD		0.37		0.37	0.34

Since 2014 program size for both the Chewuch and Twisp rivers have been significantly reduced. The program size reduction makes it critical that both programs are performing to standards and achieving the desired goal of supplementing the targeted area. Current release numbers for Chewuch and Twisp Rivers are approximately 61,000 and 30,000, respectively

Sequential Imprinting Method

The sequential imprinting hypothesis as described by Harden-Jones (1968) and Brannon (1982) shows that salmon learn a series of olfactory cues as they migrate through freshwater, retracing the olfactory pattern as they return as adults. Sequential imprinting also occurs in hatchery fish that are transported and released off-site. The sequential imprinting hypothesis predicts that hatchery fish will return to the release site where they initiated their seaward migration, however if the returning hatchery fish can still detect the odors of their rearing site they will continue onward to their rearing hatchery (Dittman et al. 2010). In cases where the acclimation site is located upstream of the rearing hatchery, returning salmon will bypass the rearing facility and continue onto the release site (Dittman et al. 2010). In an evaluation of homing and spawning site selection in the Yakima River, the sequential imprinting hypothesis explains why fish released from Clark Flat and Jack Creek (both downstream of the Cle Elum Hatchery) are often recovered in the vicinity of the Cle Elum Hatchery, while relatively few fish released from the Easton Acclimation Site (upstream of the rearing facility) were recovered in the vicinity of the Hatchery. Fish released from the upstream Easton site had the highest homing fidelity (95.5%; Dittman et al. 2010). Consistent with the sequential imprinting hypothesis, spring Chinook acclimated at the Easton site returned to the vicinity of the acclimation site; being unable to detect any earlier imprint signal, chose to spawn in the vicinity of their last familiar homing cue (Dittman et al. 2010). Sequential imprinting also explains patterns of adult returns for programs where hatchery fish are reared in the lower Columbia and then transported to upper Columbia tributaries, such as the Yakama Nation's coho reintroduction project, and the discontinued White River spring Chinook program. Importantly, the sequential imprinting hypotheses would predict that high stray rates to the Methow FH due to the location upstream of the Chewuch and Twisp Rivers.

In the Methow Basin, fish returning to both the Twisp River and Chewuch River, continue to recognize upstream olfactory cues from Methow Fish Hatchery. The sequential imprinting hypothesis would predict that a proportion of spring Chinook would continue on past the confluences with the Twisp and Chewuch Rivers to return to the vicinity of the Methow Fish Hatchery, which is what is observed in patterns of spawning and carcass recovery (Murdoch et al. 2012).

Embryonic Imprinting Hypothesis

The importance of imprinting at the parr-smolt life stage is commonly known, but embryonic imprinting hypothesis emphasizes the imprinting to the desired 'natal' site earlier during development. Embryonic imprinting for hatchery programs could be tested as either an alternative or complementary method to sequential imprinting (above) to improve homing fidelity to an acclimation site. As suggested by sequential imprinting, adult salmon terminate their spawning migration upon reaching the area associated with olfactory cures learned in the natal redd. Dittman et al. (2015) speculates that hatchery reared salmon returning as adults will seek the earliest detectable imprinted olfactory waypoint as the appropriate location to terminate their spawning migration. If salmon are exposed in the hatchery as embryos to the water derived from the release location, they may spawn in the targeted location.

Methods

Part 1: Embryonic Imprinting Hypothesis

The embryonic Imprinting Hypothesis will be tested at the Chewuch Acclimation site in brood years 2017 and 2018.

Spring Chinook will be spawned and incubated at the Methow Fish Hatchery. All spring Chinook eggs destined for the Chewuch acclimation site will be subjected to the treatment application of Chewuch River water. The treatment will consist of recirculated and chilled Chewuch River water applied continuously between eye-up and first feeding.

Chewuch River water will be transported to Methow Fish Hatchery on a weekly basis via tank truck. Chewuch River water will be UV treated and chilled prior to use. The isolation buckets will be designed to allow for a high level of recirculation (amount to be determined) to limit the amount of Chewuch River water required. Water brought to Methow FH by tank truck will be stored up to a week.

Part 2: Sequential Imprinting Method

The Sequential Imprinting Method will be tested at the Chewuch Acclimation site in brood years 2019 through 2022.

To test the Sequential Imprinting method it is imperative that spring Chinook intended for release at the Chewuch Acclimation Pond are not reared at Methow Fish Hatchery for any part of their life cycle.

After spawning, green gametes will be transported to Wells Fish Hatchery for fertilization and incubation. These fish would remain on station at the Wells Fish Hatchery until transfer to the Chewuch Acclimation Site in the spring prior to release. If necessary to accommodate the rearing space, a similar number of steelhead intended for the Methow Fish Hatchery release could be reared at Methow Fish Hatchery.

All fish used in the evaluation will receive a unique CWT.

Data Analysis:

Upon return as adults CWT recovery on the spawning grounds and at the Methow FH will be used to evaluate the efficacy of embryonic imprinting (brood years 2017 and 2018), and sequential homing (brood years 2019-2022) to improve homing fidelity in the Methow River. The spawning distribution and return rates to the Methow Fish Hatchery will be compared as described for Objective 6 in the M&E plan (Hillman et al, 2013). A fish returning to Methow Fish Hatchery will be considered a 'stray', fish returning to the Chewuch and/or Twisp rivers will have homed successfully.

The study will follow a Before-After Control-Impact (BACI) design. Before (BY2001-2016) and after treatment data will be available for analysis. The Twisp River release, which will not receive any treatment will serve as a control group (both before and after). The proportion of Chewuch acclimated Chinook not homing back to the Chewuch (stray) will be compared with ANOVA before and after treatment relative to the control group (Twisp).

Timeline

May 2016-August 2017: Planning, design and infrastructure modifications to include a chiller and recirc incubation system.

BY 2017: Embryonic Imprinting Treatment

BY 2018: Embryonic Imprinting Treatment

BY 2019: Sequential Imprinting Treatment

BY 2020: Sequential Imprinting Treatment

BY 2021: Sequential Imprinting Treatment

BY 2022: Sequential Imprinting Treatment

2019-2028: Collection and analysis of adult return data

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GPUD Comments sent to Sarah for distribution to the HC/HSC (4/20/2016)

I (Todd) had a difficult time hearing the discussion about the homing proposal, so I thought I would provide some written comments to contribute to the dialog. Some of the comments are duplicative to what I mentioned on the phone during the meeting.

If an embryonic imprinting proposal is adopted, there will be at least two concurrent imprinting studies in the Methow Basin to improve spawning distribution (Goat Wall Remote Acclimation and Embryonic Imprinting). GPUD thinks that an embryonic imprinting study should be a minimum of 5 years to meet statistical rigor and usefulness of the results and that it shouldn't be mixed with a different imprinting method that involves moving fish to Wells Hatchery.

GPUD believes it is prudent to work out the embryonic imprinting methods on a small number of HxH Methow spring Chinook at Methow Hatchery beginning in 2017. Although the procedure appears to be relatively simple, it has not been widely applied and there continue to be uncertainties about methodological applications (Dittman et al. 2015). As such, it is not a best management practice but rather the development of a new method (pioneering). Recent work on kokanee has been implemented, but it has not been done on spring Chinook and the results have not conclusively demonstrated that its methodology has been effective for adult homing. Some of the factors that need to be developed and tested are: water collection location (permits?, accessibility), water transportation to Methow hatchery, water treatment, water recirculation, water filtration, etc.

One test that could be implemented during a pilot year would be to compare U.V. treated water and non- or partial U.V. treated water. The U.V. treatment may change the water signature (Dittman et al. 2015) and so use of U.V. should be treated experimentally. As Dittman et al. (2015) pointed out "Further studies of the effects of UV treatment and other sterilization techniques on odor qualities are needed before embryonic imprinting is accepted for use as a salmon rehabilitation or enhancement tool." Another test might be related to how often water needs to be refreshed and when it should be applied.

Some advantages of working out the methods prior to the full production experiment include 1) reduced risk to progeny of WxW crosses on an endangered species, 2) increased probability of having consistent treatments in the experiment (not changing methods through the experiment), and 3) decreased probability of implementing a flawed methodology.

Concerns about a delay in getting fish back to the Chewuch by spending a year or two on methods refinement could be alleviated by starting an adult transportation program in 2017. This would likely result in adult spawning in the Chewuch a few years before adults would return from an embryonic imprinting study at the production scale in 2017. Furthermore, adding adults to the Chewuch may increase attraction to the Chewuch by providing a pheromone attractant (Pheromone hypothesis – which may partially explain attraction for Methow Hatchery). As such, 3 different methods would be evaluated in the Methow Basin as a means to increase spawner numbers in target areas (e.g., adult transportation/pheromone, remote acclimation, and embryonic imprinting).

GPUD has also invested in a meta-analysis to evaluate a variety of imprinting approaches and their influence on homing in the Columbia Basin. We want to use this analysis to help inform the development of an imprinting experiment. We hope that the analysis will be completed within the next few months.

Proposed Schedule

2016-spring 2017. Complete imprinting meta-analysis to inform experiment (NOAA and GPUD), develop detailed methods for experiments, get committee approval, purchase and install equipment

2017. Adult transportation in Methow and Chewuch begins (could be conducted from 2017-2020), remote acclimation at Goat Wall Pond begins, conduct embryonic imprinting pilot experiment on HxH eggs to refine methods for production experiment

2018. If embryonic imprinting methods are sufficiently vetted, then begin embryonic imprinting on half of the Chewuch hatchery production (about 30,000). Otherwise conduct an additional year of pilot study.

2019-2023. If feasible, then implement embryonic imprinting on half of the Chiwawa hatchery production (about 30,000 of 60,000). If not feasible then consider doing downstream hatchery rearing.

2020-2028. Monitor adult returns

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DRAFT MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	October 12, 2016
From:	Catherine Willard, Chelan PUD		
Cc:	Sarah Montgomery, Anchor QEA		
Re:	Draft Summary of Reviewing the 5-Year Hatchery Monitoring and Evaluation Report		

The purpose of this document is to summarize the review of the "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-year Report 2006-2010" and more current data regarding Methow Basin spring Chinook and to identify, develop and implement investigations to address elements of the Methow Fish Hatchery spring Chinook programs to improve program performance. This review was agreed to by the Rocky Reach, Rock Island and Wells HCP Hatchery Committees in a Statement of Agreement dated March 27, 2015. This document is organized into the following four sections: 1) Agreements and Decisions, 2) Discussions of Objectives, 3) Summary of Review by Objectives, and 4) Attachments. (Note: Attachments are ordered by their appearance in this document, and have been renamed from their original appearance in meeting minutes.)

I. AGREEMENTS AND DECISIONS

- *[March 27, 2015]* The Hatchery Committees' representatives present approved an SOA to review results of "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-year Report 2006-2010" and more current data regarding Methow Basin spring Chinook and identify, develop and implement investigations to address elements of the Methow FH spring Chinook programs to improve program performance.
- *[May 20, 2015]* The Hatchery Committees' representatives present supported the proposed approach and schedule to review the spring Chinook salmon results of the "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-year Report 2006-2010" (Item V-A).
- *[June 17, 2015]* The Hatchery Committees representatives present agreed to convene

joint sessions with the PRCC HSC when there are agenda items applicable to and which require participation from both the Hatchery Committees and PRCC HSC, with the conditions that: 1) any items requiring Committees decision (i.e., Decision Items) will be discussed to the extent necessary and voted on separately in the respective Committees; 2) prior to joint sessions, it will be made clear at the onset of the discussion that the item is a joint discussion and all Parties are welcome to speak freely; and 3) following joint sessions, the PRCC HSC will be provided with the joint section(s) of the draft meeting minutes for review, as well as the opportunity to comment on the joint discussions, and with the final minutes for their respective administrative records (Item IX-B).

- *[December 16, 2015]* The Hatchery Committees and PRCC HSC representatives present approved using the new method for calculating HRR targets. Chelan PUD, Douglas PUD, USFWS, WDFW, the Yakama Nation (YN), and the Colville Confederated Tribes (CCT) approved the new method on December 16, 2015. Grant PUD approved on December 17, 2015, and NMFS approved on December 22, 2015 (Item II-A).
- *[January 20, 2016]* The Hatchery Committees representatives present agreed to revise the method (now, 40th percentile, including harvest) for calculating HRR targets (Item II-B).
- *[January 20, 2016]* The Hatchery Committees representatives present decided to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly (Item II-B).
- *[February 17, 2016]* The Hatchery Committees and PRCC HSC representatives present agreed to use the methods for calculating and assessing HRR targets described in Grant PUD's Target HRR Proposal, as revised during the Hatchery Committees February 17, 2016, meeting (Item II-C). *(Note: Sarah Montgomery distributed the revised HRR Target Agreement to the Hatchery Committees on February 19, 2016.)*

II. GENERAL DISCUSSIONS

May 20, 2015 Hatchery Committees Meeting

Catherine Willard said she, Keely Murdoch, and Greg Mackey developed a Methow Spring Chinook approach and schedule to review the spring Chinook salmon results of the "Evaluation of Hatchery Programs Funded by Douglas County PUD 5-year Report 2006-2010" (Attachment A), which was distributed to the Hatchery Committees by Kristi Geris on May 14, 2015. Willard reviewed Attachment A, noting that today, the plan is to review a summary of findings for the Twisp, Methow, and Chewuch spring Chinook salmon programs. She said an excerpt from the Five-Year Hatchery M&E Plan Report (Attachment B) was distributed to the Hatchery Committees by Geris on May 18, 2015, which Mackey will review. Willard said, as outlined in Attachment A, Hatchery M&E Plan objectives have been divided into groups and will be reviewed during subsequent Hatchery Committees meetings. She said Hatchery Committees members will document which objectives are not meeting targets, flag items to revisit, and where applicable, develop recommendations or document reasons for not revisiting objectives. She said the goal is to complete a review of all objectives by August 2015, and start a process of addressing flagged objectives by February 2016. Murdoch noted that similar objectives were grouped together for discussion purposes. The Hatchery Committees representatives present supported the proposed Methow Spring Chinook Review of Five-Year Annual Report Plan Outline.

Mackey reviewed Attachment B, which compiles summary information contained at the end of each section of the Five-Year Hatchery M&E Plan Report for Twisp River, Chewuch River, and Methow River spring Chinook salmon. He said for each program, the following information is being provided: 1) goal and program descriptions; 2) summary; and 3) a table containing a summary assessment of M&E objectives. He noted that each program indicated a fish release number of about 183,000, which he said were not the actual release numbers. He recalled the reason for this was because the HCPs did not specify how many fish were to be released at various locations. The total release of 550,000 was divided equally among the Twisp, Methow, and Chewuch for HCP "goal" purposes, and recommended ignoring those numbers as they have changed dramatically. Mackey then reviewed the major findings of each Objective or each of the three programs: Methow, Twisp, and

Chewuch. The review was a verbal narrative of the report findings summary tables that were supplied to the Committees and were taken for the 5-Year report.

Tracy Hillman asked what needs to be done to keep on schedule, as outlined in Attachment A. Mackey, Willard, Murdoch, Todd Pearsons, Charlie Snow, Andrew Murdoch, and Hillman will coordinate to prepare information on Hatchery M&E Plan Objectives 1, 4, and 7, for discussion during the next Hatchery Committees meeting on June 17, 2015. Murdoch said, considering the change in landscape, she is hopeful people will keep an open mind while reviewing these objectives. Hillman also noted there are additional data available since the Five-Year Hatchery M&E Plan Report was completed. Pearsons asked what types of discussions and review will take place throughout the next few months. Mackey said there will first be a technical review of results, and then, starting in September 2015, a review from a management standpoint will begin as an adaptive management feedback loop. Hillman reiterated that these programs have changed significantly, and recommended the Hatchery Committees keep that in mind as they make projections about possible changes. Mackey agreed, noting that recalculation was well underway when the original report was being written and the authors were aware of this; however, the recalculated numbers were not yet finalized at that time.

June 17, 2015 Hatchery Committees Meeting

Greg Mackey shared a presentation titled, “Review of Five-Year Hatchery M&E Report – Methow Spring Chinook Salmon,” (Attachment C), which Kristi Geris distributed to the Hatchery Committees on June 18, 2015. Mackey recalled the Hatchery Committees’ agreement to review the Methow Basin spring Chinook results in the Five-Year Hatchery M&E Report. Keely Murdoch also recalled when discussing the schedule of the review of the Five-Year Hatchery M&E Report, the intent was to review and compare the results to objective targets and then flag items the Hatchery Committees believe need further addressing. Mackey reviewed Attachment C, which was organized by Hatchery M&E Objective and by stock. Hatchery M&E Objectives addressed included: 1) Objective 1: total spawner abundance, NOR abundance, and adult productivity; 2) Objective 4: hatchery replacement rate; and 3) Objective 7: freshwater productivity. These objectives were reviewed for each Methow spring Chinook salmon program (i.e., Twisp, Chewuch, and

Methow). All graphs, tables, and summaries were copied directly from the Five-Year Hatchery M&E Report.

…

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Hatchery M&E Objective 1

Murdoch said several changes are underway (e.g., reduced program sizes, lower rearing densities, and adult management), and once everything goes into effect, maybe changes will become apparent. Mackey suggested, in the case of the Methow Basin, to consider setting up a management program where the Twisp is operated as a small "state of the art" conservation program with careful control of PNI, and the Methow operated as a heavily hatchery influenced river with both Winthrop NFH and Methow programs operating, and the Chewuch not supplemented. Given it can easily take 15 years of data just to begin to understand the effects of such approaches on population dynamics, such an approach would allow a 3-way comparison in about 15 years that would take 45 years if each treatment were applied sequentially. Setting up simultaneous contrasting management approaches would identify whichever approach works best in comparison to others in a much shorter period of time.

Hatchery M&E Objective 4

Murdoch suggested re-evaluating HRR targets. Busack suggested thinking about whether HRRs are better or worse than expected. He asked if hatcheries are performing as they should, or if this is as good as it gets. He suggested comparing Methow Basin HRRs to other programs.

Hatchery M&E Objective 7

Murdoch said it seems that the goals to not decrease productivity are being met; however, there are not much data to review. Mackey agreed that data are lacking.

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Hatchery M&E Objectives 1,4, and 7)

Gale noted the Five-Year Hatchery M&E Report indicating that "in the case of the Chewuch, the hatchery program has apparently not provided a benefit," and Gale asked if there has been a negative effect. Murdoch said the results do not indicate that either. Tonseth said the hatchery programs were intended to contribute to recovery. He added that a benefit (increase) needs to be demonstrated from the program, and not 'no change.' Murdoch reiterated that the Hatchery Committees can get at this by flagging items requiring more in-depth discussions to determine why there is no improvement.

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General Comments

Slides Referencing Evaluations of Hatchery Supplementation Effectiveness

Snake River Basin (Scheuerell et al. 2015, abstract) (slide 43)

Busack noted that in this paper, modeling showed fewer spawners with supplementation. He said he is not sure if supplementation is not working or if it is not being run correctly. Pearsons said the point of noting this paper was to put Twisp and Methow data into perspective. He questioned how different the Scheuerell et al. (2015) findings are from other basins. He added, he believes that findings in the Methow are not that different than what is happening in other basins (i.e., not anomalous).

Columbia River Basin (Independent Scientific Advisory Board 2015 Density Dependence Report; slide 46)

Busack criticized this report for including sweeping statements, demonstrating a limited understanding of the diversity of supplementation programs, and including significant data but from an unpublished source (i.e., smolts per spawner). He said it would be interesting to take Methow data and conduct the same analysis.

Pearsons asked Mackey if he can provide his presentation titled, "Carrying Capacity of Spring Chinook and Summer Steelhead in the Methow River Basin, Washington," that Mackey presented at a past AFS Conference to Geris for distribution to the Hatchery Committees. Mackey agreed. *(Note: Mackey provided this presentation to Geris on June 18, 2015, which Geris distributed to the Hatchery Committees that same day.)*

Hillman suggested, as Murdoch said, to review Hatchery M&E Objectives 1, 4, and 7, and flag items that warrant further discussion. He said the Hatchery Committees will then circle back and re-evaluate these pieces. He said next month, Hatchery M&E Objectives 2 and 5 will be reviewed.

July 15, 2015 Hatchery Committees Meeting
Catherine Willard shared a presentation titled "Review of 5-Year Hatchery M&E Report – Methow Spring Chinook Salmon" (Attachment D), which Sarah Montgomery distributed to the Hatchery Committees following the meeting on July 15, 2015. The presentation was organized by Hatchery M&E Objective and by stock. Hatchery M&E Objectives addressed in this presentation were Objective 2 (migration timing, spawn timing and redd distribution), and Objective 5 (stray rates). These objectives were reviewed for each Methow spring Chinook salmon program (i.e., Twisp, Chewuch, and Methow).

August 28, 2015 Hatchery Committees Meeting
Keely Murdoch shared a presentation titled "5-Year Analytical Report Review: Objectives 3, 6, and 8" (Attachment E), which Sarah Montgomery distributed to the Hatchery Committees on September 1, 2015. The presentation was organized by Hatchery M&E Objective and by stock. The presentation addressed Objective 3 (genetic diversity, population structure, and effective population size), Objective 6 (size and number of hatchery fish released), and Objective 8 (harvest opportunities using hatchery adults). These objectives were reviewed for each Methow spring Chinook salmon program (i.e., Twisp, Chewuch, and Methow rivers).
…
<u>General Comments</u>
Gale asked if the frequency of genetic sampling was changed to every 10 years. Kahler said it had been every 5 years. Gale noted now sampling occurs in 10-year intervals and asked when the next round of sampling is scheduled to occur. Kahler said the next round of sampling will take place in 2016 or 2017. Tonseth added he thinks it is due before the next 5-year report. Hillman noted genetic monitoring started in 2007. Andrew Murdoch said WDFW scheduled monitoring year-by-year and did one program species each year. He said each program has a different year to smooth out budgeting. Tonseth suggested they go back and look at these schedules because it might make sense to realign everything for every other 5-year report in order to update all programs within one report. Andrew Murdoch said the year-by-year monitoring was scheduled in a staggered manner so that each round of monitoring and the associated data analysis is completed in time for the 5-year report. He said the timeline was specifically developed to fit the report schedule. Tonseth suggested he

and Andrew Murdoch develop a timeline for conducting genetic sampling for HCP program species.

Kirk Truscott asked if the target for size at release should be revisited at a later meeting, considering the less-than-desired SAR values in the Methow Basin. Truscott said rate of growth matters as well as size at release. Truscott questioned if the target size at release is currently at an appropriate level to maximize survival. Catherine Willard said NMFS is presenting data on CPUD's and GPUD's summer Chinook salmon size target study during the November 2015 HC meeting. Alene Underwood agreed a target for size at release should be revisited. Hillman said the HETT put together an appendix for this, presenting length and weight relationships for each stock. Underwood said it was a data synthesis, not a recommendation. Hillman said it is up to Hatchery Committees to decide to re-evaluate the size at release. Truscott stated the important topic is looking at the growth pattern to get to that length of fish. Truscott asked if the fish need a fast growth period in the fall prior to release. Underwood said it is also important to measure this against what is actually possible in the hatchery in terms of growth. Truscott said the same consideration should be given to transferring fish. Hillman said during the production of the Chelan PUD 5-year Hatchery M&E Report, size at release and growth were discussed. He said they did not include any recommendations; rather, it was highlighted for the Hatchery Committees to address. Andrew Murdoch said that jacks are driving survival, so the Hatchery Committees should be sure to discuss adults. He said if growth is manipulated to reduce jacks, lower smolt-passage survival but more adults may result. Tonseth agreed and said it depends on the preferred tradeoff. Andrew Murdoch said hatchery constraints at the facility level should also be considered; it is hard to balance because there could be smaller size at release, as well as lower jacks and adults if hatchery constraints are not considered. He said the HETT has discussed the importance of monitoring growth each month and is asking hatchery staff to collect data on growth rates and size distributions. Hillman stated when Chelan PUD was writing its Chelan PUD 5-year Hatchery M&E Report, slowing down growth rates in the winter was discussed.

Hillman asked about possible flags regarding the relative differences in size and age at maturity of natural and hatchery-produced fish. Busack said there were concerns about this in other programs. In another project, hatchery fish were returning 2 centimeters shorter at age, but this difference disappeared over time. The fish may be returning younger and smaller at age, but that may be related to the hatchery rearing regime. Hillman agreed with Busack, noting that differences in size and age at maturity will exist; however, the current working hypothesis is that natural and hatchery fish will be the same. Hillman suggested developing a threshold size difference (effect size), and Tonseth suggested incorporating such information in the next 5-year report. He said programs have been weighted predominantly toward HORs in the last 5 years, whereas the difference may be more broodstock-oriented. Tonseth thinks it should remain the same unless an increasing or consistent difference is reported. Andrew Murdoch said if there is a constant hatchery effect through time, it can be explained as the cause; however, if the hatchery effect changes over time, it becomes a red flag. Truscott asked if the females are shorter and have differences in fecundity. Tonseth said the females are shorter but does not believe that differences in fecundity were significant. Truscott asked if the egg sizes were different. Andrew Murdoch said fecundity and egg size are not included in this report, but they did see differences. Busack added in another project fish were younger and smaller at age and less fecund at size, which may or may not remain true in other systems. Andrew Murdoch noted they are tracking those relationships, and does not think there are differences in egg size, just differences in fecundity.

Truscott asked if they see a difference in pre-spawn mortality between hatchery and wild fish. Andrew Murdoch said they are seeing differences in fat content and are still working on figuring out pre-spawn mortality. He said spawning location and where the fish hold up likely affects pre-spawn mortality.

Hillman said, according to the 5-Year Hatchery M&E Report review schedule, from September 2015 through February 2016, the Hatchery Committees will review and summarize findings from this review process. He noted that Montgomery has been tracking flagged objectives, and that following this meeting, she will compile the 5-Year Hatchery M&E Report objectives flagged for Methow spring Chinook salmon and distribute the compiled list to the Hatchery Committees for review. *(Note: Montgomery compiled the* *flagged M&E Report objectives and distributed the list to the Hatchery Committees on September 4, 2015* (Attachment F)*.)*

Hillman asked the group what strategy it prefers for identifying recommendations. Keely Murdoch recalled once objectives were flagged for review, the plan was to circle back on those and discuss in committee whether they can do studies or address them in committee. Keely Murdoch suggested starting at the top of the flagged objectives list and proceeding in the order they were flagged. Tonseth asked if this suggested process was recorded. Keely Murdoch responded that yes, the September meeting marks the start of the process to address studies or recommendations. Gale suggested all flagged objectives be looked at in totality for prioritization. Hillman said the Hatchery Committees will review the flagged objectives table in September and identify which ones to address at the October meeting. The Hatchery Committees will review and prioritize the 5-Year Hatchery M&E Report objectives flagged for Methow spring Chinook salmon during the next Hatchery Committees meeting on September 16, 2015.

September 16, 2015 Hatchery Committees Meeting

Greg Mackey explained that the Methow spring Chinook Review of 5-Year Annual Report Outline Flags (Attachment F) are organized by the date of the meeting, the content of the objective, and any flagged items or comments for further discussion. The Hatchery Committees reviewed the flagged objectives and comments. Questions and comments were discussed as described in the following section.

Mackey said one comment from Objective 1 was that the Twisp River program could be operated as a conservation program, the Chewuch River left un-supplemented, and the Methow River managed as a typical hatchery program. Mackey said the Hatchery Committees had flagged Objective 4 for discussion of HRR targets and should put available data into context in order to understand the HRR targets. Mackey said Objective 7 was flagged for further discussion because there is not much information about freshwater productivity, and it remains unknown if hatchery fish influence productivity. Mackey added smolt-trap population-estimate data are the current source of data for this objective, but the population estimates are not reliable and not many years were available for analysis for this

5-year report. Mackey said there was a lot of variance in the regression graph because data are lacking. Tracy Hillman said there are few years of data on juvenile productivity. Bill Gale asked if the question about productivity is not confounded by other factors contributing to juvenile productivity in the basin, such as climate change and habitat restoration. Mackey said pHOS does not vary much throughout the years of data, so there is very little contrast in the data, making it hard to distinguish the effects of pHOS on productivity. Gale said pHOS will change with adult management, so it will become easier to distinguish. Hillman suggested that as pHOS changes with adult management, greater contrast in pHOS will allow a better evaluation of the effects of pHOS on juvenile productivity

Mackey said Objectives 1 and 7 are linchpins because they address whether the hatchery program has a positive effect on the population. Mackey said Objectives 1 and 7 cannot necessarily be used directly for management decisions, but they are big signals, and other objectives could help inform what is going on with Objectives 1 and 7. Hillman said several changes have already been made to the hatchery program that will affect Objectives 1 and 7.

Mackey said, for Objective 2, Keely Murdoch pointed out the Goat Wall evaluation study currently underway provides data for looking at spawner distribution. Mackey said the data suggested that there may also be a downstream shift in mean spawning location of natural-origin recruits, but this seems to be an artifact of the graph in the 5-year report. Mackey said, for Objective 5 (straying, or non-target-returning), the Hatchery Committees discussed techniques to evaluate site fidelity. Mike Tonseth said the first set of data on return rates to Methow Fish Hatchery will inform fidelity, and after spawning began this year, several hundred additional fish have been collected through the Methow Hatchery Trap. Mackey said some fish that stray into the Methow River come from the Chewuch River, and one way to solve this would be to not put fish in the Chewuch River. Keely Murdoch said YN does not support terminating supplementation in the Chewuch River, rather, they desire higher homing fidelity and propose we address the fidelity problem. Gale said Objective 5 addresses site fidelity, so a fish returning to the Methow River should not be called a stray because Methow Basin is a composite program. Keely Murdoch said the fish would not be called a genetic stray, but there is poor site fidelity for hatchery fish released in the Chewuch River.

Gale asked whether site fidelity belongs in Objective 5. Gale said fish not returning to target areas should be addressed, but it might not fall under Objective 5. Hillman said successful homing is discussed under Objective 5 in the annual reports, so the terminology may be confusing; however, breaking out site fidelity as a separate objective might be more confusing. Tonseth confirmed in the context of a specific supplementation strategy, like for the Chewuch River, that if fish released in the Chewuch River do not return, it is a site fidelity and a straying issue. Tonseth said it is not a genetic stray, but it is still contradictory to management practice. Hillman said, in the recovery plan, Chewuch is split out as a separate stock, so Craig Busack's feedback will be needed to determine whether this is a genetic issue. Mackey said there might not be management issues if an adequate number of fish are returning to the Chewuch River despite some Chewuch releases also returning to the Methow River, so a target should be developed for how many fish should return to fulfill the intent of the release strategy.

Hillman said that the topics flagged so far as high priorities for continued discussion are HRR, spawning distribution, and homing. Alene Underwood said the purpose of today's discussion is to prioritize which objectives should be highlighted for further discussion in the coming months. Mackey said, for Objective 6, target size at release of juveniles should be addressed in terms of early maturation and survival. Gale said, from the Winthrop NFH perspective, Winthrop stocks should be included or studied concurrently for genetics. Mackey said that samples are gathered from all populations in a region, an outgroup is also collected, and then genetic diversity (Fst) and population structure analyses are performed. Tonseth said the genetic analysis addresses species, not programs, so all programs for one species should be studied at once. Tom Kahler said, for spring Chinook salmon, the analyses were all in separate reports for separate rivers. Tonseth said it might be simpler to have all analyses in one report, but it may have been contracted out separately in the past. Todd Pearsons asked if Busack had a concern about the frequency of monitoring or the variables being monitored. Tonseth clarified in order to detect genetic differences, 5 years may be too frequent, but the variables being monitored were okay. Catherine Willard said Busack's opinion was that Fst should still be monitored, but it is not a concern at the moment. Tonseth said, for Objective 6, an evaluation of the coefficient of variation should be included in the next round of analyses. Kirk Truscott said a size-at-release was identified, but it might not be the most appropriate value. Hillman said accurate length-weight relationships with associated condition factors have been obtained. Tonseth said corrections should have been made in appendices to the 5-year monitoring plan. Mackey said length-weight relationships were calculated for the 5-Year Hatchery M&E Report, but it may or may not be in the appendix to the plan.

Gale asked if there are enough PIT-tag data to assess the relationship between length-weight and survival to Rocky Reach Dam. Tonseth replied no because length and weight are measured at PIT tagging, well before the fish are released.

Hillman summarized the objectives flagged for further discussion and topics for discussion within those objectives:

- Objective 2 – Spawning distribution of wild and hatchery fish
- Objective 4 – Hatchery replacement rates
- Objective 5 – Straying and homing
- Objective 6 – Size-at-release of juveniles
- Objective 7 – Freshwater productivity (review methods)

Gale suggested Objective 4 would be a good objective to discuss first. Pearsons asked whether each objective will be discussed separately or whether there should be a strategy for addressing more than one at a time. Tonseth said once an objective is discussed, insights can be applied to later objectives, but not all need to be discussed at once. Kahler asked whether every hatchery program measures HRR. Gale replied all of the hatchery programs collect the data necessary to calculate HRR. Kahler said, for the Upper Columbia River spring-run Chinook salmon evolutionarily significant unit, HRR for Winthrop NFH, Chiwawa Fish Hatchery, and Leavenworth NFH should be used for analytical context. Kahler asked whether Yakima/Klickitat and Cle Elum hatcheries should be included. Mackey said it can be problematic to compare to other facilities because coded wire tag expansion was done differently at different locations, and differential harvest results in noise in the data. Gale asked why HRR is an important statistic and what it informs that SAR does not. Mackey said HRR represents adult-to-adult data and it is convenient, and also allows comparing to wild

"NRR". Gale said Matt Cooper will calculate HRR for Winthrop NFH for discussion during the next Hatchery Committees meeting on October 21, 2015.

Mackey said there is an escapement target for Methow spring Chinook salmon, and HRR can be calculated for the production of a set number of fish. Mackey said one approach for calculating an HRR target is to establish the number of hatchery returns needed based on escapement goals, and then calculate HRR using the program size. This would provide an HRR target that is based on management goals and the program size. Mackey said he will develop an HRR calculation spreadsheet for discussion during the next Hatchery Committees meeting on October 21, 2015. Hillman said the HRR appendix to the 5-Year M&E Implementation Plan may be useful to the discussion of Objective 4. Gale asked what the schedule is for reviewing the flagged objectives. Underwood said objectives through the end of 2015 will be reviewed in order to keep with the timeline. Underwood clarified that in the new 5-year plan, straying is discussed in Objective 6.

The Hatchery Committees will discuss Objective 4 (HRR) of the prioritized 5-Year Hatchery M&E Report objectives flagged for Methow spring Chinook salmon during the next Hatchery Committees meeting on October 21, 2015.

Sarah Montgomery will update the 5-Year Hatchery M&E Report objectives flagged for Methow spring Chinook salmon and distribute the updated list to the Hatchery Committees for review.

January 20, 2016 Hatchery Committees Meeting

Review Timeline

Tracy Hillman said that he and Sarah Montgomery developed a timeline ensuring all flagged objectives are discussed before the March 31, 2016 deadline; however, discussion of each objective may also continue past the deadline. He said today's agenda includes objectives 4, 6, and 2, and the agenda for the Hatchery Committees February 17, 2016 meeting includes objectives 5, 7, and 1. At the Hatchery Committees March 16, 2016 meeting, a write-up of the review process and any ongoing items can be discussed.

III. SUMMARY OF REVIEW BY OBJECTIVE

1. Objective 1 – Spawner abundance, natural-origin abundance, and adult productivity

June 17, 2015 Hatchery Committees Meeting

Objective 1: Spawner Abundance, NOR Abundance, and Adult Productivity Graphs (slides 4 to 12)

Mackey explained that reference streams were chosen for each stock as depicted on separate graphs (i.e., Twisp: N=4; Chewuch: N=3; and Methow: N=5). He said the vertical gray line on each graph defines the periods of time before and after the Methow Hatchery Program began (i.e., before and after supplementation). He said the analysis was a Before-After-Control-Impact design (BACI) with the ratios of before and after metrics of reference stream to target stream compared to determine whether the hatchery program was having an effect on the population.

Objective 1: Chewuch Spawner Abundance (slide 5)

Craig Busack asked what percentage of HORs were in the Chewuch prior to supplementation. Charlie Snow said some historical indices indicate there were hatchery fish; however, age and origin data are lacking. Busack recalled when NMFS first genetically sampled in the Chewuch, they found relatively few fish that were HORs. Tracy Hillman said HORs were first measured in the Methow in 1993 at 2%. He said by 1996, based on elemental scale analyses, the estimated proportion of HORs increased to 68%. Busack asked if this was lower for the Chewuch and Twisp, and Hillman said it was.

Objective 1: Twisp Recruits/Spawner (slide 10)

Murdoch said it appears during the post-supplementation period, productivity is decreasing. Mackey agreed, but noted the key point is that the patterns of reference and target streams are roughly the same. He added that although the data in the graphs jump around, the relationships are almost identical for the two in each comparison. He also noted that even though recruits per spawner have changed throughout the years, those changes track with changes observed in the reference streams. Busack asked if the graphs were plotted using the same scale, and Mackey said they were.

Objective 1: Twisp, Chewuch, and Methow Tables (slides 13, 15, 17)
Busack asked if the analyses addressed auto-correlation in the data, and Hillman said they did not. Busack asked if this analysis was conducted combining all three stocks (i.e., Twisp, Chewuch, and Methow). Mackey said all analyses were separate and an analysis on a combined stock was not performed. Busack noted that some argue these are not sub-populations, and he asked if reference streams could be paired to the whole basin. Hillman said considering how well each spawning aggregate matched up with the reference streams, he guessed reference streams would match up with the entire population.

Objective 1: Summary (slide 19)
Busack asked about the effect size. Hillman said this was shown in earlier tables.

December 16, 2015 Hatchery Committees Meeting
Mackey said Objective 1 should be added to the list of flagged objectives. He said it was not initially flagged because the proper data are being collected, and it is not an objective that assesses an action that can be directly addressed from a management perspective.
Keely Murdoch agreed, and said there are PNI targets and release numbers. Hillman asked the representatives if they want to add Objective 1 to the list of flagged objectives. Mackey said Objectives 1 and 7 are the population dynamics assessments that Objectives 2 through 6 are supposed to inform and provide information to institute program changes. Pearsons said it is important to discuss Objective 1 relative to the overall goal of the program.
Keely Murdoch disagreed and said it has been reviewed and discussed, and significant changes have already been made to the program. She said there is not much to discuss in regards to ending acclimation in the Chewuch River, because adult management is being performed, the conservation program has been reduced significantly, and other major changes have also been made. Mackey said Objective 1 should be discussed again because it needs the write-up of the adaptive management feedback loop assessment needs to be written in the context of Objectives 1 and 7. Keely Murdoch asked for whom and in what document it needs to be written up. Mackey replied that the review of objectives will need to be synthesized. Tonseth said Objective 2 has already been addressed with the ongoing discussions about Goat Wall Acclimated Release activities, and changes to the implementation of adult management cannot be made until adult return numbers from Goat Wall Acclimated Release activities are available for discussion. Hillman said he and

Montgomery will add Objective 1 of the 5-Year M&E Report to the list of objectives flagged for further discussion, and will develop a strategy to ensure all flagged objectives are discussed before the 1-year review timeline ends on March 31, 2016.

February 17, 2016 Hatchery Committees Meeting

Pearsons said that he recommended the Hatchery Committees discuss Objective 1 in order to confirm that programs are not negatively affecting the abundance of natural-origin spawners. Murdoch said several changes have been made to programs that may increase the abundance of natural-origin spawners. Pearsons said HRRs, stray rates, and other objectives should be put into the context of Objective 1 in order to ensure hatchery programs have a positive effect on the population.

Mackey said the review of Hatchery M&E Report objectives should be documented. Murdoch said the recommendations included in the Hatchery M&E Report are recommendations of the report authors only, and not of the Hatchery Committees. Pearsons said the Hatchery M&E Report can be cited and put into appropriate context in the Hatchery Committees' review of the report.

Montgomery said she will compile all Hatchery Committees discussions regarding the 5-Year Hatchery M&E Review process into one document organized by objective and send it to Catherine Willard. Willard said she will draft a summary of the 5-Year Hatchery M&E Review process.

2. Objective 2 – Migration timing, spawn timing, and redd distribution

July 15, 2015 Hatchery Committees Meeting

<u>Objective 2: Twisp Migration Timing (Slide 4 of Attachment D)</u>

Mike Tonseth asked if migration timing is still an issue, and Andrew Murdoch said it is not. Tonseth asked if the next 5-year report will have some values where data were not yet available in the previous report, and Murdoch said he believes so. Murdoch added that he does not believe there has been a big difference in migration timing.

Objective 2: Twisp Redd Distribution (Slide 6 of Attachment D)
Tracy Hillman asked if low run size was the reason why there appeared to be a relatively large difference in NOR and HOR redd distribution in 2006. Murdoch said he is not sure, but noted that during that time, sample size in the spawner surveys was a problem.

Objective 2 (General Comments)
Hillman asked if there are any concerns or items that should be flagged for future discussion under Objective 2. The following were discussed:

Keely Murdoch said spawner distribution in the Methow Basin is a problem that needs to be addressed. She noted that last year, the Hatchery Committees approved the Goat Wall Evaluation Study, which is addressing this; at this time, no action is needed until that study is underway. She said she does not believe additional studies are needed unless the Hatchery Committees want to discuss adult management plans.

Bill Gale noted that the years reviewed in this presentation were years when there was no adult management. He said now, with HORs being removed, the numbers should be better. He added he believes there should be a significant net improvement in productivity in the basin.

Tonseth noted the downstream shift in mean spawning location for NORs, as depicted in Figure 49 on Slide 14 of Attachment D. Gale asked if there might be some other explanation why in later years NORs were further downstream. Tom Kahler suggested tracking this. Kirk Truscott questioned whether the evaluation of spawning location is proportional. He suggested this may not be an environmental issue; rather, it may be the product of NORs spawning lower in the basin. He asked if there are corresponding data for NORs in the upper basin. Hillman noted that the y-axis only shows river kilometers (rkm) ranging from 80 to 120 rkm. He said if the axis showed rkm ranging from 0 to 120 rkm, these data points would look like a horizontal line suggesting little trend in spawning distribution. He said it seems significant because of the way the figure was developed.

Andrew Murdoch said regarding the Wenatchee Basin, and the Relative Reproductive Success (RRS) Study, at the tributary level, there are different patterns between HORs and

NORs. He said in areas of similar spawning distribution of HORs and NORs, there is no difference in RRS; however, overall reproductive success of hatchery fish is lower. Keely Murdoch said the report speculated that the similar RRS could be the result of lower overall densities in the White and Little Wenatchee rivers. She added that the overall reduced survival was the result of known low survival rates through Lake Wenatchee, rather than similar spawning distribution. Andrew Murdoch said everything is measured at the Lower Wenatchee River, so there is a lake effect. He added that in the Upper Wenatchee River there is a habitat issue, and in the White River there is a lake issue. He said habitat and genetic effects need to be separated. He said in the Chiwawa Basin, HORs are spawning in suboptimal habitat in the lower river, but their adult progeny move upstream to spawn, resulting in a different distribution than their parents, which is slowly biasing productivity estimates. He questioned whether this is happening in other locations.

January 20, 2016 Hatchery Committees Meeting
Keely Murdoch said Objective 2 was flagged for further discussion because there are issues with the spawning distribution of hatchery and wild fish; however, the Hatchery Committees already approved a study design to determine if spawner distribution in the Methow Basin can be improved with short-term acclimation (the Goat Wall proposal and SOA).

3. Objective 3 – Genetic diversity, effective population size, age at maturity, and size at maturity

August 28, 2015 Hatchery Committees Meeting
<u>Objective 3: Twisp mean heterozygosity and allelic richness (Slide 3 of Attachment E)</u>
Craig Busack asked how many broodstock were used. Mike Tonseth said at the time, there were widely varying program sizes. Tonseth said he does not believe there were ever more than 30 spawners. He added that release numbers were between 50,000 and 70,000 every year. Busack said he is not surprised by these results considering the small numbers of spawners. Andrew Murdoch noted that the report has all of the sample size information.

Objective 3: Differentiation over time between natural origin broodstock and hatchery-origin broodstock collections (Slide 4 of Attachment E)

Busack said it seems the hatchery-origin recruits (HORs) are diverging from the natural-origin recruits (NORs); however, this is difficult to interpret with the separation. Andrew Murdoch noted that for many years there was no integration; it was 100% HOR broodstock. Keely Murdoch asked if different results are expected for the next 5-year report. Andrew Murdoch said yes, because these data show the last 5 years plus the previous 15 years.

Objective 3: Relationship between the effective population size and the spawning population (Slides 6 and 7 of Attachment E)

Busack said it appears the effective number of breeders is about one-tenth of the spawning population size. Keely Murdoch asked what this means, and Busack explained that the population may have several hundred spawners, and the rate of genetic change through drift may be faster than predicted. He added that it could also mean that few fish are producing a lot of progeny and some are not producing many. Busack said this is a unique dataset because the populations are not closed, yet they are differentiated to this degree, affecting the true rate of genetic drift.

Objective 3: Pairwise Fixation Index (Fst) values and ratio of effective population size/spawning population (Ne/N) over time (Slides 13 and 14 of Attachment E)

Bill Gale asked if lines portrayed on these graphs mean that the line is significantly different than zero. Keely Murdoch noted that the Twisp River is an example where there is an increase in pairwise Fst over years of separation, but the relationship is not significant. Busack noted that in this slide, Fst is calculated for all samples, and then time between years is calculated. He said, for example, a comparison between a 2012 and a 2000 sample would be made. He said this graph is entirely predictable because all populations drift and change over time. Gale asked if the slope is not different than zero, how can there be an increase or change over time. Busack explained that the data are increasing; therefore, it cannot be rejected that there is no change. He added that a slight uptick in Fst is entirely consistent with what would be expected. He said understanding what large Fsts represent would help interpretation of the statistic. He noted that populations drift, so a large increase in Fst may or may not indicate a hatchery effect; he suggested that the programs are over-monitored for molecular genetic information. Keely Murdoch said a p-value is not cited in the report, and significance is not discussed. Gale said he is trying to determine how important this is and if it warrants further evaluation and discussion. Busack said calculating pairwise Fsts for multi-year samples will always result in an increase. Keely Murdoch said the slope would be close to zero if the outlier is removed. Busack suggested that everything drifts and these comparisons are not very important.

4. Objective 4 – Hatchery Replacement Rate

June 17, 2015 Hatchery Committees Meeting

Objective 4: Natural Replacement Rate (NRR) versus Hatchery Replacement Rate (HRR) (slides 20, 22, and 24)

Mackey said for each stock, NRR and HRR were calculated for all available years, then the arithmetic and geometric means were calculated and compared to determine if HRR was substantially higher than NRR. He said the Biological Assessment and Management Plan (BAMP 1998) indicated an expected HRR value of 4.5, and the goal is to have an HRR notably higher than NRR. Busack asked how HRR is measured, and Hillman said HRR was calculated using the total HORs returning to the basin. He said HRRs were calculated using HORs with and without harvest adjustments. Matt Cooper asked how NRR is measured. Charlie Snow said NRR is largely calculated based on spawning ground surveys, but also accounts for harvest and harvest-related mortalities. He said for Chinook salmon stocks that are adipose-present, surrogate coded-wire-tagged stocks are used to determine contribution, and fisheries-related mortality rates are applied to those fishery numbers.

Mackey said geometric means were used to dampen the effect of divergent numbers. He said the HRR and NRR means are not very different; however, the geometric means differ a bit more when the effects of large values are removed. Busack questioned the use of geometric means for this analysis. Hillman noted that geometric means are typically used in multiplicative processes and are probably not appropriate in this case. Mackey explained that these data include occasional years that are really high compared to others, and they have a big influence on the mean. Busack said he still does not agree that the geometric mean is applicable here. Murdoch asked how the BAMP value (i.e., 4.5) was derived. Hillman said he thinks Andrew Murdoch (WDFW) and Chuck Peven (former Chelan PUD; Peven Consulting, Inc.) calculated the value, which is a back-calculation to determine the return rate for smolt-to-adult return ratios (SARs). Busack asked if the value was related to mitigation requirements, and Snow said he thinks it was.

Busack said he is uncertain what a reasonable HRR would be in the Methow Basin; and he asked if the calculated HRRs for this basin are considered poor performance. Willard said for the Twisp, as noted on slide 21 of Attachment C, the Five-Year Hatchery M&E Report indicated that, "poor post-release survival, resulting in HRRs below the 4.5 target, is responsible for the low observed HRR values." Pearsons also suggested a good basis for comparison might be nearby basins. Murdoch suggested evaluating HRRs by life stage and determining where it can be improved. Busack asked what HRRs are for Winthrop NFH, and Cooper said he suspected they were not too different. Mackey guessed they might be slightly lower because Winthrop NFH SARs are typically somewhat lower. Hillman reviewed HRRs for Chiwawa versus the Methow, noting that in general, Chiwawa HRRs are a bit higher; however, he said Chiwawa HRRs do not appear to correlate with the Methow. Mackey said the value of striving to have a high HRR in this age of pHOS and adult management should be considered. He questioned how many hatchery fish should be returning if 60 to 80% are removed each year. The key metric is to at least have an HRR that is high enough to avoid mining the wild population for broodstock.

Truscott suggested that to improve the program, it may be wise to conduct precocity work (i.e., evaluating growth rate and size at release). He noted if fish have a high precocity rate, they will not contribute as anadromous adults. Tonseth said high precocity rates might bias HRRs because SARs are being calculated based on juvenile releases, which may not accurately reflect the smolt population. This is because some of the released fish residualize and do not smolt. He said if calculations are corrected for this, it may result in higher HRRs (i.e., HRRs may be artificially suppressed by released fish that residualize). Gale noted that this is supposed to be a question of program performance. Tonseth said he is not suggesting removing this program element. Rather, he is suggesting evaluating how precocial males and/or residual fish may be affecting HRRs.

October 21, 2015 Hatchery Committees Meeting

Greg Mackey shared a spreadsheet titled “HRR Target Calculation” (Attachment G), which Sarah Montgomery distributed to the Hatchery Committees on October 13, 2015. Mackey said the calculation is based on spawning escapement, and the sliding scale in the spreadsheet shows a minimum spawning escapement of 500 hatchery fish. He said the proportionate natural influence (PNI) target constantly changes depending on how many wild fish return, but 500 is used as a target escapement because more than 500 hatchery fish are rarely needed. Mackey said HRR is calculated as escapement divided by broodstock (3.85 in the example shown). Todd Pearsons said that the old target was 4.5 (from the latest Snow et al. report[1]), which is similar to Mackey’s calculated target. Pearsons said the goal of this discussion is to relate HRR to management objectives that the Hatchery Committees are trying to meet, and an unachievable target would not meet that goal. Mackey said the target of 3.85 represents the minimum. Bill Gale said Charlie Snow (WDFW) usually uses total adult return, including harvest, to calculate HRR, and Mackey’s calculation does not factor in prespawn mortality or harvest. Mike Tonseth said HRR is calculated with and without harvest, so more refinement may be needed if prespawn mortality should be accounted for. Gale asked whether the target is for a subbasin HRR, or if it is an HRR from total adult return. Mackey said the 500 represents spawners, not returns, and the topics are mixed here because HRR measures return. Mackey presented another way for calculating HRR targets using the Hatchery and Genetic Management Plan (HGMP) for Methow spring Chinook salmon. Mackey said the minimum escapement is 500 spawners, and with the pHOS-based sliding scale, 500 is also approximately the greatest number of hatchery spawners that would ever be needed. So, a HRR calculated on 500 spawners serves as the minimum necessary HRR value. Tracy Hillman said the M&E Plan consists of two targets or goals: 1) HRR being greater than the set target; and 2) HRR being greater than the natural replacement rate (NRR). He said hatchery returns to the entire subbasin are included in the

[1] Snow, C., C. Frady, D. Grundby, B. Goodman, and A. Murdoch. 2015. Monitoring and evaluation of the Wells Hatchery and Methow Hatchery programs: 2014 annual report. Report to Douglas PUD, Grant PUD, and the Wells HCP Hatchery Committee, East Wenatchee, WA.

calculation, and HRR is estimated with and without freshwater harvest. Hillman said surplused fish are included in the HRR calculation.

Gale shared a spreadsheet titled, "Winthrop NFH Spring Chinook Yearling Release Metrics" (Attachment H), which Montgomery distributed to the Hatchery Committees on October 19, 2015. Gale said when USFWS prepared the Winthrop NFH HRR data, it discussed comparing HRR to other programs. Gale asked whether it is appropriate to do subbasin-level HRR calculations, because one set of data includes adipose (ad)-clipped fish and might compromise future comparisons. Kirk Truscott said in the HGMP there is 24% prespawn mortality, so if no wild fish return, the amount of hatchery fish that would have to return in order to meet the HRR target, including the prespawn mortality component, would equal 666, which differs from 525 based on the proportion of hatchery origin spawners (pHOS). Truscott said Methow spring Chinook salmon contribute to harvest (tribal, especially) in the lower Columbia River, so identifying an HRR target that would not provide the opportunity for harvest benefits of surplus would not be advantageous. Mackey said the current HRR target (4.5) and the one calculated using his spreadsheet (3.85) do not differ greatly, but it would be better to have a rational method for calculating HRR so that it can be easily adjusted in the future. Mackey asked what the 10-year HRR average is. Pearsons listed data from the most recent Snow et al. report[1]: from 2001 to 2008, Methow River HRR was 5.1, Twisp River HRR was 4.39, and Chewuch River HRR was 4.15. He said the Winthrop NFH HRR was 3.27 from 2001 to 2008, as presented in Gale's spreadsheet. Mackey said the aggregate average HRR for the Methow River with all three programs combined was 4.6. Gale said the HRR for the MetComp Methow River program was 4.17.

Hillman asked what happens if the HRR target is not met. Hillman said for the Chiwawa River spring Chinook salmon program, the HRR target was only met in 8 out of 18 years. He said a target can be set, but what does it mean or what happens if the target is not met? Tonseth said one issue is that there is not much to do to change HRR, as it depends primarily on ocean survival. He said producing more smolts would increase abundance, but it would not change the HRR, so maintaining at or near the 5-year average should be considered achieving the objective. Catherine Willard said if the HRR is low due to hatchery effects, it can be controlled. Gale said the factors predominantly driving HRR are mostly outside of the hatchery.

Craig Busack said it appears that the Winthrop NFH HRR is one-third lower than the Methow Basin hatchery programs. Gale said that care should be taken in comparing HRRs from certain programs, because many factors are program-specific. Tonseth added that transition years, such as from 2002 to 2006, should be accounted for, because they are not reflective of expected future performance. Tonseth said HRR is driven by broodstocking, and because hatchery fish can be over-collected and culled, wild-driven broodstocking programs are stricter, thus the number of broodstock used is important. He said comparing programs becomes difficult when the broodstocking policies are different. Gale said Winthrop NFH collects extra fish, which is reflected in the HRR. Truscott said the point of HRR is to calculate the parent brood that contributes to production. Gale said the point of HRR is to determine how many fish were collected and subsequently produced. Tonseth said the calculation is based on what is collected and retained. Gale said culling is included in the calculation of HRR. Tom Kahler said HRR takes into account the number of fish from which gametes were collected. Tonseth said using that number is not an accurate representation of the adults collected in order to collect gametes. Hillman said the denominator of the HRR calculation is total broodstock collected, which includes pre-spawn loss, surplused fish, and those spawned.

Pearsons shared data from 2006 to 2008 from the Snow et al. report, showing that Winthrop NFH would still have a lower HRR (5.7) than the Methow programs (average HRR of 7.9). Gale said the difference could be a result of performance or a result of difference in broodstock collection. Truscott said it also depends on how the fish perform; because Methow Fish Hatchery (FH) is supported by natural-origin recruits, equal performance would not be expected. Tonseth added that different disease-management strategies at Winthrop NFH would also result in a lower HRR. Pearsons said the point is to compare HRRs to other hatcheries and see if Methow FH is anomalous. Tonseth said recalculating HRR using the number of adults contributing to juveniles (by removing culled fish and prespawn mortalities) would eliminate bias.

Hillman asked why the Hatchery Committees think a target is necessary. He said the programs currently calculate internal hatchery performance metrics and smolt-to-adult returns (SARs), which are all components of HRR. These are evaluated by the Hatchery Committees in concert with HRRs. He said given that the Hatchery Committees have not reacted to the lack of HRRs meeting program targets in the past, HRR targets may have little bearing on adaptive management. Mackey said there are three components to HRR: 1) fecundity varies, 2) in-hatchery survival is generally maximized; and 3) SARs are uncontrollable due to ocean conditions. Hillman agreed and said the Hatchery M&E Plan calls for comparing HRRs to the derived targets and NRRs. He said HRRs are nearly always greater than the NRRs, but HRRs rarely meet HRR targets. Willard said the HRR target exercise was part of the HETT assignment for appendices, but the values in the appendices come from the Biological Assessment and Management Plan. Keely Murdoch said the Hatchery Committees should use the established values, or task HETT to come up with new values. Tonseth said this relates back to the purpose of the programs; if the natural population catastrophically failed, the hatchery programs can help in recovery. He said the HRR target is a check-in so the program is performing at the right level in case of a natural population failure. Mackey said the PUD programs for No Net Impact (NNI) are set by survival studies and are not directly related to the number of hatchery fish that need to return to meet spawning escapement. He said the programs can change size, but if the spawning escapement number is static, HRR would change. He said holding the program to a target is an objective but a difficult one, and more importantly, HRR should be higher than the NRR. Hillman said the productivity standards for the supplementation programs are well above the levels needed to avoid extinction based on quasi-extinction risk modeling. He said the question is how to calculate the target and determine the information needed to include in the calculation of the target. Truscott said HRR targets for summer Chinook salmon need to include harvest objectives, and pre-spawn mortality also needs to be accounted for in summer Chinook salmon. Tonseth said distinct calculations should be maintained, because looking at just HRR with harvest included might hide other impacts. He said different harvest components should be included in order to discover which harvest component has the largest impact. Truscott said if HRR is calculated for a brood year, the benefit of the doubt is afforded to the hatchery program. Mackey said interceptions of fish en route to their final destination should be accounted for. Busack said HRR should be calculated before and after harvest, and conservation fisheries should be excluded from the harvest calculation. Truscott said conservation fisheries should be included in HRR calculations because they are fish that return to the subbasin. Hillman said harvest varies greatly by year and location, and the average from 1989 to 2008 for Chiwawa spring Chinook salmon has been about 25 fish per year.

Gale asked whether an annual target or a 10-year running average target should be calculated. Gale said an HRR target would be meaningful in the 5-year reports, but should also be included in the annual reports. Hillman indicated that HRRs are presented in the annual and 5-year reports. Tonseth said HRR is like PNI or SARs, so the 5-year average is more valuable. Hillman said a running average has not previously been calculated. Busack recommended calculating a running average. Hillman suggested using the geometric mean given that replacement rates represent a multiplicative process. He also recommended assigning this task to the HETT, which will be meeting soon. Truscott said one method could be to pick a long-term average and try to improve on it. As a side note, Hillman said the Wenatchee River steelhead HRR target is 19.2, which has only been met once.

The Committees agreed the HETT will develop a method for calculating HRR targets before the next Hatchery Committees meeting on November 18, 2015.

Hillman suggested discussing Objective 5, in addition to continuing the discussion of Objective 4, at the next Hatchery Committees meeting. Hillman said the Hatchery Committees will discuss Objective 4 (HRR) and Objective 5 (stray rates) of the prioritized 5-Year Hatchery M&E Report objectives flagged for Methow spring Chinook salmon during the next Hatchery Committees meeting on November 18, 2015.

November 18, 2015 Hatchery Committees Meeting

Catherine Willard said the HETT met on October 29, 2015, and came up with different approaches to calculating an HRR target. Tracy Hillman summarized the approaches as follows:

> The HETT considered several methods for estimating HRR targets for each hatchery program. The HETT proposes the following approach for setting HRR targets:

$$HRR_T = \begin{Bmatrix} >1.0 & \text{if } NRR<1.0 \\ NRR \times (\Theta) & \text{if } NRR \geq 1.0 \end{Bmatrix}$$

where:

HRR_T	= a program-specific HRR target
NRR	= natural replacement rate
Θ	= a program-specific multiplier

The HETT identified several methods for identifying a program-specific multiplier:

- Calculate the average HRR/NRR ratio during the historic time series for each program. Use the highest average ratio and apply it to all programs of the same species. For example, if the Chiwawa spring Chinook salmon program has the highest average ratio, that ratio is then used as the multiplier for all spring Chinook salmon programs.
- Calculate the average HRR/NRR ratio during the historic time series for each program. Use that average as the multiplier for the specific hatchery program. That is, the average ratio for Chiwawa spring Chinook salmon would be used as the multiplier for the Chiwawa spring Chinook salmon program, and the average ratio for Twisp spring Chinook salmon would be used as the multiplier for the Twisp spring Chinook salmon program.
- Calculate the average HRR/NRR ratio during the historic time series for each program. Calculate the mean (or weighted) mean of the average ratios for each species. This mean average ratio is used as the multiplier for all programs of the same species. For example, all spring Chinook salmon programs would use the same multiplier.
- Calculate the ratio of the hatchery egg-smolt survival rate to wild egg-smolt survival rate for each program. Multiply this ratio by an estimated correction factor for hatchery fish SARs for each program. These estimates are then used as the multiplier for each specific program.
- Select program-specific multipliers based on management interests.

Questions and comments were discussed as follows:

Hillman said the HETT recommends using a fixed multiplier instead of a fixed target. As such, the target changes yearly. He said if the adaptive management implications of not meeting a target are limited, another option would be to set a simpler target, such as HRR greater than 1.

Andrew Murdoch said the objective in the original M&E program was targeted at post-release performance, and the HRR target was calculated based on broodstock and SAR rates. He said, because the broodstock part of the program is captured in hatchery survival rates, the equation is much improved. He said the HETT should try to anchor the natural variation in hatchery SARs by comparing it to wild SARs in order to understand how HRRs change over time. He said he has assessed SARs for wild Chiwawa spring Chinook salmon after adjusting differential in-basin survival, and he found that hatchery fish have approximately 70% of the SAR of wild fish. He said this has changed and increased over time, partly due to noise in estimation of adult returns. He said data collection for adult returns of spring Chinook salmon are focused on the spawning grounds, so it is important to understand how the data have been collected over time given that sampling effort has varied widely across the years. Craig Busack asked if hatchery SAR rates were much lower than wild SAR rates, and if a pattern holds true across other basins. Andrew Murdoch said that earlier on in the time series, hatchery SAR rates were approximately half of wild SAR rates.

Kirk Truscott asked how to assess comparison of natural and hatchery SARs in the Chiwawa River when a known number of hatchery fish are released and only an estimate of smolt production that has some degree of error. Andrew Murdoch replied there is a survival model that takes into account the size and abundance of emigrants, and wild Chiwawa River smolt survival can be estimated to the mouth of the Wenatchee River. Truscott said there is an error in the natural-origin smolt estimate. Andrew Murdoch replied he has not figured out how to capture that uncertainty, but the method for calculating emigrant estimates is relatively precise. He said in-hatchery survival is not an objective of the M&E Plan; it just supports other objectives. He said there are enough data to look at SAR rates for wild and hatchery fish over time to see how they compare.

Todd Pearsons said there are not concerns about in-hatchery survival, but adults still return in variable numbers. Pearsons said a lot of data are being collected and asked what objective criteria SARs should be measured against. He asked what the purpose of an HRR target is, and said HRRs should exceed NRRs and should also exceed 1. Andrew Murdoch said the original intent of the M&E Plan was to use HRRs in order to signal that something is wrong in the hatchery, outside environment, release strategy, or other area. He said a better way of determining an HRR target is needed in order to identify a problem. Pearsons said it would help to identify if post-release survival is a significant problem. He asked why a manufactured HRR target is needed when these comparisons can already be made with the data that are being collected for SAR. He said the key pieces are whether or not a program is mining the wild population, and if the program is sustainable. Hillman said there is a specific performance objective for HRR (unlike SARs and in-hatchery survival metrics), which drives the assessment of hatchery performance and SARs. He asked if it would be better to identify specific objectives for within-hatchery performance, and perhaps SARs, rather than identifying HRR targets. Andrew Murdoch said, after looking at the data and the wild SAR rates, he thinks a simple expansion is not relevant because there is a lot of variability. Greg Mackey said SAR data for hatcheries is more reliable than for wild populations because there are more measurement error factors in wild SARs. He said the point of having an HRR target is to assess the program and determine whether a minimum standard is being met. Hillman said there were a few years when HRRs were less than NRRs. When this happened, the monitoring team examined within-hatchery performance and SARs to see if the problem could be identified. Because this happened rarely and did not occur over several consecutive years, the source of the problem was not identified. He said it was likely related to carcass sampling.

Mackey said, referring to adult management practices, setting an HRR or SAR target would be nonsensical when 80% of the hatchery fish are removed. He said setting an HRR target makes sense if it is above the minimum level and is set in the context of how fish are managed. Hillman said comparing NRRs to HRRs is confusing because NRRs are based only on spawning escapement, and HRRs would be based on both spawning escapement and hatchery fish surplused. Mackey said a regional comparison in the M&E Report would be useful so that SAR and NRR can be seen for each program.

Truscott said comparing SAR rates between programs is a reasonable process to assess efficacy of individual programs and is a good idea. He said CCT wants to ensure that just meeting the minimum HRR does not preclude harvest opportunities. Hillman asked if data are available to calculate natural-origin SAR rates for every program and said SAR rates are often estimated for natural fish based on tagged hatchery fish. Andrew Murdoch said reliable natural-origin SAR is only available for Chiwawa spring Chinook salmon.

Mike Tonseth said Chelan, Douglas, and Grant PUDs have an obligation to meet mitigation responsibilities, and Joint Fisheries Program management objectives and expectations are above that. Tonseth said the settlement agreement and HCPs outline that the main objectives are that the Program contributes to recovery, augments natural populations, and contributes to harvest, with priority given to recovery, and excess fish going to harvest. He said part of the scope of the Hatchery Committees is to maximize the efficiency of the program so that if adults are taken in, products from those adults are optimized. Pearsons asked what the escapement objectives should be for different basins. Tonseth replied that has only been done for Wenatchee River spring Chinook salmon. Truscott said the total spring Chinook salmon escapement to the Wenatchee basin should account for target plus harvest. Pearsons said targeting a harvest on a listed population, other than a conservation fishery, is a troublesome concept. Andrew Murdoch said there is always surplus for every hatchery program because mitigation is not spread across the landscape, and the safety-net programs can be used for harvest. He said all fish produced by appropriately sized conservation programs ideally would be needed and allowed to spawn naturally on spawning grounds.

Hillman asked if everyone agrees that the HRR target should at least be greater than 1. Keely Murdoch asked how often HRR has been less than 1. Andrew Murdoch replied that HRR has been less than 1 only a few times as a result of major disease issues or weird outliers in the data. Busack said HRR could be below 1 for non-hatchery reasons. Hillman agreed, and said not meeting the HRR target is a trigger to look at each of the metrics making up HRRs. Tonseth asked if comparing HRRs to NRRs should be an objective rather than a standard. He said real-time adaptive management tools are not readily available because at least 2 years go by before information becomes available to make a change. He said the ratio between HRR and NRR might be more important than absolute values, especially considering the potential period of poor ocean conditions likely ahead. He said, in order to compare the values, a complete brood year is needed, and by the time change can be affected in the causal factor, several generations would have passed.

Hillman said the HETT proposed that the 5-year geometric mean of HRRs should be greater than or equal to 1 in order to ensure reaction to a single year does not occur. This provides the lower target. The higher target would be based on a multiplier applied to the NRRs. If HRRs fall below the lower target, the program is in need of change. If the HRRs fall between the upper and lower targets, the program is doing well. Andrew Murdoch said tying HRR targets to NRRs is a good idea, and if there is introgression, it may be simple to come up with more realistic SAR rates for these programs. Hillman said other options for identifying HRR targets include using the old approach with more up-to-date SAR estimates or using the approach that Mackey presented during the November 18, 2015, meeting. Mackey said a deviation metric could also be used to flag HRR values that are out of the ordinary. Pearsons agreed and said HRR can be compared across programs and against earlier time periods. He said HRRs outside of one standard deviation from the norm should be flagged for assessing causation. Hillman said the HETT could provide those results using spring Chinook salmon as an example. Truscott added that the minimum HRR value should not be identified as the target. The HETT will recalculate HRR targets using revised SAR calculations. The variability in HRRs will also be calculated and evaluated if one standard deviation can be used as a measure of tolerance for identifying low HRRs for spring Chinook salmon programs.

Willard said the HETT is setting up a conference call for December to discuss these items, and setting up a monthly recurring meeting time to discuss Appendices 1 through 6 starting in January 2016.

December 16, 2015 Hatchery Committees Meeting

Tracy Hillman said the HETT met on December 14, 2015, and discussed methods for calculating HRR. As a bit of background, Hillman stated that the HRR is a productivity metric, so survival rates figure into its calculation. He said it is a multiplicative process where broodstock is multiplied by HRR to calculate the hatchery adults returning to a system. Because it is multiplicative, a geometric mean, rather than an arithmetic mean, should be used. He added that the egg-to-smolt survival rate is directly influenced by the hatchery, and the smolt-to-adult survival rate is influenced by the hatchery and out-of-basin effects. Thus, any changes in the hatchery could affect HRRs by affecting egg-to-smolt survival rates, SARs, or both. With that in mind, Hillman described the different methods the HETT evaluated for setting HRR targets.

Approach Linking HRR Targets to NRRs

Hillman said that during the first meeting of the HETT, a method was devised that would link HRR targets to NRRs. In other words, the HRR target should be greater than 1 if NRRs are less than 1. However, if NRRs are greater than 1, HRR targets would be some number multiplied by the natural replacement rate (NRR). This can be shown as the following:

$$HRR_T = \begin{Bmatrix} >1.0 & \text{if NRR}<1.0 \\ \text{NRR}\times(\Theta) & \text{if NRR}\geq 1.0 \end{Bmatrix}$$

where:

HRR_T = a program-specific HRR target

NRR = natural replacement rate

Θ = a program-specific multiplier

Hillman explained the HETT identified several ways to calculate the multiplier. Those were discussed during the last Hatchery Committees meeting. At that time, this method did not gain much traction. Therefore, the Hatchery Committees asked the HETT to evaluate two other methods for calculating HRR targets. One is to use the previous method, but include revised SARs (not SARs identified in the Biological Assessment and Management Plan [BAMP]), and the other is to use some measure of spread (e.g., 1 standard deviation) as a measure of tolerance. Hillman said the HETT evaluated both methods.

Previous Approach Using Revised SARs

Hillman said the previous method estimated HRR targets as the product of the number of smolts released multiplied by SAR, divided by the number of broodstock needed. This is shown as the following:

$$HRR_T = \frac{Smolts\ x\ SAR}{Broodstock}$$

where:

HRR_T = a program-specific HRR target

SAR = smolt-to-adult return rate

Catherine Willard shared a document titled "Hatchery Replacement Rate Targets Methodology" (Attachment I), which Sarah Montgomery distributed to the Hatchery Committees on December 17, 2015. Hillman said the HETT discussed whether to use hatchery or wild fish SARs. He noted wild fish SARs (for Wenatchee spring Chinook salmon) are typically higher than hatchery fish SARs, as shown in the gravel-to-gravel SARs table in the document. Given that there are no wild fish SARs for most programs, the HETT calculated possible targets based on hatchery fish SARs. This was accomplished using the entire time series of SARs available for each program and with only the 5 most-recent years of SARs. Hillman said the number of smolts released and broodstock needed are now mostly fixed. As such, HRR is primarily influenced by SAR.

Standard Deviation Approach

Hillman said the HETT calculated arithmetic and geometric averages and standard deviations for Chiwawa spring Chinook HRRs. McLain Johnson (WDFW) shared a spreadsheet titled "SAR HRR Update" (Attachment J), which Montgomery distributed to the Hatchery Committees on December 17, 2015. The HETT found that the average SAR does not change much if the entire time series of HRRs (1989 to 2008) is used, or only the most recent HRRs (2000 to 2008). On the other hand, the variability in HRRs differs substantially between the two time series. Variation in HRRs is much greater if the entire time series is used. Hillman said this is probably because of the limited effort used to sample carcasses in the early years.

Hillman shared a spreadsheet titled "Chiwawa Spring Chinook HRRs and NRRs" (Attachment K), which Montgomery distributed to the Hatchery Committees on

December 17, 2015. He said, under this approach for the Chiwawa spring Chinook salmon program, the HRR target would be 1 standard deviation below the mean, which is 0.75 if the entire time series of HRRs is used. In contrast, if the shorter time series is used, the HRR target would be 4.75. Hillman commented that these estimates were based on using arithmetic means. Using geometric means, the target for the shorter time series would be 4.29, which is slightly less than using the arithmetic mean. Hillman commented that it is easier to calculate variance for the arithmetic mean than the geometric mean. Therefore, he suggested the evaluation of percentiles.

Percentile Method

Hillman noted, if the Hatchery Committees want to avoid calculating variance for the geometric mean, they can set targets based on percentiles. He said, for example, if HRRs fall below a certain percentile of the existing time series of data, then the Hatchery Committees could take some adaptive management action. For example, using the 2000 to 2008 time series, the 5th percentile is 4.62 (not including harvest) for Chiwawa spring Chinook salmon. This means, if HRRs fall below 4.62, the Hatchery Committees could take some action. Hillman said one can select the percentile that makes the most sense, but a key step is to decide what will be done if the target is not met. Keely Murdoch said not meeting the HRR target should trigger the Hatchery Committees to look closely at each component and find out why the target is not being met (e.g., disease outbreaks or ocean conditions). Mackey said if the HRR target is the 20th percentile, the target would not be met in 1 out of every 5 years, or about 20% of the years. Keely Murdoch said meeting the HRR standard in 4 out of 5 years for the 5-year analytical report would show that there is likely not a huge problem with HRR. She recalled a red-light, yellow-light, and green-light system related to meeting targets each year. Hillman said the red-light, yellow-light, and green-light system was used to assess when a management action would be warranted, and that would certainly apply in this case. He urged the Hatchery Committees to decide on a method for calculating HRR targets, because the SOA says the review of the 5-Year Hatchery M&E Report should be complete by March 31, 2016.

Mackey said the BAMP HRR target was 4.5, which is functionally close to the 20th percentile targets in Hillman's spreadsheet (all near 4.5 or 5 for the Chiwawa program).

He said there are two options: 1) use the Chiwawa program as a standard to compare to other programs; or 2) fit each program with its own target. Hillman recalled that the HETT voiced concern about using a "gold standard" approach (such as the Chiwawa program) for HRR targets because each program would have to be weighted differently. He said it would be easier to develop an approach for calculating the HRR target and then apply it to each basin or program. Keely Murdoch said the HRR target should be applied basin-wide instead of for each program in order to avoid giving poorly performing programs low targets. She said, because the Chiwawa program performs well, its calculated HRR target may be an appropriate target for the entire Wenatchee Basin. She said the Methow Basin has lower SARs than the Wenatchee Basin due to longer migrations, and explained that survival standards could be used to inform the HRR target. She said the Chiwawa program can be used to develop an HRR target for spring Chinook salmon programs in the Wenatchee Basin, and a similar technique could be used to develop values in other basins (like the Methow Basin) and for other species.

Hillman asked if data before brood year (BY) 2000 should be used in calculating HRR targets. Mike Tonseth said he favors using data from BY 2000 to present because from 1989 to 2000, in-hatchery survival standards from the BAMP were significantly lower than current program survival standards, and they have subsequently been updated. Hillman added that the more recent time series has less variance in HRRs and consistent sampling effort across years. Keely Murdoch said the Methow Fish Hatchery (FH) SARs are slightly higher than the Chiwawa SARs, so perhaps the standard could be the same. Hillman said if the Hatchery Committees decide on a method for developing the standard, the HETT or Hillman and Andrew Murdoch could calculate the targets. Keely Murdoch said the 5-year Methow FH HRR is higher than the Chiwawa FH HRR. Matt Cooper asked why harvest is separated in the Chiwawa HRR and NRR spreadsheet. Hillman replied the monitoring plan states that HRR and NRR should be calculated with and without harvest. Cooper asked if separate targets should be developed for harvest and no harvest. Mackey said only one target should be used. Tonseth said harvest should be included because there may be a significant harvest effect on adult returns to the tributaries. Cooper said excluding harvest may better show whether HRR is poor due to out-of-basin effects. Tonseth agreed, and said excluding harvest gives a better basin-wide benchmark, but that does not mean that HRR, including harvest, will not also be examined.

Hillman said there appears to be consensus that HRR targets should be calculated for each species and by basin, using data from BY 2000 to present. He asked if the Hatchery Committees preferred the percentile method for calculating HRR targets. Mackey said 1 standard deviation below the mean is approximately the 16th percentile, so using a target between the 15th and 20th percentile would roughly correspond to the standard deviation method. Keely Murdoch asked if using the mean and variance of the HRRs throughout the time series would mean that HRRs would not meet the target 50% of the time. Hillman said using the median (not mean) would indicate that, on average, the threshold value would be exceeded 50% of the time. He said he calculated the variance for the geometric mean by hand. He said he discussed the calculation of variance for the geometric mean with Rich Hinrichsen (Hinrichsen Environmental), who verified his calculations. Kirk Truscott asked if the Hatchery Committees decide to use the red-light, yellow-light, and green-light system, would the 20th percentile be considered a yellow light or a red light. Hillman said it would be up to the Hatchery Committees, but it could be stated that one instance out of five would be green, two out of five would be yellow, and three out of five would be red. Each color would require a different response from the Hatchery Committees. He added, that because the programs changed about 2 years ago, the 5-Year M&E Report due in 2018 will have little adult information resulting from the program changes. Truscott agreed, and said this process should be in a rolling 5-year review. Mackey said 5 years are already done, so in 2 years there will be another report, at which time the dataset will have 10 years of information. Hillman said the percentile approach would not use a rolling 5-year average, but rather simply compare HRRs to the target annually.

Todd Pearsons asked if the proposal is to use the 20th percentile approach to calculating HRR targets instead of the previous approach (i.e., BAMP-based SAR targets). He said Grant PUD will need more time to review the information before providing a decision on this. He asked if the targets would increase over time, which would make it more difficult to reach the target in a given year. Hillman confirmed the proposal and said the targets would be set for at least a 5-year period. Keely Murdoch said there is always the option to revisit the HRR targets (like the Hatchery Committees are doing now) or decide if the target is appropriate for any 5-year period. She said a target should be set that does not automatically reset, in order to ensure the target does not react to drastic changes in SARs (e.g. due to ocean conditions or other factors). Hillman said the percentile approach does two things: 1) sets a target value that is greater than 1, which means the hatchery programs need to do better than just replace themselves; and 2) uses recent past performance, so it must perform at least as well as it did in the past. Tonseth said the values in the BAMP were set as a starting point because the Hatchery Committees did not know what to expect from the programs, and many changes have occurred since then because programs have exceeded initial expectations.

Hillman asked the Hatchery Committees if they agree to implement the 20th percentile method for calculating HRR targets for each basin and species using data from BY 2000 to present. Keely Murdoch said the method is good, but the targets should not be automatically adjusted every 5 years; rather, the target should only be changed if the Hatchery Committees decide that the target is no longer appropriate. Truscott asked if this method includes harvest. Hillman said no, but because HRRs are calculated with and without harvest, one can determine if harvest is precluding a program from meeting its HRR target. Tonseth asked if it can be determined whether or not harvest drives the HRR down. Truscott said all returning adults are accounted for when harvest is included, so if harvest decreases, the fish not harvested would show up at the hatchery or spawning grounds. Keely Murdoch agreed, and said if the program is intended to be harvested, harvest should be included in the calculation of HRR. Tonseth said HRRs to the tributary would be insufficient if harvest is included, but HRR will be calculated with and without harvest, regardless. Mackey said even if HRR changes significantly, the reason for not meeting the HRR target can still be deduced by looking at with and without harvest information. Truscott said the assessment is designed to evaluate the survival performance of hatchery program fish after they are released, not to assess if they return to the basin or sub-basin; therefore, harvest should be included. Hillman said the HRR target for conservation programs should not include harvest; if harvest were to be included, the HRR target might be met, but basin escapement might be insufficient.

The Hatchery Committees representatives present (Chelan PUD, Douglas PUD, USFWS, WDFW, YN, and CCT) approved using the 20th percentile method for calculating HRR targets (harvest not included).

Pearsons said he will discuss internally whether Grant PUD approves using the percentile method for calculating HRR targets. *(Note: Pearsons provided Grant PUD agreement to using this methodology on December 17, 2015.)*

Hillman said he will ask Craig Busack if NMFS approves the new method for calculating HRR targets. *(Note: Hillman asked Busack, who provided NMFS agreement to using this methodology on December 22, 2015.)*

January 20, 2016-Hatchery Committees Meeting
Tracy Hillman said the HETT met on January 7, 2016 and discussed Objective 4, hatchery replacement rates (HRRs). Hillman shared a spreadsheet titled "HRRs and Targets (Hillman revisions 1-13-16)" (Attachment L). (*Note: Hillman provided a revised version of the spreadsheet to Sarah Montgomery on January 22, 2016, which she distributed to the Hatchery Committees that same day [Attachment M].)* He said he revised the spreadsheet to reflect recommended changes from the HETT (to include harvest) and added data from additional programs (Okanogan and Omak steelhead). He said the HETT did not pick a representative target program for each basin, but used the example that in the Okanogan basin, all Okanogan steelhead programs should assess HRR compared to the Okanogan steelhead HRR, because the Okanogan steelhead program performs better than the Omak steelhead program.

Kirk Truscott said it is not suitable to set a target less than the mean; therefore, the 20th percentile should not be used. He said if HRRs greater than the 20th percentile are met in all 5 years, the resulting 5-year mean could be less than the previous 5-year mean. He said the mean or something greater than the mean should be used as the HRR target. Hillman replied that the 20th percentile method was developed in order to set a target that is 80% of the time achievable, always greater than one, and can be used as a tool in assessing hatchery performance. He said high targets are often not met and the Hatchery Committees have not acted when these targets were not met. Truscott said his understanding was that the HRR target would be the 80th percentile, and expressed concern that if programs achieve low targets, they will provide fewer returning adults than the dataset that was used for calculating the target. He said meeting a target less than the mean can decrease the target over time. Hillman said using the 50th percentile would mean that on average, two to three years in a five-year period would not achieve the target if the programs perform as well as they did during 2000 to present. Truscott said at least the median of past performance should be used as the target.

Bill Gale asked if a range about the median could be used as the HRR target, for example, within 10 percent of the median would be green, 10 to 20 percent could be yellow, and outside of that could be red. Tom Kahler responded that the stoplight approach is based on the number of years, not the variance within 1 year. Gale said the 5-year median should be used as the HRR target. Mike Tonseth said the approaches could be combined. For example, within 10 percent of the median value in 1 year would be considered meeting the target. He said sensitivity should be built into HRR assessments so that potential problems can be identified, and it can be used as a monitoring indicator. Hillman asked if not meeting a 20th percentile target in 2 out of 5 years would have the same reaction as not meeting the median target in 2 out of 5 years. Truscott replied that the recommendation to the program might be the same, but urgency would be greater if a 20th percentile target is not being met. Hillman said the HETT sought a target at a reasonable level to denote a red flag, requiring action. He said the higher the target is set, the less concern there is for not meeting that target. For example, he asked if the Committees would have the same reaction if a program fell just below a 50% target of 5.2 versus falling below a 20% target of 1.2. Truscott said his concern is that there would not be a red flag for values between the 20th and 50th percentiles, which could result in slow program performance decline, and the Hatchery Committees cannot condone an underperforming program.

Alene Underwood said the Hatchery Committees are continuing to discuss a target that does not hold much relevancy based on past Hatchery Committees actions. Keely Murdoch said the 20th percentile was agreed upon as a target, and it was also agreed to set a target for each species per basin. She said if one program is underperforming, the 20th percentile target of a better program would be used to assess the underperforming program. Underwood said, for example, the median HRR for Methow summer Chinook salmon is 3.8. Hillman said that if the program performed in the future as it did in the recent past, the target would not be met in 2 or 3 years out of a 5-year period and asked the Hatchery Committees if they would consider that program underperforming because it did not meet the median target value. Keely Murdoch said the Okanogan summer Chinook salmon program outperformed the Methow summer Chinook salmon program and explained an above-Wells Dam standard could be used as the 20th percentile target because the fish from both programs have similar migrations.

Gale asked if the Hatchery Committees are more concerned about HRR trends over time or depending on year-to-year values. He said HRRs could be assessed on a 5-year cycle, and the target could be achieving or exceeding the median in 3 out of 5 years. Kahler and Pearsons suggested reconsidering the linkage of HRR targets to NRRs. Hillman said the original proposal from the HETT was to link the HRRs to NRRs; however, the approach did not find favor with the Hatchery Committees. Hillman said any percentile can be chosen as the target, but if it is too high, not meeting the target might trigger unnecessary actions. Relating back to a suggestion from Gale to include a range about the median, Hillman suggested the 40th percentile as a target. Truscott said the easiest way to achieve a target is to set a low target, and he is not willing to set a target that could result in hatchery programs not meeting past performance. Pearsons said Grant PUD will need to discuss internally the implications of changing the HRR targets. Peter Graf suggested changing the stoplight approach for flagging low performance instead of the target itself. Hillman said the HETT also discussed the sequence of not meeting targets; that is, whether it is worse if a program misses its target in consecutive years. Tonseth said HRRs are calculated based on brood year effects, which will factor into whether or not the HRR target is met. He said either hatchery effects or longstanding environmental conditions would result in missing targets in sequential years.

The Hatchery Committees representatives present agreed to revise the method (now 40th percentile, including harvest) for calculating HRR targets. Hillman said he will calculate 40th percentile HRR targets that include harvest.

Catherine Willard said conversations in HETT and Hatchery Committees meetings are often similar or repetitive, and improvements should be made in communication between the HETT and the Hatchery Committees. She said the Hatchery Committees should keep this in mind when assigning tasks to the HETT.

February 17, 2016 Hatchery Committees Meeting

Pearsons shared the Grant PUD proposal, "Target HRR Proposal" (Attachment N), which Montgomery distributed to the Hatchery Committees on February 9, 2016. Pearsons said the proposal includes maintaining the same HRR targets for 20 years. Tonseth said HRR is a metric in the M&E Plan, which is subject to review and modification every 5 years, including its appendices, so it would not make sense to propose a 20-year constraint on HRR targets. He said a radical program modification, for example, would result in a change in HRR performance, which should change HRR targets. Pearsons said Grant PUD does not support making the targets harder to achieve every time a program modification is made, and he said changing the HRR targets frequently only makes it more likely that targets are not met. Tonseth said setting a target for 20 years could limit adaptive management, which is already very difficult with HRRs. Gale said demanding incremental program improvements by updating HRR targets frequently should be avoided, but a bad program's underperformance would be perpetuated if HRR targets are not updated frequently enough. Mackey said the Hatchery Committees should revise HRR targets during recalculation.

Murdoch said some programs should be held to targets from other in-basin programs that are performing better. Specifically, she said one standard should be set for Methow spring Chinook salmon programs because they are all capable of achieving the same HRRs and differ only in factors such as transfer methods and crowding at acclimation ponds. She said the differences between programs can be compared and improved upon. Mackey said size-at-release differs between programs, for example, but the Hatchery Committees are already aware of the differences, and HRR does not need to be assessed to look into size-at-release differences. He said the Methow and Chewuch programs are both Methow Composite (MetComp) stock and should share a target, but the Twisp program should have its own target. Mackey said Okanogan and Omak steelhead are separate stocks and should also have separate targets.

Mackey said the most important piece of assessing HRRs is making sure they are above natural replacement rates. He said HRR is useful only as a quick way to assess the hatchery program and is not very informative. HRR includes a conglomeration of factors such as fecundity, in-hatchery survival with multiple components, and out of hatchery survival which also includes multiple components. The components should be looked at individually when considering management changes.

The Hatchery Committees representatives present and Grant PUD agreed to the following HRR targets and edited Grant PUD's Target HRR Proposal *(note: Sarah Montgomery distributed the revised Target HRR Agreement to the Hatchery Committees on February 19, 2016.)*:

- Use the estimated 40th percentile HRR target during 5-year evaluation periods.
- Use varying degrees of action depending on the number of years that the HRR deviates from the target; green light (below 40th percentile for 2 years or fewer, with no action) and red light (below 40th percentile for 3 years or more, investigate the cause of the performance issue, and potentially adapt the program if the cause can be attributed to the hatchery program).
- Each program will have its own HRR target, with the following exceptions:
  - Nason Creek will use the Chiwawa spring Chinook salmon target because there are no data for the Nason Creek program to calculate its target.
  - The Methow spring Chinook and Chewuch spring Chinook programs will use the higher of their two targets, because they both include MetComp stock and should be assessed together.

5. Objective 5 – Stray rates

July 15, 2015 Hatchery Committees Meeting

Objective 5: Twisp Summary (Slide 21 of Attachment D)

Gale asked about the stray rate target of 5%. Hillman explained that the current criteria were established by the Interior Columbia Basin Technical Recovery Team and included in the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. These criteria indicate that fish that do stray to non-target independent populations should not comprise greater than 5% of the non-target spawning population, and fish that stray into non-target spawning areas within a population should not comprise greater than 10% of the non-target spawning aggregate.

Objective 5: Chewuch Summary (Slide 26 of Attachment D)

Gale said with regard to Andrew Murdoch's question about whether what is happening in the Wenatchee Basin is happening elsewhere, this does not seem to be the case in the Methow River. Keely Murdoch noted that there is a strong attraction back to the Methow River. She added that the Wenatchee River is different because fish are not reared in the Wenatchee River; rather, they are reared at Eastbank FH and overwintered at the Chiwawa Facility. Tonseth said early rearing at Eastbank FH may be the reason for high stray rates into the Entiat River. Gale questioned whether progeny of HORs will return to the Chewuch River. Andrew Murdoch said this has not been observed in the Wenatchee pedigree data. He said progeny of HORs in the Chiwawa River may stray from their natal locations due to parents spawning in suboptimal habitat. He hopes adult progeny of fish spawning in the lower Chewuch River will spawn in the upper Chewuch River. He said the Upper Wenatchee River is a similar example, where the habitat is so poor, the few surviving adult progeny go elsewhere to spawn.

Objective 5 (General Comments)

Willard asked if there are any concerns to flag regarding Objective 5. The following were discussed:

Tonseth said the opportunity exists to test alternative techniques to evaluate site fidelity, such as eyed-egg-imprinting and side-by-side evaluations.

Truscott said it is a problem if NORs are removed for programs and they are not returning to the tributaries of origin. Keely Murdoch agreed and suggested flagging this objective for further discussion. Truscott added that he is also concerned with the return rates to Methow FH, notably juveniles of NOR parents.

Gale said Methow spring Chinook salmon are different than Wenatchee spring Chinook salmon in that the hatchery population is not tributary-specific; rather, they are Methow composites (MetComp). He said he is not sure whether there are two populations at this point. He said it would be optimal to get more fish in the Chewuch River and better quality habitat, but it seems this is being viewed as if fish are being removed. He added that fish are not being removed from the Chewuch River; rather, they are not going into the Chewuch River. Keely Murdoch disagreed with Gale, noting that although MetComp is one population. She said the purpose of Chewuch River releases is to supplement the Chewuch River. Gale said he largely agrees; however, the discussions for Objective 5 imply that fish are straying when they are really returning. He clarified that the Hatchery Committees want more fish in certain locations. Tonseth noted that if the goal is to supplement the Chewuch River, there is no benefit if all the fish go to the Methow River. Tom Kahler said the Hatchery Committees also need to determine how many fish should be returning to the Chewuch River; and Gale added also what is feasible. Mackey said that number needs to be within the management goals (e.g., pHOS and spatial distribution). Gale suggested adult outplanting, where HOR adults are outplanted in the Chewuch River at an acceptable pHOS level, and hoping their progeny return to the Chewuch River; Tonseth said this can be tested. Hillman noted the importance of obtaining input from Craig Busack to align with other regulatory functions. Hillman also suggested the importance of sequential imprinting on where fish tend to home.

<u>How Spawner Distribution Affects Productivity and Reproductive Success (Slide 42 of Attachment D)</u>

Keely Murdoch reviewed quotes from the Chiwawa RRS Study. She said the study includes empirical data explaining why spawning distribution is so important to productivity and RRS. She said the study showed that spawning location for females accounted for a fair amount of difference in RRS when using spawning habitat as a covariate.

<u>Ford et al. 2013 (Slides 43 to 44 of Attachment D)</u>

Keely Murdoch said Andrew Murdoch was referring to this study while discussing RRS in the Wenatchee Basin.

Ford et al. 2009 (Slide 45 of Attachment D)
Keely Murdoch said the far right column of Table 9 represents RRS, which she believes illustrates the importance of having equal spawning distributions. She said she believes low RSSs in the Wenatchee system are due to predation on fish moving through Lake Wenatchee, which is consistent with other studies.

November 18, 2015 Hatchery Committees Meeting
Willard summarized flagged topics from previous discussions about Objective 5.
Keely Murdoch said there are high stray rates for Chewuch Acclimation Facility spring Chinook releases, which are intended to supplement Chewuch River populations. She said the YN hoped that their proposed plan to overwinter spring Chinook salmon in acclimation ponds at Carlton Ponds, with short-term acclimation at Chewuch Acclimation Facility, would provide information on homing back to the Chewuch River. She said, in the current arrangement, with fish overwintering at Methow Fish Hatchery (FH), the homing sequence is not linear; fish are getting familiar inputs from multiple directions (Methow FH and Chewuch River), and some of the fish choose the wrong input to follow. She said the numbers of stray rates in the annual and 5-year report do not match, but both are too high. She said her understanding is that in the new annual reports, Chewuch-acclimated fish that return to Methow FH are not counted as strays, but they should be counted as strays because they are not returning to their release site. Busack asked if the conversation is about fish not returning to the tributary in which they were acclimated. Keely Murdoch replied yes, and that stray rates are not meeting the standards. She said the YN thought there would be benefit to the alternative arrangement that was conceived for overwintering fish in circular ponds at Carlton Acclimation Facility in order to improve stray rates. She said the YN has previously brought this up as a concern, because rearing at Methow FH and acclimating at Chewuch Acclimation Facility is not linear, and the fish do not spend much time in the Chewuch River. She said she would like the Hatchery Committees to come up with a study plan to address these issues. She said some study plan ideas could be a 5-year study where two groups of fish are acclimated at Chewuch Acclimation Facility, or a side-by-side study with Methow-FH-reared and Wells-FH-reared fish using short term acclimation. She said the homing failure of 80% of fish is not achieving the objectives of supplementation.

Pearsons asked if the report indicates that fish returning to the Chewuch River increase the number of natural-origin fish. Keely Murdoch replied the 5-year report states that the number of natural-origin fish has not increased. Pearsons asked if an increase in natural-origin fish is apparent in the Methow and Chewuch rivers. He suggested an alternative of not supplementing the Chewuch River. Keely Murdoch said the YN would not agree to not supplementing the Chewuch River. Pearsons asked if it makes sense to spread the risk and not supplement all different populations in the Methow basin. Keely Murdoch said if fish are acclimated in the Chewuch River, and return to the Methow River, they do not have the option of contributing to natural-origin recruits (NORs). Pearsons asked how many hatchery-origin recruits are in the Chewuch River. Andrew Murdoch said there is a fundamental issue in spawner density over available habitat. He asked if the objective of the Goat Wall proposal, for example, is to redistribute some adults that currently spawn in the Methow River up into higher quality spawner habitat. Keely Murdoch said the fish released in the Chewuch River are similar but in a different tributary, and the difference is that fish released in the Chewuch River are not supplementing the Chewuch River population. Andrew Murdoch said the Twisp program brood year stray rate also exceeds the target. Tonseth said one issue is that the hatchery program may or may not increase natural productivity. He said another issue is, despite the intent for adults to return to the intended tributary, there is an issue with site fidelity.

Pearsons said focusing on each M&E objective individually is a problem because multiple objectives can be achieved with a single solution such as not supplementing the Chewuch, and that a solution to one objective (e.g., lack of homing in the Chewuch River) might be undone with a solution for another (e.g., not supplementing the Chewuch River). He asked how or when the concept of not supplementing the Chewuch River would be addressed. Tonseth asked how to improve site fidelity regardless of location. Hillman said there are three different stray-rate calculations. In one case, strays from fish short term acclimated in the Chewuch Pond cannot make up more than 10% of the spawning escapement within other major spawning areas of the Methow basin. He said, additionally, brood year stray rates identified in the M&E plan cannot be greater than 5%. In this case, the brood year stray rates are much greater than 10%. Keely Murdoch said the Chewuch River is the most extreme example of stray rates, and therefore a study design should be conceived to address site fidelity issues. Busack said this issue appears like an imprinting and acclimation issue rather than just a general stray-rate issue. Keely Murdoch said that the issue is the location of Methow FH compared to the acclimation sites; it is not linearly arranged. She said the Twisp River is a separate gene flow issue, but the issue for Chewuch River is homing.

Truscott said this has importance for the way Methow programs are stocked (predominantly NOR-based). He said a fraction of NORs are being removed for broodstock and if the adult returns from this production return to the Methow FH rather than contribute to the natural spawning population to support attainment of the escapement target and natural production, this could have a mining effect and adversely affect future natural production. Busack said the implicit assumption is that Chewuch, Methow, and Twisp rivers have three different gene pools, but are all considered the same population from a population genetic standpoint. He said the treatment of the three rivers as separate may be inappropriate given what is known about natural gene flow rates between the areas. Tonseth said the Methow and Chewuch rivers are managed similarly, and the Twisp River is managed as a separate component. Hillman said, when the Upper Columbia Recovery Plan was written, the authors followed the Interior Columbia Basin Technical Recovery Team recommendations, which identified major and minor spawning areas and stray rate targets. These recommendations were carried over into the Hatchery M&E Plan. He said, according to the Recovery Plan and the Hatchery M&E Plan, the upper Methow River, Chewuch River, and Twisp River are considered separate spawning aggregates (major spawning areas). As such, the recommendations within the Recovery Plan call for allowing local adaptation of the spawning aggregates. Keely Murdoch said broodstock for the Methow and Chewuch is composite, so local adaptation is not occurring. She said when the YN agreed to supplement the Chewuch River, the intent was for supplemented fish to spawn there.

Pearsons asked why more hatchery fish are needed in the Chewuch River. Keely Murdoch replied, in many years, 80 to 90% of the supplemental fish do not return to the Chewuch River. She said a standard was agreed to, and is not being met. She said using 10 years of historic SAR rates and assuming 100% of fish from a 60,000-fish release would return to the Chewuch River, PNI would not be affected. Mackey said, regardless of stray rate, more than half of the spawners in the Chewuch River have been hatchery fish, so supplementation targets are being met. Keely Murdoch disagreed that the historic spawning composition was an appropriate argument in that the current release number has been reduced to about 60,000 so the numbers of hatchery fish returning to the Chewuch to begin with will be significantly reduced. Mackey asked if the final destination of the of fish matters, as long as the Chewuch River is supplemented. He said the question is if the number of fish returning to the Chewuch River is within the bounds of a prudent management number. Hillman said the way broodstock are collected for these programs may preclude local adaptation, unless the Hatchery Committees have redefined subpopulation structure, which would change this discussion from a straying issue to a spawning distribution issue. Keely Murdoch said the genetic composite issue means these fish are not strays, but the point is that more fish should be returning to habitat in the Chewuch River. Pearsons said, from 2004 to 2013, the proportion of hatchery origin spawners (pHOS) in the Chewuch River was high. Tonseth said, in the context of programs, there have been sufficient hatchery fish in the Chewuch River to meet escapement objectives, but those are based on larger smolt releases.

Keely Murdoch said pHOS is 0.25 when calculated using historic hatchery SARs, a release size of 60,000, and historic natural-origin run sizes. She said if 80% of those fish go back to the hatchery, then pHOS would be much less. Keely Murdoch said that it would not be unreasonable for the Hatchery Committees to come up with a study plan. Andrew Murdoch suggested focusing on improving imprinting and homing in the Twisp River, because that is a site everyone can agree on. Keely Murdoch said the YN may agree to that arrangement. Andrew Murdoch also suggested an option could be building long-term acclimation sites in the Twisp River where homing fidelity is a problem. Mackey said the number of strays from a brood year is actually quite low, even if it exceeds 5 to 10%, and it may not make much of a population-level difference for the level of effort that may be needed to investigate and attempt to address the issue. Andrew Murdoch said if survival was better in the Chiwawa River, there would be more fish for investigating this issue. Keely Murdoch said one benefit the YN thought would come from using circular tanks at Carlton is higher SAR rates. Willard asked if more than 60,000 fish could be acclimated at the Chewuch Acclimation Facility. Keely Murdoch said yes, and that the capacity of the pond is the only constraint. Truscott said CCT would be okay with a larger program at Chewuch Acclimation Facility.

Andrew Murdoch asked if the Methow FH has a hatchery-by-hatchery program. Tonseth said no, but the program could have a safety-net component designed to prevent mining if the conservation program is deemed too large. He said pulling out large numbers of wild fish and not meeting related goals would not be acceptable. Truscott said a few things have been identified, which help prevent straying: incubation on natal water source and acclimation in the tributary to which homing is desired.

Pearsons said a larger-scale discussion about adaptive management of supplementation across the basin is needed. He said risk management and decreasing the amount of supplementation should be considered if strong evidence is not presented to support it. Pearsons said, if the monitoring plans are designed to help the Chewuch River, but the better thing would be to not supplement in the first place, then ending supplementation there should be considered. Pearsons asked if no increase, or a decrease in NOR fish would change Keely Murdoch's mind about supplementation in the Chewuch River. Keely Murdoch replied that no data have been presented yet that would change her mind. She said the program has not been operated in a manner that gives supplementation a chance to work as designed. She said adaptive management should figure out a way to fix the homing fidelity problem. Tom Kahler said increasing homing could decrease the proportion of natural origin spawners to hatchery origin spawners. Keely Murdoch replied that the input of fish could be adjusted. Kahler suggested that supplementing the Methow basin with fewer hatchery fish, or supplementing less often, might increase the productivity of natural populations. He said the PUD Hatchery Programs are supposed to contribute to recovery. Keely Murdoch suggested adjusting the release numbers instead of ending the program. Busack said he does not see a way to solve the homing problem except to incubate fish elsewhere in the basin. He said if the Methow tributaries were the focus, Chewuch River could be a control, which may result in allowing diversity to development and lead to greater success. Keely Murdoch said fish should not be reared at Methow FH, or an incubator should be set up at Chewuch Acclimation Facility, and the program changes could be tested on a small scale.

The HETT will discuss potential methods for increasing homing fidelity of spring Chinook salmon in the Methow basin.

December 16, 2015 Hatchery Committees Meeting
Keely Murdoch said the HETT briefly discussed Objective 5 on December 14, 2015. She said the HETT listed different ways in which homing fidelity of spring Chinook salmon in the Methow Basin could be studied, including egg incubation, passive integrated transponder tag versus coded-wire tag studies, and comparing the Chewuch River to the Twisp River. She said the HETT has not decided on a study plan to address homing fidelity, but she will outline study plan options for discussion at the HETT January 7, 2016, meeting.

She said the HETT also discussed engaging Andrew Dittman in discussions on homing fidelity. Tom Kahler said he has talked to Dittman, who expressed potential availability for the Hatchery Committees meeting in February 2016. Kahler will request that Dittman attend the Hatchery Committees February 17, 2016, meeting.

February 17, 2016 Hatchery Committees Meeting
Keely Murdoch shared a paper titled, "Twisp and Chewuch Homing Fidelity Study Options" (Attachment O), which Sarah Montgomery distributed to the Hatchery Committees on January 26, 2016. Murdoch said the paper addresses two options for improving homing fidelity: 1) sequential imprinting; and 2) embryonic imprinting.

Sequential Imprinting
Murdoch said an example of sequential imprinting from Andrew Dittman's presentation occurred when fish returned to the Easton Acclimation Site, passing the hatchery they were reared in, on their way upstream. In the Twisp and Chewuch rivers, fish appear to be confused from the olfactory cues coming from the Methow River, where the Methow FH is located, and instead of returning to their acclimation sites in the Twisp and Chewuch rivers, they stray into the Methow River. Methow FH is not in sequence with the Twisp and Chewuch AFs. She said fish acclimated in the Chewuch River have particularly poor stray rates, which could be attributed to the short distance between the confluence of the Chewuch and Methow rivers and Methow FH. Murdoch said rearing the fish farther downstream and outside of the Methow Basin would allow for sequential imprinting; fish returning upstream would be less likely to stray into the Methow River because the only familiar olfactory cue is the acclimation site (i.e., Twisp or Chewuch rivers). She said a paired release at both Twisp and Chewuch AFs could be a good sequential imprinting study.

Embryonic Imprinting
Murdoch said other methods to increase homing to the Chewuch and Twisp rivers could involve bringing in natal river water during embryonic development (using isobuckets) or setting up temporary incubation facilities in the Twisp River before transfer to the chosen hatchery. She said her paper discusses different methods for marking and detecting study fish, such as spawning-ground surveys, recoveries of coded wire tags, and PIT tags.

Questions and Comments
Todd Pearsons asked where Murdoch proposes to incubate and rear fish. Murdoch said she would propose incubating and rearing fish at Eastbank Hatchery or Wells FH and avoid keeping fish at Methow FH altogether, unless they were transferred from Methow FH as unfertilized gametes. She said embryonic imprinting at Methow FH could confound the study and should be avoided. Pearsons asked if temperature would be a problem for the study at Eastbank Hatchery or Wells FH. He said fish could be incubated at Eastbank Hatchery or Wells FH and transferred as fry to avoid temperature issues affecting precocious maturation. Murdoch replied that initial rearing at Eastbank Hatchery with overwintering at Carlton Ponds and final acclimation upstream in Chewuch or Twisp rivers would fit the sequential imprinting model, but not every Hatchery Committees member supports using Carlton Ponds, and that would also involve more fish transport. Jayson Wahls said Wells FH has similar temperatures to Methow FH but may not currently have space for these study fish.

Murdoch said in this study, the early rearing period would be split; half of the fish would be reared at Methow FH, and half elsewhere. Murdoch said spawning would be done at Methow FH, and then eggs and milt would be transferred to another facility to avoid an eyed-egg transfer. Murdoch said the chosen rearing facility should be downstream of the final AF, and Wells FH would make sense because it is more than 50 river miles away. Wahls asked if the fish should be reared on well water or surface water. Dittman said distance is a more important factor than water source, but they should be reared on well water as much as possible. Mike Tonseth said the fish cannot overwinter at Eastbank Hatchery due to temperatures, and adult management also cannot be performed at

Eastbank Hatchery, in contrast to Wells FH, where the volunteer trap can be operated. Greg Mackey said, because water exits the Wells FH through the volunteer channel, it is always open and would be highly attractive to fish. Murdoch asked if the volunteer channel trap is operated during the time of year that spring Chinook salmon would pass Wells FH during upstream migration. Wahls said yes, because the trap is operated for steelhead.

Craig Busack asked how many fish Murdoch proposes to use in this study. Murdoch said half of the Chewuch River release group (about 30,000 fish) and half of the Twisp River release group (15,000 fish) would serve as treatment fish. The other half of the release groups would serve as controls.

Mackey said Wells FH would not be available for this study until brood year 2018 because of construction. Tracy Hillman said it may make sense to start with the embryonic imprinting study in 2016 and 2017 and then consider the sequential studies when Wells FH facility is up and running. Mackey said the embryonic imprinting study may result in more management tools, because it would theoretically allow for acclimating fish to more locations. Murdoch said the study could be performed for 5 years, like the Goat Wall agreement. Bill Gale said the straying difference between the two release groups might not be statistically measurable due to uncertainties introduced by the number of returning adults, out-of-basin straying, and carcass recovery. He said it would be inefficient for the Hatchery Committees to partake in a 5-year study that might not produce statistically significant results. Murdoch said an alternative to a 5-year study would be a before-and-after style study in which the whole program is subjected to the treatment and compared to the previous 15 years of data. She also said that even though the programs and sample sizes are small, which increases the risk of producing statistically insignificant results, the Hatchery Committees should still aim to improve homing fidelity. Hillman said replication, and, therefore, statistical power in this study, would come from the number of years it is performed and the recapture rate of the fish. Dittman asked how reliable PIT-tag detection arrays are in the proposed study area. Murdoch replied that antennas are in place in the Chewuch, Twisp, and Methow rivers. Mackey said spring Chinook salmon likely migrate through the areas that have PIT-tag arrays during high water, which is associated with low detection rates.

Tom Kahler said adult management should not be performed on study fish because they should be allowed to explore and potentially turn around. Murdoch said conservation study fish should be adult-managed, and it is unlikely that Chewuch- or Twisp-acclimated fish that migrate to Methow FH are merely exploring—they would be straying in response to olfactory cues from the hatchery, and are no longer exposed to olfactory cues from their natal sites (confluence is downstream).

Gale asked if all adult-managed fish are bio-sampled for coded wire tags. Tonseth said the study fish could be distinguished using a secondary mark, an elastomer, or a body tag. Gale asked how the logistics of sorting, handling, and collecting data from study fish would work. Murdoch said Methow FH fish are marked differently than Winthrop NFH fish, which allows for samplers to target Methow FH fish for data collection. Gale said he would need to understand the impact of data-collection efforts on Winthrop NFH staff before approving a study design. Murdoch said the cost-benefit analysis of hatchery staff effort versus the cost of additional markings on fish can be decided by the Hatchery Committees once a detailed study plan is developed.

Mackey said the Hatchery Committees should also consider the potential effort put into this study and its potential gains. He said a statistical difference in homing may be detectable, but might not result in biologically meaningful differences. He said extreme results such as 100% decreases in straying are unlikely, and straying may not matter compared to the ultimate goal of promoting the recovery of spring Chinook salmon. Murdoch said extreme decreases in straying, such as down to 5%, are possible, and recalled Dittman's example of the Easton Acclimation Site in the Yakima River study.

Peter Graf said this study would take multiple years, and in the meantime, straying issues continue. He asked if more immediate actions can be taken to address homing fidelity. Murdoch said the rearing location of the entire program could be changed, but that likely would not be approved. Graf asked if fish could be truck planted in the Chewuch River. Murdoch said the current numbers of fish in the Chewuch River are unknown, so deciding on the number to truck plant would be difficult. She said the benefit of beginning the sequential imprinting study in 2018 would be that it gives the Hatchery Committees time to see if programs in the Methow Basin are meeting targets with adult management. She said she will develop her draft, "Techniques to Improve Homing Fidelity for Chewuch and Twisp River Releases of Spring Chinook Salmon," into a study plan and coordinate with Chelan, Douglas, and Grant PUDs regarding feasibility.

March 16, 2016 Hatchery Committees Meeting

Keely Murdoch said she is still working on the study plan draft and will try to have something for the Hatchery Committees to review at the April 20, 2016, meeting. She said the embryonic imprinting section is largely blank. Tom Kahler said he and Murdoch may want to discuss the draft with Andrew Dittman (NMFS), and that they should consider designing pilot studies, since some techniques contemplated for application in the proposed study are theoretical or have not been previously implemented at the production scale. He said the Hatchery Committees should convene a workgroup including Murdoch, Jayson Wahls (WDFW), Mike Tonseth, representatives from the PUDs, and other participants to discuss the logistical and fish-health aspects of designing a study plan for imprinting and homing in the Methow basin.

Tonseth asked if any part of the draft study plan could affect the 2016 Broodstock Collection Protocols. Murdoch said she does not think so, because if a pilot study were implemented in 2016, the eggs would be spawned at the same location as described in the protocols. Tonseth said the study may require an amendment to the protocols, but that can be determined once the study plan is further developed. Catherine Willard asked if hatchery-by-hatchery fish would be used for the pilot study. Kahler said the workgroup will discuss these aspects of the potential study plan. Murdoch said, as long as fish health is maintained throughout the process of bringing water into the hatchery, she does not see a risk to using hatchery-by-wild or wild-by-wild fish. Kahler said, if there were a risk for fish health, the Hatchery Committees would have to decide how much of a risk the study fish pose to loss in production. He said it may not make sense to use conservation fish for testing a new method in a pilot study. Wahls said Trista Welsh-Becker (WDFW) should be invited to the workgroup meeting. Bill Gale suggested that someone call Kirk Truscott to inform him of the workgroup, and Tracy Hillman said he would call Truscott to discuss the purpose of the workgroup. Kahler said the workgroup can meet at Douglas PUD, and asked

Sarah Montgomery to schedule a 2-hour meeting between March 21 and April 1, 2016. Montgomery said she will send a Doodle poll to the Hatchery Committees to convene a workgroup to discuss the logistics of a draft study plan for addressing imprinting and homing in the Methow basin.

April 20, 2016 Hatchery Committees Meeting

(Note: The Hatchery Committees continue to discuss Objective 5, stray rates, in the context of the Draft Chewuch Homing Study Proposal.)

Commented [SM4]: Note: The HC has transitioned from reviewing Objective 5 to implementing a study plan to address Objective 5. For that reason, I think the "review" can end on 3/16/2016 and I have made this note to make it clear that discussions about the objective are continuing, but the "review" is over.

6. Objective 6 – Size and number of juveniles released

August 28, 2015 Hatchery Committees Meeting

Objective 6: Mean size at release of Twisp River spring Chinook salmon (Slide 29 of Attachment E)

Busack asked if there is a standard for coefficient of variation. Tonseth said 9 was originally identified as the standard, but it was an arbitrary value identified as a target when the program was first set up. Tracy Hillman asked if the standard is still 9 and Tonseth confirmed. Busack said that for any serious attempt at assessing ecological interactions, one needs to know the coefficient of variation. Andrew Murdoch noted the standard is listed in the M&E plan. Tom Kahler added it is also in the annual reports.

Objective 6: Target length for Methow spring Chinook salmon releases (Slides 29, 31, and 33 of Attachment E)

Keely Murdoch asked why the target length is different between Twisp, Chewuch, and Methow rivers. Andrew Murdoch explained the target length is based off of the target weight, which is the original program goal, and they tailored the length targets based on length-weight analysis for each program. Kahler noted Douglas PUD could not meet the length targets identified in Piper[2] for these spring Chinook salmon programs, without greatly exceeding the weight targets. Andrew Murdoch said it is easy to complete such an analysis

[2] Piper, R., I. McElwain, L. Orme, J. McCraren, L. Fowler, and J. Leonard, 1982. Fish hatchery management. U.S. Department of the Interior Fish and Wildlife Service, Washington D.C.

for the Chelan PUD program. Hillman conferred that length-weight relationships have been completed for Chelan PUD programs.

Objective 6: Recommendations (Slide 35 of Attachment E)
McLain Johnson asked if the recommendation is to run the Twisp Weir better.
Keely Murdoch explained that all releases except Twisp spring Chinook salmon were meeting program goals, and broodstock collection was identified as lacking. Tonseth said that prior to recalculation the release targets for each program were simply the total Methow Hatchery production divided by three, which resulted in an unrealistic target for the Twisp program. The new goals are more achievable. Tonseth stated USFWS does not believe WDFW should maximize the use of the Twisp Weir, over concerns for impacts on bull trout. Andrew Murdoch agreed, and noted that modifications to the weir and reduced broodstock collection facilitate achievement of collection targets for the Twisp program. Tonseth said no broodstock was collected at the Twisp Weir this year, as the necessary number of Twisp broodstock (identified via genetic analysis) was collected at Wells Dam.

December 16, 2015 Hatchery Committees Meeting
Truscott said Objective 6 of the 5-Year Hatchery M&E Report, which accounts for size-at-release targets for juvenile fish, was flagged for further discussion because smolt-to-smolt survival data are available, but not smolt-to-adult survival data.
Catherine Willard said smolt outmigration survival data are available for two brood years of the Chiwawa spring Chinook salmon program at the smaller size at release (18 fish per pound from 20 fish per pound), but they have not yet been summarized. Tonseth said growth modulation was analyzed for the White River program. Pearsons said there can be competing tradeoffs between the production of precocious males and returning adults. He said the focus has been on reducing the numbers of precocious males, which generally prescribes reducing size-at-release. However, it may be that larger smolts may have higher survival to adulthood, so both minimization of precocious males and production of adults cannot be optimized independently. He asked if the goal is to maximize returning adults or returning females, or reduce precocious males, which all factor into assessing the target size-

at-release. Hillman said length-weight relationship targets, which came out of Piper et al.[3], do not work for Upper Columbia stocks. He said the monitoring team has developed appropriate length-weight relationships for Upper Columbia stocks (those in the last 5-year reports). Those relationships can be used to set appropriate length, weight, and condition targets. Hillman asked if the SOA calls for the evaluation of all PUD-funded programs, or just the Methow spring Chinook salmon program. Alene Underwood said the SOA calls for the evaluation of just the Methow program. Tonseth said it would be good to compare the Wenatchee River data to Methow River and Nason Creek data. Willard will summarize the available data on size-at-release targets for spring Chinook salmon in the Chiwawa River, and will coordinate with Douglas PUD, Grant PUD, and WDFW to summarize available size at release data for Nason Creek and Methow River spring Chinook salmon.

January 20, 2016 Hatchery Committees Meeting
Willard shared a presentation titled, "Juvenile Spring Chinook Size at Release Summary," (Attachment P), which Montgomery distributed to the Hatchery Committees on January 21, 2016.

<u>Summary</u>
Willard said she summarized size-at-release data to date by coordinating with WDFW, Douglas PUD, and Grant PUD. Pearsons said size-at-release targets were initially set from a biological basis, but there are mutually exclusive tradeoffs in optimizing different variables. He said reducing precocity needs to be balanced with trying to get many females and older males onto spawning grounds. He said it is currently understood that growth occurring before February affects the chance of precocity. For example, in the White River program, growth is kept low during fall and winter because that is thought to be the key period for precocious maturation. After February, growth is maximized in order to reduce predation based mortality and increase survival. He said due to cold water temperature, it is difficult to reduce precocious maturation and still produce large fish. Willard shared a quote

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[3]Piper, R., I. McElwain, L. Orme, J. McCraren, L. Fowler, and J. Leonard, 1982. *Fish hatchery management*. U.S. Department of the Interior Fish and Wildlife Service, Washington D.C.

from Brian Beckman (NOAA), "There is no best size at release that optimizes across all management goals; therefore, size-at-release targets represent a compromise across a series of management values." Results, questions, and comments were discussed:

Size at Release (Slide 3)
Methow composite and Chiwawa spring Chinook salmon were smaller than the size-at-release target on average. Twisp salmon were, on average, close to the target.

Growth Profiles (Slide 7)
Willard said Chiwawa River and Methow River composite spring Chinook salmon had similar growth profiles, and the Nason Creek growth profile differed, which could be attributed to different water temperatures or winter feeding regimes.

Mini-jack Rates (Slides 8 and 9)
Based on the brood year 2013 results from a size target study conducted with NOAA-Fisheries on the Chiwawa, Nason and White River stocks, Willard said mini-jack rates were measured by examining gonads during lethal sampling. Nason Creek spring Chinook salmon had the lowest mini-jack rates, which could be attributed to size at release, growth profiles and/or circular tank rearing. Pearsons said Grant PUD and Douglas PUD evaluated mini-jack rates and precocious male maturation for Brood Year 2012 Methow spring Chinook in April 2014 using gonadosomatic index (GSI) measurements and visual observation. Mature fish were larger than immature fish, and all fish with a fork length of greater than 160 millimeters were mature (n=300).

Outmigration Performance (Slide 10)
Willard said Chiwawa River spring Chinook salmon had higher survival and less travel time to McNary Dam than Nason Creek fish, which could be attributed to method of release. Graf said some fish, which were not volitionally released, had higher survival. Kahler asked if the date of travel was analyzed, and noted that survival through the hydroelectric system varies widely over time. Graf said, even when date of travel was similar for different groups of fish, their survival varied.

Proportion of Age Classes by Group (Slide 11)

Willard said, based on the fork lengths during fall PIT-tagging of Chiwawa spring Chinook salmon (BY 2009-2011), the larger half of the smolt groups released returned a greater proportion of mini-jacks and jacks. However, it must also be considered that releasing smaller fish may result in fewer returns. She said growth profiles should be considered, as well, because how the size at release is reached may be just as important as the size of the fish released.

Questions and Comments

Tonseth asked if mini-jack rates were only representative of sampled males and what the size distribution of females compared to males was in the Methow spring Chinook salmon evaluation. Pearsons said mini-jack rates were only calculated using males, and the length distribution rates of females had not been calculated.

Hillman asked if maximizing smolt-to-adult return is a management goal. Tonseth said more than 1 year of data is needed in order to make broad-scale program changes. Truscott asked if the graph of mini-jacks included females. Kahler said no, but those data are available. Gale said early maturation could be considered its own objective so that it is duly addressed. Underwood said that would imply a target should be set for maturation, and asked if that was really the best plan forward. Kahler said maturation is a fundamental part of the size-at-release objective, so targets would be set for growth rates or size, but not maturation itself. Gale asked if a plan should be drafted for how to obtain size-at-release targets and if programs should be evaluated based on their ability to reach a size-at-release target a certain way.

Willard summarized that the same size-at-release target can be reached in different ways (for example, Nason Creek and Chiwawa River), and the existing standards should not be changed until more data are available. The Hatchery Committees and PRCC HSC representatives present decided to maintain the existing standards for Methow spring Chinook salmon size-at-release targets and re-evaluate the targets yearly.

7. Objective 7 – Freshwater productivty

June 16, 2015 Hatchery Committees Meeting

Objective 7: Methow Freshwater Productivity (slide 32)

Gale asked if this graph includes only the upper Methow or the entire river. Murdoch guessed it was just the upper because each was analyzed separately in the report. Hillman asked if the number of emigrants included subyearlings and yearlings, or only yearlings. He asked because the relationship can be used to determine if spawning habitat or rearing habitat is limiting juvenile abundance. For example, if a density-dependent relationship is found with subs and yearlings combined, spawning habitat may be limiting. In contrast, if there is no density dependence with subs and yearlings combined, but there is with only yearlings, then rearing habitat may be limiting. Mackey guessed this graph included subs and yearlings. Kahler asked when WDFW started operating smolt traps into the fall (until ice-up). Snow thought in the Twisp, it was in the past 2 to 3 years. He added that the juvenile production would be included in the spring smolt estimate and added to the fall parr estimate.

February 17, 2016 Hatchery Committees Meeting

Hillman said the biggest issue identified by the Hatchery Committees for assessing Methow spring Chinook salmon freshwater productivity is that there are only a few years of data available for juvenile productivity. Mackey said more data are being collected to better assess the effects of pHOS on juvenile productivity.

8. Objective 8 – Harvest

Objective 8 was not flagged for further discussion.

Commented [SM5]: Objective 8 was presented briefly during the August 28, 2015 meeting, but there were no questions and comments about the ppt therefore no notes specific to Objective 8.

IV. LIST OF ATTACHMENTS (DISTRIBUTION DATE)

Attachment A	Evaluation of Hatchery Programs Funded by Douglas County PUD 5-year Report 2006-2010 (also titled: Methow Spring Chinook Review of Five-Year Annual Report Plan Outline; May 14, 2015)
Attachment B	Five-Year Hatchery M&E Plan Report (May 18, 2015)

Attachment C	Review of Five-Year Hatchery M&E Report – Methow Spring Chinook Salmon (June 18, 2015)
Attachment D	Review of 5-Year Hatchery M&E Report – Methow Spring Chinook Salmon (July 15, 2015)
Attachment E	5-Year Analytical Report Review: Objectives 3, 6, and 8 (September 1, 2016)
Attachment F	Methow spring Chinook Review of 5-Year Annual Report Outline Flags (September 4, 2016)
Attachment G	HRR Target Calculation (October 23, 2015)
Attachment H	Winthrop NFH Spring Chinook Yearling Release Metrics (October 19, 2015)
Attachment I	Hatchery Replacement Rate Targets Methodology (December 17, 2015)
Attachment J	SAR HRR Update (December 17, 2015)
Attachment K	Chiwawa Spring Chinook HRRs and NRRs (December 17, 2015)
Attachment L	HRRs and Targets (Hillman revisions 1-13-16; January 13, 2016)
Attachment M	HRRs and Targets (Hillman revisions 1-22-16; January 22, 2016)
Attachment N	Target HRR Proposal (February 9, 2016)
Attachment O	Twisp and Chewuch Homing Fidelity Study Options (January 26, 2016)
Attachment P	Juvenile Spring Chinook Size at Release Summary (January 21, 2016)

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Draft Methow Steelhead Programs PNI Model for ESA Permits

October 13, 2016

The Following uses data from the draft 2015 Douglas PUD & WDFW M&E report. I used an average of the most recent 5 years for return data (2011-2015). The dataset consists of the run at Wells Dam with the following subtracted to arrive at spawning escapement:

Broodstock collection for PUD programs

Double counts of fish

Fallbacks

WDFW fishery mortality in Columbia and Methow rivers

Okanogan fish

Therefore, the "Removal" columns in the tables below would represent additional removal of adults that would need to be performed in order to obtain the fish numbers presented in the following scenarios.

The following scenarios present the "Current Conditions" which is meant to provide a baseline of how the programs have operated in recent years. This does not affect the proposed permit conditions.

The results indicate that the proposed changes in broodstock composition have a large effect on PNI. It may be possible to meet a PNI of >0.50 with no additional adult management. PNI > 0.63 may be possible but with the Methow Safety-Net program operated at pHOS <0.10 which would require removal of approximately 80% of returns after the fishery and broodstock collection have taken place. This is unlikely to be achieved.

The Twisp program has been operated to achieve pHOS of 0.50 for the last 5 years. We believe this can be achieved in most years.

WNFH and Methow Hatchery have only begun to evaluate the use of their respective volunteer traps to remove steelhead. The effectiveness of these is still uncertain.

Current Conditions

Currrent Conditions									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.1611	405	0.00	405	0.1610	0.116232		1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.3356	844	0.00	844	0.3356	0.242222		0.00	0.00	0.00	1.00	1.00
WNFH	150,000	0.5034	1,266	0.00	1,266	0.5034	0.363334		0.80	0.00	0.20	0.00	1.00
	298,000		2,515		2,515		0.721789						
Wild					969	0.2782							
Total					3,484								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.28	0	0.8	1		
PUD Program Returnees	0.24	1	0	0	Overall PNI	0.16
WNFH Program Returnees	0.36	0	0.2	0		
Twisp Returnees	0.12	0	0	0	Overall pHOS	0.72
Total (each column must add to 1.0)	1	1	1	1		

Proposed Permit Conditions (WNFH @ 150,000; force pHOS to be ~0.50)

Proposed Application Conditions														
										Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS			Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.20	324	0.1288	0.164684			1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.80	168	0.0668	0.085392			0.00	0.25	0.75	0.00	1.00
WNFH	150,000	0.503355705	1,266	0.60	506	0.2012	0.257192			0.90	0.00	0.10	0.00	1.00
	298,000		2,515		998		0.507268							
Wild					969	0.4927								
Total					1,967									

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.5	0	0.9	1		
PUD Program Returnees	0.08	0	0	0	Overall PNI	0.63
WNFH Program Returnees	0.26	0.75	0.1	0		
Twisp Returnees	0.16	0.25	0	0	Overall pHOS	0.50
Total (each column must add to 1.0)	1	1	1	1		

Proposed Permit Conditions (WNFH @ 200,000; force pHOS to be ~0.50)

If program is larger you just have to remove more fish to maintain the pHOS and PNI target – same result but more fish removed with the larger WNFH number. Upshot- there is no advantage (but there is added risk) to increasing a program size beyond what is needed to meet a pHOS target under a PNI management regime.

Proposed Application Conditions									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.20	324	0.1288	0.16758		1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.80	168	0.0668	0.086894		0.00	0.25	0.75	0.00	1.00
WNFH	200,000	0.67114094	1,688	0.72	472	0.1877	0.24413		0.90	0.00	0.10	0.00	1.00
	348,000		2,937		964		0.498603						
Wild					969	0.5014							
Total					1,933								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.5	0	0.9	1		
PUD Program Returnees	0.08	0	0	0	Overall PNI	0.63
WNFH Program Returnees	0.26	0.75	0.1	0		
Twisp Returnees	0.16	0.25	0	0	Overall pHOS	0.50
Total (each column must add to 1.0)	1	1	1	1		

Proposed Permit Conditions with PNI at least 0.50. (WNFH @ 150,000). No adult management at traps.

It turns out that we would hit about PNI = 0.51 with no "additional" adult management.

Proposed Application Conditions													
									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.00	405	0.1610	0.116232		1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.00	844	0.3356	0.242222		0.00	0.25	0.75	0.00	1.00
WNFH	150,000	0.503355705	1,266	0.00	1,266	0.5034	0.363334		0.90	0.00	0.10	0.00	1.00
	298,000		2,515		2,515		0.721789						
Wild					969	0.2782							
Total					3,484								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.28	0	0.9	1		
PUD Program Returnees	0.24	0	0	0	Overall PNI	0.51
WNFH Program Returnees	0.36	0.75	0.1	0		
Twisp Returnees	0.12	0.25	0	0	Overall pHOS	0.72
Total (each column must add to 1.0)	1	1	1	1		

NMFS Request with pHOS = 0.30; pNOB per proposed composition. (WNFH @ 150,000).

Proposed Application Conditions									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.70	121	0.0481	0.087339		1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.95	42	0.0167	0.030316		0.00	0.25	0.75	0.00	1.00
WNFH	150,000	0.503355705	1,266	0.80	253	0.1006	0.182619		0.90	0.00	0.10	0.00	1.00
	298,000		2,515		416		0.300274						
Wild					969	0.6997							
Total					1,385								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.7	0	0.9	1		
PUD Program Returnees	0.03	0	0	0	Overall PNI	0.75
WNFH Program Returnees	0.18	0.75	0.1	0		
Twisp Returnees	0.09	0.25	0	0	Overall pHOS	0.30
Total (each column must add to 1.0)	1	1	1	1		

NMFS Request with pHOS = 0.30; pNOB relaxed for Safety-Net due to current brood collection challenges. (WNFH @ 150,000).

Proposed Application Conditions									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.70	121	0.0481	0.087339		1.00	0.00	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.95	42	0.0167	0.030316		0.00	0.13	0.13	0.75	1.00
WNFH	150,000	0.503355705	1,266	0.80	253	0.1006	0.182619		0.90	0.00	0.10	0.00	1.00
	298,000		2,515		416		0.300274						
Wild					969	0.6997							
Total					1,385								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.7	0	0.9	1		
PUD Program Returnees	0.03	0.75	0	0	Overall PNI	0.72
WNFH Program Returnees	0.18	0.125	0.1	0		
Twisp Returnees	0.09	0.125	0	0	Overall pHOS	0.30
Total (each column must add to 1.0)	1	1	1	1		

NMFS Request with pHOS = 0.30; pNOB relaxed for Safety-Net, Twisp, WNFH programs due to potential brood collection challenges. (WNFH @ 150,000).

Proposed Application Conditions									Broodstock Composition				
Program	Number	Proportion	Escapement to Methow	Removal	Spawners	Proportion	pHOS		Wild	Twisp Hatchery	WNFH	Safety_net	check
Twisp	48,000	0.161073826	405	0.70	121	0.0481	0.087339		0.80	0.20	0.00	0.00	1.00
Safety net	100,000	0.33557047	844	0.95	42	0.0167	0.030316		0.00	0.13	0.13	0.75	1.00
WNFH	150,000	0.503355705	1,266	0.80	253	0.1006	0.182619		0.70	0.00	0.30	0.00	1.00
	298,000		2,515		416		0.300274						
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	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
Natural	0.7	0	0.7	0.8		
PUD Program Returnees	0.03	0.75	0	0	Overall PNI	0.68
WNFH Program Returnees	0.18	0.125	0.3	0		
Twisp Returnees	0.09	0.125	0	0.2	Overall pHOS	0.30
Total (each column must add to 1.0)	1	1	1	1		

NMFS Request with pHOS = 0.30; pNOB relaxed for Safety-Net, Twisp, WNFH programs due to potential brood collection challenges. (WNFH @ 200,000).

If program is larger you just have to remove more fish to maintain the pHOS and PNI target – same result but more fish removed with the larger WNFH number. Upshot- there is no advantage (but there is added risk) to increasing a program size beyond what is needed to meet a pHOS target under a PNI management regime.

Proposed Application Conditions													
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WNFH	200,000	0.67114094	1,688	0.85	253	0.1006	0.182619		0.70	0.00	0.30	0.00	1.00
	348,000		2,937		416		0.300274						
Wild					969	0.6997							
Total					1,385								

	Spawners/Broodstock					
Sources	Naturally spawning component	PUD Program	WNFH program	Twisp program		
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PUD Program Returnees	0.03	0.75	0	0	Overall PNI	0.68
WNFH Program Returnees	0.18	0.125	0.3	0		
Twisp Returnees	0.09	0.125	0	0.2	Overall pHOS	0.30
Total (each column must add to 1.0)	1	1	1	1		

IMPLEMENTATION OF COMPREHENSIVE MONITORING AND EVALUATION OF WELLS HATCHERY COMPLEX PROGRAMS IN 2017

Greg Mackey

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October 2016

Introduction

The contractor for the M&E Implementation Plan will conduct the field work, data collection, and data management. Reporting will be a collaborative effort between the contractor, Douglas PUD, Grant PUD, and Chelan PUD.

The Douglas County PUD and Grant County PUD Monitoring and Evaluation Plans (M&E Plan; Wells HCP Hatchery Committee 2007) described eight objectives specific to the hatchery programs funded by Douglas County PUD, Grant County PUD, and Chelan County PUD, and two regional objectives that were related to artificial propagation in general. These objectives were designed to address key questions regarding the use of supplementation as mitigation for unavoidable mortality associated with the operation of the Wells Hydroelectric Project (Douglas PUD), the Priest Rapids Hydroelectric Project (Grant PUD), and Rock Island and Rocky Reach hydroelectric projects (Chelan PUD). In 2013, these M&E Plans were reviewed and updated (Hillman et al. 2013) to reflect shifting management paradigms and to incorporate data collection and analysis from the first five years of hatchery program monitoring (Murdoch et al. 2012) conducted under the original M&E Plans. The updated M&E Plan (hereafter referred to as the M&E Plan) contains ten objectives specific to hatchery programs funded by PUDs and two regional objectives. One regional objective has been completed and the other is not planned to be addressed. The primary focus of this plan is assessment of the first ten objectives outlined in the M&E Plan.

Successful implementation of the M&E Plan requires relationships between the PUDs, M&E contractor, and other entities conducting similar field work in the Upper Columbia River Basin. Certain objectives require the collection of data from both target populations and non-target populations, such as reference populations. This proposal does not include field activities conducted by other entities to collect data for reference non-target populations required to implement the M&E Plan.

Addressing all the objectives within the M&E Plan requires multiple years of data collection. This is year four under the 2013 update of the M&E Plan and year twelve of the plan under the HCP. Objectives 5, 7, 8, and 10 are designed to be addressed after one year or five years (Table 1), and may require only periodic monitoring. Statistical analyses will be conducted consistent with the M&E Plan, revisions thereof, or the 5-year M&E report (Murdoch et al. 2012) as applicable. The Implementation Plan is formatted such that species, programs, and the associated M&E Objectives are presented in separate sections that are subdivided into modules to clearly define actions under the M&E Plan and allow flexibility in administering budgets.

Table 1. A potential long-term implementation schedule of objectives outlined in the PUD M&E Plan. The HCP HCs/PRCC HSC may change the M&E plan, its objectives, and implementation in future years. Monitoring and evaluation of hatchery programs in years prior to the 6-9 year period have been completed and are included here for reference only. The work conducted within this proposal would be implementation year ten.

Objective	Year of implementation									
	1-4	5	6-9	10	11-14	15	16-19	20	21-24	25
1	X	X	X	X	X	X	X	X	X	X
2	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X	X	X
5	X	X		X		X		X		X
6	X	X	X	X	X	X	X	X	X	X
7	X				X				X	
8	X				X				X	
9	X	X	X	X	X	X	X	X	X	X
10	X	X		X		X		X		X

This plan encompasses one year of work to implement the updated Monitoring and Evaluation Plan for PUD Hatchery Programs operated at the Wells Hatchery and Methow Hatchery, as described in the work plan, below.

2017 M&E Work Plan by Species, Programs, and Activities

Summer Steelhead

Module 1: In-Hatchery Metrics – Steelhead

Required to meet:

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.

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Objective 9: Determine if hatchery fish were released at the programmed size and number.

Biological data for origin, sex, age, size, fecundity, and survival of broodstock will be recorded for all steelhead hatchery programs: Twisp Conservation, Methow Safety-Net, Columbia Safety-Net, Okanogan Safety-Net, Omak Creek Conservation. Number of fish, stage-specific survivals, size, coefficient of variation, condition factor, and fish health issues will be recorded. An annual review of size, number and supporting statistics of fish from each program will be compared to those values defined in the M&E Plan Appendix 6, or adjusted values agreed to by the Wells HCP Hatchery Committee. Values within acceptable precision (i.e., +/-10% of HCP defined values) will constitute achievement of program objectives. Failure to achieve release targets will trigger evaluation to determine probable causation and recommendations, when necessary, for improving performance.

Hatchery personnel will assess fecundity of spawned females when fertilized eggs are at the eyed stage, and will provide data to evaluation staff. To assess overall egg mass, we will collect total egg weight samples just after removal from lethally-spawned females, and will record the weight of female fish after egg removal.

Module 2: Steelhead Adult Stock Assessment

Required to meet:

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.

Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.

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.

Objective 4: Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.

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.

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.

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The Twisp Weir will be operated for steelhead adult stock assessment between March 1, 2017 (approximate as environmental conditions allow) and June 30, 2017. Activities implemented at the Twisp Weir will include sampling all adult steelhead captured (origin, length, sex, genetic tissue sample, record any marks or tags, Floy tag fish to be released according to color scheme [Table 2]); PIT tagging and releasing adult steelhead (abdomen or pelvic girdle); retain (as necessary) natural origin Twisp returns for broodstock; handle any non-target species captured according to operational protocols and permit conditions; and, perform adult management of hatchery origin returns to achieve a 1:1 hatchery:natural origin ratio of spawners upstream of the Twisp Weir. Fish sacrificed for adult management may be sampled for fecundity to augment the sample size for hatchery-origin fish. Rainbow trout and cutthroat trout captured at the Twisp Weir will also be sampled and tagged similarly to steelhead.

Table 2. Floy tag colors for adult Twisp steelhead released upstream of the Twisp Weir in 2017.

Sex	Origin	Tag color
Female	Natural	Pink
Female	Hatchery	Chartreuse
Male	Natural	Red
Male	Hatchery	Blue

Floy tag colors will be alternated every other year between hatchery and wild fish to control for any potential color effects on reproductive success.

Wells Dam fish counts will provide data on escapement upstream of Wells Dam. Stock assessment will be used to estimate the composition of the escapement. Wells Dam stock assessment will be performed concurrent with broodstock collection activities at Wells Dam and Wells Hatchery from July 2017 – November 2017. Activities will include sampling all adult steelhead captured (origin, length, sex, genetic tissue sample (broodstock only), record any marks or tags, PIT tags may be applied to released fish [pelvic girdle]), retain hatchery-origin returns for Columbia Safety-Net, Methow Safety-Net, and Okanogan broodstock, handle any non-target species captured according to operational protocols and permit conditions. Management (removal) of excess hatchery origin adult steelhead may also occur at the Wells Hatchery volunteer channel and the Methow Hatchery outfall channel between March and May, 2017.

HRR will be estimated and values that fall below the expected values or the corresponding estimate of NRR (Appendix 2 of the M&E Plan) will be evaluated to determine whether in-hatchery or out-of-hatchery factors contributed to the reduced survival. Smolt to adult returns (SAR) will be estimated for each program and for the natural origin Twisp population. The proportion of hatchery origin spawners (pHOS) and proportion of natural influence (PNI) will be estimated for the Twisp steelhead program and population. Data for pHOS and PNI (for broodstock within Douglas PUD program facilities) will be collected for other parts of the basin. Numbers and proportions of hatchery origin returns removed for adult management for the Twisp, Methow and Columbia programs will be estimated and reported consistent with terms and conditions (Appendix 3 of the M&E Plan) in the pending Wells Complex Summer Steelhead HGMP ESA permit.

Module 3: Report Steelhead Contribution to Harvest

Required to meet:

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.

In years when the expected returns of hatchery adults exceed the level required to meet program goals of Wells Complex steelhead programs, surplus fish may be available for harvest. The contribution to harvest will be reported for programs that are consistent with harvest. Conservation fishery data derived from creel census (funded and conducted by WDFW) are reported to NMFS annually, and harvest data reported outside the scope of this plan (PTAGIS, etc.) will be summarized.

Module 4: Steelhead Spawning Distribution and Timing

Required to meet:

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.

Spawner surveys will be conducted at least weekly in the Twisp River using standard spawning ground survey methodology and data analysis as described in Snow et al. (2012). Locations of redds will be recorded using GPS; fish location and origin (identified by Floy tags) will also be recorded. Data collected will provide the number of redds, and timing and spatial distribution of spawning by fish origin. Any carcasses encountered will be sampled for sex, origin, age, egg retention, PIT tag, and other relevant biological data. Spawn timing comparisons of hatchery and natural origin steelhead will be conducted using data from Twisp River reaches T4-T10. The capture efficiency of the Twisp Weir will be estimated by comparing observations of Floy tagged and un-tagged fish in sections upstream of the weir.

Additionally, temporary in-stream PIT tag antenna arrays may be placed in selected tributaries in the Twisp drainage to assist with evaluation of spawning spatial distribution and timing. In conjunction with returning steelhead adults tagged as juveniles and adult steelhead tagging at the Twisp Weir and the Wells and Priest Rapids dams, these arrays are expected to provide a reliable, cost-effective means of corroborating current survey methodologies with observed steelhead use, and detect spawning (if any) in locations where spawning is presumed to not occur, or where surveys are difficult to conduct. Permanent PIT tag arrays located in the Chewuch River, Lost River, and in the Methow River near Winthrop, Washington will be used to estimate overall steelhead spawner abundance, origin of spawners, and pHOS, for the Chewuch River, Lost River, and the upper Methow River. Index redd surveys will be used in the lower Methow reaches in conjunction with PIT tag detection and AUC modeling to estimate the number of spawners in the lower Methow.

Module 5: Estimation of Steelhead Stray Rates

Required to meet:

Objective 6: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.

Stray rates of Twisp conservation, Methow Safety-Net, and Columbia Safety-Net steelhead will be estimated by PIT tag detections at in-stream PIT tag detection stations in the Methow Basin and in watersheds outside the Methow Basin (via PTAGIS), and positive identification of recovered or captured steelhead at traps (Twisp Weir, Methow Hatchery, Omak Weir), during spawner surveys, or through creel census.

Collecting stray rate information for steelhead poses a challenge because carcasses are not available for examination. Adult PIT tag monitoring provides the most accurate assessment of stray rates, both within and among populations.

Module 6: Steelhead Juvenile Population Assessment

Required to meet:

Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.

The population abundance of juvenile steelhead will be estimated in the rivers supplemented by Douglas PUD's steelhead hatchery programs. Sampling locations and methods may utilize a combination of the following methods: screw traps, mark-recapture population estimates, electrofishing removal population estimates, snorkel surveys, and PIT tag based survival modeling.

Approach 1: The efficacy of this approach is currently being analyzed and continued implementation of this approach will be determined based on this assessment. Rotary screw smolt traps in the Twisp River and the Methow River. Trapping locations and methods will remain as described in Snow et al. (2012). Biological data (species, length, origin, scale samples, genetic samples [Twisp River only]) will be collected from fish collected each day. Scale samples will be taken from random samples of steelhead juveniles to estimate the age structure of the emigrants. The Twisp trap will be fished from early March through late November, and the Methow Trap will be fished from late February through late November, as conditions allow at both trapping locations. Steelhead greater than 65 mm will be PIT tagged. Trap efficiency trials will be conducted at various flows as the number of available fish for trials allows. Population estimates will be calculated by expanding the number of fish caught on a daily basis by the estimated trap efficiency on that day as estimated using a flow-efficiency model.

Approach 2: The efficacy of this approach is currently being analyzed and continued implementation of this approach will be determined based on this assessment. Juvenile in-stream PIT tag population estimate coupled with survival model in the Twisp River, Methow and/or Chewuch rivers. Sampling may be limited to testing the methodology. Steelhead will be captured by electrofishing at sites chosen using General Random Tessellation Sampling (GRTS) or other random sample method. The standing crop of juveniles will be estimated by both multiple-pass removal estimates or mark-recapture estimates coupled with single-pass electrofishing extrapolated to the amount of habitat in the stream. Captured fish will be PIT tagged. Survival of the fish will be estimated through emigration using a multi-state survival model (J. Skalski and R. Buchanan, personal communication). The number of emigrants will be estimated using this PIT tag based survival model. This approach will be implemented for the third time in the fall of 2016. The results of the pilot studies in 2014-2016 will be used to improve the assessment. As informative results from the initial implementation become available, this approach may be modified to better meet M&E objectives.

Module 7: Steelhead Population Genetic Monitoring

Required to meet:

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.

Hypotheses related to genetic diversity, population structure, and effective population size were addressed in the 2008-2010 work plans and will not be addressed in 2017. However, to provide the ability to conduct future analysis, we will collect and archive representative tissue samples (opercle-punch or fin clip) from all steelhead broodstocks, and from natural origin steelhead collected on the spawning grounds and at the Twisp River Weir. Samples will have associated data recorded (fish origin, age, date, location, sex, and biological characteristics).

Table 3. Cross reference of steelhead M&E implementation modules and M&E objectives.

	Objective	Modules	Data
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, 4	• Adult returns • Sex and Origin of Adults • Number of Spawners
2	Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	2, 4, 6	• Adult Returns • Sex and Origin of Adults • Number of Spawners • Juvenile Population Estimates
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.	1, 2, 4	• Broodstock Data • Adult returns • Sex and Origin of Adults • Number of Spawners
4	Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	2, 4	• Adult returns • Sex and Origin of Adults • Number of Spawners
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.	2, 4	• Run timing • Spawn timing • Spatial Distribution of Spawning • Adult returns • Sex and Origin of Adults • Number of Spawners
6	Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	4, 5	• Sex and Origin of Adults • Number of Spawners • Spatial Distribution of Spawning
7	Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.	1, 2, 4, 7	• Sample Broodstock • Sample Adult Returns • Sample Spawners • Sample Juveniles • Various Population Genetic Analyses
8	Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	1, 2	• In-Hatchery Metrics • Adult Phenotype Metrics
9	Determine if hatchery fish were released at the programmed size and number.	1	• In-Hatchery Metrics
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.	3	• Various Harvest Data (PTAGIS, RMIS, Agency Reports, etc.)

Spring Chinook

Module 8: Spring Chinook In-Hatchery Metrics

Required to meet:

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.

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Objective 9: Determine if hatchery fish were released at the programmed size and number.

Biological data for origin, sex, age, size, fecundity, and survival of broodstock will be recorded for the Twisp and Methow Conservation hatchery programs. Number of fish, stage-specific survivals, size, coefficient of variation, condition factor, and fish health issues will be recorded. An annual review of size, number and supporting statistics of fish from each program will be compared to those values defined in the M&E Plan Appendix 6, or adjusted values agreed to by the Wells and Rocky Reach HCP Hatchery Committees and PRCC HSC. Values within acceptable precision (i.e., +/- 10% of HCP defined values) will constitute achievement of program objectives. Failure to achieve release targets will trigger evaluation to determine probable causation and recommendations, when necessary, for improving performance.

Hatchery personnel will assess fecundity of spawned females when fertilized eggs are at the eyed stage, and will provide data to evaluation staff. To assess overall egg mass, we will collect total egg weight samples just after removal from lethally-spawned females, and will record the weight of female fish after egg removal.

Module 9: Spring Chinook Adult Stock Assessment

Required to meet:

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.

Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.

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.

Objective 4: Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.

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.

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.

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The Twisp Weir and Methow Hatchery volunteer trap(s) will be operated for spring Chinook broodstock collection between July 1, 2017 and August 30, 2017 (Twisp Weir is operated under the auspices of steelhead collection and sampling through June 30, but spring Chinook will be collected opportunistically prior to July 1). Wells Dam fish ladders will be operated between about 1 May and 30 June for spring Chinook broodstock collection and overall population stock assessment. Activities will include sampling all adult spring Chinook captured (origin, length, sex, genetic tissue sample, record any marks or tags, retain natural origin Twisp returns for broodstock, handle any non-target species captured according to operational protocols and permit conditions, and PIT tags may be applied to the pelvic girdle of released fish).

Carcass recoveries and coded wire tag data will be the primary means of stock assessment (see the spawner survey section for more information). Samples and data for run composition, age, origin, size, spawn timing, egg retention, and population genetic analyses will be collected. HRR will be estimated and values that fall below the expected values or the corresponding estimate of NRR (Appendix 2 of the M&E Plan) will be evaluated to determine whether in-hatchery or out-of-hatchery factors contributed to the reduced survival. SAR will be estimated for each program and for the natural origin fish of the Twisp, Methow, and Chewuch rivers.

The pHOS and PNI will be estimated for the Twisp and MetComp programs and populations. Numbers and proportions of hatchery origin returns removed for adult management for the Twisp and Methow programs will be estimated and reported consistent with terms and conditions (Appendix 3 of the M&E Plan) in the pending Methow Hatchery Spring Chinook ESA permit.

Module 10: Spring Chinook Contribution to Harvest

Required to meet:

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.

In years when the expected returns of hatchery adults exceed the level required to meet program goals for the Methow Hatchery spring Chinook programs, surplus fish may be available for harvest. The contribution to harvest will be reported based on numbers of fish released for programs that are consistent with harvest. Conservation fishery data derived from creel census (funded and conducted by WDFW) will be reported to NMFS annually, and harvest data reported outside the scope of this plan (PTAGIS, RMIS, etc.) will be summarized.

Module 11: Spring Chinook Spawner Surveys

Required to meet:

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.

Spawner surveys will be conducted at least weekly in all spawning reaches of the rivers supplemented by the Methow Hatchery (Table 4) using standard spawning ground survey methodology and data analysis as described in Snow et al. (2012), and will incorporate surveyor efficiency models to estimate precision. Locations of redds will be recorded using GPS. Data collected will provide the number of redds, and timing and spatial distribution of spawning by origin. Carcasses encountered will be sampled for location of recovery, sex, origin, age, egg retention, CWT, PIT tag, and other relevant biological data.

Table 4. Spring Chinook spawning ground surveys and methods.

River	Spawning ground methodology	Spawner composition	Age composition
Methow	Total ground	Carcasses	Wells Dam
Chewuch	Total ground	Carcasses	Wells Dam
Twisp	Total ground	Carcasses	Wells Dam

Module 12: Estimation of Spring Chinook Stray Rates

Required to meet:

Objective 6: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.

Stray rates of Twisp, Chewuch, and Methow conservation programs will be estimated by CWT recoveries within and outside of the Methow Basin. The Regional Mark Information System (RMIS) database will provide all necessary CWT information needed to estimate stray rates for each brood year for within- and outside-basin stray rates based on spawning escapement estimates. Brood year stray rates for Chinook will require multiple-year CWT recoveries (i.e., all age classes) from broodstock and carcass recoveries on the spawning grounds to account for all cohort age classes. The estimated number of strays for the entire brood year will be calculated by dividing the number of strays by the total number of hatchery fish that returned. Stray rates within, and between independent populations will be calculated in a similar manner as brood year stray rates, except on an annual basis and based on the estimated spawning escapements of the receiving populations.

Module 13: Juvenile Spring Chinook Population Assessment

Required to meet:

Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.

The population abundance of juvenile spring Chinook will be estimated in the rivers supplemented by the PUDs' spring Chinook hatchery programs. Sampling locations and methods may utilize a combination of the following methods: screw traps, mark-recapture population estimates, electrofishing removal population estimates, snorkel surveys, and PIT tag based survival modeling.

Approach 1: The efficacy of this approach is currently being analyzed and continued implementation of this approach will be determined based on this assessment. Rotary screw smolt traps in the Twisp River and the Methow River. Trapping locations and methods will remain as described in Snow et al. (2012). Biological data (species, length, origin, scale samples, genetic samples) will be collected from fish trapped each day. The Twisp trap will be fished from early March through late November, and the Methow Trap will be fished from late February through late November, as conditions allow at both trapping locations. Spring Chinook greater than 65 mm will be PIT tagged. Trap efficiency trials will be conducted at various flows as the number of available fish for trials allows. Population estimates will be calculated by expanding the number of fish caught on a daily basis by the estimated trap efficiency on that day as estimated using a flow-efficiency model. A similar methodology will be employed with the Twisp PIT tag antenna array to estimate over-winter emigration provided that adequate numbers of spring Chinook parr are PIT tagged under Approach 2.

Approach 2: The efficacy of this approach is currently being analyzed and continued implementation of this approach will be determined based on the assessment. Juvenile in-stream PIT tag population estimate coupled with survival model in the Twisp River, Methow and/or Chewuch rivers. Sampling may be limited to testing the methodology. Spring Chinook will be captured by electrofishing at sites chosen using General Random Tessellation Sampling (GRTS) or other random sample method. The standing crop of juveniles will be estimated by multiple-pass removal estimates or mark-recapture estimates coupled with single-pass electrofishing extrapolated to the amount of habitat in the stream. Captured fish will be PIT tagged. Survival of the fish will be estimated through emigration using a multi-state survival model (J. Skalski and R. Buchanan, personal communication). The number of emigrants will be estimated using this PIT tag based survival model. This approach will be implemented for the third time in the fall of 2016. The results of the pilot studies in 2014-2016 will be used to improve the assessment. As informative results from the initial implementation become available, this approach may be modified to better meet M&E objectives.

Module 14: Spring Chinook Population Genetic Monitoring

Required to meet:

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.

Hypotheses related to genetic diversity, population structure, and effective population size were addressed in the 2008-2010 work plans and will not be addressed in 2017. However, to provide the ability to conduct future analysis, we will collect and archive tissue samples (opercle-punch or fin clip) from all spring Chinook broodstock, and from natural origin spring Chinook collected on spawning grounds and at the Twisp River Weir. Samples will have associated data recorded (fish origin, age, date, location, sex, and biological characteristics).

Table 5. Cross reference of spring Chinook M&E implementation modules and M&E objectives.

	Objective	Modules	Data
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.	9, 11	• Adult returns • Sex and Origin of Adults • Number of Spawners
2	Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	9, 11, 13	• Adult Returns • Sex and Origin of Adults • Number of Spawners • Juvenile Population Estimates
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.	8, 9, 11	• Broodstock Data • Adult returns • Sex and Origin of Adults • Number of Spawners
4	Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	9, 11	• Adult returns • Sex and Origin of Adults • Number of Spawners
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.	9, 11	• Run timing • Spawn timing • Spatial Distribution of Spawning • Adult returns • Sex and Origin of Adults • Number of Spawners
6	Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	11, 12	• Sex and Origin of Adults • Number of Spawners • Spatial Distribution of Spawning
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, 9, 11, 14	• Sample Broodstock • Sample Adult Returns • Sample Spawners • Sample Juveniles • Various Population Genetic Analyses
8	Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	8, 9	• In-Hatchery Metrics • Adult Phenotype Metrics
9	Determine if hatchery fish were released at the programmed size and number.	8	• In-Hatchery Metrics
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.	10	• Various Harvest Data (PTAGIS, RMIS, Agency Reports, etc.)

Summer Chinook

Module 15: Summer Chinook In-Hatchery Metrics

Required to meet:

Objective 3: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the target hatchery survival rate.

Objective 9: Determine if hatchery fish were released at the programmed size and number.

Biological data for origin, sex, age, size, fecundity, and survival of broodstock will be recorded for the Wells yearling and subyearling hatchery programs. Number of fish, stage-specific survivals, size, coefficient of variation, condition factor, and fish health issues will be recorded. An annual review of size, number and supporting statistics of fish from each program will be compared to those values defined in Appendix 6, or adjusted values agreed to by the Wells HCP Hatchery Committee. Values within acceptable precision (i.e., +/-10% of HCP defined values) will constitute achievement of program objectives. Failure to achieve release targets will trigger evaluation to determine probable causation and recommendations, when necessary for improving performance.

Module 16: Summer Chinook Adult Stock Assessment

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.

Stock assessment will be performed on broodstock collected at Wells Hatchery. Activities will include sampling all adult summer Chinook broodstock for origin, length, sex, genetic tissue sample (for CRITFC PBT), record any marks or tags, handle any non-target species captured according to operational protocols and permit conditions. Coded wire tag data will be the primary means of stock assessment. Samples and data for run composition, age, origin, size, spawn timing, egg retention, and population genetic analyses will be collected. HRR will be estimated and values that fall below the expected value (Appendix 2 of the M&E Plan) will be evaluated to determine whether in-hatchery or out-of-hatchery factors contributed to the reduced survival. SAR will be estimated for each program.

Module 17: Summer Chinook Contribution to Harvest

Required to meet:

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.

In years when the expected returns of hatchery adults exceed the level required to meet program goals, surplus fish may be available for harvest. The contribution to harvest will be reported based on numbers of fish released for programs that are consistent with harvest and harvest data funded, collected, and reported outside the scope of this plan (PTAGIS, RMIS, etc.).

Module 18: Estimation of Summer Chinook Stray Rates

Required to meet:

Objective 6: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.

Stray rates of Wells yearling and subyearling summer Chinook will be estimated through CWT recoveries reported in RMIS. The RMIS database will provide all necessary CWT information to estimate stray rates for each brood year for within- and outside-basin stray rates based on spawning escapement estimates. Brood year stray rates for Chinook will require multiple-year CWT recoveries (i.e., all age classes) from broodstock and carcass recoveries on the spawning grounds to account for all cohort age classes. The estimated number of strays for the entire brood year will be calculated by dividing the number of strays by the total number of hatchery fish that returned. Stray rates in independent populations will be calculated in a similar manner as brood year stray rates, except on an annual, run-year basis and based on the estimated spawning escapement.

Module 19: Summer Chinook Population Genetic Monitoring

Required to meet:

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.

Hypotheses related to genetic diversity, population structure, and effective population size were addressed in the 2008-2010 work plans and will not be addressed in 2017. However, to provide the ability to conduct future analysis, we will collect and archive tissue samples (opercle-punch or fin clip) from summer Chinook broodstock. Samples will have associated data recorded (fish origin, age, date, location, sex, and biological characteristics).

Table 6. Cross reference of summer Chinook M&E implementation modules and M&E objectives.

	Objective	Modules	Data
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.	NA	NA
2	Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	NA	NA
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.	15, 16	• Broodstock Data • Adult returns • Sex and Origin of Adults
4	Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	NA	NA
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.	NA	NA
6	Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	18	• Sex and Origin of Adults • Number of Spawners • Spatial Distribution of Spawning
7	Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.	19	• Sample Broodstock • Sample Adult Returns • Sample Spawners • Sample Juveniles • Various Population Genetic Analyses
8	Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	NA	NA
9	Determine if hatchery fish were released at the programmed size and number.	15	• In-Hatchery Metrics
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.	17	• Various Harvest Data (PTAGIS, RMIS, Agency Reports, etc.)

DELIVERABLES

Annual Reports: Reporting will follow the schedule in Table 7.

Table 7. Monitoring and Evaluation Annual Report Review Dates.

Date	Reporting Phase
June 1	WDFW Internal Review
July 15	Draft submitted to PUDs for 30 day review
August 15	PUDs comments to WDFW
September 15	Draft to HC for 30 day review
October 15	HC comments to PUDs and WDFW
November 1	Final Report submitted to NMFS and HC

The annual report will summarize all field activities conducted during the contract period. The report will be in a scientific format, organized so that the HCP HCs and the PRCC HSC members can clearly and concisely evaluate M&E Plan results. Data tables and figures will be cumulative such that all comparable data from previous years is included and that the most recent report supersedes all previous reports. Monitoring indicators and the data used in calculations will be presented for each hypothesis evaluated.

Five-Year Summary Report: In addition to the annual report, a five-year summary report will be written by December 31, 2017. Statistical analysis of data will be based on, but not limited to, the statistical design in the M&E Plan (Hillman, et al., 2013). All raw data used in the statistical analysis will also be presented in the report.

Monthly Reports: Monthly reports will be provided to keep Douglas PUD, Grant PUD, Chelan PUD, as well as the HCP HCs and PRCC HSC members and co-managers informed on all hatchery and evaluation related activities. Unless otherwise requested by the PUDs, the role of monthly reports will remain the same. Upon request, additional information can be included in the monthly reports.

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Murdoch, A. R., C. Snow, C. Frady, A. Repp, M. Small, S. Blankenship, T. Hillman, M. Miller, G. Mackey, and T. Kahler. 2012. Evaluation of hatchery programs funded by Douglas County PUD 5-year report 2006-2010. Wells HCP Hatchery Committee, East Wenatchee, WA.

Snow. C., C. Frady, A. Repp, A. Murdoch, M. Small, and S. Bell. 2012. Monitoring and evaluation of Wells and Methow hatchery programs: 2011 annual report. Douglas County Public Utility District, East Wenatchee, Washington.

Wells HCP Hatchery Committee. 2007. Conceptual approach to monitoring and evaluation for hatchery programs funded by Douglas County Public Utility District. Douglas PUD Habitat Conservation Plan Hatchery Committee, East Wenatchee, Washington. Last updated September 2007.

APPENDIX C
HABITAT CONSERVATION PLAN
TRIBUTARY COMMITTEES
2016 MEETING MINUTES

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 7 January 2016

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Chris Fisher (Colville Tribes) and Steve Hays (Chelan PUD).[1]
.
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 Thursday, 7 January 2016 from 9:30 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 addition:

- HCP Coordination Committees' Chair 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.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 12 November 2015 meeting notes with one edit.

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.

- Upper Beaver Habitat Improvement Channel Restoration Project – The project is complete and the sponsor (Methow Salmon Recovery Foundation; MSRF) has submitted the final report.
- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that the E2-E5 lateral contract was awarded to Lloyd Logging and weather permitting work should begin in spring 2016. The contractor is aware of the timeframe and that the work must be complete before the 2016 irrigation season. Bach Drilling has mostly completed the drilling of production wells. They will return in mid-March to complete a small punch list before irrigation season. Individual wells are not being drilled at this time. There are four wells to be drilled, five pump upgrades to install, and nine wells to be commissioned. This work will be completed in spring 2016. Sweberg Contracting was awarded the contract to remove west-side trees. They mobilized crews and equipment in late November. Branches less than 20 inches were chipped,

[1] Chris and Steve provided their votes on decision items following the meeting.

while larger branches and logs were shipped to a west-side pallet manufacturer. All work now is complete and the contractor will return in spring to finish clean- up.

- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit the final report soon.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) provided a lengthy update on this project. Of the four properties included in the original proposal, only the Bockoven South parcel has been purchased. The Price parcel was sold to an adjacent landowner, who paid well over the appraised value for the property. The Bockoven North parcel was appraised at $145,000. The landowner is pursuing evidence that additional lots would be allowed on the parcel with the northern access (one-lane rail-car bridge). If successful, the appraised value of the parcel will increase. The last property, Crone parcel, is still being negotiated. The landowner is willing to sell the 8+ acres on the west side of the river, release the easement and all interest in the bridge (incomplete bridge), permit the bridge removal, and allow use of their property on the east side of the river for construction access. The landowner is asking for $50,000 for the 8+ acres. The appraised value is $25,000. The sponsor asked the Rocky Reach Tributary Committee if they would be willing to pay more than the appraised value (see Section IV below).
- Post-Fire Landowner Assistance/Habitat Protection in Beaver and Frazer Creeks Project – This project is complete. The project sponsor (MSRF) has submitted the final report.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) indicated that the Report of Examination process continues with Chelan County Water Conservancy Board. The sponsor is working to estimate water use at the irrigation diversion, which is unmetered and has a broken pressure gauge. Electrical records and typical pressures for system infrastructure are being used to provide estimates. The Conservancy Board members will review these estimates. A test well was drilled on 15 December. Unfortunately, the test well was not as productive as needed and it was too shallow to meet Health Department guidelines for the type of public drinking water system used by the campground resort landowner. The sponsor is currently researching a secondary well location.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) provided no new updates on this project.
- Methow Watershed Beaver Reintroduction Project – The sponsor (MSRF) said there are no new activities on this project.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) said there are no new activities on this project.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) provided no new updates on this project.

IV. Time Extension: Entiat Stillwaters Gray Reach Acquisition Project

The Rocky Reach Tributary Committee received a time extension request from Chelan Douglas Land Trust on the *Entiat Stillwaters Gray Reach Acquisition Project*. The sponsor indicated that they are still negotiating on the Crone property and therefore asked the Committee to extend the period of the project to 30 June 2016. After careful consideration, ***the Rocky Reach Tributary Committee approved the time extension***.

The sponsor also asked the Rocky Reach Tributary Committee if they would be willing to pay more than the appraised value for the Crone property. The Tributary Committees' appraiser assessed the value of the

8+ acres on the west side of the river at $25,000. The owner of the property is asking $50,000 for the 8+ acres. This project has a cost share with the Salmon Recovery Funding Board, who cannot pay more than the appraised value. Like the SRFB, the Rocky Reach Tributary Committee cannot pay more than the appraised value; therefore, ***the Rocky Reach Tributary Committee declined the opportunity to pay more than the appraised value.***

V. Review of Middle Entiat 60% Restoration Plans

In November, the Committees received a request from Chelan-Douglas Land Trust and the Bureau of Reclamation to review and approve the 60% middle Entiat River restoration plans. Specifically, the Committees were asked to review projects proposed on the Tyee Creek Confluence and Bockoven South parcels. In November, the Committees were unable to review the proposed restoration actions because of the short time period for review. Therefore, they asked the Bureau of Reclamation for additional time to review the plans and to provide the Committees with a brief summary of changes between the 30% and 60% plans. The Bureau granted additional time to review the plans and they provided the Committees with a spreadsheet identifying the proposed changes between the 30% and 60% plans.

The Committees reviewed the proposed changes and concluded that they were appropriate. They also appreciate the Bureau proposing methods that will minimize disturbance to the riparian areas. The Committees asked the Bureau to keep them updated on any changes in the restoration plans.

VI. Review of Wells HCP Tributary Committee Action Plan

Tom Kahler (via e-mail) provided the Committees with the Draft Wells HCP Tributary Committee Action Plan for 2016. The 2016 Draft Action Plan for the Wells Tributary Committee is as follows:

Plan Species Account Annual Contribution

- $176,178 in 1998 dollars: January 2016

Annual Report – Plan Species Account Status

- Draft to Tributary Committee (TC): January 2016
- Approval Deadline: February 2016
- Integration into HCP Annual Report: February 2016

General Salmon Habitat Program

- Project Review and Funding Decision January – December 2016

Small Projects Program

- Project Review and Funding Decision January – December 2016

The Wells Tributary Committee approved the revised Wells Action Plan for 2016.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in December and January:

   Rock Island Plan Species Account:

   - $422.06 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection.

- $4748.73 to the Methow Salmon Recovery Foundation for the Post-Fire Landowner Assistance/Habitat Protection in Beaver and Frazer Creeks Project.
- $181.25 to Clifton Larson Allen for Rock Island financial administration during the third quarter 2015.
- $54.00 to Clifton Larson Allen for Rock Island financial administration during November and December 2015.

Rocky Reach Plan Species Account:

- $5,534.10 to the Methow Salmon Recovery Foundation for the Upper Beaver Habitat Improvement Channel Restoration Project.
- $181.25 to Clifton Larson Allen for Rocky Reach financial administration during the second quarter 2015.
- $54.00 to Clifton Larson Allen for Rocky Reach financial administration during November and December 2015.

Wells Plan Species Account:

- $5,534.10 to the Methow Salmon Recovery Foundation for the Upper Beaver Habitat Improvement Channel Restoration Project.
- $78,464.24 to Trout Unlimited for the MVID Instream Flow Improvement Project.

2. Tracy Hillman reported that he and Becky Gallaher completed Section 2.6 (Tributary Committees and Plan Species Accounts) for the Annual Report of Activities under the Anadromous Fish Agreement and Habitat Conservation Plan for each hydroelectric project. Tracy said he sent the draft reports to the Tributary Committees members for review in December. He received comments only from Tom Kahler. Tracy said he will send the Tributary Committee reports to Anchor QEA, who is compiling the draft annual reports. The draft reports will go the Coordinating Committees for their review. The PUDs will submit the final reports to the Federal Energy Regulatory Commission in April.
3. Tracy Hillman said that the Tributary Committees will continue to meet on the second Thursday of each month in 2016. Those meeting dates are as follows:

- Jan. 7
- Feb 11
- Mar 10
- Apr 14
- May 12
- Jun 9
- Jul 14
- Aug 11
- Sep 8
- Oct 13
- Nov 10
- Dec 8

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 them 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.

5. Tracy Hillman reported that he received an e-mail from Chelan County Natural Resources Department asking the Tributary Committees to attend the first Icicle Creek Funding Coordination meeting on Monday, 11 January in Ellensburg, WA. The following topics will be discussed during the meeting:

    - Background on the development of the Icicle Strategy
    - Timeline
    - Overview of projects and project benefits
    - Overview of possible funding sources and strategies
    - Current funding commitments and gaps
    - Long-term needs

    Tracy indicated that he will not be able to attend the meeting and asked if anyone would like to attend in his stead. Justin Yeager volunteered. Everyone present agreed that Justin will represent the Tributary Committees at the Coordination meeting.

6. Tracy Hillman gave a presentation on the project tour in Canada that some of the Tributary Committee members attended in October. Tracy described the Shuttleworth Creek sediment basin project, and proposed and completed projects on Ellis, Penticton, and Naramate creeks. He also talked about the proposed removal of Allendale Lake Dam, which is in the headwaters of Shuttleworth Creek. He then described the restoration projects implemented in the Penticton Channel (Okanogan River). These include the addition of spawning ramps and placement of boulder clusters. Tracy and Tom Kahler indicated that the spawning ramps are being used heavily by sockeye and kokanee. Finally, Tracy showed pictures of the ORRI Phase II side-channel reconnection project. The side channel appears to be functioning as designed. Tracy encouraged members to attend the tour in 2016, if there is one.

VIII. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 11 February 2016 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
10 March 2016

Members Present: Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Chas Kyger (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Jeremy Cram (WDFW).[1]

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 Thursday, 10 March 2016 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 following additions:

- Tour restoration projects.
- Presentations on completed restoration projects.
- Update on the Icicle Creek Funding Coordination meeting held on 11 January 2016.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 7 January 2016 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that work has been relatively quiet the past month because of weather conditions. The project is on schedule and will be ready for the 2016 irrigation season.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit the final report soon.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) provided no new updates on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) continues to develop plans for an alternate well location and will begin to vet the selection process with Thousand Trails in the coming weeks. After snowmelt, the sponsor will work with a local Ground

[1] Jeremy provided his votes on decision items following the meeting.

Penetrating Radar expert to assess alternatives for a new well location. The sponsor has also selected Pacific Engineering to lead the engineering plans and design.

- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported that in February they focused work on conceptual redesigns of the Barkley pump station after closing on the Wilson property on 1 February 2016. The cultural resources report was also completed and sent to the Department of Archaeology and Historic Preservation. In addition to permitting, the sponsor has been working on compiling all easement records and working with Ecology on the water rights change process. Construction is scheduled for autumn 2016.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) said that deep snow will likely delay 2016 field activities.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) said there are no new activities on this project.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) held a site visit to discuss construction routes and logistics. They continue discussions with permitting agencies. Permits will be ready for submittal by the end of March.
- M2 Sugar Acquisition Project – The sponsor (MSRF) said they received the appraisal and requested an appraisal review.
- Icicle Boulder Field Project – The draft agreement was sent to the sponsor (TU) in January. The Rock Island Tributary Committee is waiting for a signed copy of the agreement.

IV. Small Projects Program Application

Permitting Nutrient Enhancement in the Chiwawa

The Committees reviewed a Small Projects Program application from Cascade Columbia Fisheries Enhancement Group titled, *Permitting Nutrient Enhancement in the Chiwawa*. The purpose of the project is to develop a treatment and effectiveness monitoring plan, and obtain permits from the U.S. Forest Service and Washington Department of Ecology to conduct a four-year, nutrient-enhancement pilot project in the Chiwawa River. The total cost of the project is $11,348. The sponsor requested $11,348 from HCP Tributary Funds. After careful consideration, ***the Rock Island Tributary Committee approved funding for the project***.

V. Review of Tributary Committees' Policies and Procedures

Policies and Procedures for Funding Projects

Tracy Hillman asked if the Committees had any changes or edits to the Policies and Procedures for Funding Projects document. After reviewing the document, members had no changes to the Policies and Procedures.

Tributary Committee Operating Procedures

Tracy Hillman asked if the Committees had any changes or edits to the Tributary Committee Operating Procedures document. After reviewing the document, members had no changes to the Operating Procedures.

VI. Rock Island and Rocky Reach Plan Species Accounts Financial Audit

Tracy Hillman mentioned to the Committees that it has been five years since Cordell, Neher & Company audited the Plan Species Accounts. Tracy said that Section 6.9 of the Policies and Procedures for Funding Project document states that, "Unless agreed to otherwise, the external review will be conducted every five years." The Rocky Reach and Rock Island Committees discussed and agreed to have the audit completed in 2016. The Wells Plan Species Account is audited every year by the State Auditor's Office. Becky Gallaher will contact Cordell, Neher, & Company to order the review.

VII. Review of Rock Island and Rocky Reach HCP Tributary Committees Action Plan

Chelan PUD provided the Committees with the Draft Rocky Reach and Rock Island HCP Tributary Committees Action Plans for 2016. The 2016 Action Plans for both Rocky Reach and Rock Island Tributary Committees is as follows:

- Plan Species Account Deposits: January 2016
- GSHP Project Review and Approval: Ongoing
- GSHP Project Implementation: Ongoing
- Small Project Review and Approval: Ongoing
- Small Project Implementation: Ongoing

The Rocky Reach and Rock Island Tributary Committees approved the Rocky Reach and Rock Island Action Plans for 2016.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in February and March:

   Rock Island Plan Species Account:

   - $563.30 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection (January invoice).
   - $856.00 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection (February invoice).
   - $162.50 to Clifton Larson Allen for Rock Island financial administration during the fourth quarter 2015.
   - $50.62 to Clifton Larson Allen for Rock Island financial administration in February 2016.
   - $413.02 to Chelan PUD for project coordination and administration during the fourth quarter of 2015.

   Rocky Reach Plan Species Account:

   - $162.50 to Clifton Larson Allen for Rocky Reach financial administration during the fourth quarter 2015.
   - $50.63 to Clifton Larson Allen for Rocky Reach financial administration in February 2016.
   - $361.17 to Chelan PUD for project coordination and administration during the fourth quarter of 2015.

   Wells Plan Species Account:

- $3,600.00 to Cascade Chelan Appraisal for evaluation of the M2 Sugar Acquisition Project (funding from Wells Administration; February Invoice).
- $300.00 to Cascade Chelan Appraisal for evaluation of the M2 Sugar Acquisition Project (funding from Wells Administration; March Invoice).
- $113,059.62 to Trout Unlimited for the MVID Instream Flow Improvement Project (January invoice).
- $6,042.45 to Trout Unlimited for the MVID Instream Flow Improvement Project (February invoice).
- $309.78 to Chelan PUD for project coordination and administration during the fourth quarter of 2015.

2. Tracy Hillman reported that the PUDs deposited funds into each of the Plan Species Accounts at the end of January. Chelan PUD deposited $721,475 into the Rock Island Account and $341,705 into the Rocky Reach Account. Douglas PUD deposited $261,970 into the Wells Account. As of March 2016, the unallocated balances within each account were $5,528,216 in the Rock Island Account, $2,042,757 in the Rocky Reach Account, and $1,300,397 in the Wells Account. Finally, Tracy shared with the Committees a summary of the different projects funded by the different Plan Species Accounts and the status of those projects (see Attachment 1).
3. Tracy Hillman shared with the Committees the draft Upper Columbia 2016 SRFB/TC Funding Schedule (see Attachment 2). Important dates are as follows:
    - 15 April: draft proposals are due.
    - 4-5 May: project tours in the Methow and Okanogan basins (tentative).
    - 11-12 May: project tours in the Wenatchee and Entiat basins (tentative).
    - 7 June: presentations to the Regional Technical Team (RTT) (members of the Tributary Committees are encouraged to attend the presentations).
    - 9 June: Tributary Committees review draft proposals and identify which proposals are fundable.
    - 15 June: Tributary Committees provide feedback to the project sponsors.
    - 1 July: final proposals are due.
    - 14 July: Tributary Committees review final proposals and make funding decisions.
    - 22 July: Tributary Committees provide feedback to the project sponsors.
4. Tracy Hillman asked the group if they would be interested in visiting some of the restoration projects they have supported over the years. Members agreed to review the list of projects (see Attachment 1) and identify projects they would like to visit. Tours would likely be scheduled for June or July, depending on stream flows.
5. Tracy Hillman asked if there are presentations on “lessons learned” from implementation of restoration projects that the Committees would like to see. Kate Terrell indicated that Robes Parrish can give a presentation on the White River Wood Atonement Project during the next meeting. Kate also suggested that Aaron Penvose may be able to give a presentation on the Lower Wenatchee Instream Flow Enhancement Project. Members will consider other presentations they would like to see.

6. The Committees discussed how they can receive final reports from project sponsors. Becky Gallaher indicated that she receives the final reports and asks Committee members if they want a copy. Generally, only a few members ask for copies. Tracy Hillman indicated that Tributary Committees notes, agendas, letters, emails, and reports are stored on the Extranet site.[2] Members indicated that they did not have access to the Extranet site and asked Tracy how they get access. Tracy will check with the HCP Coordinating Committees to see if Tributary Committee members can access to the site.
7. Justin Yeager reported that he attended the first Icicle Creek Funding Coordination meeting on Monday, 11 January in Ellensburg, WA. The following topics were discussed during the meeting:
   - Background on the development of the Icicle Strategy
   - Timeline
   - Overview of projects and project benefits
   - Overview of possible funding sources and strategies
   - Current funding commitments and gaps
   - Long-term needs

   Justin indicated that they talked about options for funding different projects. He noted that there was some discussion about the Tributary Committees possibly funding a bathymetric evaluation of the Alpine lakes. Committee members indicated that they were not interested in funding a bathymetric study. However, they did show interest in the Cascade Orchards Irrigation Efficiency and Point of Diversion Change Project. This project could result in a savings of 1,000 ac-ft at an average cost of $2,500/ac-ft. The flow benefit is non-consumptive, reach specific, and occurs during the irrigation season. The project will provide a flow benefit on Icicle Creek from the COID Diversion to the mouth of Icicle Creek.

IX. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 14 April 2016 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

[2] Following the meeting, it was discovered that the Tributary Committees section on Extranet has not yet been set up.

Attachment 1

Projects Funded by Plan Species Accounts

Rock Island Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 White River Floodplain & Habitat Protection	Chelan-Douglas Land Trust	General	Protection	$1,986,200	$693,548	$693,548	Complete
05 Nason Creek Off-Channel Habitat Restoration	Chelan County NRD	General	Off-Channel Habitat	$125,034	$18,787	$18,787	Complete
05 Alder Creek Culvert Replacement	Chelan County NRD	General	Fish Passage	$89,804	$89,804	$89,804	Complete
05 McDevitt Diversion Project	Cascadia Conservation District	Small	Fish Passage	$5,278	$5,278	$2,831	Complete
07 LWD Removal and Relocation	Chelan County NRD	Small	Instream Structures	$5,000	$5,000	$871	Complete
07 WRIA's 45/46 Riparian Restoration	Cascadia Conservation District	Small	Riparian Habitat	$50,000	$25,000	$24,779	Complete
07 Entiat PUD Canal System Conversion	Cascadia Conservation District	General	Instream Flows	$496,584	$99,360	$99,360	Complete
07 Roaring Creek Flow Enhancement	Cascadia Conservation District	General	Instrm Flows/Fish Passage	$147,069	$25,000	$987	Cancelled
07 Wildhorse Spring Creek Conservation Easement	Colville Confederated Tribes	General	Protection	$67,826	$62,826	$62,826	Complete
08 Twisp River Conservation Acquisition II	Methow Salmon Recovery Found	General	Protection	$481,814	$220,000	$200,500	Complete
08 Twisp River Riparian Protection (Zinn)	Methow Conservancy	General	Protection	$349,988	$104,996	$104,996	Complete
08 Cashmere Pond Off-Channel Habitat Project	Chelan County NRD	General	Off-Channel Habitat	$914,076	$249,110	$240,139	Complete
08 Keystone Canyon Habitat Project	Cascadia Conservation District	General	Off-Channel Habitat	$0	$0	$0	Cancelled
09 LWD/Rootwad Acquisition and Transport II	Cascadia Conservation District	Small	Instream Structures	$35,000	$35,000	$35,000	Complete
09 Sleepy Hollow Reserve Protection Feasibility	Chelan-Douglas Land Trust	Small	Assessment	$25,000	$20,000	$16,599	Complete

Rock Island Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
09 White River Nason View Acquisition	Chelan-Douglas Land Trust	General	Protection	$639,000	$76,635	$76,635	Complete
09 Upper Methow II (Tawlks) Riparian Protection	Methow Conservancy	General	Protection	$411,943	$61,948	$61,948	Complete
09 Nason Creek UWP Floodplain Reconnection - PUD Powerline Reconnection Alternatives Analysis	Chelan County NRD	General	Assessment	$53,500	$53,500	$45,569	Complete
09 Lower Wenatchee Instream Flow Enhancement	Washington Rivers Conservancy	General	Instream Flows	$4,954,466	$167,500	$167,499	Complete
10 White River Dally-Wilson Conservation Easement	Chelan-Douglas Land Trust	General	Protection	$194,000	$120,000	$120,000	Complete
10 Mission Creek Fish Passage	Cascadia Conservation District	Small	Fish Passage/Instrm Structures	$0	$0	$0	Cancelled
10 Assessing Nutrient Enhancement	CC Fisheries Enhancement Group	Small	Assessment	$9,875	$9,875	$6,670	Complete
11 Boat Launch Off-Channel Pond Reconnection	Chelan County NRD	General	Off-Channel Habitat	$136,500	$62,000	$62,000	Complete
11 White River Van Dusen Conservation Easement	Chelan-Douglas Land Trust	General	Protection	$440,000	$60,000	$60,000	Complete
12 Wenatchee Nutrient Enhancement - Treatment Design	CC Fisheries Enhancement Group	General	Assessment/Instream Structures	$240,000	$80,000	$80,000	Complete
12 White River Large Wood Atonement	CC Fisheries Enhancement Group	General	Instream Structures	$352,392	$100,000	$100,000	Complete
12 Lower White Pine Upper Connection B+	Chelan County NRD	General	Off-Channel Habitat	$2,162,290	$250,000	$0	On hold
12 Wenatchee Levee Removal & Riparian Restoration	Chelan County NRD	Small	Off-Channel Habitat	$67,450	$56,700	$20,386	Complete
14 Twisp to Carlton Reach Assessment	CC Fisheries Enhancement Group	General	Assessment	$173,016	$46,500	$46,483	In progress
14 Post Fire Landowner Assist/Habitat Protection	Methow Salmon Recovery Found	Small	Fish Passage	$100,000	$57,328	$50,796	Complete
14 Icicle Irrigation District Flow Control Structure	Chelan County NRD	General	Instream Flows	$140,633	$70,000	$30,653	Complete
14 Lehman Riparian Restoration	Methow Conservancy	Small	Riparian Habitat	$40,267	$9,053	$9,053	Complete
14 MVID Instream Flow Improvement	TU - Washington Water Project	General	Instream Flows	$9,747,000	$300,000	$112,438	In progress

Rock Island Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
15 Barkley Irrigation Company - Under Pressure	TU - Washington Water Project	General	Instream Flows	$3,293,180	$300,000	$0	In progress
15 White River Floodplain Connection (RM 3.4)	CC Fisheries Enhancement Group	Small	Off-Channel Habitat	$35,500	$35,500	$4,487	In progress
16 Icicle Creek-Boulder Field-Wild Fish to Wilderness	TU - Washington Water Project	General	Fish Passage	$1,571,189	$250,000	$0	In progress
16 Permitting Nutrient Enhancement in the Chiwawa	CC Fisheries Enhancement Group	Small	Assessment	$11,348	$11,348	$0	In progress
16 Peshastin Creek RM 10.5 PIT-Tag Detection Site	WA Dept of Fish & Wildlife	Small	Assessment	$66,859	$36,256	$0	In progress
Total				**$29,619,081**	**$3,867,852**	**$2,645,644**	

Current Rock Island Plan Species Account Balance (unallocated): $5,528,216
Contribution to the Rock Island Account is made annually (January 31): $485,200 (in 1998 dollars)

Rocky Reach Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 Entiat Instream Structure Engineering	Cascadia Conservation District	General	Instream Structures	$59,340	$59,340	$48,659	Complete
05 Twisp River Conservation Acquisition	Methow Salmon Recovery Found	General	Protection	$200,835	$40,000	$40,000	Complete
05 Clees Well and Pump	Okanogan Conservation District	General	Instream Flows	$40,875	$15,000	$14,924	Complete
05 Entiat Instream Habitat Improvements	Chelan County NRD	General	Instream Structures	$250,000	$37,500	$37,500	Complete
06 Entiat PUD Canal Juv Habitat Enhancement	Cascadia Conservation District	Small	Instream Structures	$23,640	$23,640	$3,059	Complete
07 LWD Removal & Relocation	Chelan County NRD	Small	Instream Structures	$5,000	$5,000	$871	Complete
07 LWD/Rootwad Acquisition & Transport	Cascadia Conservation District	Small	Instream Structures	$24,600	$24,600	$24,600	Complete
07 Harrison Side Channel	Chelan County NRD	General	Off-Channel Habitat	$797,300	$90,105	$68,647	Complete
08 Entiat PUD Canal Log-Boom Installation	Cascadia Conservation District	Small	Instream Structures	$10,660	$7,160	$4,526	Complete
08 Twisp River Riparian Protection (Buckley)	Methow Conservancy	General	Protection	$299,418	$89,825	$89,825	Complete
08 Below the Bridge	Cascadia Conservation District	General	Instream Structures	$398,998	$150,000	$115,353	Complete
09 Foreman Floodplain Reconnection	Chelan County NRD	General	Off-Channel Habitat	$0	$0	$0	Cancelled
09 Entiat NFH Habitat Improvement Project	Cascadia Conservation District	General	Off-Channel Habitat	$285,886	$61,373	$61,373	Complete
10 Methow Subbasin LWD Acquisition & Stockpile	Methow Salmon Recovery Found	Small	Instream Structures	$50,000	$50,000	$49,914	Complete
11 Chewuch River Permanent Instream Flow Project	TU – Washington Water Project	General	Instream Flow	$1,200,000	$325,000	$306,752	Complete
11 Christianson Conservation Easement	Methow Conservancy	Small	Protection	$16,350	$15,000	$15,000	Complete
12 Entiat Stormy Reach Phase 2 Acquisition	Chelan-Douglas Land Trust	General	Protection	$165,000	$46,800	$44,003	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection	$660,000	$0	$0	Cancelled

Rocky Reach Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
12 Nason Creek Lower White Pine Coulter Creek Barrier Replacement	Chelan County NRD	General	Fish Passage	$83,126	$12,469	$12,469	Complete
12 Nason Creek LWP Alcove Acquisition	Chelan-Douglas Land Trust	General	Protection	$353,000	$72,000	$72,000	Complete
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	$59,225	$180,950	$59,225	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	$674,600	$102,613	$68,982	Complete
13 Okanogan Basin Stream Discharge Monitoring	Colville Confederated Tribes	Small	Instream Flows	$90,954	$74,984	$65,515	In Progress
14 Silver Side Channel Design	CC Fisheries Enhancement Group	General	Design	$180,733	$132,000	$132,000	Complete
14 Similkameen RM 3.8 Design	Okanogan Conservation District	General	Design	$84,640	$84,640	$79,483	Complete
14 Entiat Stillwaters Gray Reach Acquisition	Chelan-Douglas Land Trust	General	Protection	$559,625	$174,000	$30,000	In progress
14 Clear Creek Fish Passage & Flow Enhancement	TU – Washington Water Project	Small	Fish Passage/Instrm Flows	$96,116	$69,500	$5,850	In progress
14 MVID Instream Flow Improvement	TU – Washington Water Project	General	Instream Flows	$9,747,000	$300,000	$0	In progress
15 Similkameen RM 3.8 Rehabilitation	Okanogan Conservation District	General	Instream Structures	$392,370	$67,370	$0	In progress
16 Lower Nason Creek KG Protection	Chelan-Douglas Land Trust	General	Protection	$192,500	$24,625	$0	In progress
Total				**$17,001,791**	**$2,335,494**	**$1,450,530**	

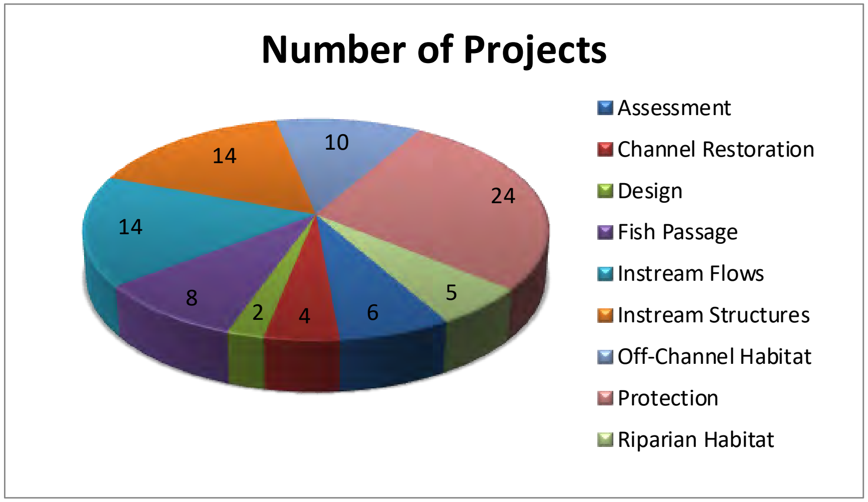
Current Rocky Reach Plan Species Account Balance (unallocated): $2,042,757
Contribution to the Rocky Reach Account is made annually (January 31): $229,800 (in 1998 dollars)

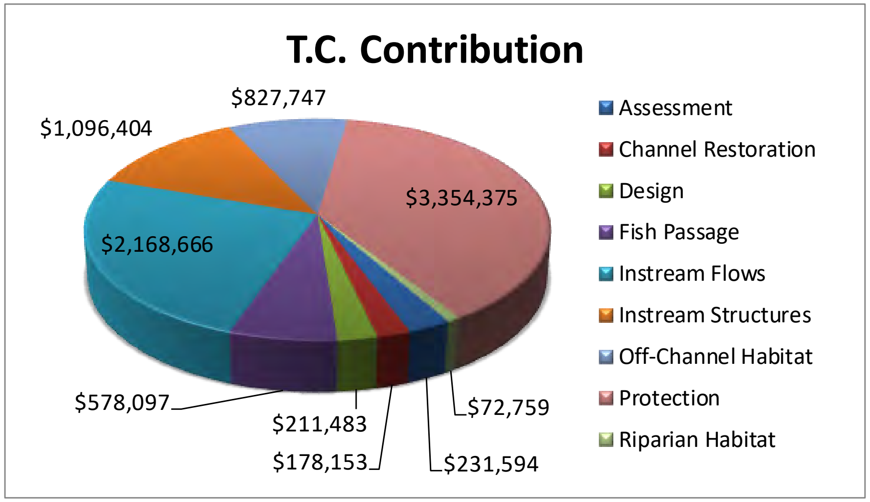
Wells Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 Okanagan River Restoration – Phase III	Okanagan Nation Alliance	General	Instream Structures	$219,121	$219,121	$197,681	Complete
05 Methow Riparian Protection (Heath)	Methow Conservancy	General	Protection	$2,684,500	$1,177,500	$812,700	Complete
05 Methow Riparian Protection (Prentice)	Methow Conservancy	General	Protection			$1,749	Complete
05 Methow Riparian Protection (MacDonald)	Methow Conservancy	General	Protection			$345,400	Complete
07 Lower Beaver Creek Livestock Exclusion	Okanogan Conservation District	Small	Riparian Habitat	$24,670	$18,559	$16,561	Complete
07 Heath Floodplain Restoration	Methow Salmon Recovery Found	Small	Off-Channel Habitat	$48,695	$48,695	$43,915	Complete
07 Okanogan River Restoration – Phase IV	Okanagan Nation Alliance	General	Instream Structures	$1,022,000	$411,000	$411,000	Complete
08 Riparian Regeneration & Restoration Initiative	Methow Conservancy	Small	Riparian Habitat	$22,737	$15,537	$15,537	Complete
08 Fort Thurlow Pump Project	Methow Salmon Recovery Found	Small	Instream Flows	$48,150	$7,000	$7,009	Complete
08 Goodman Livestock Exclusion Project	Okanogan Conservation District	Small	Riparian Habitat	$8,080	$7,980	$6,829	Complete
08 Poorman Creek Barrier Removal	Methow Salmon Recovery Found	General	Fish Passage	$191,579	$53,748	$53,748	Complete
08 Twisp River Riparian Protection (Pampanin)	Methow Conservancy	General	Protection	$119,720	$48,649	$48,649	Complete
08 Twisp River Riparian Protection (Neighbor)	Methow Conservancy	General	Protection	$260,000	$55,000	$55,000	Complete
08 Twisp River Riparian Protection (Speir)	Methow Conservancy	General	Protection	$79,976	$23,993	$23,993	Complete
10 Prevent Fish Entrainment on Inkaneep Creek	Okanagan Nation Alliance	Small	Instream Flows	$24,000	$0	$0	Cancelled
11 Methow River Acquisition MR 39.5 (Hoffman)	Methow Salmon Recovery Found	General	Protection	$195,048	$74,415	$74,415	Complete
11 Methow River Acquisition MR 48.7 (Bird)	Methow Salmon Recovery Found	General	Protection	$292,140	$111,680	$109,786	Complete
11 Methow River Acquisition MR 41.5 (Risley)	Methow Salmon Recovery Found	General	Protection	$148,210	$31,854	$26,518	Complete

Wells Plan Species Account							
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
12 Twisp River Acquisition 2011 (Hovee)	Methow Salmon Recovery Found	General	Protection	$140,700	$29,000	$1,074	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection	$660,000	$0	$0	Cancelled
12 Twisp River Well Conversion	Trout Unlimited	Small	Instream Flows	$87,739	$68,023	$68,023	Complete
13 Twisp River Poorman Crk Wetland Acquisition	Methow Salmon Recovery Found	General	Protection	$423,000	$338	$338	Cancelled
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	$180,950	$59,225	$59,224	Complete
13 Methow/Chewuch Groundwater Monitoring	Cascade Columbia Fisheries Enhancement	Small	Instream Flows	$34,180	$30,580	$29,962	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	$674,600	$102,613	$68,982	Complete
13 Lower Chewuch Beaver Restoration	Methow Conservancy	General	Off-Channel Habitat	$247,985	$27,000	$27,000	Complete
13 MVID Instream Flow Improvement Project	Trout Unlimited	General	Instream Flows	$9,747,000	$400,000	$201,553	In progress
14 Remove Collapsed Bridge from Shingle Creek	Okanagan Nation Alliance	Small	Channel Restoration	$8,193	$6,693	$6,689	Complete
15 Methow Watershed Beaver Reintroduction	Methow Salmon Recovery Found	General	Channel Restoration	$216,000	$33,500	$0	In progress
15 M2 Sugar Acquisition	Methow Salmon Recovery Found	General	Protection	$119,652	$15,185	$0	In progress
Total				**$17,928,625**	**$3,076,888**	**$2,713,335**	

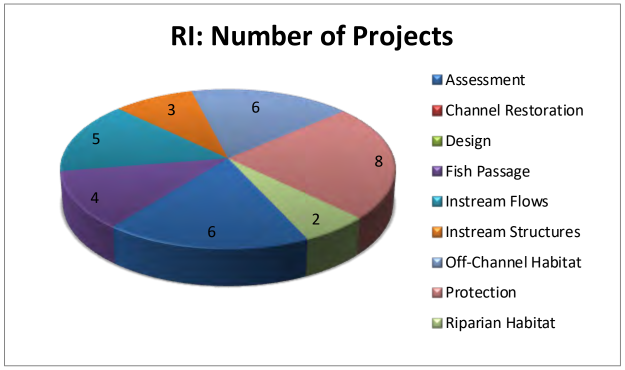
Current Wells Plan Species Account Balance (unallocated): $1,300,397
Contribution to the Wells Account will be made annually beginning in 2010: $176,178 (in 1998 dollars)

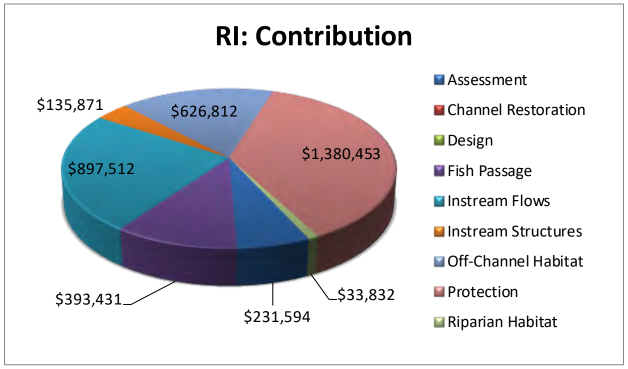
Projects Funded by the Tributary Committees

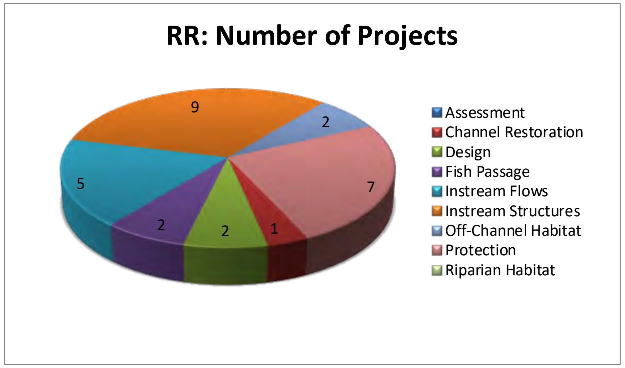


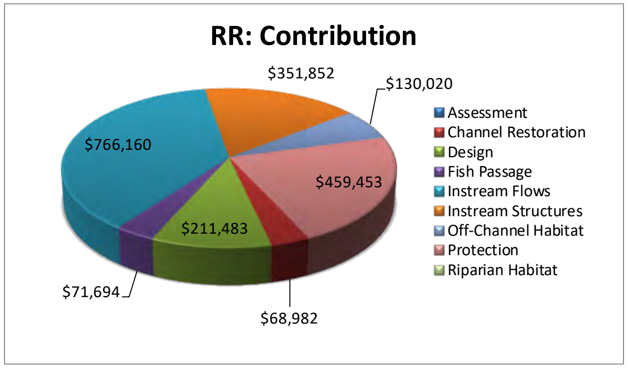


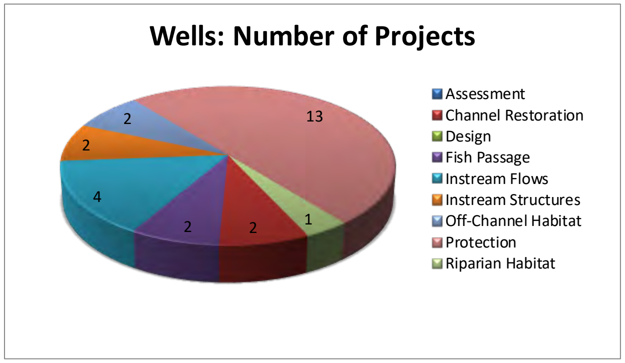
Projects Funded by each Plan Species Account

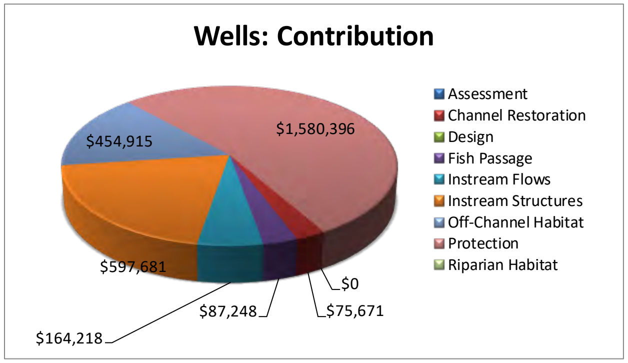












Attachment 2

Proposed 2016 SRFB/GSHP Process Schedule

DRAFT UPPER COLUMBIA SRFB/TRIB 2016 FUNDING SCHEDULE				
DATE	**ACTIVITY/MILESTONE**	**PARTICIPANTS**	**LOCATION**	**FACILITATOR/ COORDINATOR**
		MARCH		
March 8	Meeting/Webinar *Optional*: Salmon Recovery Grants Workshop	Sponsors, RCO	Online Webinar	RCO
March 9	Meeting *Optional*: Project preview RTT regular March meeting	Sponsors, RTT, TRIB	Wenatchee, TBD	RTT Chair
March 23	Meeting: SRFB/TRIB/BPA Kick-Off Meeting	LE, RTT, TRIB, Sponsors, RCO	Chelan, WA. Fire District	LE/RCO
March 31	**Deadline:** One paragraph project abstracts submitted to Lead Entity	Sponsors	Email	LE
		APRIL		
April 15	**Deadline:** Draft proposals due	Sponsors, LE, RCO, SRP, RTT, CAC, TRIB	PRISM	LE
		MAY		
May 4 & 5 Requested	Meeting/Tours: SRFB/TRIB Project Tours Okanogan (Wed) Methow (Thur)	Sponsors, LE, RTT, TRIB, SRFB SRP	TBD	LE
May 11 & 12 Requested	Meeting/Tours: SRFB/TRIB Project Tours Wenatchee (Wed) Entiat (Thur)	Sponsors, LE, RTT, TRIB, SRFB SRP	TBD	LE

DRAFT UPPER COLUMBIA SRFB/TRIB 2016 FUNDING SCHEDULE				
DATE	**ACTIVITY/MILESTONE**	**PARTICIPANTS**	**LOCATION**	**FACILITATOR/ COORDINATOR**
JUNE				
June 7	Presentations	RTT	TBD	RTT Chair
June 8	Meeting: RTT meets and provides questions and comments to sponsors	RTT	TBD	RTT Chair
June TBD	Action: SRP provides comments	SRP	Email via LE	RCO/SRP
June 9	Action: TRIB reviews draft proposals	TRIB	TRIB	TRIB
June 15	Action: RTT and TRIB provide comments	SRP, TRIB	Emails	RCO, TRIB
JULY				
July 1	**DEADLINE:** Final proposals due for Regional scoring and ranking	Sponsors, LE, RTT, CAC, TRIB	PRISM	LE
July 13	Action: RTT technical scoring	RTT, CAC, LE, BOR	RTT Meeting (Closed)	RTT
July 14	Action: TRIB reviews final proposals	TRIB	TRIB Meeting	TRIB
July 22	Action: TRIB Decisions	TRIB	Email/Letter	TRIB
Week of July 18th	Meetings/Presentations to Citizens: Chelan and Okanogan CAC's	Sponsors, CAC's, RTT, LE	Wenatchee Reclamation Dist. & TBD	LE
Week of July 25th	Meetings: CAC Project Rankings Chelan and Okanogan CAC's	CAC's, LE	Wenatchee Reclamation Dist. & TBD	LE

DRAFT UPPER COLUMBIA SRFB/TRIB 2016 FUNDING SCHEDULE

DATE	ACTIVITY/MILESTONE	PARTICIPANTS	LOCATION	FACILITATOR/ COORDINATOR
AUGUST				
August TBD	Meeting: Joint CAC approves Final Ranked Project List	Joint CAC, LE	Chelan PUD, Chelan WA	LE
August 10	Deadline: Sponsors PRISM upload	Sponsors, LE	PRISM	LE
August 12	Deadline: Regional List	LE	PRISM	LE/RCO
SEPTEMBER				
Sept 7	Deadline: Regional Submittal	LE	Email	LE
Sept 30	Action: SRP provides comments	SRP	Email via LE	SRP
OCTOBER				
Oct 13	Deadline: Response to comments from project sponsors to SRP	Sponsors, LE	Email via LE	LE
Oct 24-26	Meeting/Presentations: Sponsors present projects to SRP (*only projects identified*)	Select Sponsors, LE	Olympia, Washington	RCO
Nov 4	Action: SRP finalizes comments	SRP	Email via LE	SRP
NOVEMBER				
Nov 17	Final report by SRP to SRFB	RCO		RCO
DECEMBER				
Dec 7-8	Action: SRFB Decisions	SRFB	Olympia, WA	RCO

Acronyms
CAC- Citizen's Advisory Committee
BPA- Bonneville Power Administration
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

Timeline Legend	
Meetings	Blue
Deadlines	Red
Actions	Black

UC- Upper Columbia Region
UCSRB- Upper Columbia Salmon Recovery Board

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 14 April 2016

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator), Julene McGregor (Douglas PUD), Robes Parrish (USFWS), Jason Lundgren (CCFEG), Dave Duvall (Grant PUD), and Denny Rohr (PRCC Habitat Subcommittee Chair).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 14 April 2016 from 9:30 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

The Committees reviewed and approved the 10 March 2016 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported on the phases of the project that are still active. With regard to production wells, Back Drilling will finish up the remaining punch list. The initial startup will be around the first of May. The remaining punch list items for the West Side Piping were scheduled to be completed by the end of March. The West Side tree removal should be completed by the end of April. Finally, 66 of the 72 individual wells have been completed. The remaining six have been drilled and are waiting for pump installation and electrical hook up.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit the final report soon.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) provided no new updates on this project.
- Clear Creek Fish Passage and Instream Flow Project – In March, the sponsor (TU) began evaluating secondary well locations. They contacted Washington Department of Health to inquire about site approval. Once sites have been identified, the Chelan Douglas Health District will conduct a site inspection, create a field report, and send comments to the Office of Drinking Water in Spokane. A response from the hydrogeologist is expected soon. When the response is

received, the sponsor can move forward with one of the well locations or they may have to consider a less accessible location.

- Barkley Irrigation – Under Pressure Project – The sponsor (TU) held several coordination meetings with permitting agencies in March. They also held a kick-off meeting with Ecology on the water rights change.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported no new activity on the project. The sponsor provided their annual report, which discusses project accomplishments in 2015.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) did not provide an update on this project.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) has been working to finalize a WDFW right-of-entry permit, because the project is on WDFW property. The sponsor has also been working to finalize the JARPA. A site visit with the permitting agencies is scheduled for 5 May. In the coming weeks, the sponsor will develop a bid package and determine a construction timeline.
- M2 Sugar Acquisition Project – The sponsor (MSRF) reported that the appraisal is being reviewed. The project will be completed in May.
- Icicle Boulder Field Project – The sponsor (TU) reported that there was no new activity in March. The sponsor will be meeting with the technical advisory group in mid-May on final alternative selection. Becky sent the draft agreement to Trout Unlimited in January. A signed agreement has not yet been received.
- Permitting Nutrient Enhancement Project – The Tributary Committee/Sponsor (CCFEG) agreement is ready for signature.

IV. Tributary Committees Extranet Site

Mrs. Julene McGregor, Douglas PUD, gave a presentation on how to set up an account on the HCP Tributary Committees Extranet Site. Representatives and their alternates will have access to the site. She walked the Committees through the process of logging onto the site, navigating through the site, how to search for documents, and how to upload information. The Tributary Committees intend to use the site as a repository for agendas, final meeting notes, monitoring reports, PowerPoint presentations, correspondence with project sponsors, project proposals, and final reports from project sponsors, and photographs of projects.

V. White River Atonement Presentation

Robes Parrish, USFWS, and Jason Lundgren, CCFEG, gave a presentation on the White River Atonement Project (see Attachment 1). Robes described briefly the project, which included placement of log pilings in locations on the lower White River where wood would naturally accumulate. In 2014, they placed a total of 128 pilings and constructed 28 wood structures.

Since the installation of the piling, they have lost only five pilings, most of which were sheared off at the river bed. These structures have experienced 2-year, 5-year, and 10-year flow events. The structures have successfully racked wood and continue to provide habitat for salmonids in the White River. Robes showed time-lapse video (with music) indicating the evolution of some structures during high flow events. Overall, the project is meeting its goals.

VI. Okanogan Restoration Projects Presentation

Chris Fisher gave a presentation on restoration activities in the Okanogan River basin (see Attachment 2). He described six different projects.

- Reconnecting Side Channels at Conservancy Island. This is a two-phase project that includes reconnecting two different side channels at Conservancy Island. Chris talked about the process of reconnecting the channels and the monitoring efforts associated with the project. The High School Science class is involved with monitoring the effects of the project, including measuring changes in physical habitat, plant communities, and aquatic communities. Chris shared some results and trends in data over the last three years. The project appears to be working well and providing habitat for juvenile summer Chinook. Chris indicated that volunteers are welcome to join the next data collection effort at the end of April 2016.
- Irrigation Intake Screening. Chris indicated that a survey conducted in 2008 showed that 143 intakes were out of compliance. They began screening the intakes in 2011 and currently have only 12 left to screen. These will be completed this year.
- Cross Channel Project. In 2010, the Colville Tribes installed a grade structure in a cross channel that connects the Okanogan River with the Similkameen River. Before installing the grade structure, during low flows, the Okanogan River flowed into the Similkameen River via the cross channel. This resulted in the dewatering of about a two-mile stretch of the Okanogan River. The installation of the cross channel structure prevents the Okanogan from flowing into the Similkameen River during low flows. Thus, there is no longer any dewatering within the Okanogan River. Summer Chinook are now spawning within the portion of the Okanogan River that used to dewater.
- ORRI and Vertical Drop Structures. Chris briefly described the ORRI project and the modifications to a vertical drop structure on the Okanagan River in Canada. He also talked about the spawning ramps that were constructed within the Penticton Channel. These are projects that some members of the Committees visit annually in the fall.
- Pleasant Valley Water Users Association (PVWUA) Irrigation Canal. Chris talked about the water loss within the canal and a proposed action to conserve water. He said by eliminating the loss of water within the canal, they would eliminate the need for the Loup Loup Creek diversion.
- North Fork Diversion on Salmon Creek. Chris described a project to upgrade the N.F. Diversion on Salmon Creek. The proposed action would increase instream flows by 1,800 acre-feet.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in March and April:

   Rock Island Plan Species Account:

   - $37.50 to Clifton Larson Allen for Rock Island financial administration in March 2016.
   - $675.88 to Chelan PUD for project coordination and administration during the first quarter of 2016.

   Rocky Reach Plan Species Account:

   - $9,465.00 to the Colville Confederated Tribes for the Okanogan Basin Stream Discharge Monitoring Project. This was the final invoice for this project.

- $37.50 to Clifton Larson Allen for Rocky Reach financial administration in March 2016.
- $571.70 to Chelan PUD for project coordination and administration during the first quarter of 2016.

Wells Plan Species Account:

- $16,524.99 to Trout Unlimited for the MVID Instream Flow Improvement Project.
- $520.00 to Chelan PUD for project coordination and administration during the first quarter of 2016.

2. Tracy Hillman shared with the Committees the draft Upper Columbia 2016 SRFB/TC Funding Schedule. Important dates are as follows:
   - 15 April: draft proposals are due.
   - 5 May: project tours in the Methow basin.
   - 11-12 May: project tours in the Wenatchee and Entiat basins.
   - 8 June: presentations to SRFB Review Panel (members of the Tributary Committees are encouraged to attend the presentations).
   - 9 June: Tributary Committees review draft proposals and identify which proposals are fundable.
   - 15 June: Tributary Committees provide feedback to the project sponsors.
   - 1 July: final proposals are due.
   - 14 July: Tributary Committees review final proposals and make funding decisions.
   - 22 July: Tributary Committees provide feedback to the project sponsors.
3. Becky Gallaher reported that she contacted Cordell, Neher & Company regarding the audit of the Rock Island and Rocky Reach Plan Species Accounts. The accountant indicated that they can begin the auditing process on 20 April.

VIII. Next Steps

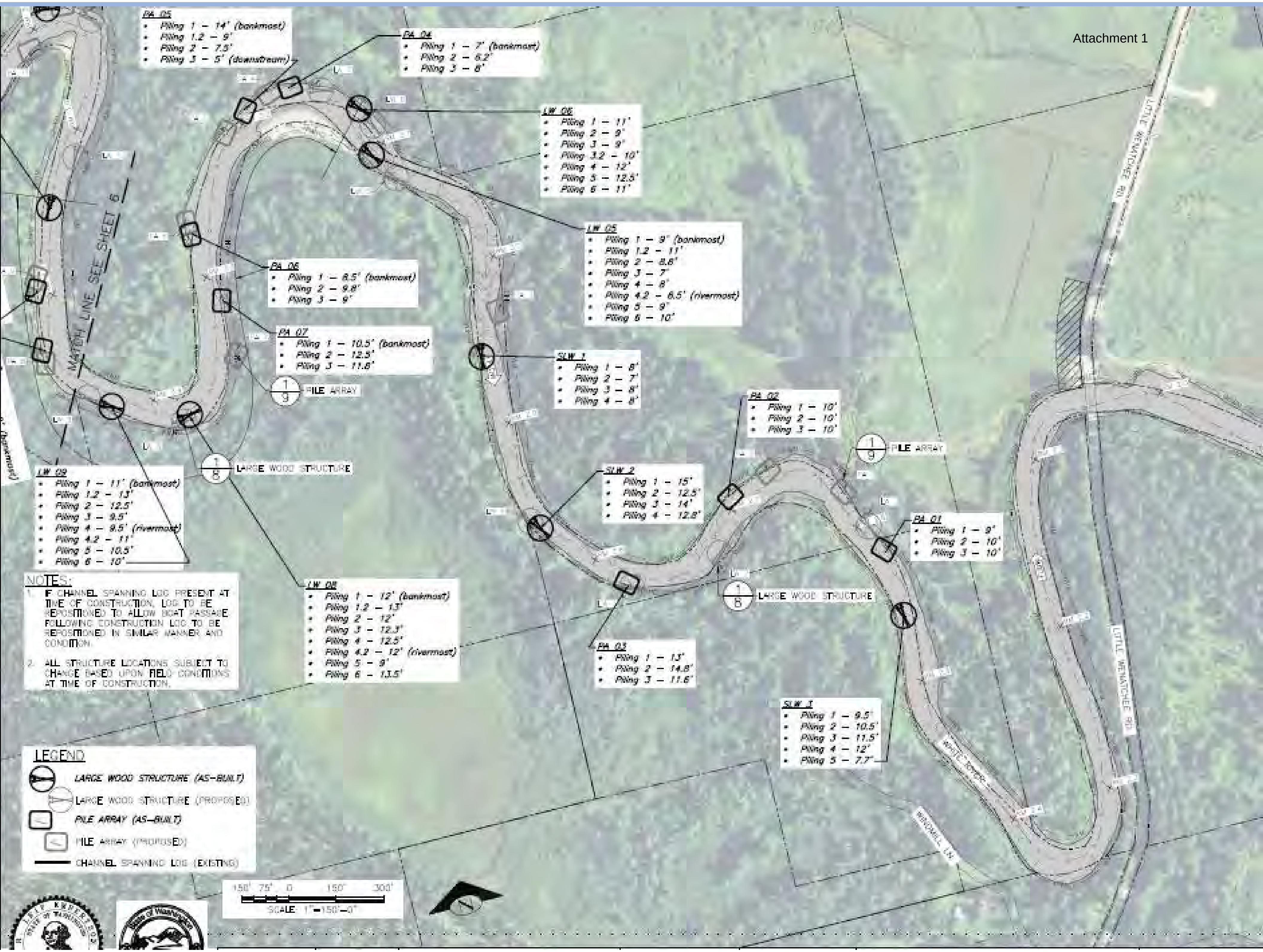
If necessary, the next meeting of the Tributary Committees will be on Thursday, 12 May 2016 at Grant PUD in Wenatchee. Project tours are also scheduled in May.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

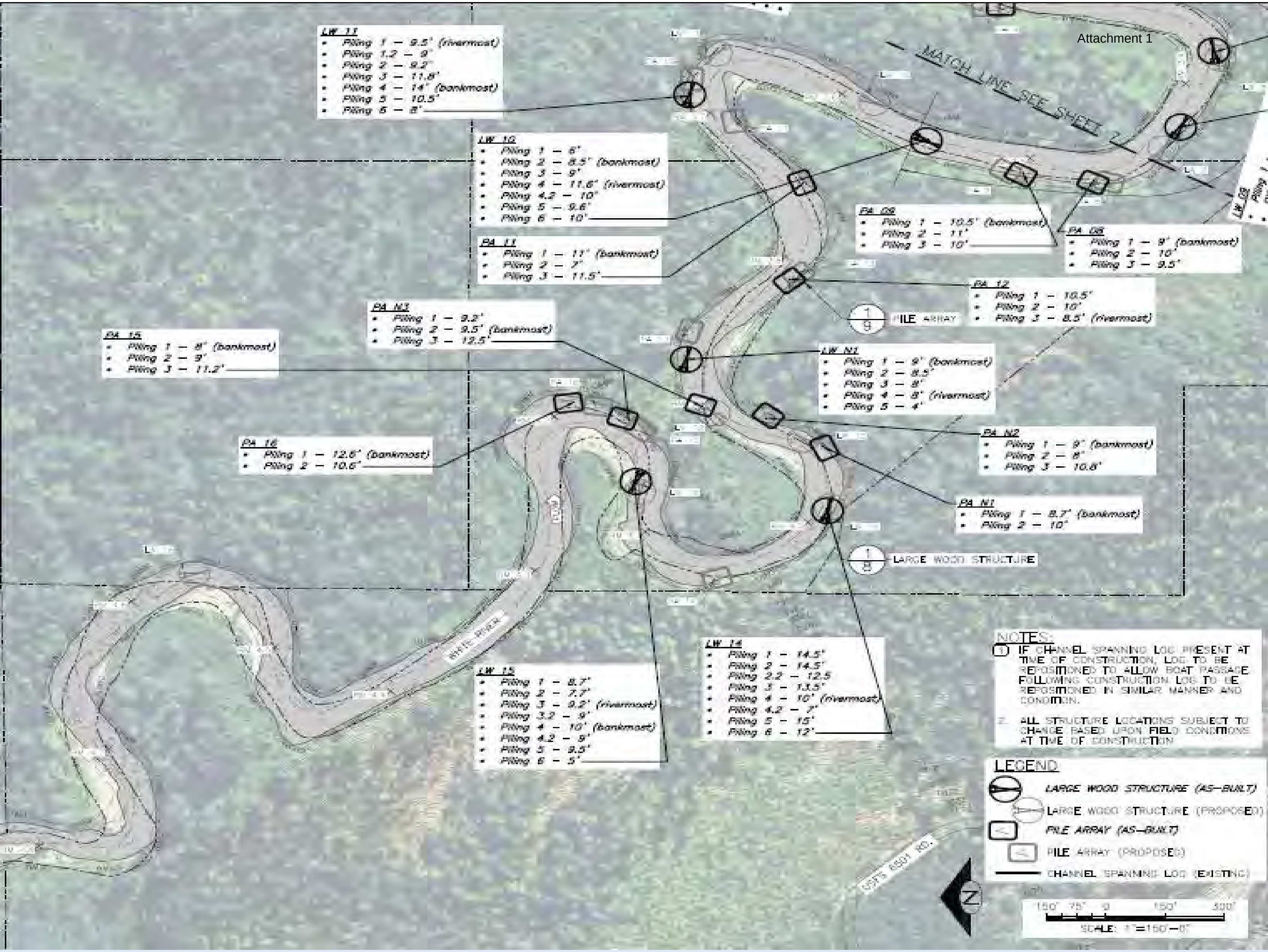
Summary:

- TRIB contribution $100k, Total budget ~ $500k incl. FWS in-kind
- Treated 1.6 miles of river (original proposal was for 3+ miles)
- Installation June 16 – July 31, 2014
- Helicopter seeding Sept. 16, 2014, 8am – noon, 50 whole trees, 20 bundles
- 128 pilings total, 28 structures—14 Large Wood (seeded from helicopter), 14 Pile Arrays
- Monitoring: effectiveness (TetraTech), bathymetry (pre-, 5yr post-), photogrammetry (2015), performance monitoring (FWS, CCGEG, ongoing)

Attachment 1



Attachment 1



Attachment 1

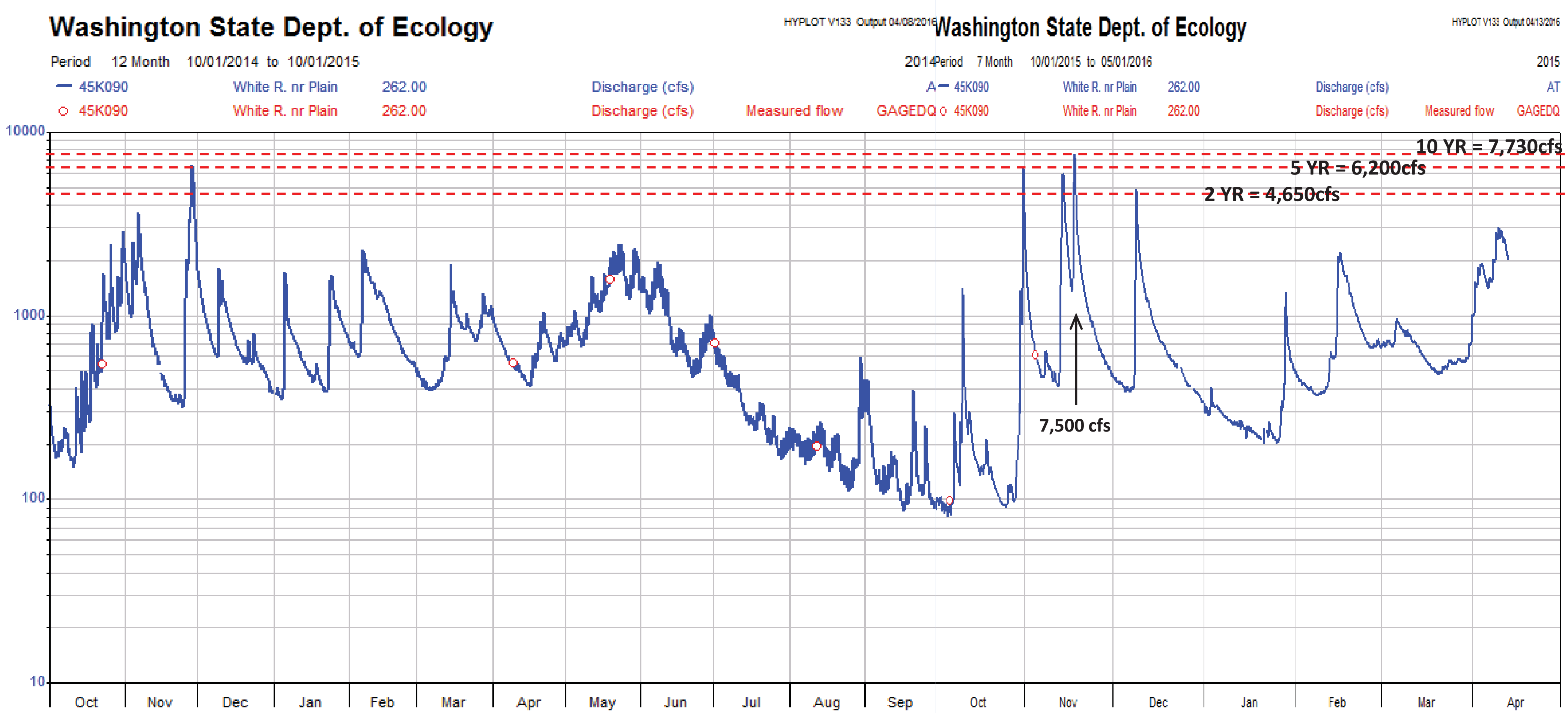

Pre-Construction


Mid-Construction


After-Construction

Attachment 1

Attachment 1



Attachment 1

Attachment 1

Attachment 1


August 2015

Attachment 1

Attachment 1

Attachment 1

Brief Post-Mortem (Nov. 2014 5+ year RI flood):

5 pilings lost, all at bare pile arrays

- LW14 (where channel spanner developed, piles pushed over) 3 piles were avg. 67% spec embedment, outer double was to 14.5 ft and still pushed over
- LW10 (where 2nd channel spanner developed, piles intact) 5 piles were avg. 60% spec embedment
- LW6 (considerable accumulation) structure avg. 71% spec embedment
- PA02 67% spec embedment, accumulated single log, lost outer piling

Lessons & Observations:

- Embedment depth not the only factor
- Double pilings do not convey 2x FOS if not structurally integrated
- Shielding effect of racked material?
- Forces vary considerably from bank > thalweg
- Scour does not seem to be an issue but soil cohesion is?
- Impact force potentially very significant?
- Pile diameter/material strength greater issue (shear)?
- Other forces (pinch & pull-out, channel spanning mass) very difficult to design for

Attachment 1

Attachment 1

Attachment 1

February 2016

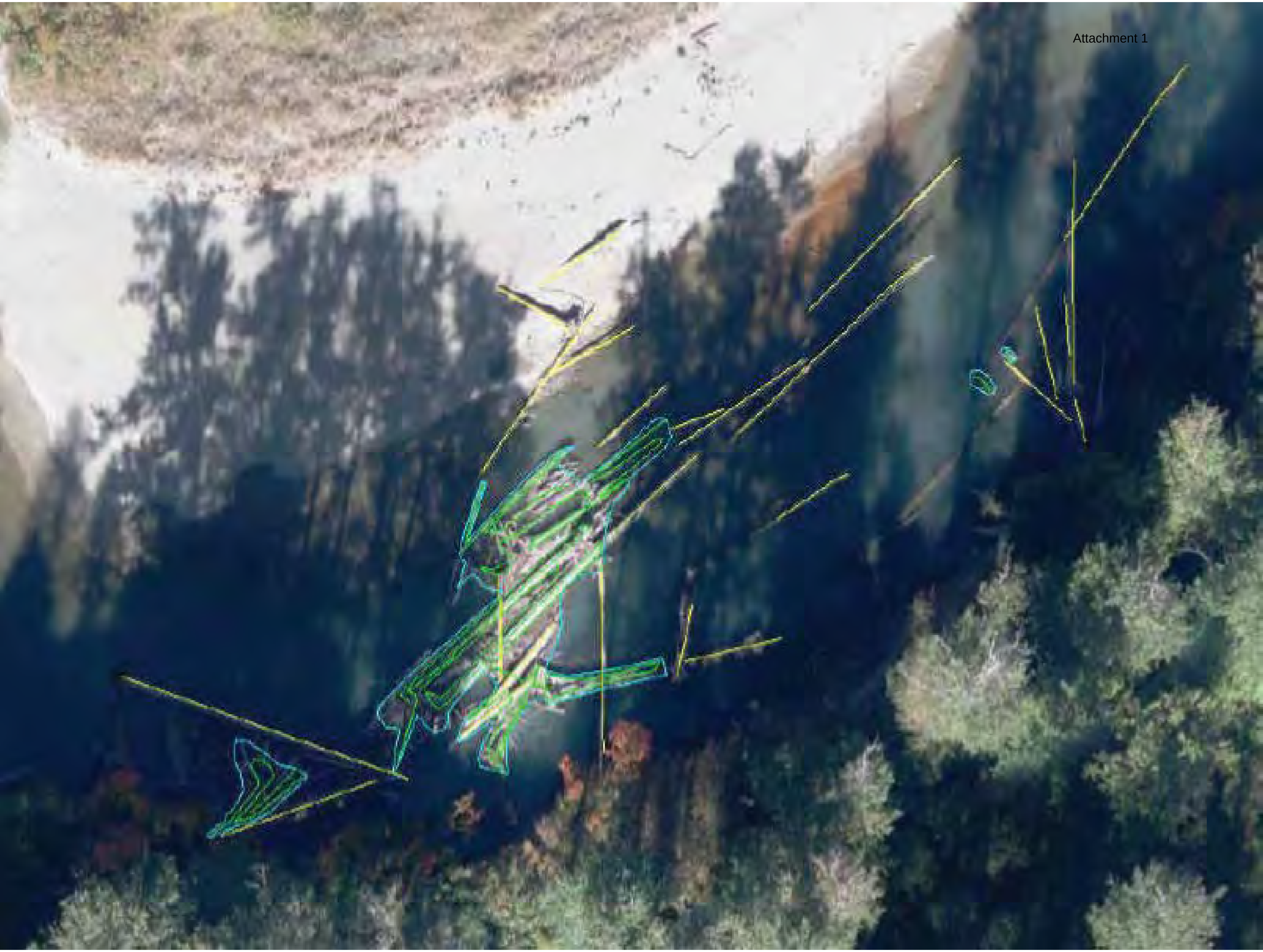
Attachment 1

Attachment 1

Attachment 1

Photogrammetry flown Sept. 27, 2015

Attachment 1



Attachment 1

Pile Name	Volume (Cu. M.)	Comments
PA 16	15.13	Individual logs
PA 15	1.88	Little debris
LW 15	23.85	Several logs above surface
LW 14	51.84	Two distinct piles
PA N1	0.37	Small pile
PA N2	140.35	Large debris pile, some logs above surface
PA N3	30.46	Medium debris pile
LW N1	9.95	Several logs above surface
PA 12	0.27	Two small logs
PA 11	57.65	Medium woody pile
LW 11	21.11	Medium woody pile, several logs above surface
LW 10	39.37	Medium woody pile, several logs above surface
PA 09	3.36	Small debris pile
PA 08	1.45	Single log, partially above surface
LW 09	74.01	Two piles, some logs above surface
LW 08	32.19	Some logs above surface
PA 07	17.32	Small debris pile, several logs above surface
PA 06	0.00	No entrained debris
PA 05	12.69	Individual logs
PA 04	19.66	Large entrainment, some logs above surface
LW 06	68.02	Medium debris pile, some logs above surface
LW 05	29.69	Medium debris pile, extends onto bank
SLW 1	5.70	Small volume, extensive mud bank
SLW 2	61.61	Medium debris pile, extends onto bank
PA 03	0.00	No entrained debris
PA 02	1.51	Two logs
PA 01	1.58	Small entrainment
SLW 3	41.95	Medium debris pile, extends onto bank

Control Reach = 146.38 m^3
Treatment Reach = 75.77 m^3

Attachment 1

Attachment 2

Selected Habitat Rehabilitation Projects within the Okanogan River sub-basin.

April 14, 2016

Presented to HCP Tributary Committee & PRCC Habitat sub-committee members

Contributors: Chris Fisher, Dennis Papa, John Rorhback

Projects -

Side Channel Reconnection at Conservancy Island

Screen Irrigation Intakes

Cross Channel Project

Okanogan River Restoration Initiative (ORRI) – I & II

Spawning Platforms – Penticton Channel

Canal piping for Pleasant Valley Water Users - Loup Loup Creek

N. F. Diversion on Salmon Creek

Conservancy Island

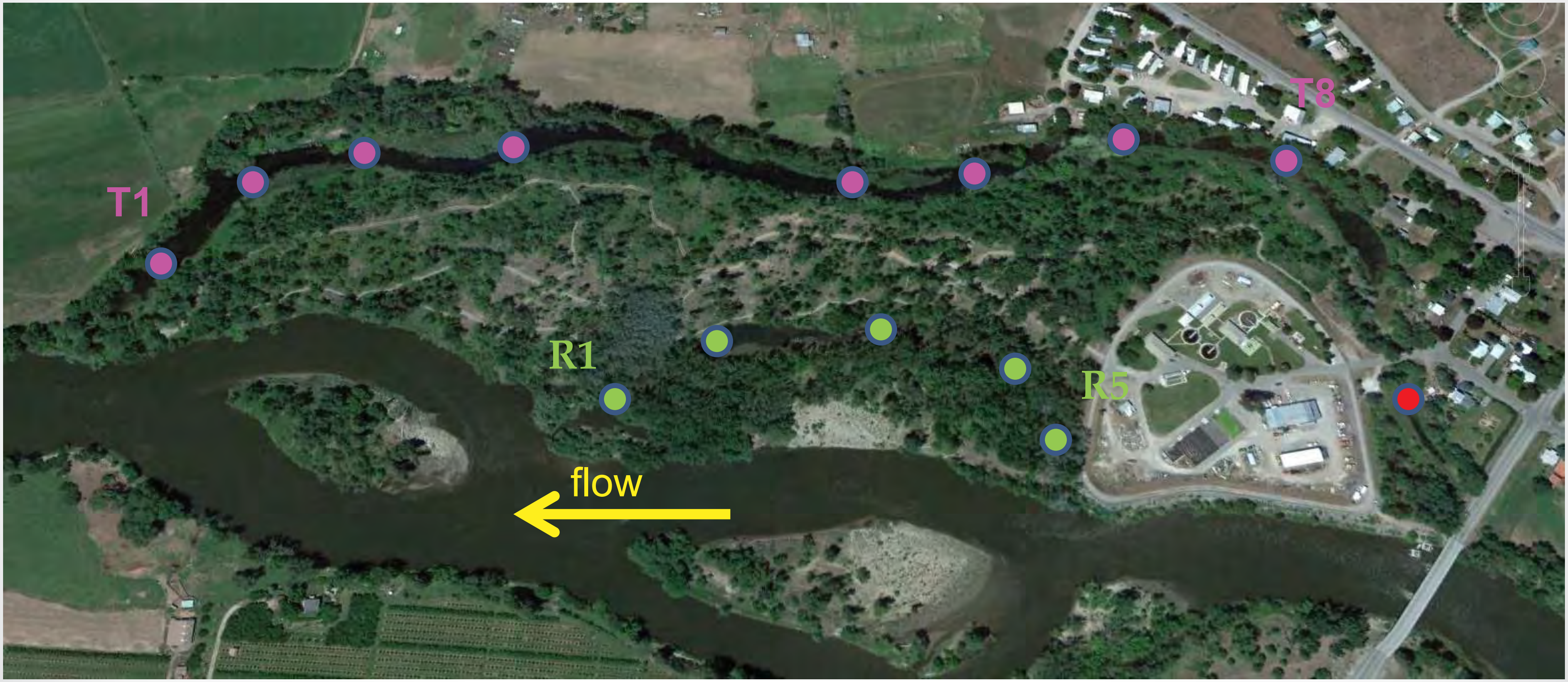
Relict channel at the entrance (looking downstream)

October 2014

March 2015

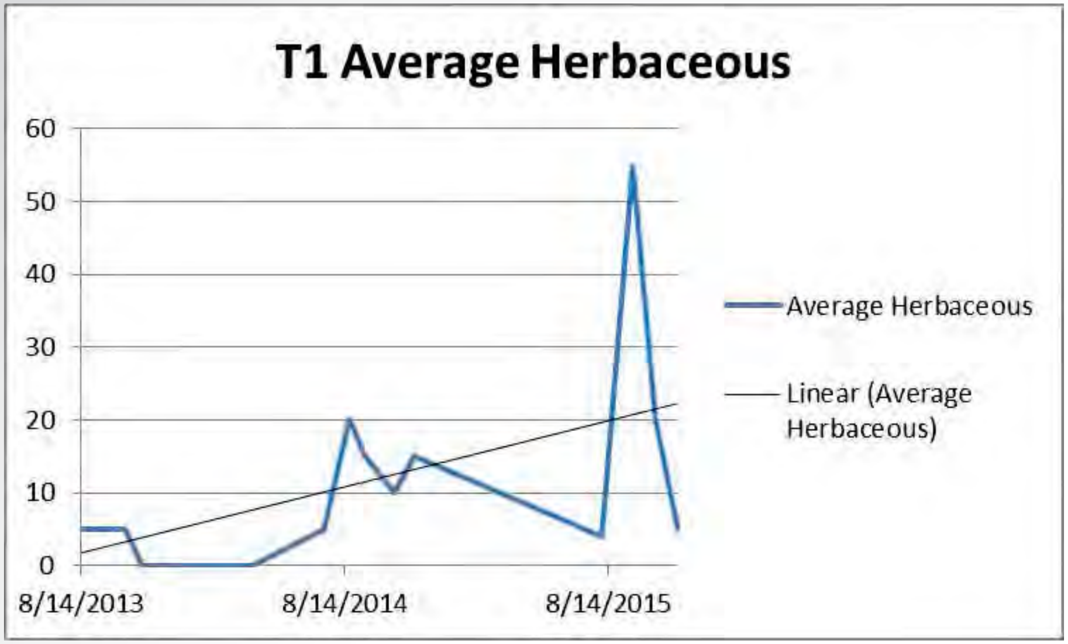
Cursory fish sampling of relict channel April 15, 2015.

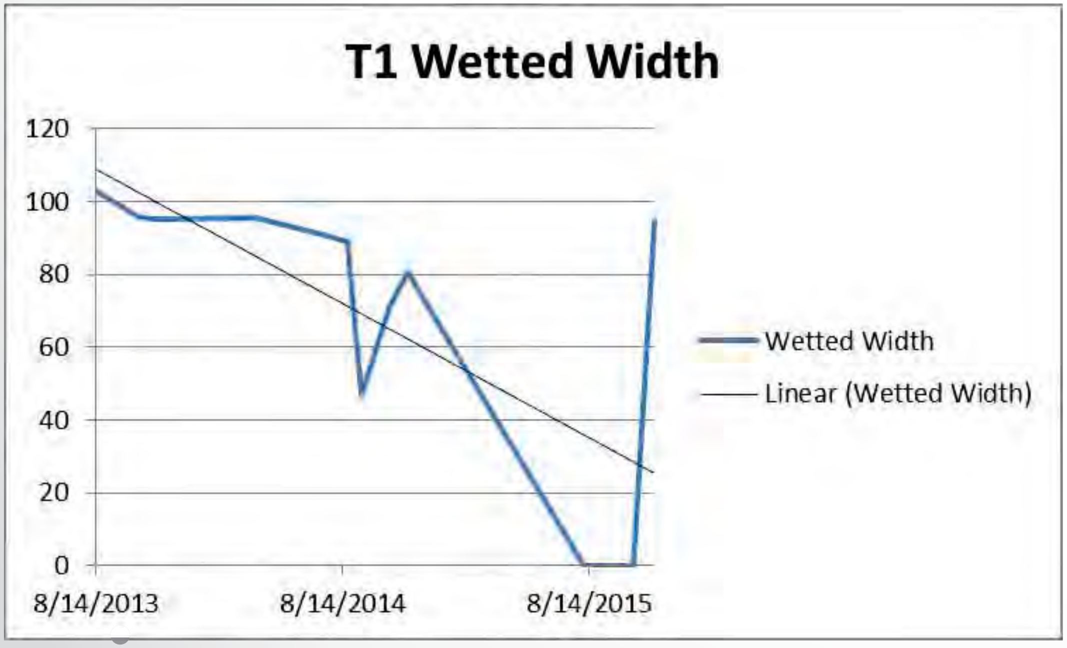
Effectiveness Monitoring

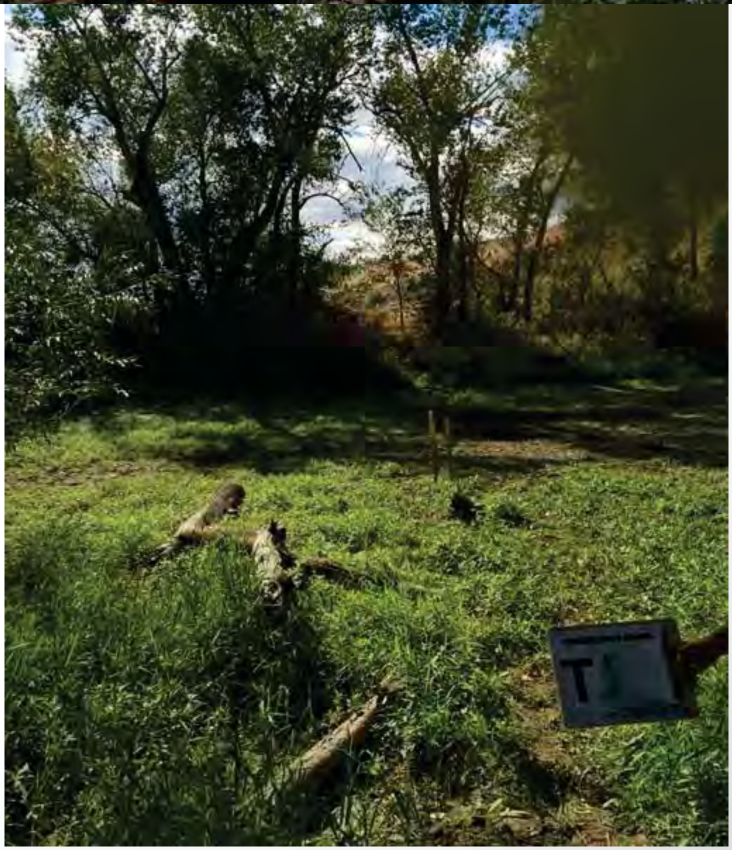


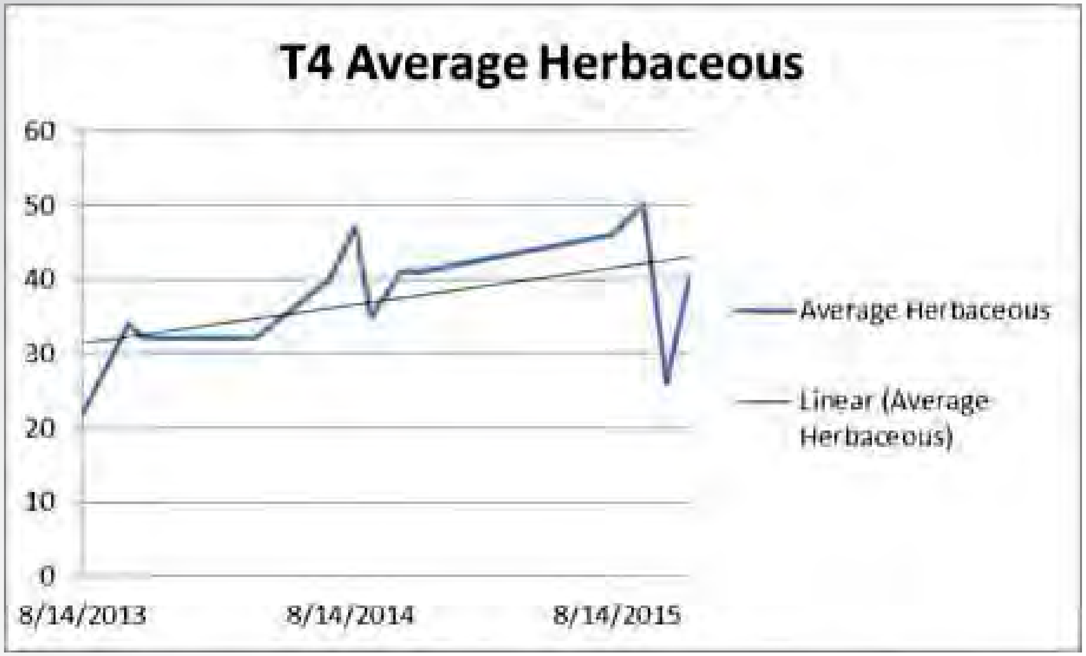
Effectiveness Monitoring

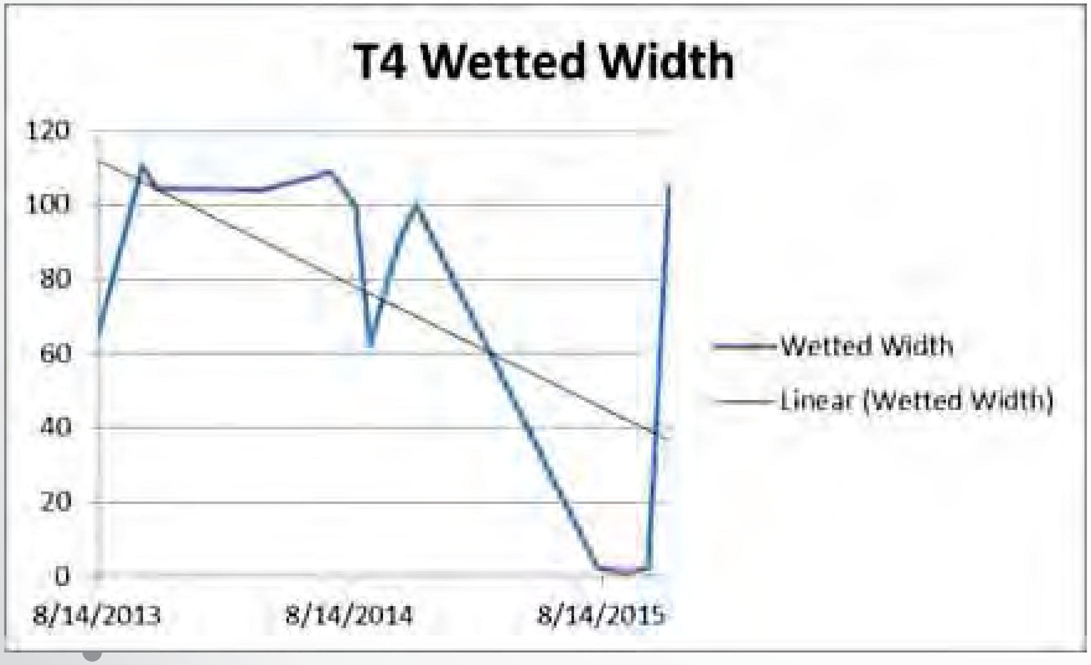
- Physical habitat
  - Photo point
  - Wetted width
  - Substrate
- Plant community
  - Woody Vegetation
  - Herbaceous vegetation
  - Canopy closure
- Animal community
  - Macroinvertebrates
  - Fish


T1 Average Herbaceous
60
50
40
30
20
10
0
8/14/2013
8/14/2014
8/14/2015
Average Herbaceous
Linear (Average Herbaceous)

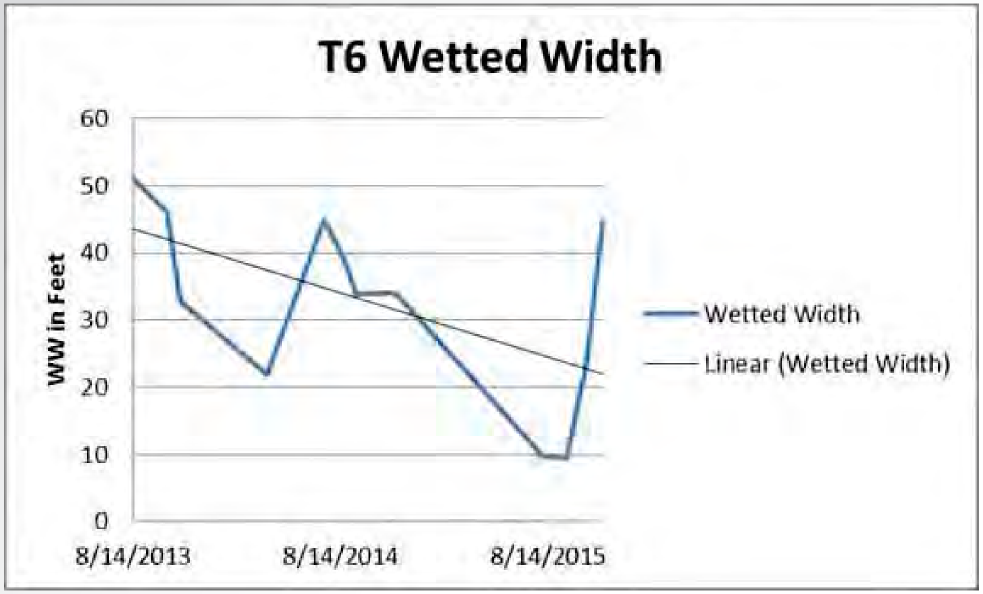

T1 Wetted Width
120
100
80
60
40
20
0
8/14/2013
8/14/2014
8/14/2015
Wetted Width
Linear (Wetted Width)



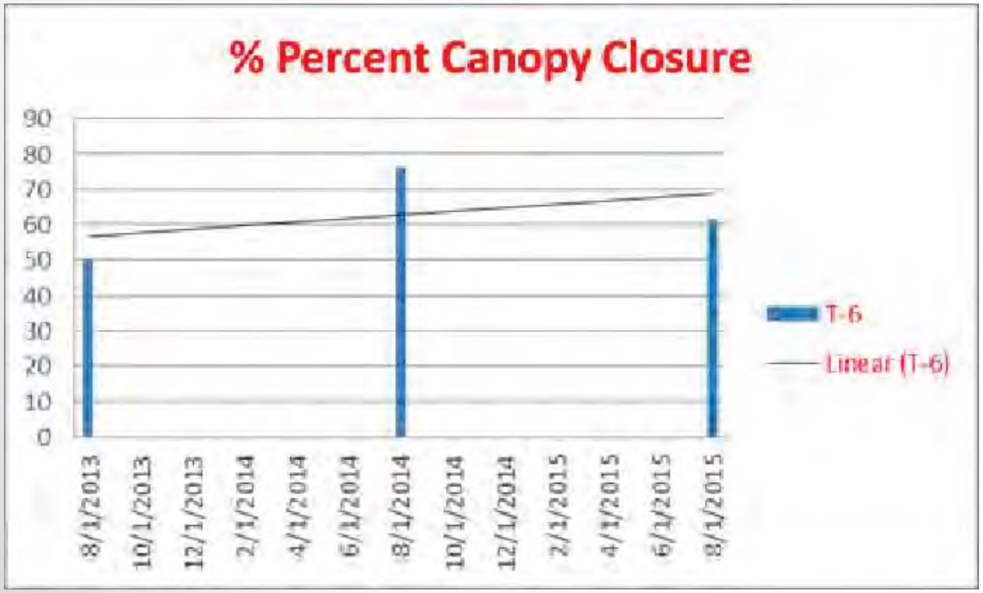

T4 Average Herbaceous
60
50
40
30
20
10
0
8/14/2013
8/14/2014
8/14/2015
Average Herbaceous
Linear (Average Herbaceous)


T4 Wetted Width
120
100
80
60
40
20
0
8/14/2013
8/14/2014
8/14/2015
Wetted Width
Linear (Wetted Width)


T4

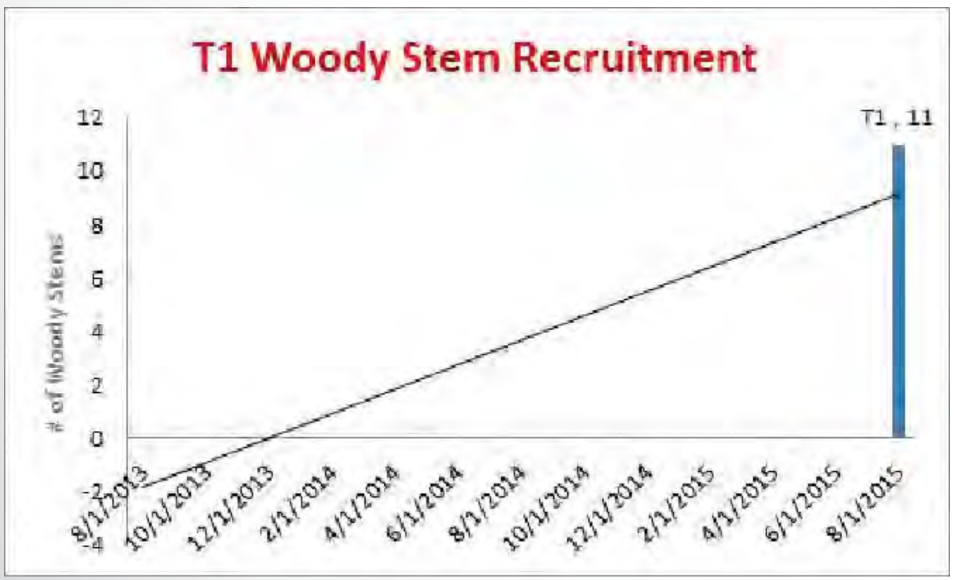

T6 Wetted Width
WW in Feet
60
50
40
30
20
10
0
8/14/2013
8/14/2014
8/14/2015
Wetted Width
Linear (Wetted Width)


8/21
T6


% Percent Canopy Closure
90
80
70
60
50
40
30
20
10
0
8/1/2013
10/1/2013
12/1/2013
2/1/2014
4/1/2014
6/1/2014
8/1/2014
10/1/2014
12/1/2014
2/1/2015
4/1/2015
6/1/2015
8/1/2015
T-6
Linear (T-6)


CONSERVANCY ISLAND
T 6
9/21/15


T1
7/19/2014


T1 Woody Stem Recruitment
# of Woody Stems
12
10
8
6
4
2
0
-2
-4
T1, 11
8/1/2013
10/1/2013
12/1/2013
2/1/2014
4/1/2014
6/1/2014
8/1/2014
10/1/2014
12/1/2014
2/1/2015
4/1/2015
6/1/2015
8/1/2015

August 2015

Relict Channel reconnection was completed in the fall of 2014, actual reconnection with the Okanogan River occurred in February of 2015 at a river stage of 2800 + CFS.
Replanting with native seed mix combined with woody cuttings every 8 feet were completed in March of 2015, natural vegetative recruitment far outstripped those efforts on site. Physical habitat data collected at the relict channel just completed the first season.

Strong Cottonwood natural regeneration throughout the Relict Channel, Willow and Poplar were also well represented. Shown below is a monitored succession plot along the Relict Channel on transect 2.

Macroinvertebrate collection indicates a positive biologic response;

Indicator species such as Mayfly have shown a steady increase, notable is that in 2015, T1 and T2 were affected by record warm weather and were seasonally de-watered limiting colonizing habitat, despite less habitat total numbers of Mayfly larva collected were significantly greater in the reach as a whole.

Collected Oct,17 2013	
Order	Ephemeroptera
Family/HBI score	Leptophlebiidae -2
HBI Score	2
T-1	
T-2	
T-3	
T-4	
T-5	
T-6	1
T-7	
T-8	
T-9	
Total Specimines	1
BI Score Tally	2

Collected Sept / Oct 2014	
Order	Ephemeroptera
Family/HBI score	Leptophlebiidae -2
HBI Score	2
T-1	
T-2	2
T-3	
T-4	6
T-5	1
T-6	10
T-7	
T-8	
T-9	1
Total Specimines	20
BI Score Tally	40

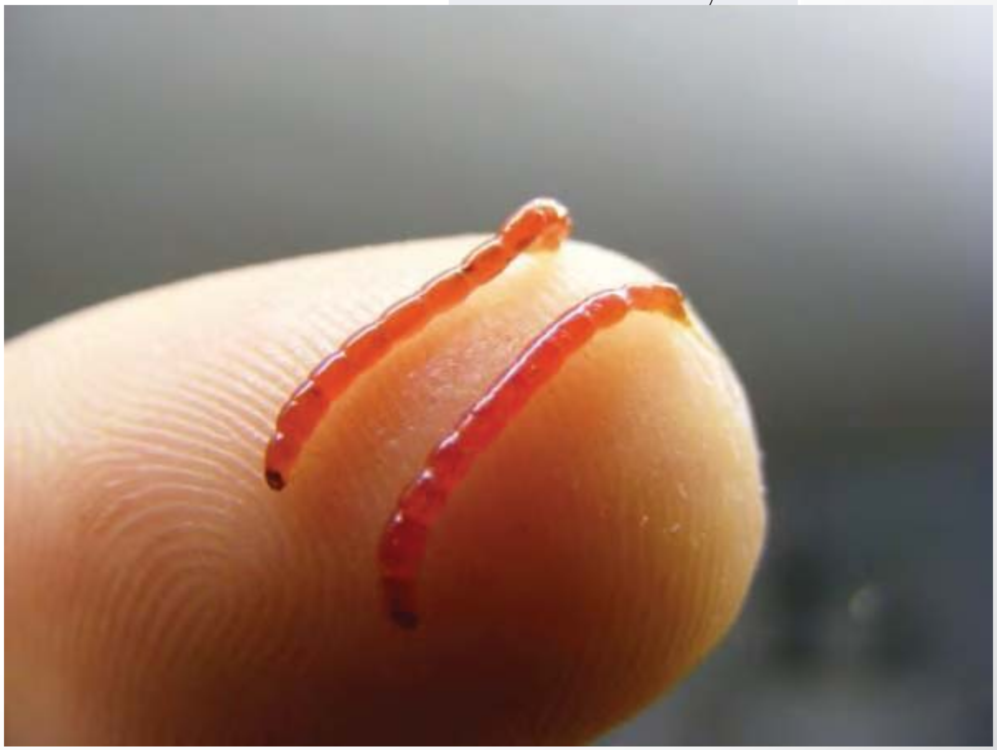
Collected Sept / Oct 2015	
Order	Ephemeroptera
Family/HBI score	Leptophlebiidae -2
HBI Score	2
T-1	
T-2	
T-3	10
T-4	1
T-5	2
T-6	8
T-7	
T-8	3
T-9	3
Total Specimines	27
BI Score Tally	54

Collected Oct,17 2013	
Order	Diptera
Family/HBI score	Chironomidae - 8
HBI Score	8
T-1	
T-2	1
T-3	1
T-4	8
T-5	11
T-6	5
T-7	
T-8	2
T-9	
Total Specimines	28
BI Score Tally	224

Pollution tolerant species maintain a stable population while pollution intolerant species colonize new habitat; Increased species richness of macroinvertebrates provides more food opportunities for juvenile Salmonids, in addition to being an important bio indicator.

Collected Sept / Oct 2014	
Order	Diptera
Family/HBI score	Chironomidae - 8
HBI Score	8
T-1	3
T-2	2
T-3	
T-4	
T-5	
T-6	3
T-7	9
T-8	5
T-9	16
Total Specimines	38
BI Score Tally	304

Collected Sept / Oct 2015	
Order	Diptera
Family/HBI score	Chironomidae - 8
HBI Score	8
T-1	
T-2	
T-3	3
T-4	4
T-5	6
T-6	7
T-7	9
T-8	3
T-9	1
Total Specimines	33
BI Score Tally	264



Fish Sampling;

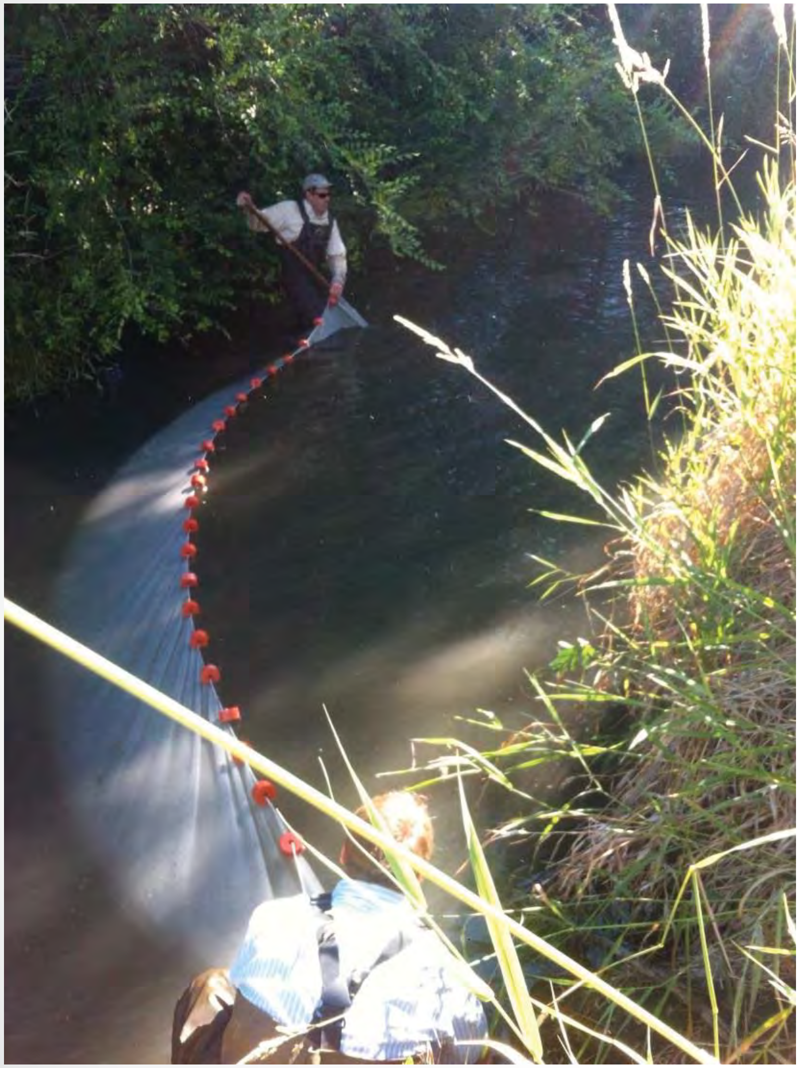
Electrofishing
Seining
Minnow Traps

Early Electrofishing efforts in the side channel produced the presence of the following species;

Bullfrog Tadpole
Bullhead
Tench
Pumpkinseed
Carp
Three Spined Stickleback
Bluegill
Large and Smallmouth Bass
Crayfish
Crappie

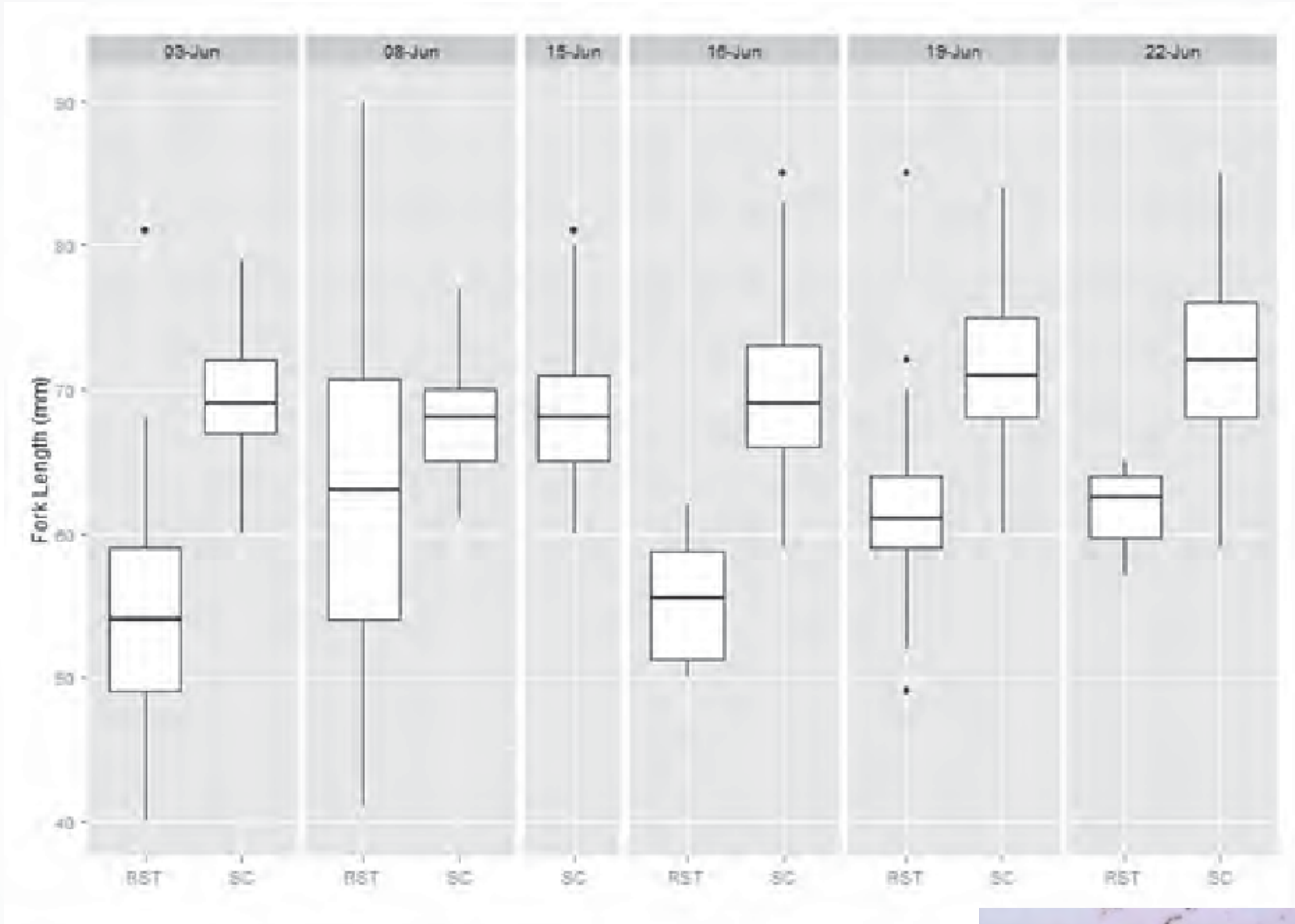
2015, after opening upstream side channel culvert, seining produced sub-yearling Chinook juveniles and Three Spined Stickleback

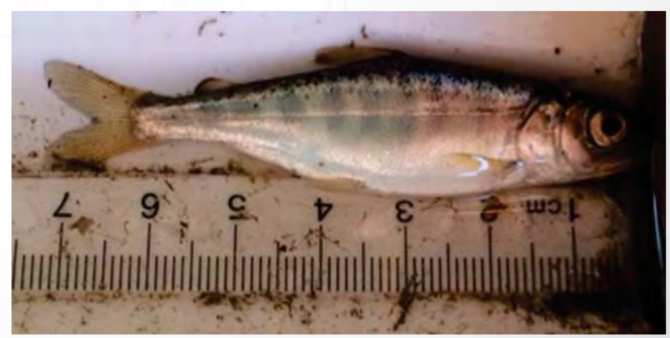
In the Spring of 2015 Sein efforts in the Side Channel resulted in over 1,100 PIT tagged Chinook Juveniles. Work and evaluation on Conservancy Island continue in an effort to restore natural process to the Side Channel, it is encouraging to see utilization occur as soon as new habitat became available.



River: the Rotary Screw Trap (RST) and the Conservancy Island Side Channel (SC) .

Fish caught in the side channel were consistently larger than fish caught in the RST.

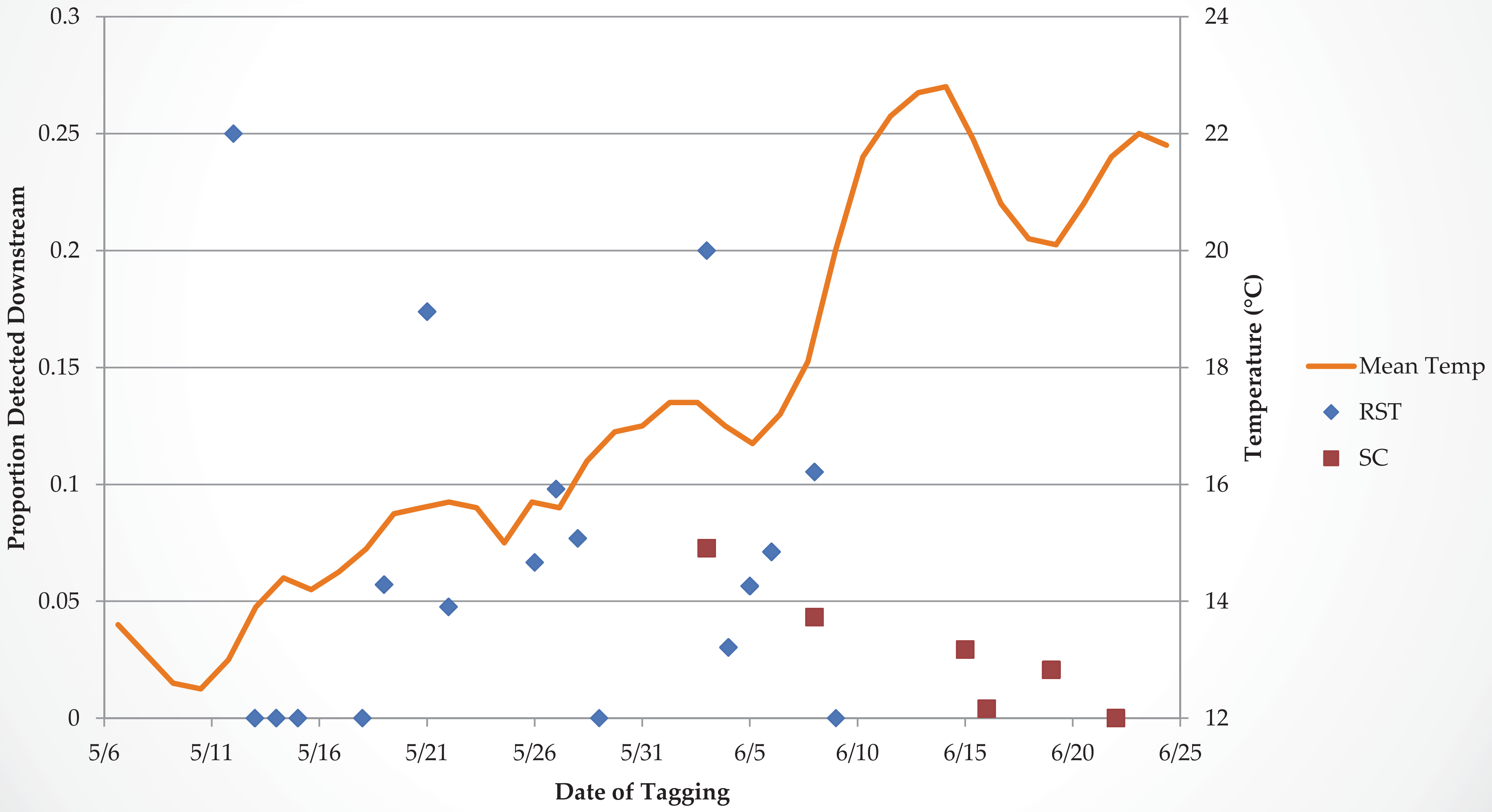


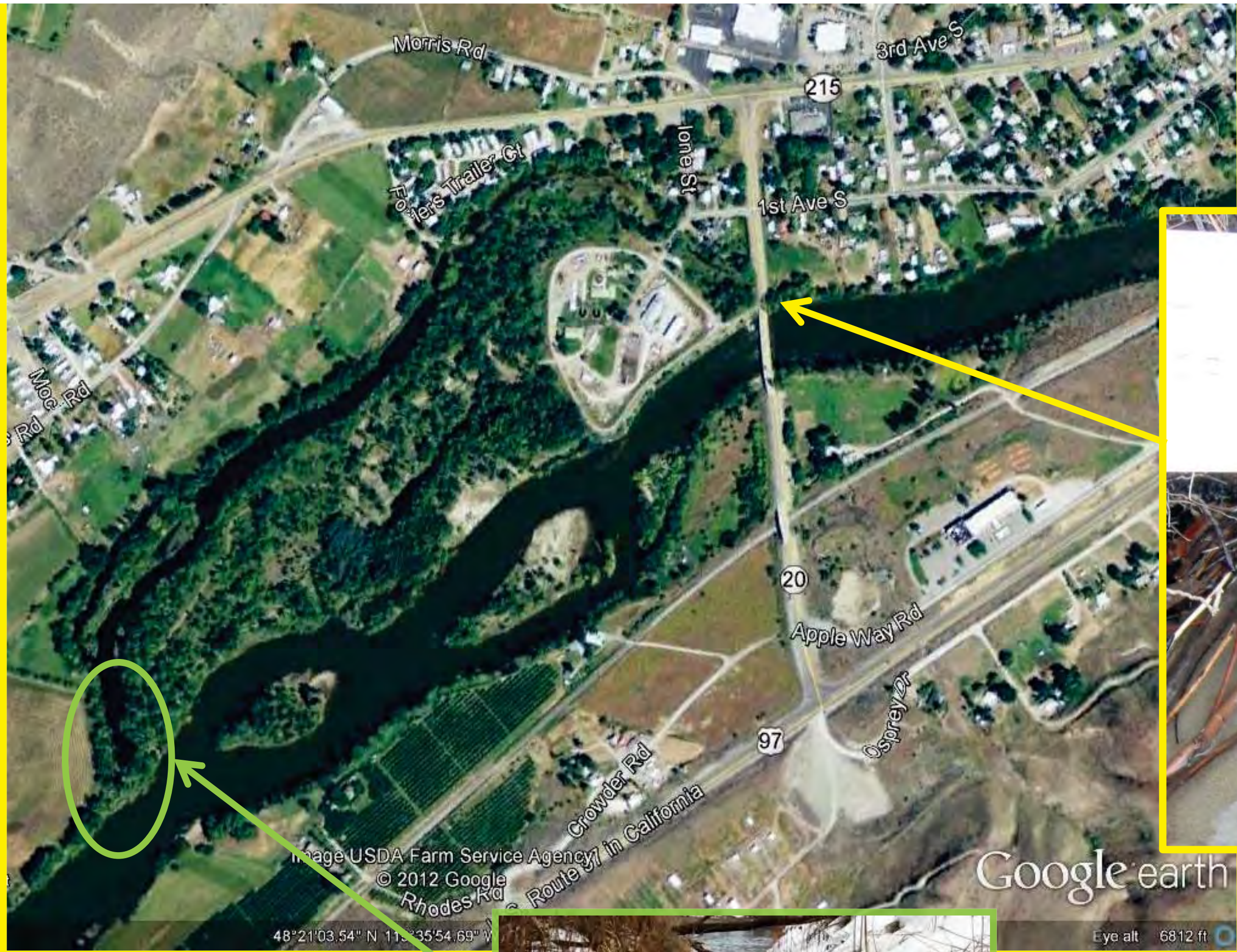


RST-tagged fish were detected downstream in higher numbers and at higher rates than SC-tagged fish.

LOCATION	SC (n=1179)	RST (n=786)	RST after 1-Jun (n=570)
OKL	5	11	4
RRJ	17	33	24
MCJ		6	6
JDJ	1	3	3
BCC	1	4	2
Total Unique	24	53	36
% Detected	2.0	6.7	6.3

Rates of downstream detection varied, and for SC fish, it decreased as the season progressed.





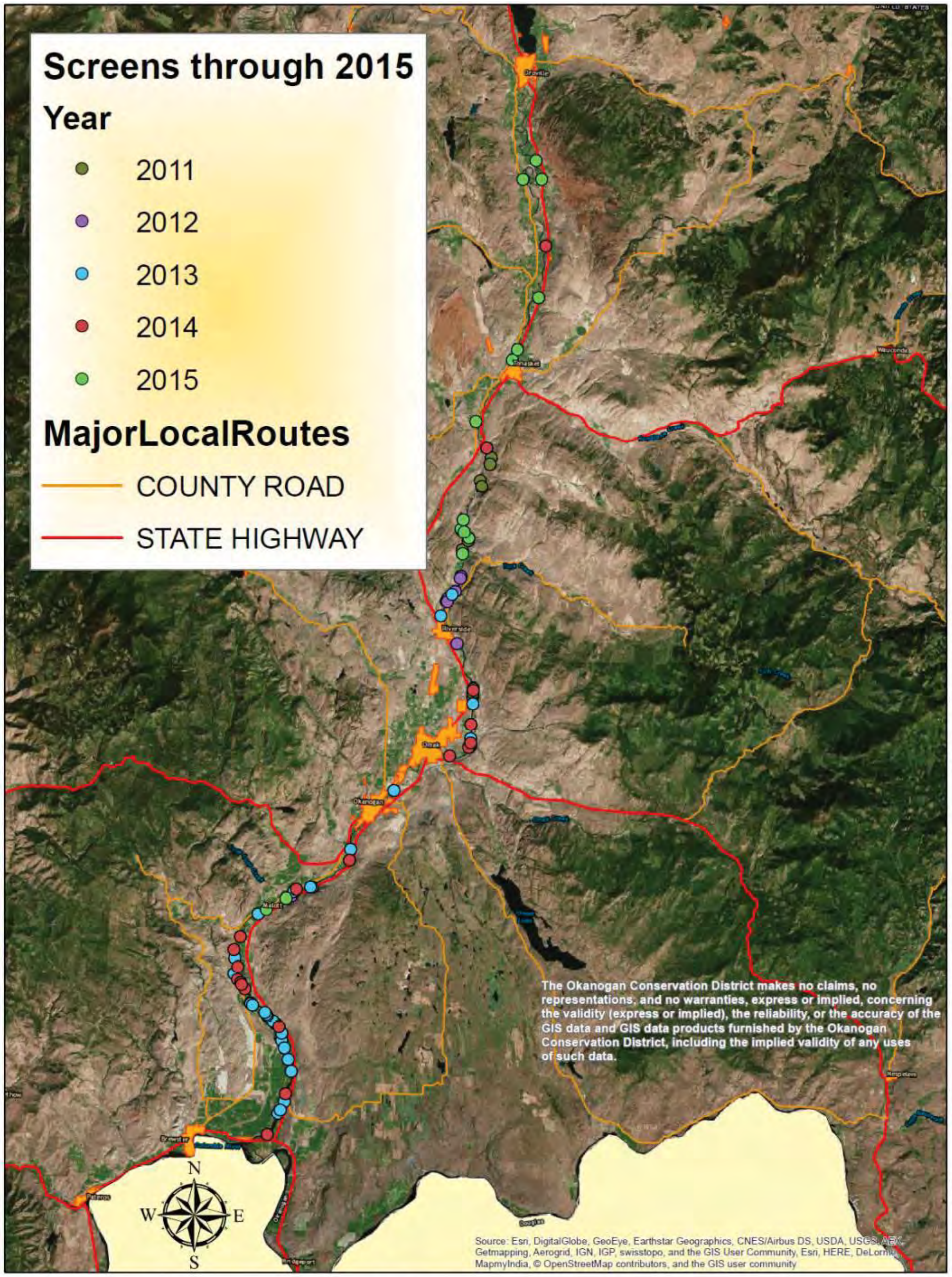
This 176 feet of 24 inch culvert was cleaned and opened in 2015 providing access for emigrating juveniles

Future efforts will consider widening of outlet to increase discharge, reduce ponding. Installation of PIT array at outlet.

Irrigation Intake Screens -

- Survey conducted 2008
- Initially 143 screens out of compliance
- Screen installation initiated 2011
- 17 screens installed in 2015
- Approximately 12 intakes remain

Attachment 2



Okanogan River Pump Screens

Okanogan Conservation District

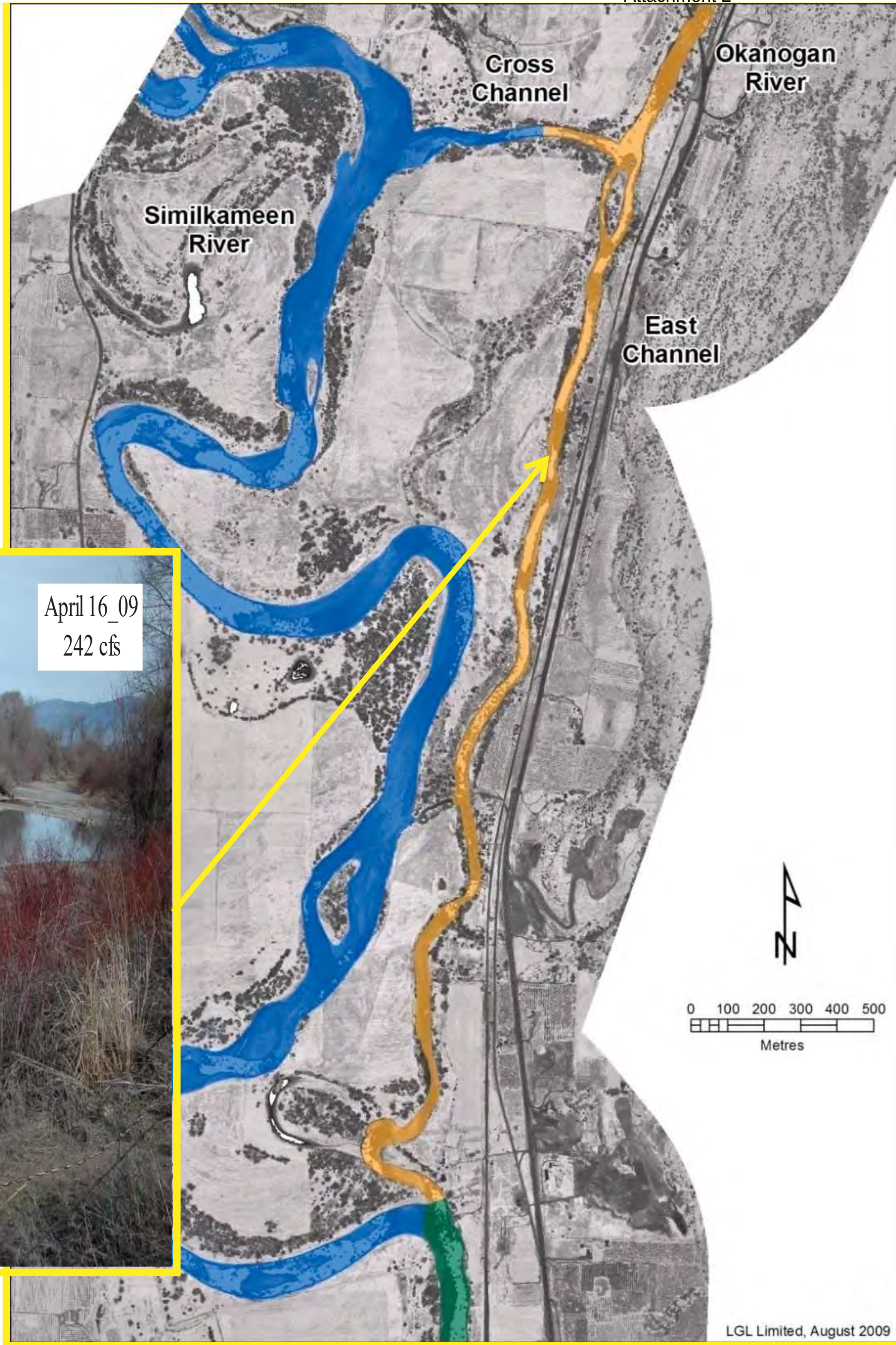
North American Datum 1983, Universal Transmercator Zone 11 North

SOURCES: Okanogan County GIS, WDFW, Okanogan Conservation District

February 18, 2016
Cartographer: Bob Clark

Cross Channel Project -

- Survey conducted 2008
- Constructed in 2010
- Prevented dewatering of ~ 2 miles Okanogan River

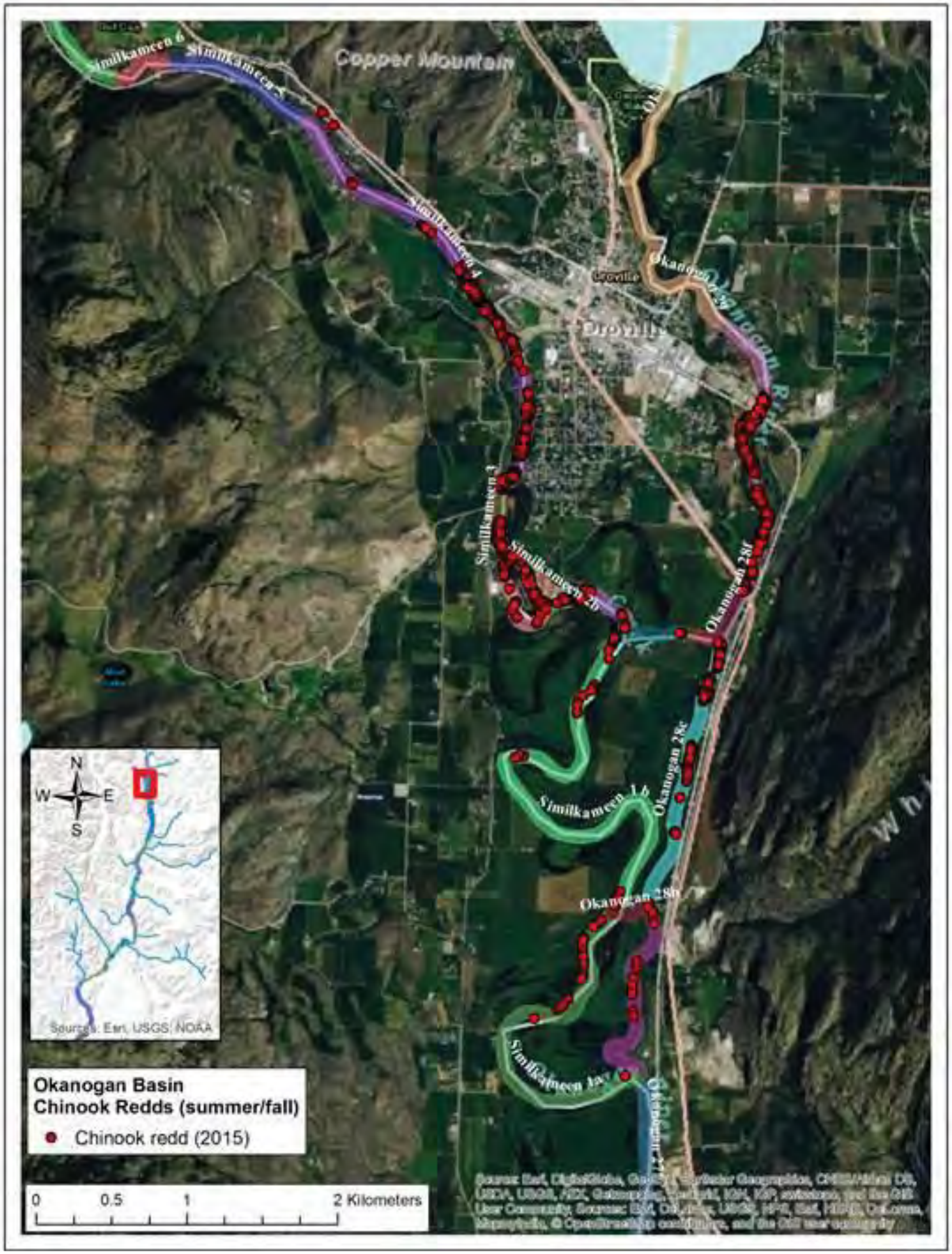


October 2010

September 2010

Summer Chinook redd distribution 2014

Attachment 2



Okanagan River Restoration Initiative (ORRI): Phase 1, 2 & Modification of Vertical Drop Structure 13

Attachment 2

Penticton, BC (pre- 1953)

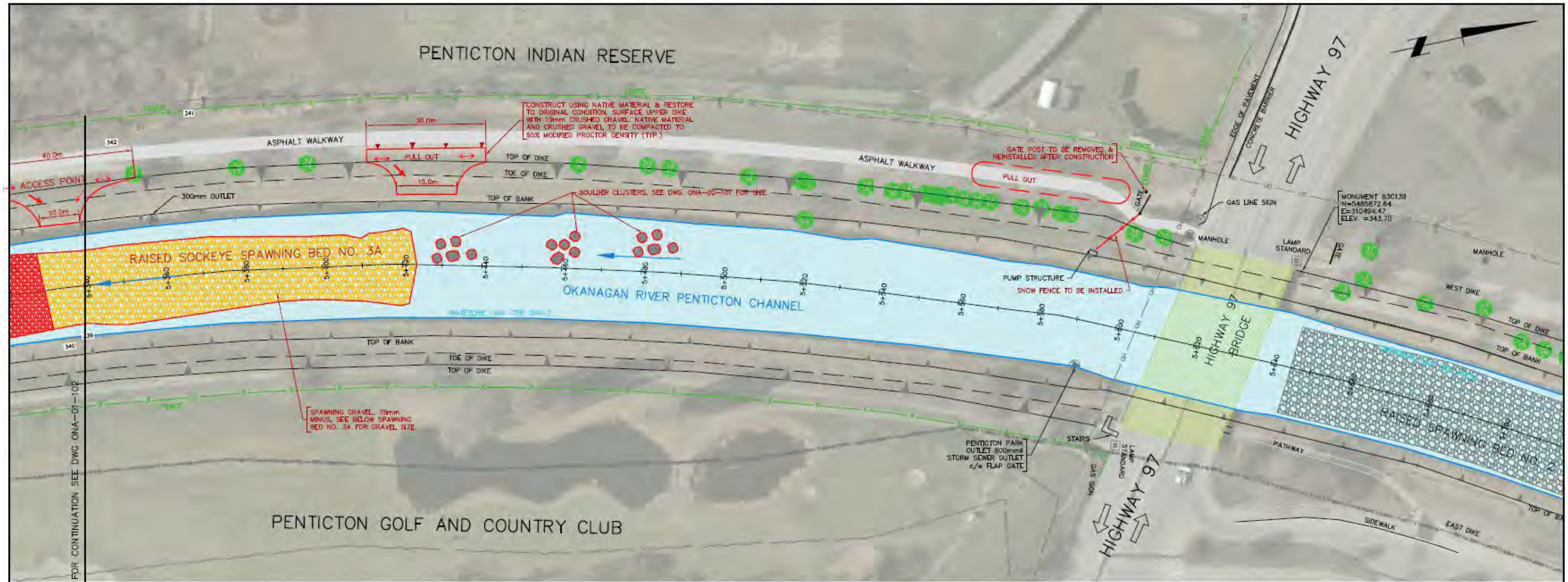
Attachment 2

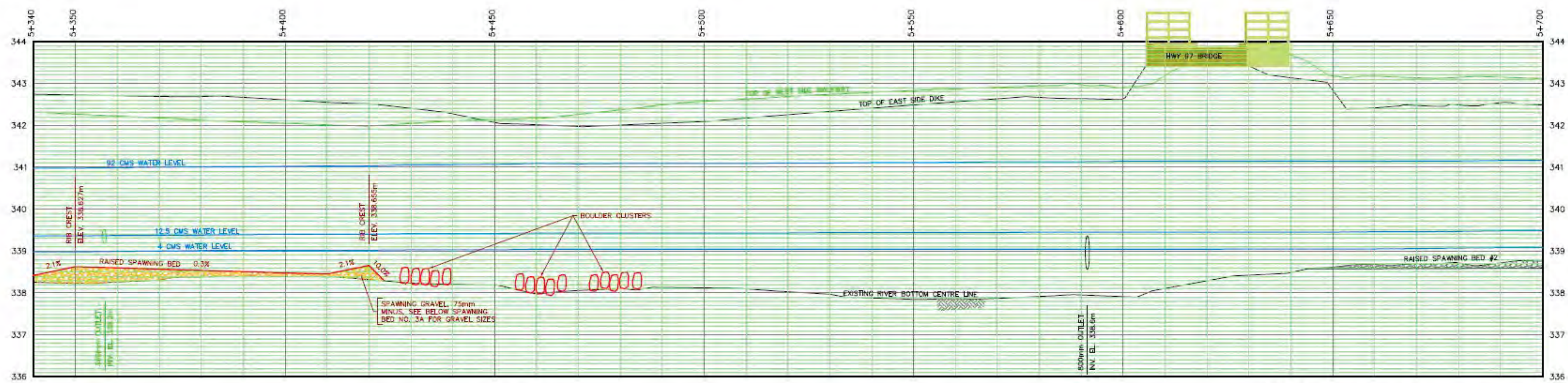
Spawning Platforms No. 1 and No. 2

Construction of Spawning Platforms 1 & 2 (September 2014)

Sockeye utilizing Spawning Platform 2
(October 2014)

Attachment 2





SPAWNING BED NO. 3A & 3C

GRAVEL SIZES			
PERCENT LARGER	PERCENT SMALLER	AVERAGE DIAMETER (mm)	WEIGHT (kg)
0	100	75	0.4
25	75	50	0.13
100	0	19	0.01

SPAWNING BED NO. 3B

GRAVEL SIZES			
PERCENT LARGER	PERCENT SMALLER	AVERAGE DIAMETER (mm)	WEIGHT (kg)
0	100	50	0.13
50	50	25	0.02
100	0	19	0.01

BOULDERS

BOULDER SIZE			
PERCENT LARGER	PERCENT SMALLER	AVERAGE DIAMETER (mm)	WEIGHT (kg)
0	100	800	750
100	0	500	180

NOTES:

1. SURVEY CONDUCTED BY MANDEVILLE LAND SURVEYING INC. IN JANUARY AND MARCH 2015. ELEVATION BASED ON PENTICTON MONUMENT #83H6727. STATIONS AND TRAVERSE LINE FROM B. SCHUBERT SURVEY (#A-5221-19), 1980.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. JANUARY WATERLINE SURVEYED FLOW = 7.4 CMS.
4. WATER PROFILES SHOWN ARE FROM HEC-RAS MODELING OF PROPOSED SPAWNING PLATFORM.

LEGEND

FENCE
TOP OF BANK
POWER POLE
TREES
IRON PIN

NO.	DATE	BY	REVISION	CH'KD	ENG.
A	SEPT. 2015	S.W.	ISSUED FOR CONSTRUCTION		
	APRIL 2015	S.W.	ISSUED FOR APPROVAL		

Mould Engineering
567 Lawrence Avenue, Kelowna, B.C. V1Y 6L8
Telephone 868-2072

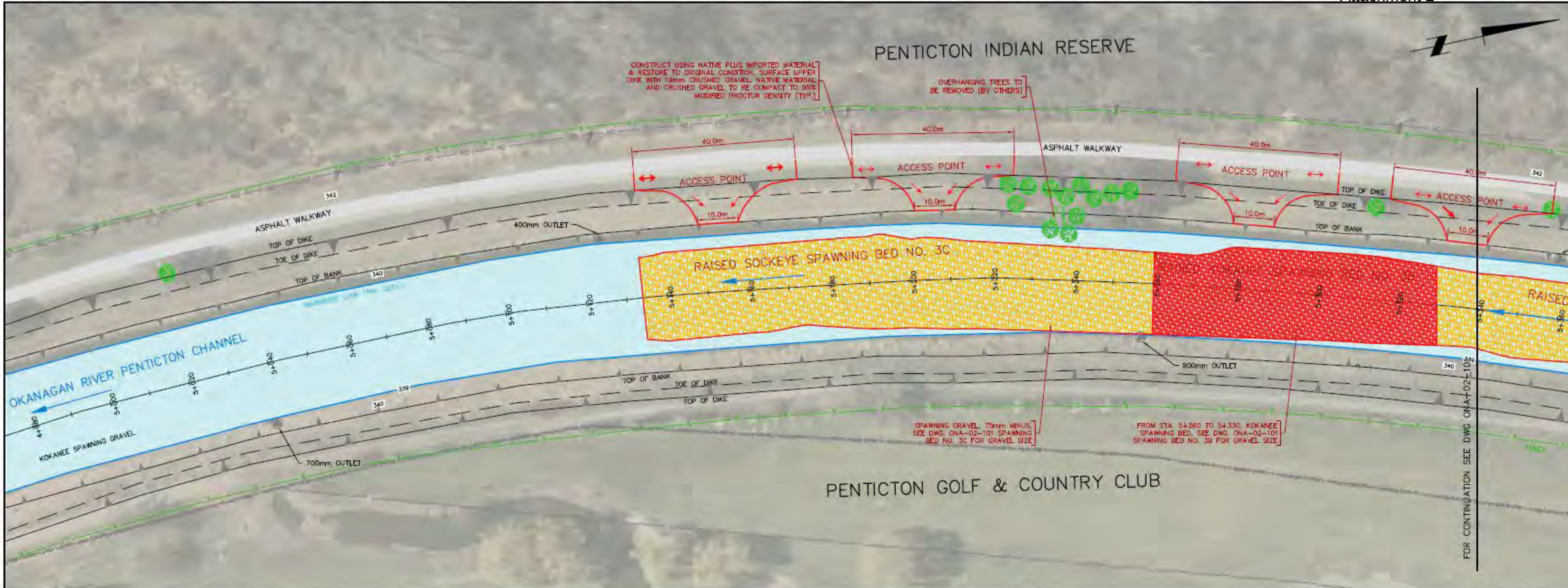
DRAWN	S.W.
DESIGN	S.M.
APPROVED	J.G.
DATE	APRIL 2015
SCALE	H: 1:500 V: 1:50

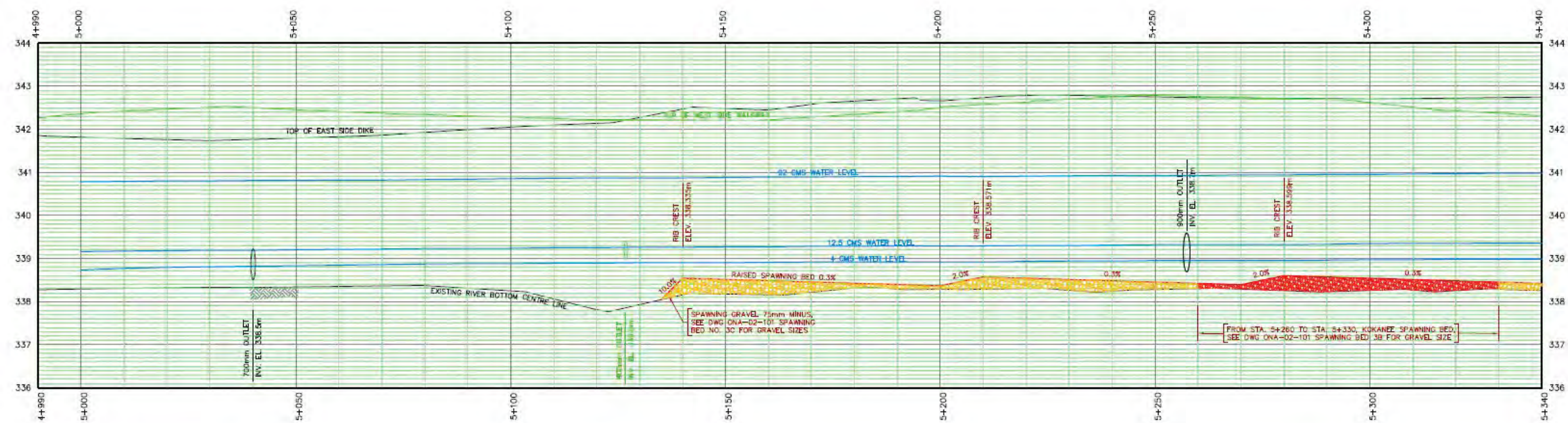
OKANAGAN NATION ALLIANCE

OKANAGAN RIVER – PENTICTON CHANNEL
SPAWNING PLATFORM NO 3
PLAN AND PROFILE VIEW
STA. 5+340 TO 5+700

DRAWING NO. ONA-02-101
REV. NO. A

Attachment 2





NOTES:

1. FOR GENERAL NOTES, SEE DWG. ONA-02-101

LEGEND

- FENCE
- TOP OF BANK
- POWER POLE
- TREES
- IRON PIN

NO.	DATE	BY	REVISION	CH'KD	ENG.
A	SEPT. 2015	S.W.	ISSUED FOR CONSTRUCTION		
	APRIL 2015	S.W.	ISSUED FOR APPROVAL		

Mould Engineering
567 Lawrence Avenue, Kelowna, B.C. V1Y 6L8 Telephone 868-2072

DRAWN	S.W.
DESIGN	S.M.
APPROVED	J.G.
DATE	APRIL 2015
SCALE	H: 1:500 V: 1:50

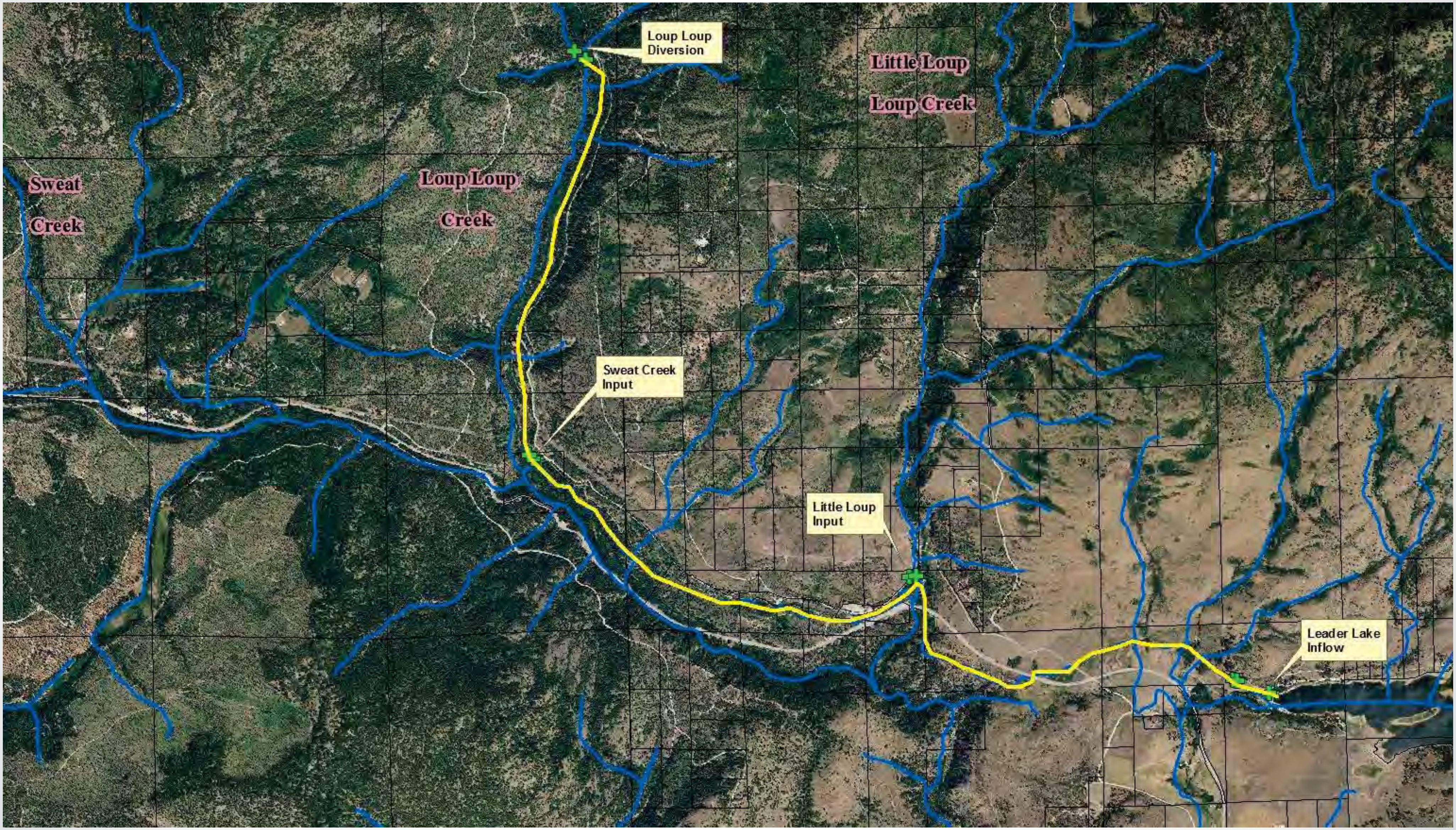
OKANAGAN NATION ALLIANCE

OKANAGAN RIVER – PENTICTON CHANNEL
SPAWNING PLATFORM NO 3
PLAN AND PROFILE VIEW
STA. 4+990 TO 5+340

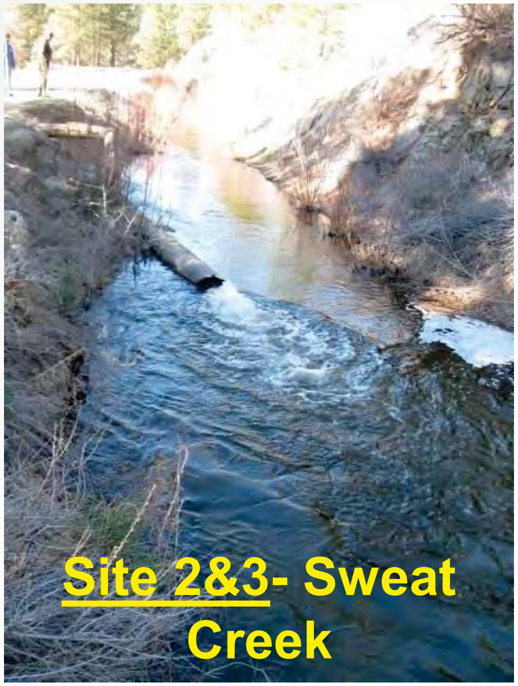
DRAWING NO.	REV. NO.
ONA-02-102	A

Attachment 2

PVWUA Irrigation Canal



Monitoring Locations

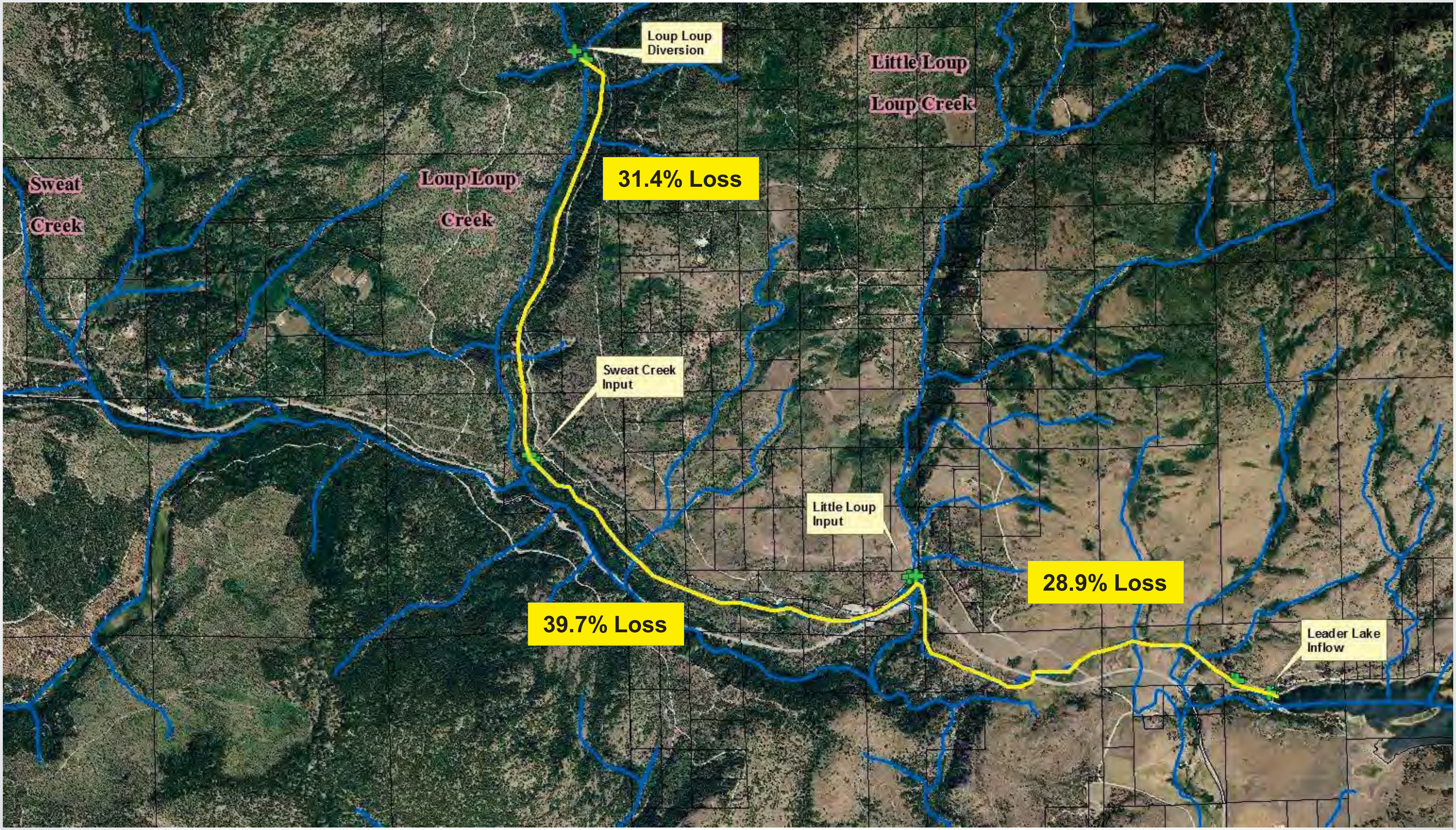


Site 1- At the Loup Loup Creek diversion (Not Pictured)

Cumulative Water Loss In The Canal

SITE	March 3rd	April 16th	June 24th	October 27th	AVERAGE
LOUP LOUP INPUT (cfs)	16.92	8.97	0.00	0.81	
SWEAT CREEK INPUT (cfs)	2.09	4.91	2.02	2.41	
LITTLE LOUP INPUT (cfs)	1.56	3.12	0.80	0.13	
TOTAL STREAM INPUTS (cfs)	20.56	16.99	2.82	3.35	10.93
LEADER LAKE DISCHARGE (cfs)	9.85	8.52	1.28	2.05	5.43
Cumulative loss of streamflow inputs (cfs)	**10.71**	**8.47**	**1.54**	**1.29**	**5.50**
Cumulative loss of streamflow inputs (ac-ft/day)	21.25	16.80	3.06	2.57	10.92
Percentage of diverted streamflow lost	**52.1%**	**49.8%**	**54.6%**	**38.7%**	**50.4%**

Segment



Loup Loup
Diversion
Little Loup
Loup Creek
31.4% Loss
Sweat
Creek
Loup Loup
Creek
Sweat Creek
Input
Little Loup
Input
28.9% Loss
39.7% Loss
Leader Lake
Inflow

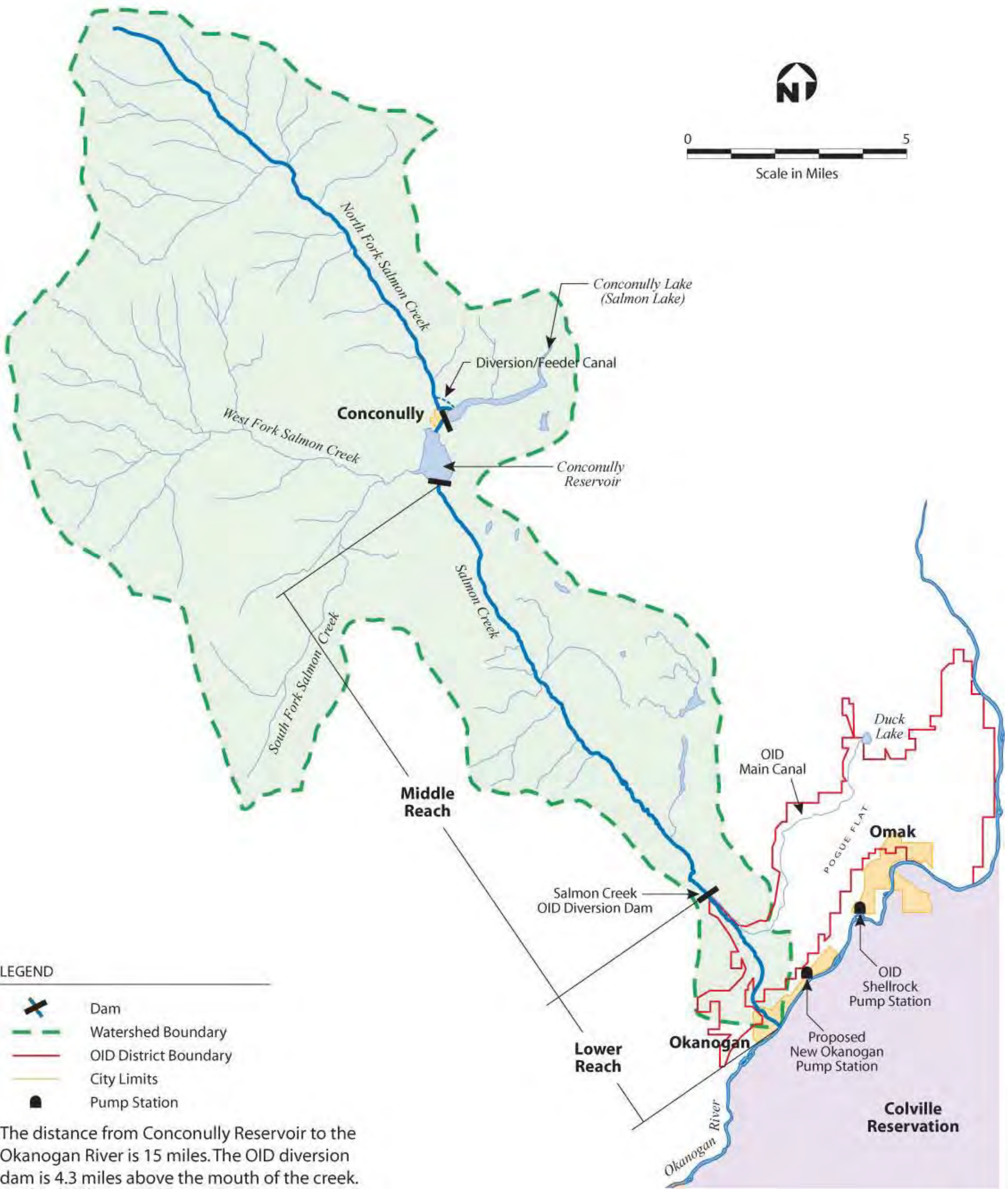
Watershed Annual Yield

Annual Yield by Watershed			AC/FT ANNUALLY	
	Area	Precipitation	DOE	Orsborn
Watershed	(MI^2)	(IN)	($0.4 cfs/mi^2$)	($0.0025(P^{1.64})(A)$)
Little Loup Creek	7.25	17	2100	1368
Sweat Creek & Tribs	17.11	21.4	4955	4707
TOTAL YIELD			**7054**	**6075**
PVWUA DUTY (1,178.12 acres @ 4 ac-ft/ac)			4712.5	4712.5
EXCESS WATER YIELD			**2342**	**1363**

✓ Annual production in Little Loup Creek and Sweat Creek watersheds by two different methods shows an excess over the annual PVWUA duty.

Conclusion: Eliminating the cumulative water loss in the canal eliminates the need for the Loup Loup Creek diversion.

Salmon Creek Study Area



The distance from Conconully Reservoir to the Okanogan River is 15 miles. The OID diversion dam is 4.3 miles above the mouth of the creek.

Watershed size: 167 square miles

Peak elevation: 8,242 ft.

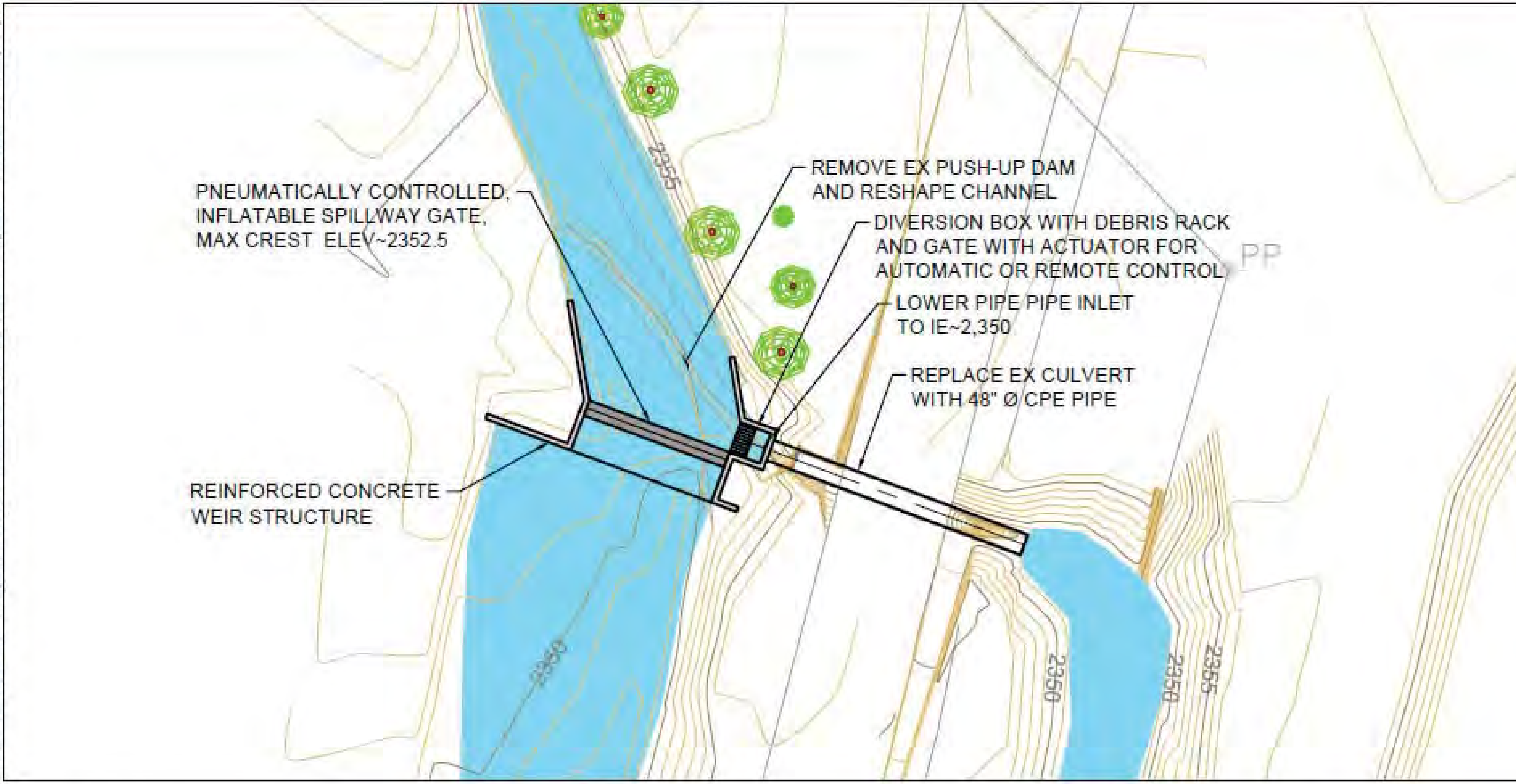
Aspect: Northeast

Max water temperature: 68^{o}F

Attachment 2

Stream flow and corresponding acre-feet diverted from North Fork of Salmon Creek for 30 days

10 cfs	15 cfs	20 cfs	25 cfs	30 cfs	35 cfs	40 cfs	70 cfs
60 seconds	60 seconds	60 seconds	60 seconds	60 seconds	60 seconds	60 seconds	60 seconds
60 minutes	60 minutes	60 minutes	60 minutes	60 minutes	60 minutes	60 minutes	60 minutes
24 hours	24 hours	24 hours	24 hours	24 hours	24 hours	24 hours	24 hours
64000 cf/day	1296000 cf/day	1728000 cf/day	2160000 cf/day	2592000 cf/day	3024000 cf/day	3456000 cf/day	6048000 cf/day
20 ac/ft per day	30 ac/ft per day	40 ac/ft per day	50 ac/ft per day	60 ac/ft per day	69 ac/ft per day	79 ac/ft per day	139 ac/ft per day
30 days/month	30 days/month	30 days/month	30 days/month	30 days/month	30 days/month	30 days/month	30 days/month
595 ac/ft per month	893 ac/ft per month	1190 ac/ft per month	1488 ac/ft per month	1785 ac/ft per month	2083 ac/ft per month	2380 ac/ft per month	4165 ac/ft per month



SOURCE: Drawing prepared from topographic survey basemap provided by the U.S. Bureau of Reclamation in 2006 for the Okanogan Irrigation District Salmon Lake Feeder Canal Upgrades Project and does not accurately represent changes in topography after the survey was completed.

HORIZONTAL DATUM: Washington State Plane North, NAD27, U.S. Feet.

VERTICAL DATUM: NGVD 29

0

Scale in Feet

C:\Users\drice\Documents\Project Work\OID Diversion\CAD\CCT - OID Diversion Upgrades - Instream OPT B.dwg Fig 2B

Sep 21, 2015 6:34am drice

Fi

Salmon Creek Confluence

2016 – 31 cfs

2005

Summary -

Re-connect 5,500 feet side channel (Conservancy Island)

Increased entrainment into side channel

PIT array at outlet

Continue PIT tagging effort

Screen installation completed by October 2016

Proposed Spawning Platform #4

Proposed piping for Pleasant Valley Water Users, non-diverted flow from Loup Loup Creek

Upgrade of N.F. diversion on Salmon Creek, result in 1,800 ac-ft. dedicated to instream flow

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 12 May 2016

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Chris Fisher (Colville Tribes).[1]

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 Thursday, 12 May 2016 from 10:00 am to 12:20 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

The Committees reviewed and approved the 14 April 2016 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported on the phases of the project that are still active. With regard to production wells, punch list items have been completed and startup and commission of the pump station was performed on 18 April. The pump station performed as engineered. The E2-E5 laterals are up and running and working as designed. The only item left to complete on the E2-E5 laterals is pressure testing, which will be conducted by Lloyd Logging. The Westside piping punch list items have been completed and a pressure test of the Westside pipe was conducted. All sections passed the pressure test and the system started operating on 18 April. Westside tree removal is complete; brush cleanup is ongoing. Only two individual wells are left to be drilled. On one site, they have drilled three wells and have not yet found enough water to fill the landowner's water right. On another parcel, power is over a mile away from the proposed well site. The sponsor is looking at other alternatives.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report soon.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) asked the Rocky Reach Tributary Committee for a time extension on this project. In order to

[1] Chris provided his votes on decision items before the meeting.

continue working with two property owners, the sponsor asked to extend the project to 31 March 2017. ***The Rocky Reach Tributary Committee approved the time extension***.

- Clear Creek Fish Passage and Instream Flow Project – In April, the sponsor (TU) continued evaluating secondary well locations. Several sites were evaluated and one was selected for ground penetrating radar (GPR) analysis, which was conducted on 27 April. A full hydrogeological/GPR report is expected by mid-May.
- Barkley Irrigation – Under Pressure Project – In April, the sponsor (TU) worked on the 30% design and reinitiated permits that were submitted last May but needed to be changed because of the relocation of the point of diversion. The sponsor is working with Okanogan County on the SEPA determination and anticipates DNS the first week of May. Cultural Resources is currently under review and the water rights processing is ongoing. The sponsor is also working with several funders to try and secure money for remaining construction needs.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) began 2016 work on 20 April.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) did not provide an update on this project.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) did not provide an update on this project.
- M2 Sugar Acquisition Project – The sponsor (MSRF) reported that the appraisal has been reviewed. The project will close on 13 May.
- Icicle Boulder Field Project – The sponsor (TU) and their consultant identified a preferred design option and will send it to the Technical Advisory Committee in early May as part of the final design report review. The Tributary Committees/Sponsor Agreement is ready for Tributary Committee signature.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The sponsor (WDFW) did not provide an update on this project. The Tributary Committees/Sponsor Agreement is ready for Tributary Committee signature. The Rock Island Tributary Committee agreed that WDFW will submit annual reports to the Committee each year by 31 December.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) did not provide an update on this project.

IV. General Salmon Habitat Program Draft Proposals

The Committees received 14 General Salmon Habitat Program draft proposals. The Committees reviewed each draft proposal and selected those that they believe warranted a final proposal. Projects that 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. The Committees assigned draft proposals to one of two categories: Fundable and Not Fundable. 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.

Silver Side Channel Acquisition Project (Fundable)

The Committees recommend that the project sponsor (Methow Salmon Recovery Foundation) address the following comment/suggestion as they develop the final proposal:

- The sponsor needs to indicate in the final proposal that the existing restoration design will be used if the property is acquired. The Committees and others have provided extensive technical input on the current design and they see no need to redesign the restoration actions for the side channel.
- Sponsor needs to include language in the proposal indicating that MSRF will return funds from the sale of the uplands to the funding entities.
- Sponsor should describe the water rights associated with the property and what they intend to do with the rights.

Twisp River Floodplain Lower Acquisition Phase II Project (Fundable)

The Committees recommend that the project sponsor (Methow Salmon Recovery Foundation) address the following comment/suggestion as they develop the final proposal:

- The Committees are only interested in supporting this project if the owner vacates the property. The Committees are not interested in a period of continued tenancy by the owner.
- The sponsor should include the relocation of the home sites as an option to recover costs of the acquisition.
- Sponsor should describe the water rights associated with the property and what they intend to do with the rights.

Burns-Garrity Floodplain Restoration Alternative Analysis and Design Project (Fundable)

The Committees recommend that the project sponsor (Cascade Columbia Fisheries Enhancement Group) address the following comment/suggestion as they develop the full proposal:

- The sponsor should remove the groundwater-driven side channel concept and focus on reconnecting the channel to the mainstem.
- The Committees are concerned with the cost of the proposal. The sponsor needs to identify ways to reduce the cost. One option is to forego the alternative analysis. In this case, the Committees do not see a need for alternative analyses.

Upper Okanogan-Similkameen Floodplain Assessment Project (Not Fundable)

The Committees recommend that this project, sponsored by Okanogan Conservation District, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe that the scope of the project is too large and that there are limited opportunities to reconnect the floodplain with the channel. The sponsor should focus their efforts on those areas that provide cost-effective restoration opportunities.

Beaver Fever – Restoring Ecosystem Function Project (Fundable)

The Committees recommend that the project sponsor (Trout Unlimited) address the following comment/suggestion as they develop the full proposal:

- The Committees believe the cost of the proposed project is excessive. The sponsor needs to find ways to reduce the total cost of the project.
- The sponsor needs to provide more information on BRAT. For example, what factors are included in the model and how much weighting is given to each factor?
- The should consider greater use of BDAs.

Upper Peshastin Flow Attenuation 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 that the project will have limited biological benefit because of the small number of trees added over a seven-mile reach. They also question why trees cut by the Forest Service during thinning along Peshastin Creek would not be used in the project. Although the trees from Nason Creek are free, it is still expensive to handle and transport them to Peshastin Creek. Finally, the Committees believe the costs for project management, project administration, stakeholder coordination and outreach, and conceptual designs are excessive for this project and the extensive technical support from Scott Nicolai is questionable.

Thermal Refuge in the Wenatchee Basin 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 Committees see value in identifying thermal refuge in the upper Wenatchee River basin, they believe the approach may not be the best approach for identifying cold-water areas. Collecting FLIR imaging may be more appropriate during autumn or early winter, prior to icing. In addition, it is not clear what actions could be implemented to increase or protect thermal refuge.

Nason Creek RM 2.3 Side Channel Reconnection Design 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:

- The sponsor should consider a design/build project. A design is appropriate for the upper connection; no design is needed for the lower connection.
- The Committees believe the cost of the proposed project is excessive. For example, the sum of project management, project administration, stakeholder coordination and outreach, wetland delineation, surveying, and indirect costs are excessive for this project. The Committees question why wetland delineation and stakeholder coordination and outreach are necessary. The sponsor needs to find ways to reduce the total cost of the project.

Peshastin Creek Barrier Removal 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 the Forest Service is responsible for replacing the culvert. In addition, the culvert is not a passage barrier and therefore there is no biological benefit associated with replacing the culvert at this time.

Peshastin Irrigation District Pump Exchange Project, Conceptual Design (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 would like to see no water diverted from Peshastin Creek. They also believe the project is too expensive for a “conceptual design” and that the pumping duration is too short. In addition, it is not clear what part of the delivery system is piped, concrete lined, or dirt lined. The Committees also asked if irrigators will pay for any of the pumping costs.

<u>Nason Creek Lower White Pine Floodplain Acquisition Project (Not Fundable)</u>

The Committees recommend that this project, sponsored by Chelan-Douglas Land Trust, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe that sale of the property will be hindered because of the powerlines. In addition, there are few opportunities to restore aquatic habitat on the property.

<u>Wenatchee Sleepy Hollow Floodplain Acquisition Project (Fundable)</u>

The Committees recommend that the project sponsor (Chelan-Douglas Land Trust) submit a full proposal.

<u>Native Fish Task Force 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 that this project will provide little to no benefit to HCP Plan Species, because most of the actions will occur outside the distribution of Plan Species.

<u>Restore Peshastin Creek Confluence 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 that the cost of the project greatly exceeds the benefits. They believe the cost of the project could be reduced significantly if actions are take that do not require the relocation of the road and powerlines.

V. General Salmon Habitat Program Application

<u>Leavenworth Diversion Screening Project</u>

The Committees reviewed a General Salmon Habitat Program application from Trout Unlimited titled *Leavenworth Diversion Screening Project*. The purpose of the project is to install a NMFS-compliant fish screen on the City of Leavenworth Icicle Creek Diversion to prevent salmonid entrainment. The diversion is located at RM 5.7 on Icicle Creek upstream from the boulder field. The total cost of the project is $161,654.28. The sponsor requested $130,255.28 from HCP Tributary Funds. After careful consideration, the Committees were unable to reach a funding decision. The Committees were surprised that the City of Leavenworth was not contributing financially to the project and asked that the sponsor seek some level of funding (match) from the City. The Committees recommended that the City contribute up to about 25% of the total cost. The Committees will revisit the proposal after the sponsor responds to the Committees' request.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in April and May:

   Rock Island Plan Species Account:

   - $136.00 to Clifton Larson Allen for Rock Island financial administration in April 2016.

   Rocky Reach Plan Species Account:

   - $136.00 to Clifton Larson Allen for Rocky Reach financial administration in April 2016.

Wells Plan Species Account:

- $37,814.06 to Trout Unlimited for the MVID Instream Flow Improvement Project.
- $15,185.00 to the Methow Salmon Recovery Foundation for the M2 Sugar Acquisition Project. This includes a $185.00 transaction fee.
- $780.00 to Valbridge Property Advisors for appraisal review on the M2 Sugar Acquisition Project.

2. Tracy Hillman shared with the Committees the Upper Columbia 2016 SRFB/TC Funding Schedule. Important dates are as follows:
   - 8 June: presentations to SRFB Review Panel (members of the Tributary Committees are encouraged to attend the presentations).
   - 1 July: final proposals are due.
   - 14 July: Tributary Committees review final proposals and make funding decisions.
   - 22 July: Tributary Committees provide feedback to the project sponsors.
3. Becky Gallaher reported that Cordell, Neher & Company began auditing the Rock Island and Rocky Reach Plan Species Accounts. The accountants have provided a list of information they need from Becky in order to complete the audit.

VII. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 9 June 2016 at Grant PUD in Wenatchee. Project presentations will occur on 8 June 2016.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Rocky Reach and Rock Island HCP Tributary Committees Conference Call Notes 16 June 2016

Members Present: Chris Fisher (Colville Tribes), Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Steve Hays (Chelan PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Rocky Reach and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees held a conference call on Thursday, 16 June from 2:00 to 3:00 pm.

I. Purpose for the Conference Call

Tracy Hillman indicated that the purpose for the call was to evaluate a time-sensitive proposal from Trout Unlimited.

II. General Salmon Habitat Program Application

Peshastin Mill Site Riverfront Preservation Project

The Committees reviewed a General Salmon Habitat Program application from Trout Unlimited titled *Peshastin Mill Site Riverfront Preservation Project*. The purpose of the project is to protect about 0.8 miles of streambank and 14 acres of riparian habitat along the Wenatchee River near the town of Peshastin. The total cost of the project is $463,000. The sponsor requested $100,000 from HCP Tributary Funds. After careful review of the proposal and extensive discussion, the Committees declined the opportunity to fund the project because of limited biological benefit and minimal restoration opportunities.

III. Budget Amendment

The Rocky Reach Tributary Committee received a budget amendment request from Trout Unlimited on the *Clear Creek Fish Passage and Instream Flow Enhancement Project*. The sponsor asked to move $5,000 from “Contract Labor” to “Professional Services.” Thus, the final amount allocated for Contract Labor would be $5,000 and the final amount allocated for Professional Services would be $10,500. Prior to the conference call, the Rocky Reach Tributary Committee approved the budget amendment via email. The total budget amount did not change as a result of this amendment.

IV. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 14 July 2016 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 14 July 2016

Members Present: Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Jeremy Cram (WDFW).[1]

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 Thursday, 14 July 2016 from 9:30 am to 12:20 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

The Committees reviewed and approved the 12 May 2016 meeting notes and the 16 June 2016 Rock Island and Rocky Reach Conference Call notes.

The Committees agreed to replace "Final Draft" from the header of notes with "Final 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that construction is substantially complete. Pressure testing on the E2-E5 Laterals was completed in June. They noted that there are a few items yet to complete this summer. All but one individual well has been drilled. One parcel does not have power and therefore the sponsor is working with Ecology on how to address the water needs for this parcel. The sponsor is also working on a few lingering issues with a couple wells. These should be resolved this summer.

  TU approached the Committees to see if the Committees would consider a scope change, which would allow using remaining funds to pipe the irrigation system from Nob Hill to the fish screen on the MVID East portion of the project. The Committees indicated that the request goes beyond a scope change. The sponsor will need to submit a new proposal.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report soon.

[1] Jeremy provided his votes on decision items before the meeting.

- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) received the final hydrogeology report indicating that they can drill a well that is capable of meeting the landowner's needs. The sponsor is coordinating a date for well drilling, which will likely occur during mid to late August. Washington Department of Health has approved the proposed work. TU is planning the water-system construction and diversion dam removal, and started preliminary consultations with USFWS as well as permitting consultation with Chelan County.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported that the 95% design was completed at the end of June. The sponsor has secured all local and state permits including the HPA. They are still waiting on the Corp permit and completion of the NEPA process. They continue to work with Ecology on the water rights change and will meet with the Barkley Directors to review the Trust Water Agreement in early July.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that five beavers were released in June. There are eight active beaver establishments.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) submitted the proposed habitat restoration design for Committee review. ***The Rocky Reach Committee studied the proposed design and approved it with no changes or edits.*** The Committee hopes the project will be completed this year.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) reported that they submitted the JARPA and received notice from the Army Corp of Engineers that the project is exempt from Sections 404 and 101 of the Clean Water Act. As a result, Ecology told the sponsor that they will not need a permit from Ecology. In addition, Chelan County Department of Community Development issued a determination of non-significance. This means the sponsor will not need to work through the SEPA process. The sponsor submitted the HPA and is working with WDFW to finalize project designs. They are also coordinating the archeology work through the WDFW archeologist. Finally, the sponsor started communicating with contractors about construction logistics.
- Icicle Boulder Field Project – The sponsor (TU) and their engineer are addressing comments from the technical advisory group and planning next steps. As stream flows drop in Icicle Creek, the sponsor will collect additional information for the final design.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The installation of the detection equipment is complete and the sponsor (WDFW) will provide an annual report to the Rock Island Committee by 31 December 2016.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) is statistically evaluating Chiwawa River data in order to identify and provide scientific support for an effectiveness monitoring plan.

IV. General Salmon Habitat Program Draft Proposals

The Committees received seven General Salmon Habitat Program proposals. Before reviewing the proposals, Becky Gallaher reported that the unallocated balances within each account were $5,528,216 in the Rock Island Plan Species Account, $2,042,757 in the Rocky Reach Plan Species Account, and $1,300,397 in the Wells Plan Species Account. In addition, and consistent with the Committees' Operating Procedures, members of the Committees identified potential conflicts of interest. Kate Terrell recused herself from voting on the *Beaver Fever: Restoring Ecosystem Function Project*.

Wenatchee Sleepy Hollow Floodplain Acquisition Project

The Chelan-Douglas Land Trust is the sponsor of the Wenatchee Sleepy Hollow Floodplain Acquisition Project. The purpose of this project is to protect 2,700 feet of riverbank and 37 acres of high quality riparian/floodplain habitat on the lower Wenatchee River (RM 2.7-3.2). The total cost of the project is $661,000. The sponsor requested $165,250 from HCP Tributary Funds. ***The Rock Island Committee approved funding for this project.***

The Rock Island Committee pointed out that the Committee will order and pay for the appraisal and review. Because the sponsor asked for $9,000 for appraisal and review, the Committee subtracted this amount from the Tributary Committee request. Thus, the amount the Rocky Island Committee will pay the sponsor for this project is $156,250 ($165,250 - $9,000).

Silver Side Channel Acquisition Project

The Methow Salmon Recovery Foundation is the sponsor of the Silver Side Channel Acquisition Project. The purpose of this project is to protect 95.8 acres, including off-channel floodplain habitat, wetlands, riparian habitat, and agricultural lands on the middle Methow River (RM 34.3-35.3). The total cost of the project is $801,470. The sponsor requested $236,406 from HCP Tributary Funds. ***The Wells Committee approved funding for this project.***

The Committee's contribution to this project is based on the following conditions:

- The Wells Committee will have input and shall approve any management decisions regarding side-channel restoration actions and the resale of the upland parcel.
- The sponsor will make sure that no surface-water rights are transferred with the sale of the upland parcel. Any and all surface-water rights associated with the upland parcel will be trusted in perpetuity.

Burns-Garrity Restoration Design Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Burns-Garrity Restoration Design Project. The purpose of this project is to prepare a restoration design that will improve instream, off-channel, and floodplain habitat on 30 acres of land owned by WDFW on the lower Chewuch River (RM 2.3-2.8). The total cost of the project is $177,335. The sponsor requested $45,550 from HCP Tributary Funds. ***The Rocky Reach Committee approved funding for this project.***

The Committee's contribution to this project is based on the following conditions:

- The Rocky Reach Committee will review alternatives and approve final designs.
- The Committee needs a detailed budget. The proposal was lacking a detailed budget.

Beaver Fever: Restoring Ecosystem Function Project

Trout Unlimited – Washington Water Project is the sponsor of the Beaver Fever: Restoring Ecosystem Function Project. The purpose of this project is to reestablish beavers and install beaver dam analogs (BDAs) in tributaries of the Wenatchee River basin. The reintroduction of beavers and installation of BDAs should enhance salmonid habitat by increasing habitat complexity, moderating water temperatures, augmenting stream flows, trapping fine sediments, and improving riparian and off-channel connectivity. The total cost of the project is $279,278. The sponsor requested $108,226 from HCP Tributary Funds. ***The Rock Island Committee approved funding for this project.***

The Committee's contribution to this project is based on the following condition:

- All money from the Rock Island Plan Species Account will be used to purchase and install BDAs. No funds from the account will be used to trap, acclimate, or relocate beavers.

Nason Creek RM 2.3 Side Channel Reconnection Design Project

Chelan County Natural Resources Department is the sponsor of the Nason Creek RM 2.3 Side Channel Reconnection Design Project. The purpose of this project is to design a restoration project that will reconnect a 0.36-0.53 mile-long, high-flow channel to the mainstem on lower Nason Creek near RM 2.3. The total cost of the project is $149,778. The sponsor requested $23,000 from HCP Tributary Funds. ***The Tributary Committees elected not to fund this project***.

The Committees believe this project has become too complex and expensive. The Committees supported protecting the floodplain property and reconnecting the downstream end of the side channel; however, the project has grown into a much larger effort that may not provide significant additional benefit. The Committees question whether creating a right-angle connection at the upstream end of the side channel will be sustained over the long term. Such a connection may suffer from deposition of fine sediments. If the intent is to reconnect the upstream end of the side channel, the Committees recommend that the sponsor look farther upstream for a reconnection point; one that does not connect at a right angle.

Thermal Refuge in the Wenatchee Basin Project

Chelan County Natural Resources Department is the sponsor of the Thermal Refuge in the Wenatchee Basin Project. The purpose of this project is to identify locations of cold-water seeps and functioning cold-water refugia, as well as identify possible protection and restoration opportunities to increase thermal refugia within the Upper Wenatchee River, Nason Creek, Chiwawa River, and the Little Wenatchee River. This will be accomplished by conducting ground-based longitudinal profiles and spot checking cold seeps identified during 2001-2002 FLIR surveys. The total cost of the project is $48,807. The sponsor requested $7,321 from HCP Tributary Funds. ***The Tributary Committees elected not to fund this project***.

As the Committees indicated in their comments to the sponsor during the draft proposal process, they believe the proposed approach may not be the best method for identifying thermal refugia. Collecting late-fall or early-winter FLIR imaging is a more practical approach to identifying and characterizing thermal refugia. Such an approach could rapidly survey the entire basin, and would readily identify groundwater inputs that summer FLIR imaging would not detect. The Committees believe that application of the proposed methodology to the entire basin will ultimately cost more, produce less reliable data, and take longer to implement and develop projects from, than a proposal based on cold-season FLIR.

Peshastin Irrigation District Pump Exchange Project, Preliminary Design

Chelan County Natural Resources Department is the sponsor of the Peshastin Irrigation District Pump Exchange Project, Preliminary Design. The purpose of this project is to increase late summer flows in the lower 2.4 miles of Peshastin Creek by up to 30 cfs. This will be accomplished by designing a pump exchange facility that will deliver water from the Wenatchee River to the Peshastin Irrigation District Canal for irrigation during late summer. The total cost of the project is $199,393. The sponsor requested $29,909 from HCP Tributary Funds. ***The Tributary Committees elected not to fund this project***.

As the Committees indicated in their comments to the sponsor during the draft proposal process, they want no water diverted from Peshastin Creek. They believe the most biological benefit would come from removing the irrigation diversion from Peshastin Creek and restoring normative flows to lower Peshastin Creek.

Summary of Review of 2016 General Salmon Habitat Program Projects.

Project Name	Sponsor[1]	Total Cost	Request from T.C.	T.C. Contribution[2]
Wenatchee Sleepy Hollow Floodplain Acquisition	CDLT	$661,000	$165,250	RI: $156,250
Silver Side Channel Acquisition	MSRF	$801,470	$236,406	W: $236,406
Burns-Garrity Restoration Design	CCFEG	$177,335	$45,550	RR: $45,550
Beaver Fever: Restoring Ecosystem Function	TU-WWP	$279,278	$108,226	RI: $108,226
Nason RM 2.3 Side Channel Reconnection Design	CCNRD	$149,778	$23,000	$0
Thermal Refuge in the Wenatchee Basin	CCNRD	$48,807	$7,321	$0
Peshastin Irrigation Pump Exchange Preliminary Design	CCNRD	$199,393	$29,909	$0
Total:		**$2,317,061**	**$615,662**	**$546,432**

[1] CCNRD = Chelan County Natural Resource Department; CCFEG = Cascade Columbia Fisheries Enhancement Group; CDLT = Chelan-Douglas Land Trust; MSRF = Methow Salmon Recovery Foundation; and TU-WWP = Trout Unlimited – Washington Water Project.

[2] RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

V. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in May, June, and July:

   Rock Island Plan Species Account:

   - $96.25 to Clifton Larson Allen for Rock Island financial administration in May 2016.
   - $77.54 to Clifton Larson Allen for Rock Island financial administration in June 2016.
   - $1,252.99 to Chelan PUD for project coordination and administration during the second quarter of 2016.
   - $95,594.73 to Trout Unlimited for the MVID Instream Flow Improvement Project.
   - $1,104 to Cascadia Columbia Fisheries Enhancement Group for permitting nutrient enhancement in the Chiwawa River.
   - $4,379.13 to Cascadia Columbia Fisheries Enhancement Group for the White River Floodplain Connection Project.

   Rocky Reach Plan Species Account:

   - $96.25 to Clifton Larson Allen for Rocky Reach financial administration in May 2016.
   - $77.54 to Clifton Larson Allen for Rocky Reach financial administration in June 2016.
   - $1,492.29 to Chelan PUD for project coordination and administration during the second quarter of 2016.
   - $5,489.54 to Trout Unlimited for the Clear Creek Fish Passage Project.

   Wells Plan Species Account:

- $50,475.81 to Trout Unlimited for the MVID Instream Flow Improvement Project (May invoice).
- $19,917.43 to Trout Unlimited for the MVID Instream Flow Improvement Project (June invoice).
- $400.00 to Cascade Chelan Appraisal for the appraisal on the M2 Sugar Acquisition project. This included time for responding to the review's questions.
- $11,687.05 to the Methow Salmon Recovery Foundation for the Methow Watershed Beaver Reintroduction Project.
- $1,067.63 to Chelan PUD for project coordination and administration during the second quarter of 2016.

2. Becky Gallaher identified a conflict in language between Section 15 (Sponsor Responsibilities) and Section 17 (Committee Review of Contractor Scope(s) of Work) in the Sponsor Agreement with the Committees. After reviewing the sections, the Committees agreed to remove Section 17 from the Sponsor Agreement.
3. Chris Fisher said that Kari Alex with the Okanagan Nation Alliance talked with him about a field trip in Canada this fall. Chris said the proposed date for the trip is 12 and 13 October. The HCP Tributary Committees and PRCC Habitat Subcommittee will attend the tour.
4. Becky Gallaher reported that Cordell, Neher & Company has completed their audit of the Rock Island and Rocky Reach Plan Species Accounts. The accountants are currently conducting QA/QC. Once that is complete, the Committees will receive a report from the accountant.

VI. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 11 August 2016 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Conference Call Notes 11 August 2016

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), 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 held a conference call on Thursday, 11 August 2016 from 10:00 to 11:00 am.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone on the call and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 14 July 2016 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that construction is substantially complete. There are a few items yet to complete this summer. The sponsor is waiting on the "as-builts" on the E2-E5 Laterals. In addition, the sponsor continues to work with Ecology on how to address the water needs for one landowner.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report this fall.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) reported that they are coordinating well-drill activities. Drilling is tentatively scheduled for late August or early September. Cultural resources consultation has been initiated. The site assessment will begin immediately after the test well is drilled.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported that all permits have been secured except the 401 and 404. The sponsor is currently looking for additional funds to complete the project. The Colville Confederated Tribes have agreed to contribute about $1.5 million. The sponsor continues to seek ways to decrease the cost and increase funding. In an effort to save money, TU is planning to purchase about four miles of pipe directly from the distributor. This will eliminate contractor markup.

- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that one beaver was released in July. There are nine active beaver establishments.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) reported that permits have been submitted and that Cardno-Entrix is finalizing project designs.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) reported that the HPA was received on 21 July. The sponsor is working with WDFW to secure the Right of Entry to implement the project on WDFW land. WDFW concluded that an archeology study was needed; therefore, Columbia Historical Consulting has been hired to do the archeology study. A site visit was held with Dickinson Excavation to discuss construction details.
- Icicle Boulder Field Project – The sponsor (TU) reported that no activity occurred during July.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The installation of the detection equipment is complete and the sponsor (WDFW) will provide an annual report to the Rock Island Committee by 31 December 2016.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) reported that Ecology will not finalize the QAPP until they are sure the implementation actions are not going to change as a result of the effectiveness monitoring plan.

IV. Review of Middle Entiat 80% Restoration Plans

The Committees received a request from Chelan-Douglas Land Trust (CDLT) and the Bureau of Reclamation (Bureau) to review the 80% middle Entiat River restoration plans. Specifically, the Committees were asked to review projects proposed on the Tyee Creek Confluence and Bockoven South parcels. In January 2016 the Committees reviewed the 60% designs and concluded that they were appropriate. The planners have made some modifications to the 60% designs and would like feedback from the Committees. Because of other pressing issues, the Committees were unable to review the 80% designs and requested more time. The Committees will provide comments to CDLT and the Bureau in September.

V. Leavenworth Diversion Screening Project

In May, the Committees reviewed a General Salmon Habitat Program application from Trout Unlimited titled *Leavenworth Diversion Screening Project*. The purpose of the project is to install a NMFS-compliant fish screen on the City of Leavenworth Icicle Creek Diversion to prevent salmonid entrainment. The diversion is located at RM 5.7 on Icicle Creek upstream from the boulder field. The total cost of the project is $161,654.28. The sponsor requested $130,255.28 from HCP Tributary Funds. After careful consideration, the Committees were unable to reach a funding decision. The Committees were surprised that the City of Leavenworth was not contributing financially to the project and asked that the sponsor seek some level of funding (match) from the City. The City has a fundamental and legal responsibility to operate with a conforming screen because resident *Oncorhynchus mykiss* and bull trout contribute to anadromous and adfluvial (respectively) offspring that emigrate past their diversion, and anadromous fish periodically ascend the boulder field. The Committees recommended that the City contribute up to about 25% of the total cost.

The project sponsor responded to the Committees' request in a letter dated 22 July 2016. In that letter, the sponsor indicated that the City of Leavenworth is unwilling to support the project financially. The City noted in a letter to the Salmon Recovery Funding Board Citizen Committee that the City's support of fish passage at the Boulder Field is contingent on coincidental upgrade to their diversion. In other words, the City will not support fish passage at the Boulder Field unless the funding entities screen the Leavenworth

Diversion. Sadly, a large portion of the funding for fish passage at the Boulder Field will go away this year unless the Leavenworth Diversion is properly screened.[1] Some members of the Committees voiced their disappointment with the regulatory agencies for not enforcing the screening of the diversion. Members are also displeased with the City for holding the Boulder Field project hostage, since the City's screening responsibility remains regardless of whether or not the Boulder Field project proceeds. The City's refusal to step up to the funding plate when offered a gift intended to help them with their legal responsibility is troubling. After further discussion, ***the Committees elected not to fund this project***.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in July and August:

   Rock Island Plan Species Account:

   - $87.50 to Clifton Larson Allen for Rock Island financial administration in July 2016.
   - $3,158.00 to Cascadia Columbia Fisheries Enhancement Group for permitting nutrient enhancement in the Chiwawa River.

   Rocky Reach Plan Species Account:

   - $87.50 to Clifton Larson Allen for Rocky Reach financial administration in July 2016.
   - $43,749.73 to Trout Unlimited for the MVID Instream Flow Improvement Project.

   Wells Plan Species Account:

   - $14,571.26 to Trout Unlimited for the MVID Instream Flow Improvement Project.

2. Becky Gallaher reported that Cordell, Neher & Company has completed their audit of the Rock Island and Rocky Reach Plan Species Accounts. The accountants submitted a report of their findings to the Committees (see Attachment 1). In summary, they reviewed and tested the deposits into the Plan Species Accounts and reviewed a sample of project financial reports. They found that deposits were made in accordance with the HCP Agreements and that all projects reviewed were approved in accordance with project budgets. The next audit of the Rocky Reach and Rock Island Plan Species Accounts will be in five years. The Wells Plan Species Account is audited annually.
3. Tracy Hillman shared with the Committees the ranking of SRFB/TC projects by the Upper Columbia Citizen Committees (see following table). Three of the four projects that the Tributary Committees approved for funding (cost share) also received high ranks by the Citizen Committees. Only the Beaver Fever Project, which received a cost share from the Committees, was ranked below the SRFB funding line by the Citizen Committees.

[1] During the September meeting, members indicated, after talking with the SRFB, that SRFB funding for fish passage at the boulder field will not disappear this year if the intake structure is not screened. However, there remains a risk that the funding could disappear next year if the structure is not screened.

CAC Rank	Project Name	RTT Biological Benefit Score	County	Subasin	SRFB Request	SRFB Allocation	Running Allocation Total
1	Nason Creek RM 2.3 Side Channel Reconnection Design	70.3	Chelan	Wenatchee	$149,778	$149,778	$149,778
2	Silver Side Channel Acquisition Project	68.1	Okan	Methow	$565,064	$494,297	$644,075
3	Peshastin Irrigation District Pump Exchange Design	63.9	Chelan	Wenatchee	$169,484	$169,484	$813,559
4	Twisp River Floodplain Lower Acquisition	56.2	Okan	Methow	$523,794	$219,406	$1,032,965
5	Spring Chinook Monitoring in Lake Wenatchee (Monitoring)	*71.5	Chelan	Wenatchee	$140,000	$140,000	$1,172,965
6	Burns-Garrity Floodplain Restoration Alternatives Analysis and Design	65.6	Okan	Methow	$81,785	$81,785	$1,254,750
7	Wenatchee Sleepy Hollow Floodplain Acquisition	62.2	Chelan	Wenatchee	$165,250	$165,250	$1,420,000
8	Identification of Thermal Refugia in Wenatchee Watershed	61.2	Chelan	Wenatchee	$41,486	$ -	$ -
9	Upper Okanogan Habitat Feasibility Assessment	32.7	Okan	Okanogan	$163,312	$ -	$ -
10	Nason Creek Lower White Pine Floodplain Acquisition	53.9	Chelan	Wenatchee	$127,500	$ -	$ -
11	Beaver Fever: Restoring Ecosystem Function	62.1	Chelan	Wenatchee	$143,428	$ -	$ -
12	Upper Peshastin Wood Replenishment Design	47.8	Chelan	Wenatchee	$60,000	$ -	$ -
13	Wenatchee-Chiwawa Irrigation District Piping Project	46.3	Chelan	Wenatchee	$99,393	$ -	$ -
14	Restoring Peshastin Confluence	53	Chelan	Wenatchee	$700,000	$ -	$ -

	Methow Bull Trout Population Status Evaluation (Monitoring) project originally ranked #6; however, we can but we can only allocate 10% of the total allocation to monitoring projects as per RCO requirments. The Spring Ch. Monitoring in Lk Wen project request meets the 10% allcation limit.	*69.9	Okan	Methow	$75,472	$ -	
	*monitoring project RTT scores are not comparable to other project scores						
	The CAC's reduced the allocation for Silver Side Channel from $565,064 to $494,297 and Twisp River Floodplan Acquisition from$523,794 to $219,406						

4. Chris Fisher reminded the Committees that the Okanagan Nation Alliance is planning a project tour on 12 and 13 October. The HCP Tributary Committees and PRCC Habitat Subcommittee will attend the tour. Chris will send a draft agenda to the Committees soon.

VII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 8 September 2016 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Rocky Reach and Rock Island Plan Species Accounts Audit Results

CORDELL, NEHER & COMPANY PLLC
CERTIFIED PUBLIC ACCOUNTANTS

PRINCIPALS

Philip R. Blakney Jr., CPA

Timothy M. Dilley, CPA

Kristine S. Loomis, CPA CVA

Jeffery R. Neher, CPA

Sean M. Patton, CPA

Of Counsel

Judy S. Conner, CPA

INDEPENDENT ACCOUNTANTS' REPORT ON APPLYING AGREED-UPON PROCEDURES

To the Habitat Conservation Plan Tributary Committees
Wenatchee, Washington

We have performed the procedures enumerated below, which were agreed to by the Habitat Conservation Plan Tributary Committees (the "Committees") over the five year period ending December 31, 2013. This agreed-upon procedures engagement was conducted in accordance with attestation standards established by the American Institute of Certified Public Accountants. The sufficiency of these procedures is solely the responsibility of those parties specified in this report. Consequently, we make no representation regarding the sufficiency of the procedures described below either for the purpose for which this report has been requested or for any other purpose.

The procedures and associated findings are as follows:

We selected a sample of completed bank reconciliations for the Rock Island and Rocky Reach Plan Species account for each of the five years in our test period. For each reconciliation selected, we tested the mathematical computations, tied the balance per bank to supporting data, traced deposits in transit and outstanding checks to subsequent bank statement and traced any other reconciling items to supporting data. We also observed that the reconciliations were prepared timely. No exceptions were noted based on the procedures we performed.

We reviewed and tested the deposits into the Plan Species accounts to ensure compliance with the HCP Agreement. Based on the procedures we performed, we noted the following:

1. Deposits to the Rocky Reach and Rock Island Plan Species accounts have been made by the Chelan County PUD on a yearly basis in January in accordance with the HCP Agreement and appear to have been calculated correctly based on the requirements set forth in that agreement.

We reviewed a sample of project financial reports which shows the actual expenditures to ensure they were in accordance with the project budget. Based on the procedures we performed, we noted the following:

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Habitat Conservation Plan Tributary Committee
July 12, 2016
Page 2

1. We haphazardly selected a sample of 1 large project and 1 small project from each Plan Species account for all HCP Tributary projects in progress or complete. Upon review of the associated project financial reports from each Plan Species accounts we noted that all projects selected were approved and were in accordance with the project budget.

We reviewed expenditures made from each of the Plan Species accounts to ensure they were in accordance with the project sponsor agreement. We tested a sample of those expenditures to determine transactions were properly recorded. No exceptions were noted based on the procedures we performed.

We were not engaged to and did not conduct an examination, the objective of which would be the expression of an opinion on the effectiveness of internal control over compliance. Accordingly, we do not express such an opinion. Had we performed additional procedures, other matters might have come to our attention that would have been reported to you.

This report is intended solely for the information and use of the Habitat Conservation Plan Tributary Committees and is not intended to be and should not be used by anyone other than this specified party.

Wenatchee, Washington
July 12, 2016

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 8 September 2016

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), 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 Thursday, 8 September 2016 from 10:00 am to 12:30 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

The Committees reviewed and approved the 11 August 2016 conference call 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that construction is substantially complete. There are a few items yet to complete this summer. The sponsor is waiting on the "as-builts" on the E2-E5 Laterals. In addition, the sponsor continues to work with Ecology on how to address the water needs for one landowner.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report this fall.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) reported that they drilled a well and conducted a 24-hour constant rate test at about 30 gpm. The sponsor expected a 16-foot drawdown; a 13-foot drawdown was realized. They collected water quality samples and gave them to Cascade Analytical for analysis. The results should be available in early September. The project hydrogeologist was present for drilling and the pump test and will be preparing a summary report in the coming weeks. ***The Rocky Reach Tributary Committee indicated that they would like to receive a copy of the summary report.*** The sponsor is preparing maps and information for locating utilities on the proposed new waterline pathway. If all goes well, the project should be ready for construction mid-November.

- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported that they have been working through the technical, social, and political issues associated with this large project. The executive team has been meeting weekly to address project specific issues and to resolve project details in advance of potential construction. The sponsor also worked closely with Forsgren to finalize the engineering and contract documents, and to ensure specifications and details are thoroughly reviewed. As a result, a bid package is ready for distribution. The sponsor has been working to address concerns about long-term maintenance costs and to develop the maintenance and replacement schedule for the pump station. This effort is needed to secure Barkley support.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that two beaver were released in August.
- Similkameen RM 3.8 Project – Chris Fisher reported that the enhancement project went out for bid. Five contractors visited the project but only two contractors submitted proposals. The lowest bid was about $931,000, which is considerably greater than the cost estimated by the engineer ($500,000). As a result, the project sponsor (Okanogan Conservation District), the Colville Tribes, and Cardno-Entrix pulled the project. They are reevaluating the project and intend to find a lower-cost approach that reduces bank erosion. As part of the new approach, they will contact the Bureau of Reclamation, who owns the property across the river, to evaluate the feasibility of reconnecting floodplain habitat on Reclamation property.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) reported that they received the final draft of the cultural resource report. The report indicates that there is no risk of damaging cultural resources. The sponsor submitted the report to the Department of Archaeology and Historic Preservation and tribes for review. Construction is scheduled for this fall.
- Icicle Boulder Field Project – The sponsor (TU) reported that Waterfall Engineering worked to revise and update the final plans. This work included plan development and updates to the general report. The sponsor and engineer are reviewing a small modification to boulder 14 in order to accommodate high flow passage improvements on the left bank of the boulder field. The project team has a field visit scheduled in mid-September to gather low-flow data and to further vet possible modifications to boulder 14 and Option 5 designs.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The sponsor (WDFW) will provide an annual report to the Rock Island Committee by 31 December 2016.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) reported that they have been reviewing literature on nutrient enhancement projects and conducting statistical analyses on Chiwawa River fish data to assess the feasibility of developing an effectiveness monitoring plan.

IV. Review of Middle Entiat 80% Restoration Plans

The Committees received a request from Chelan-Douglas Land Trust (CDLT) and the Bureau of Reclamation (Bureau) to review the 80% middle Entiat River restoration plans. Specifically, the Committees were asked to review projects proposed on the Tyee Creek Confluence and Bockoven South parcels. In January 2016 the Committees reviewed the 60% designs and concluded that they were appropriate. The planners have made some modifications to the 60% designs and would like feedback from the Committees. The Committees reviewed and approved the 80% designs on the Tyee Creek Confluence and Bockoven South parcels.

V. General Salmon Habitat Program Application

Fish Passage at Ellis Creek Sediment Basin

The Committees reviewed a General Salmon Habitat Program application from the Okanagan Nation Alliance (ONA) titled, *Fish Passage at Ellis Creek Sediment Basin*. The purpose of the project is to provide fish passage at the lower end of Ellis Creek, which is currently blocked with a rock weir designed to trap fine sediments. Passage at the rock weir would open 2.5 miles (4.1 km) of stream to salmonids. The total cost of the project is $185,638. The sponsor requested $39,784 from HCP Tributary Funds. After careful consideration, ***the Tributary Committees declined the opportunity to fund the project***.

The Committees believe this project has limited biological benefit, compared to other potential projects in the Okanagan River basin. Because Ellis Creek is an urban stream, it has limited spawning and rearing habitat, and the increase in carrying capacity is small relative to the cost of the project. The Committees recommend that ONA focus enhancement efforts in other tributaries that have a greater potential to improve habitat quality and increase capacity for Plan Species.

VI. Monitoring Beaver Reintroductions

In July, the Rock Island Tributary Committee agreed to fund the Beaver Fever: Restoring Ecosystem Function Project, which was submitted by Trout Unlimited. The purpose of this project was to reestablish beavers and install beaver dam analogs (BDAs) in tributaries of the Wenatchee River basin. The Committee told the sponsor that money from the Rock Island Plan Species Account can only be used to install BDAs; no funds from the account can be used to trap, acclimate, or relocate beavers.

During the September meeting, the Committees discussed the lack of information on the effects of beaver relocation projects on salmonids in the Upper Columbia River basin. A beaver relocation project in the Methow River basin has not evaluated the effects of beaver on salmonids. To that end, the Committees would like to receive and evaluate a monitoring proposal from TU that evaluates the effects of beaver and/or BDAs on water temperature, stream flows, and salmonid abundance. TU is welcome to do the monitoring or they can hire an entity to do the monitoring work. Tracy Hillman will send TU an email inviting them to submit a monitoring proposal for Committees’ review.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in August and September:

   Rock Island Plan Species Account:

   - $115.00 to Clifton Larson Allen for Rock Island financial administration in August 2016.
   - $2,337.50 to Cordell, Neher and Company for Rock Island Plan Species Account auditing.
   - $4,329.09 to Trout Unlimited for the MVID Instream Flow Improvement project.
   - $23,448.67 to WDFW for the Peshastin Creek RM 10.5 PIT-Tag Detection project.

   Rocky Reach Plan Species Account:

   - $115.00 to Clifton Larson Allen for Rocky Reach financial administration in August 2016.
   - $2,337.50 to Cordell, Neher and Company for Rocky Reach Plan Species Account auditing.

- $33,132.32 to Trout Unlimited for the MVID Instream Flow Improvement project.
- $729.45 to the Okanogan Conservation District for the Similkameen RM 3.8 Rehabilitation project

Wells Plan Species Account:

- $2,985.74 to Trout Unlimited for the MVID Instream Flow Improvement project.
- $19,801.67 to Methow Salmon Recovery Foundation for the Methow Watershed Beaver Reintroduction project.

2. Chelan PUD asked the Committees for a list of funded projects that address spring Chinook. The Committees reviewed the list of funded projects and identified the key species addressed by each project (see Attachment 1). They also identified possible projects that they would like to visit next year. Those include Nason Creek Off-Channel Habitat Restoration project, Twisp River Conservation Acquisition II, White River Nason View Acquisition, White River Dally-Wilson Conservation Easement, Boat Launch Off-Channel Pond Reconnection project, Wenatchee Levee Removal and Riparian Restoration project, Entiat Instream Habitat Improvements project, Christianson Conservation Easement, Lehman Riparian Restoration project, Upper Beaver Habitat Improvement Channel Restoration project, Methow Riparian Protection (Heath), Heath Floodplain Restoration, Twisp River Riparian Protection (Pampanin), and Lower Chewuch Beaver Restoration project. The Committees will revisit this list early next year.
3. Chris Fisher reminded the Committees that ONA is planning a project tour on 12 and 13 October. The HCP Tributary Committees and PRCC Habitat Subcommittee will attend the tour. Chris reviewed the draft agenda with the Committees (see Attachment 2). Chris needs to know who will be attending the tour by the end of the month.

VIII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 10 November 2016 at Grant PUD in Wenatchee. The Committees will tour projects on the Okanagan River during 12-13 October.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

List of Funded Projects by Plan Species Account

Rock Island Habitat Conservation Plan
Tributary Committee

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 White River Floodplain & Habitat Protection	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$1,986,200	$693,548	$693,548	Complete
05 Nason Creek Off-Channel Habitat Restoration	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, St	$125,034	$18,787	$18,787	Complete
05 Alder Creek Culvert Replacement	Chelan County NRD	General	Fish Passage	Spr Ch, St	$89,804	$89,804	$89,804	Complete
05 McDevitt Diversion Project	Cascadia Conservation District	Small	Fish Passage	Spr Ch, St	$5,278	$5,278	$2,831	Complete
07 LWD Removal and Relocation	Chelan County NRD	Small	Instream Structures	NA	$5,000	$5,000	$871	Complete
07 WRIA's 45/46 Riparian Restoration	Cascadia Conservation District	Small	Riparian Habitat	Spr Ch, Sum Ch, St	$50,000	$25,000	$24,779	Complete
07 Entiat PUD Canal System Conversion	Cascadia Conservation District	General	Instream Flows	Spr Ch, Sum Ch, St	$496,584	$99,360	$99,360	Complete
07 Roaring Creek Flow Enhancement	Cascadia Conservation District	General	Instrm Flows/Fish Passage	St	$147,069	$25,000	$987	Cancelled
07 Wildhorse Spring Creek Conservation Easement	Colville Confederated Tribes	General	Protection	St	$67,826	$62,826	$62,826	Complete
08 Twisp River Conservation Acquisition II	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$481,814	$220,000	$200,500	Complete
08 Twisp River Riparian Protection (Zinn)	Methow Conservancy	General	Protection	Spr Ch, St	$349,988	$104,996	$104,996	Complete

Rock Island Habitat Conservation Plan
Tributary Committee

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
08 Cashmere Pond Off-Channel Habitat Project	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$914,076	$249,110	$240,139	Complete
09 LWD/Rootwad Acquisition and Transport II	Cascadia Conservation District	Small	Instream Structures	NA	$35,000	$35,000	$35,000	Complete
09 Sleepy Hollow Reserve Protection Feasibility	Chelan-Douglas Land Trust	Small	Assessment	Spr Ch, Sum Ch, St	$25,000	$20,000	$16,599	Complete
09 White River Nason View Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$639,000	$76,635	$76,635	Complete
09 Upper Methow II (Tawlks) Riparian Protection	Methow Conservancy	General	Protection	Spr Ch, St	$411,943	$61,948	$61,948	Complete
09 Nason Creek UWP Floodplain Reconnection - PUD Powerline Reconnection Alternatives Analysis	Chelan County NRD	General	Assessment	Spr Ch, St	$53,500	$53,500	$45,569	Complete
09 Lower Wenatchee Instream Flow Enhancement	Washington Rivers Conservancy	General	Instream Flows	Spr Ch, Sum Ch, St	$4,954,466	$167,500	$167,499	Complete
10 White River Dally-Wilson Conservation Easement	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$194,000	$120,000	$120,000	Complete
10 Assessing Nutrient Enhancement	CC Fisheries Enhancement Group	Small	Assessment	Spr Ch, St	$9,875	$9,875	$6,670	Complete
11 Boat Launch Off-Channel Pond Reconnection	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$136,500	$62,000	$62,000	Complete
11 White River Van Dusen Conservation Easement	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$440,000	$60,000	$60,000	Complete
12 Wenatchee Nutrient Enhancement - Treatment Design	CC Fisheries Enhancement Group	General	Assessment/Instream Structures	Spr Ch, St	$240,000	$80,000	$80,000	Complete
12 White River Large Wood Atonement	CC Fisheries Enhancement Group	General	Instream Structures	Spr Ch, St, Sock	$352,392	$100,000	$100,000	Complete
12 Wenatchee Levee Removal & Riparian Restoration	Chelan County NRD	Small	Off-Channel Habitat	Spr Ch, Sum Ch, St	$67,450	$56,700	$20,386	Complete
14 Twisp to Carlton Reach Assessment	CC Fisheries Enhancement Group	General	Assessment	Spr Ch, Sum Ch, St	$173,016	$46,500	$46,483	In progress

Rock Island Habitat Conservation Plan
Tributary Committee

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
14 Post Fire Landowner Assist/Habitat Protection	Methow Salmon Recovery Found	Small	Fish Passage	Spr Ch, St	$100,000	$57,328	$50,796	Complete
14 Icicle Irrigation District Flow Control Structure	Chelan County NRD	General	Instream Flows	Spr Ch, St	$140,633	$70,000	$30,653	Complete
14 Lehman Riparian Restoration	Methow Conservancy	Small	Riparian Habitat	Spr Ch, St	$40,267	$9,053	$9,053	Complete
14 MVID Instream Flow Improvement	TU - Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$300,000	$208,033	In progress
15 Barkley Irrigation Company - Under Pressure	TU - Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$3,293,180	$300,000	$0	In progress
15 White River Floodplain Connection (RM 3.4)	CC Fisheries Enhancement Group	Small	Off-Channel Habitat	Spr Ch, St, Sock	$35,500	$35,500	$8,866	In progress
16 Icicle Creek-Boulder Field-Wild Fish to Wilderness	TU - Washington Water Project	General	Fish Passage	St	$1,571,189	$250,000	$0	In progress
16 Peshastin Creek RM 10.5 PIT-Tag Detection Site	WA Dept of Fish & Wildlife	Small	Assessment	St	$62,872	$32,269	$23,449	Complete
16 Permitting Nutrient Enhancement in the Chiwawa	CC Fisheries Enhancement Group	Small	Assessment	Spr Ch, St	$11,348	$11,348	$4,262	In progress
Total					**$27,452,804**	**$3,613,865**	**$2,773,328**	

Current Rock Island Plan Species Account Balance (unallocated): $5,528,216
Contribution to the Rock Island Account is made annually (January 31): $485,200 (in 1998 dollars)

Rocky Reach Habitat Conservation Plan
Tributary Committee

Rocky Reach Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Target Species	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
05 Entiat Instream Structure Engineering	Cascadia Conservation District	General	Instream Structures	Spr Ch, Sum Ch, St	$59,340	$59,340	$48,659	Complete
05 Twisp River Conservation Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$200,835	$40,000	$40,000	Complete
05 Clees Well and Pump	Okanogan Conservation District	General	Instream Flows	Spr Ch, Sum Ch, St	$40,875	$15,000	$14,924	Complete
05 Entiat Instream Habitat Improvements	Chelan County NRD	General	Instream Structures	Spr Ch, Sum Ch, St	$250,000	$37,500	$37,500	Complete
06 Entiat PUD Canal Juv Habitat Enhancement	Cascadia Conservation District	Small	Instream Structures	Spr Ch, Sum Ch, St	$23,640	$23,640	$3,059	Complete
07 LWD Removal & Relocation	Chelan County NRD	Small	Instream Structures	NA	$5,000	$5,000	$871	Complete
07 LWD/Rootwad Acquisition & Transport	Cascadia Conservation District	Small	Instream Structures	NA	$24,600	$24,600	$24,600	Complete
07 Harrison Side Channel	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$797,300	$90,105	$68,647	Complete
08 Entiat PUD Canal Log-Boom Installation	Cascadia Conservation District	Small	Instream Structures	Spr Ch, Sum Ch, St	$10,660	$7,160	$4,526	Complete
08 Twisp River Riparian Protection (Buckley)	Methow Conservancy	General	Protection	Spr Ch, St	$299,418	$89,825	$89,825	Complete
08 Below the Bridge	Cascadia Conservation District	General	Instream Structures	Spr Ch, Sum Ch, St	$398,998	$150,000	$115,353	Complete
09 Entiat NFH Habitat Improvement Project	Cascadia Conservation District	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$285,886	$61,373	$61,373	Complete
10 Methow Subbasin LWD Acquisition & Stockpile	Methow Salmon Recovery Found	Small	Instream Structures	NA	$50,000	$50,000	$49,914	Complete
11 Chewuch River Permanent Instream Flow Project	TU – Washington Water Project	General	Instream Flow	Spr Ch, St	$1,200,000	$325,000	$306,752	Complete
11 Christianson Conservation Easement	Methow Conservancy	Small	Protection	Spr Ch, St	$16,350	$15,000	$15,000	Complete

Rocky Reach Habitat Conservation Plan
Tributary Committee

Rocky Reach Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Target Species	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
12 Entiat Stormy Reach Phase 2 Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, Sum Ch, St	$165,000	$46,800	$44,003	Complete
12 Nason Creek Lower White Pine Coulter Creek Barrier Replacement	Chelan County NRD	General	Fish Passage	Spr Ch, St	$83,126	$12,469	$12,469	Complete
12 Nason Creek LWP Alcove Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St	$353,000	$72,000	$72,000	Complete
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	Spr Ch, St, Sock	$59,225	$180,950	$59,225	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$674,600	$102,613	$68,982	Complete
13 Okanogan Basin Stream Discharge Monitoring	Colville Confederated Tribes	Small	Instream Flows	NA	$90,954	$74,984	$74,980	Complete
14 Silver Side Channel Design	CC Fisheries Enhancement Group	General	Design	Spr Ch, Sum Ch, St	$180,733	$132,000	$132,000	Complete
14 Similkameen RM 3.8 Design	Okanogan Conservation District	General	Design	Sum Ch, St	$84,640	$84,640	$79,483	Complete
14 Entiat Stillwaters Gray Reach Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St	$559,625	$174,000	$30,000	In progress
14 Clear Creek Fish Passage & Flow Enhancement	TU – Washington Water Project	Small	Fish Passage/Instrm Flows	St	$96,116	$69,500	$11,340	In progress
14 MVID Instream Flow Improvement	TU – Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$300,000	$81,211	In progress
15 Similkameen RM 3.8 Rehabilitation	Okanogan Conservation District	General	Instream Structures	Sum Ch, St	$392,370	$67,370	$729	In progress
Total					**$16,149,291**	**$2,310,869**	**$1,547,425**	

Current Rocky Reach Plan Species Account Balance (unallocated): $2,042,757
Contribution to the Rocky Reach Account is made annually (January 31): $229,800 (in 1998 dollars)

Wells Habitat Conservation PlanTributary Committee

Wells Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Target Species	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
05 Okanagan River Restoration – Phase III	Okanagan Nation Alliance	General	Instream Structures	Spr Ch, St, Sock	$219,121	$219,121	$197,681	Complete
05 Methow Riparian Protection (Heath)	Methow Conservancy	General	Protection	Spr Ch, St	$2,684,500	$1,177,500	$812,700	Complete
05 Methow Riparian Protection (Prentice)	Methow Conservancy	General	Protection				$1,749	Complete
05 Methow Riparian Protection (MacDonald)	Methow Conservancy	General	Protection				$345,400	Complete
07 Lower Beaver Creek Livestock Exclusion	Okanogan Conservation District	Small	Riparian Habitat	Spr Ch, St	$24,670	$18,559	$16,561	Complete
07 Heath Floodplain Restoration	Methow Salmon Recovery Found	Small	Off-Channel Habitat	Spr Ch, St	$48,695	$48,695	$43,915	Complete
07 Okanogan River Restoration – Phase IV	Okanagan Nation Alliance	General	Instream Structures	Spr Ch, St, Sock	$1,022,000	$411,000	$411,000	Complete
08 Riparian Regeneration & Restoration Initiative	Methow Conservancy	Small	Riparian Habitat	Spr Ch, St, Sock	$22,737	$15,537	$15,537	Complete
08 Fort Thurlow Pump Project	Methow Salmon Recovery Found	Small	Instream Flows	Spr Ch, St	$48,150	$7,000	$7,009	Complete
08 Goodman Livestock Exclusion Project	Okanogan Conservation District	Small	Riparian Habitat	St	$8,080	$7,980	$6,829	Complete
08 Poorman Creek Barrier Removal	Methow Salmon Recovery Found	General	Fish Passage	Spr Ch, St	$191,579	$53,748	$53,748	Complete
08 Twisp River Riparian Protection (Pampanin)	Methow Conservancy	General	Protection	Spr Ch, St	$119,720	$48,649	$48,649	Complete
08 Twisp River Riparian Protection (Neighbor)	Methow Conservancy	General	Protection	Spr Ch, St	$260,000	$55,000	$55,000	Complete
08 Twisp River Riparian Protection (Speir)	Methow Conservancy	General	Protection	Spr Ch, St	$79,976	$23,993	$23,993	Complete
11 Methow River Acquisition MR 39.5 (Hoffman)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$195,048	$74,415	$74,415	Complete
11 Methow River Acquisition MR 48.7 (Bird)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$292,140	$111,680	$109,786	Complete

Wells Habitat Conservation PlanTributary Committee

Wells Plan Species Account

Project Name	Sponsor	Fund Type	Project Type	Target Species	Total Cost	Tributary Contribution	Tributary Contribution (actual to date)	Project Status
11 Methow River Acquisition MR 41.5 (Risley)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$148,210	$31,854	$26,518	Complete
12 Twisp River Acquisition 2011 (Hovee)	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$140,700	$29,000	$1,074	Complete
12 Twisp River Well Conversion	Trout Unlimited	Small	Instream Flows	Spr Ch, St	$87,739	$68,023	$68,023	Complete
13 Twisp River Poorman Crk Wetland Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$423,000	$338	$338	Cancelled
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	Spr Ch, St, Sock	$180,950	$59,225	$59,224	Complete
13 Methow/Chewuch Groundwater Monitoring	Cascade Columbia Fisheries Enhancement	Small	Instream Flows	NA	$34,180	$30,580	$29,962	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$674,600	$102,613	$68,982	Complete
13 Lower Chewuch Beaver Restoration	Methow Conservancy	General	Off-Channel Habitat	Spr Ch, St	$247,985	$27,000	$27,000	Complete
13 MVID Instream Flow Improvement Project	Trout Unlimited	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$400,000	$343,842	In progress
14 Remove Collapsed Bridge from Shingle Creek	Okanagan Nation Alliance	Small	Channel Restoration	Spr Ch, St	$8,193	$6,693	$6,689	Complete
15 Methow Watershed Beaver Reintroduction	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$216,000	$33,500	$19,802	In progress
15 M2 Sugar Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$119,652	$15,185	$15,185	Complete
Total					**$17,244,625**	**$3,076,888**	**$2,890,611**	

Current Wells Plan Species Account Balance (unallocated): $1,300,397
Contribution to the Wells Account will be made annually beginning in 2010: $176,178 (in 1998 dollars)

Attachment 1

Draft Agenda for the Okanagan Tour

HCP & PRCC OKANAGAN PROJECT TOUR
Wednesday, October 12th, 2016
&
Thursday, October 13th, 2016

TOUR AGENDA

October 12th, 2016

7:30 am	Arrive at U.S. Forest Service Building in Wenatchee
9:30 am	Arrive at Okanogan Waste Water Treatment Plant (visit Conservancy Island)
10:00 am	Depart from Okanogan
12:15 pm	Arrive at Vaseux Creek
1:15 pm	Lunch in Penticton, TBD
2:30 pm	Arrive at Penticton Channel
	Walk En'owkin floodplain, then past Beds 4, 3, 2 and 1 before finishing at Okanagan Lake Dam
3:45 pm	Discuss prioritized tributaries above Okanagan Lake Dam and next steps
4:30 pm	Walk back to vehicle/Ramada Inn
5:30 pm	Dinner at *KVR Pub*

October 13th, 2016

7:00 am	Depart *Ramada Inn* in Penticton; breakfast en route (TBD)
9:30 am	Arrive at Equesis Creek
10:05 am	Arrive at Nashwito Creek
11:20 am	Arrive at Trepanier Creek
12:10 pm	Arrive at Trout Creek
12:30 pm	Depart for home

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 10 November 2016

Members Present: Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Jeremy Cram (WDFW) and Steve Hays (Chelan PUD).[1]

Others Present: Becky Gallaher (Tributary Project Coordinator). Deanne Pavlik-Kunkel (Grant PUD), Denny Rohr (PRCC Habitat Sub-Committee Chair), and Aaron Penvose (Trout Unlimited) attended the discussion on the Barkley Irrigation Company – Under Pressure Project.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 10 November 2016 from 9:30 am to 12:00 pm.

ACTION ITEMS

1. **For the Similkameen RM 3.8 Project, Chris Fisher will check to see (1) how much dewatering will be necessary to implement alternative 5 and (2) what is the back-up plan if pilings cannot be driven 25 feet below EG**.
2. **Becky Gallaher will check with Larry Rees and Tom Walters (Committees' approved appraisers) to see if they can recommend appraisers in Canada**. **Chris Fisher will check with ONA on appraisers in Canada**.
3. **Tracy Hillman will modify the language in the Policies and Procedures document to reflect that the Committees will not require project sponsors to submit draft GSHP applications outside the SRFB process.**
4. **Using the list of funded projects identified under item #2 on page 4 of the September meeting notes, each member will select five projects they would like to visit in 2017**. **During the December or January meeting, members will combine their lists and identify which projects will be selected for a field visit.**

[1] Jeff Osborn, Chelan PUD alternate, provided votes on decision items before the meeting. Jeremy Cram provided his votes on decision items after the meeting.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda. Tom Kahler added to the agenda an evaluation of the HCP TC Chair. Tracy added a discussion on the Barkley Irrigation Company – Under Pressure Project to the agenda. He said that Aaron Penvose will join the meeting at 11:00 am to discuss the status of the project.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 8 September 2016 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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that construction is substantially complete. There are a few items yet to completed. The sponsor hopes to decommission five wells before winter. In addition, the sponsor continues to monitor a few wells in the Poorman Creek area to make sure the wells are operating correctly. One well needs additional work.
- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report later this year.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) reported that state and tribal officials approved the cultural resources assessment. In addition, the sponsor completed the line extension by the end of October and they continue to work on the water right change and new source approval package. Finally, the sponsor submitted to the Rocky Reach Tributary Committee the pump test report, which was uploaded to the Extranet site.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported that they spent the month of October working with the directors of Barkley Irrigation Company and their counsel to resolve long-term O&M issues. The sponsor determined that the system as designed is cost prohibitive. The sponsor will meet with Barkley in early November to discuss other options. See discussion below for more details.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that five beavers were released at two sites in October. Trapping in 2016 is now complete with a total of 36 beavers captured this year.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) reported that Cardno prepared a set of alternative designs to reduce or prevent bank erosion at the project site. Chris Fisher reminded the Rocky Reach Tributary Committee that the lowest bid on implementing the original preferred design was about $931,000, which was considerably greater than the cost estimated by the engineer ($500,000). As a result, the project sponsor pulled the project and asked Cardno to provide cost-effective alternative designs. Chris shared with the Committee two alternatives (alternatives 4 and 5). Chris indicated that the landowner, sponsor, and Colville Tribes support alternative 5. Of the two alternatives, the Rocky Reach Tributary Committee also supported alternative 5. Chris will check to see (1) how much dewatering will be necessary to implement alternative 5 and (2) what is the back-up plan if pilings cannot be driven 25 feet below EG.

- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) reported that they intend to plant 100 western red cedars and about 25 other riparian plant species at the culvert removal site. Because of a bonding situation with the contractor, they have not yet received the right-of-entry permit from WDFW. Because flows are rising in the White River, it is unlikely they will complete the culvert removal portion of the project this year.
- Icicle Boulder Field Project – The sponsor (TU) reported that they are working on hiring a contractor for the permitting process. The sponsor intends to have a contractor selected within the next six weeks. Permitting will begin shortly thereafter.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The sponsor (WDFW) will provide an annual report to the Rock Island Committee by 31 December 2016.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) continues to develop a monitoring plan for the nutrient enhancement project. They will schedule a meeting with the Forest Service to clarify monitoring goals and requirements. In addition, they will meet with local experts to assess feasibility.

IV. Okanagan Field Trip

Tracy Hillman, Chris Fisher, and Tom Kahler provided the Committees with a brief overview of the project tours in Canada. The project tour occurred on 12-13 October 2016. The tour began with a visit to Conservancy Island, where Chris Fisher described current restoration efforts and results from monitoring and evaluation studies conducted in side channels around the island. Chris indicated that water quality sampling in a side channel revealed high levels of *E. coli*. Once the source of the problem was fixed, *E. coli* levels dropped dramatically. The Committees then traveled to Canada and met with the Okanagan Nation Alliance (ONA), who provided an overview and results of past projects funded by the Priest Rapids Coordinating Committee (PRCC) Habitat Sub-Committee and the HCP Tributary Committees. Those projects included Shuttleworth diversion and passage projects, Shingle Creek dam decommissioning, monitoring of the Okanagan River Restoration Initiative (ORRI) projects, and monitoring at Skaha and McIntyre dams. Members present visited Vaseux Creek, where two unscreened open ditch diversions entrain fish. The goal here is to develop optimal flow regimes for fish and reduce or eliminate entrainment of fish into the diversions. Members then visited spawning beds constructed in the Penticton Channel. These beds are used heavily by sockeye and kokanee. The goal is to add a fourth spawning bed downstream from the upper three beds. Along the Penticton Channel is a large disconnected wetland/floodplain, which ONA is proposing to reconnect with the Channel. First, however, ONA needs to acquire a small parcel of the southern portion of the floodplain to complete the reconnection project. Once that parcel is secured (the current landowner is willing to sell it to the Tribe), ONA can move forward with designing a strategy to reconnect the floodplain with the Penticton Channel.

The second day of the tour included visiting major tributaries to Okanagan Lake. The first stream was Equesis Creek, a third-order stream about 24-km long. A diversion dam in the upper portion of the watershed prevents fish access to spawning and rearing habitat. The goal in Equesis Creek is to provide fish passage, reduce entrainment, and increase instream flows. They also plan to work with ranchers to reduce cattle access to the stream. As in Equesis Creek, ONA intends to improve instream flows and fish passage in Nashwito Creek and eliminate fish entrainment. Nashwito Creek is about 13-km long. The final stream visited by members present was Trepanier Creek, a 28-km long tributary to the lake. In this stream, a deactivated dam at Rkm 1.0 limits fish passage to the upper watershed. ONA is looking into adding fish passage at the dam site and also through the upstream canyon reach. Members present noted that restoration actions in these streams are relatively straightforward. That is, fish passage and entrainment are the primary concerns to be addressed in these tributaries.

V. Acquisitions in Canada

Tracy Hillman reported that during the tour in Canada, ONA asked if Plan Species Account (PSA) funds can be used to acquire property in Canada, specifically the lower portion of the floodplain along the Penticton Channel described above. Tracy indicated that he would discuss this with the Committees during their November meeting. Just before the November meeting, ONA submitted a GSHP application titled, "Ecommunity Place Locatee Lands Land Acquisition for Off-Channel Salmon Habitat." The purpose of this project is to use PSA funds to acquire and protect the lower 7.96 acres of floodplain/riparian habitat adjacent to the Penticton Channel. Once this parcel is secured, ONA can work on reconnecting the wetland/floodplain with the Channel. The total cost of the acquisition is $456,514 (Can). ONA requested $59,676 (Can) from the Tributary Committees.

Members indicated that PSA funds can be used by project sponsors to acquire property in Canada; however, at this time, the Committees do not have approved appraisers and reviewers in Canada. Therefore, the Committees directed Becky Gallaher to check with Larry Rees and Tom Walters (Committees' approved appraisers) to see if they can recommend appraisers in Canada. In addition, Chris Fisher will check with ONA on appraisers. Once the Committees have an approved appraiser in Canada, they can evaluate the GSHP application from ONA.

VI. Budget Amendment: Clear Creek Fish Passage and Instream Flow Project

The Rocky Reach Tributary Committee received a budget amendment request from Trout Unlimited on the *Clear Creek Fish Passage and Instream Flow Enhancement Project*. The sponsor asked to move $3,000 from "Contract Labor" to a new budget line item titled "Project Materials." After careful consideration, ***the Rocky Reach Tributary Committee approved the budget amendment***. This amendment will not change the total budget amount. This is the third budget amendment on this project.

VII. Time Extension and Budget Amendment: MVID Instream Flow Improvement Project

The Rock Island, Rocky Reach, and Wells Tributary Committees received a time extension request from Trout Unlimited on the *MVID Instream Flow Improvement Project*. The sponsor indicated that they need additional time to complete the punch-list items (primarily decommissioning non-productive wells), hookup of a surface irrigation well, and final connection of the Tackman water supply from Alder Creek. They also need additional time to respond to a landowner's concern about groundwater pumping on groundwater levels in the Poorman Creek area. The sponsor asked the Committees to extend the period of the project to 31 March 2017. After careful consideration, ***the Rocky Island, Rocky Reach, and Wells Tributary Committees approved the time extension***.

The sponsor also asked the Rock Island and Wells Tributary Committees to approve budget amendments on the project. The sponsor asked the Rock Island Committee to approve moving the remaining budget for "Sponsor Salaries and Benefits" ($56,457.13) and "Indirect/Administration" ($14,966.68) to "Contract Labor." They asked the Wells Committee to approve moving $15,000.00 form "Cultural Resources," $11,406.78 from "Project Materials," and $3,027.04 from "Indirect/Administration/Overhead" to "Contract Labor." After careful consideration, ***the Rock Island and Wells Tributary Committees approved the budget amendments***. These amendments will not change the total budget amounts. This is the second budget amendment on this project.

VIII. General Salmon Habitat Program Draft Proposals

Within the Tributary Committees Policies and Procedures for Funding Projects document, Section 3.4 states that "The Committees require a draft proposal application process to give Project Sponsors an early indication of the appropriateness of a project concept, without having to complete an entire application form prior to getting an indication from the funding source." When GSHP proposals are submitted outside the Salmon Recovery Funding Board (SRFB) process, the Committees have not required sponsors to use the draft application process. Therefore, Tracy Hillman asked the Committees if they would like to modify the language in the Policies and Procedures document. Members agreed that it is not necessary to use the GSHP draft application process and directed Tracy to revise the language in the Policies and Procedures document accordingly. However, the Committees will continue to use the SRFB draft application process when sponsors include the Tributary Committees as a cost share on SRFB applications.

IX. Effectiveness Monitoring Application

During the September meeting, the Committees asked Trout Unlimited to submit a monitoring proposal that evaluates the effects of beaver and/or BDAs on water temperature, stream flows, and salmonid abundance in the Wenatchee River basin. Given that the Committees do not have an application form for monitoring projects, Tracy Hillman and Becky Gallaher developed an application form and asked the Committees to review it. After review and discussion, the Committees approved the Effectiveness Monitoring Application form (see Attachment 1). Project sponsors seeking funding for monitoring or assessments will use this application form.

X. Barkley Irrigation Company – Under Pressure Project Discussion with Trout Unlimited

Aaron Penvose, Trout Unlimited, joined the Committees (and the PRCC Habitat Sub-Committee) at 11:00 am to discuss the status of the Barkley Irrigation Company – Under Pressure Project. Aaron reminded the Committees that the purpose of the project was to eliminate mortality of ESA-listed fish species, improve stream flows (add up to 26 cfs) within eight miles of the Methow River, eliminate fish stranding within the upper half mile of the diversion side channel, and reconnect Bear Creek with the Methow River. This would be accomplished by building a pressurized irrigation system about two miles downstream from the current diversion. To date, TU has spent about $500,000 on design. Aaron indicated that the Irrigation Company hired a large consulting firm to evaluate O&M costs. In short, the consulting firm estimated an O&M cost that was 150% higher than the TU estimate. TU attempted to resolve the cost issue with the directors, but they were unsuccessful. Therefore, there will be no construction in 2016 or 2017.

Aaron said they have been working on an alternative to the original proposal. Briefly, the alternative will use the MVID headworks to serve Barkley users. The larger pump station will not be constructed; although they will use the smaller pump stations. The revised system will not be pressurized. It will be an on-demand gravity system with no spill-water return. According to Aaron, benefits to fish and their habitat will actually be greater than what was described in the original proposal. The project will still eliminate mortality of ESA-listed fish species, eliminate fish stranding within the upper half mile of the Barkley diversion side channel, and reconnect Bear Creek with the Methow River. Stream flows, however, will be improved in the Methow River for a longer distance than what was described under the original action. Aaron said both Barkley and MVID are on board with the proposed system and that Barkley wants to make this work.

Once Aaron has more information on O&M costs associated with the alternative action, and there is a signed agreement between MVID and Barkley, he will come back to the Committees and see how the Committees would like to proceed with the project. Aaron stated that most of the engineering work covered under the original plan can be used for the alternative design, and surveys and cultural work are complete. Aaron hopes to have more information for the Committees by early 2017.

XI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in September, October, and November:

   Rock Island Plan Species Account:

   - $52.50 to Clifton Larson Allen for Rock Island financial administration in September 2016.
   - $92.50 to Clifton Larson Allen for Rock Island financial administration in October 2016.
   - $935.85 to Chelan County PUD for project coordination during the third quarter of 2016.
   - $7,879.43 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection Project.
   - $13,074.60 to Trout Unlimited for the MVID Instream Flow Improvement Project.
   - $7,425.92 to WDFW for the Peshastin Creek RM 10.5 PIT-Tag Detection project (final payment).

   Rocky Reach Plan Species Account:

   - $52.50 to Clifton Larson Allen for Rocky Reach financial administration in September 2016.
   - $92.50 to Clifton Larson Allen for Rocky Reach financial administration in October 2016.
   - $909.13 to Chelan County PUD for project coordination during the third quarter of 2016.
   - $121,304.61 to Trout Unlimited for the MVID Instream Flow Improvement Project (September work).
   - $5,405.00 to Trout Unlimited for the MVID Instream Flow Improvement Project (October work).
   - $2,298.84 to Trout Unlimited for the Clear Creek Fish Passage and Instream Flow Enhancement Project.
   - $32,484.85 to the Okanogan Conservation District for the Similkameen RM 3.8 Rehabilitation project.

   Wells Plan Species Account:

   - $2,416.00 to Douglas County PUD for Wells administration for fiscal year 2016.

2. Tom Kahler reported that the Committees agreed unanimously to retain Tracy Hillman as the Chairperson for the next three-year period (2017 through 2019). Tracy accepted the appointment. Members requested that Tracy freely offer technical information on projects.

3. During the September meeting, members of the Committees identified possible funded projects they would like to visit in 2017 (see Item #2 on page 4 of the September meeting notes). Given the long list of possible projects, Tracy Hillman asked the Committees if they would like to refine the list so the tour would take no more than two days (one day for Okanogan/Method projects and one day for Entiat/Wenatchee projects). Chris Fisher recommended each member identify five projects they would like to visit. During the December or January meeting, members will combine their lists and identify which projects will be selected for a field visit in 2017.

4. Although Jeremy Cram was unable to attend the meeting, he asked Tracy Hillman to discuss with the Committees the issue of liability associated with restoration on property owned by Chelan-Douglas Land Trust (CDLT). Tracy informed the Committees that BPA was unable to come to an agreement with CDLT on liability and therefore BPA removed most of their funding of restoration work in the Middle Entiat. BPA is redirecting those funds to improve habitat in the Wenatchee and Methow River basins. Restoration may still occur in the Entiat on parcels not owned by CDLT; however, NEPA has stopped because there is no certainty on what actions will be implemented given that BPA has reprogrammed their funding.

   Members of the Committees voiced their concerns about CDLT demanding compensation for liability insurance on restoration projects implemented on their lands. Paying for liability insurance will reduce the amount of funding available to do restoration work and it does not comport with the Committees' desire to support acquisitions and conservation easements where restoration work is needed. In the past, the Committees have provided funds to CDLT for acquisitions because the Committees understood that CDLT would allow restoration to take place on those parcels. Given CDLT's recent reluctance to allow restoration work on their properties without liability compensation, the Committees are reevaluating their support of protection projects within the Upper Columbia Region.

XII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 8 December 2016 at Grant PUD in Wenatchee. Trout Unlimited asked to discuss the Icicle Boulder Field Project with the Committees in December.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Habitat Conservation Plan Tributary Funds

Douglas PUD: Wells Chelan PUD: Rock Island Chelan PUD: Rocky Reach

EFFECTIVENESS MONITORING APPLICATION

PROJECT SPONSOR INFORMATION

Contact Person:
Affiliation/Agency:
Address:
City, State Zip Code:
Telephone:
Email:

PROJECT TITLE

PROJECT BUDGET

Request from Tributary Committee:	$
Other Contributions/Matches:	$
TOTAL Project Budget	**$**

Note: These budget numbers should be consistent with those in the "DETAILED PROJECT BUDGET" of this application.

PROJECT SUMMARY

Provide a brief summary of the monitoring project.

PURPOSE

A: What are the goals of the project?

The goal of your project should broadly articulate desired outcomes of the proposed monitoring activity.

B. What are the objectives and hypotheses of the project?
*Objectives support and refine your goals, breaking them down into smaller steps. Objectives are specific, quantifiable actions. Each objective should be "SMART:" **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**ime-bound.* ***Your description should include clearly stated, testable hypotheses.***

GEOGRAPHIC SCALE

A: Explicitly identify the geographic scale of data collection and conclusions referred to within the data.
Describe if the design and analyses allow for generalized results beyond the initial geographical scale of the project. Attach a map that illustrates the spatial scale of the monitoring project.

METHODS

A: Experimental Design
Describe the design (e.g., before-after, BACI, etc.) that will be used to address the hypotheses.

B. Sampling Design
Provide a written description and map of the sampling locations. If locations are not yet defined, describe the process by which you will identify sampling locations.

C. Data Collection Methods
Describe the response variables or metrics evaluated, the rationale for their selection, field methods, protocols, and essential equipment. Are the selected metrics consistent with ongoing monitoring efforts in the region? If not, provide justification for the departure.

D: Analytical Approach
Describe the statistical tests used to test the hypotheses. If possible, include a preliminary power analysis.

E: Data Management

Describe your approach to data management, storage, and archival to ensure data quality and availability for sharing.

TASKS AND SCHEDULE

Identify project collaborators and their roles and contributions to the project. Provide a detailed description of the proposed project tasks, the party responsible for each task, a schedule or timeline for accomplishing them, and list the project deliverables. Include an annual report as a deliverable.

Item/Milestone	Outcome	Target Date (Month/Year)

ASSUMPTIONS AND CONTINGENCIES

Identify assumptions and constraints that could affect your ability to achieve objectives and how you will modify your approach if you do not meet assumptions.

DETAILED PROJECT BUDGET

Item	Cost/unit	Units	Trib. Fund Request	Donated/Other Source

TOTAL PROJECT COST: $

Note: These budget numbers should be consistent with those in the "PROJECT BUDGET" section of this application.

LITERATURE CITED

Clearly cite documents referenced within the study plan and, if available, provide electronic links.

Submit this completed form via email to Becky Gallaher, Becky.gallaher@chelanpud.org. Any electronic submittals must be in MS Word. Or you may submit a paper copy or diskette (or CD) to the following address:

Becky Gallaher
HCP Tributary Fund
Post Office Box 1231
Wenatchee, WA 98807

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 8 December 2016

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Justin Yeager (NOAA Fisheries; on phone), and Tracy Hillman (Committees Chair).

Members Absent: Lee Carlson (Yakama Nation)[1]

Others Present: Becky Gallaher (Tributary Project Coordinator). Joe Connor (BPA) attended the meeting for the Middle Entiat Restoration discussion.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 8 December 2016 from 9:30 am to 12:00 pm.

ACTION ITEMS

1. **Using the list of funded projects identified under item #2 on page 4 of the September meeting notes, each member will select five projects they would like to visit in 2017. During the January meeting, members will combine their lists and identify which projects will be selected for a field visit.**

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda. Tracy indicated that the Icicle Boulder Field agenda item has been removed. Aaron Penvose with Trout Unlimited contacted Tracy indicating that there is no need for the Icicle Boulder Field discussion at this time.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 10 November 2016 meeting notes with one edit.

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.

- MVID Instream Flow Improvement Project – The project sponsor (Trout Unlimited; TU) reported that the project is almost complete. Five wells remain to be decommissioned. The sponsor hopes to decommission these wells soon.

[1] Lee Carlson provided his votes on decision items after the meeting.

- Twisp-to-Carlton Reach Assessment Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) will submit a final report later this year.
- Entiat Stillwaters Gray Reach Acquisition – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- Clear Creek Fish Passage and Instream Flow Project – The sponsor (TU) reported that they spent most of November focusing on the water-right change and Health Department permitting. The sponsor prepared the notice of the water-right change as required by Ecology. Chelan County Construction and Shoreline Permitting processes were reviewed and project exemptions were identified.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) continued to assess O&M options. They hope to complete analysis of options in early December. They will then reconvene the executive team and evaluate costs.
- Methow Watershed Beaver Reintroduction Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that there is no new activity on this project. Trapping in 2016 is complete with a total of 36 beavers captured this year.
- Similkameen RM 3.8 Project – The project sponsor (Okanogan Conservation District) asked the Rocky Reach Tributary Committee for a time extension on the project. The sponsor indicated that they need additional time to complete the final design and implement the project. ***The Rocky Reach Tributary Committee agreed to extend the period of the project to 31 October 31 2017***.

  During the November meeting, Chris Fisher was asked see how much dewatering will be necessary to implement alternative 5 and what is the back-up plan if pilings cannot be driven 25 feet below EG for the Similkameen RM 3.8 project. Chris indicated it is unknown at this time how much dewatering will be necessary. They will not know that until they implement the project. With regard to driving pilings, Chris said they will use a small auger to test the depth of bedrock at the project site. Chris added that the sponsor will meet with the landowner on 20 December to discuss alternatives 4 and 5. The goal is to implement the preferred alternative during summer 2017. Recall that the Rocky Reach Tributary Committee supported alternative 5.
- White River Floodplain (RM 3.4) Connection Project – The sponsor (CCFEG) reported that there is no new activity on this project.
- Icicle Boulder Field Project – The sponsor (TU) indicated that they are working to finalize the design report. They have hired Ecosystem Solutions for permitting assistance and started compiling permitting documents. They are consulting with agencies on ways to navigate the permitting processes.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The sponsor (WDFW) will provide an annual report to the Rock Island Committee by 31 December 2016.
- Permitting Nutrient Enhancement Project – The sponsor (CCFEG) reported that they met with local experts (WDFW and BioAnalysts) to gain some insight on the Chiwawa and the feasibility of monitoring. They discussed available data and identified challenges of monitoring at this scale. Tracy Hillman and Jeremy Cram stated that it is unlikely that the sponsor will be able to set up a cost-effective monitoring plan that will be sensitive enough to detect survival changes associated with nutrient enhancement. Therefore, the sponsor is evaluating the use of food-web models to evaluate treatment effects.

IV. Canadian Appraisers

During the November meeting, members concluded that Plan Species Account funds can be used by project sponsors to acquire property in Canada. However, the Committees had not identified approved appraisers in Canada. Therefore, the Committees directed Becky Gallaher to check with Larry Rees and Tom Walters (Committees' approved appraisers) to see if they could recommend appraisers in Canada. In addition, they asked Chris Fisher to check with the Okanagan Nation Alliance (ONA) on appraisers.

Chris Fisher recommended the use of David Bush with Inland Appraisers. Mr. Bush has been a member of the Appraisal Institute of Canada since 1997. He is experienced in the valuation of a wide range of commercial and residential properties including First Nations/Locatee lands and interests. He has experience in property acquisition as well as a background in law. He comes highly recommended by the Penticton Indian Band and the Lower Similkameen Indian Band because of his experience working with the unique status of Federal Indian Reserve Lands in Canada. Following discussion, the Committees approved the use of Mr. Bush as their appraiser in Canada.

V. General Salmon Habitat Program Application

Ecommunity Place Locatee Lands Land Acquisition for Off-Channel Salmon Habitat

In November, the Committees reviewed a General Salmon Habitat Program application from the Okanagan Nation Alliance (ONA) titled, *Ecommunity Place Locatee Lands Land Acquisition for Off-Channel Salmon Habitat*. The purpose of this project is to acquire and protect in perpetuity 7.96 acres, including wetlands, riparian, and floodplain habitat adjacent to the Okanagan River (Penticton Channel) in Canada. This is the last parcel to be acquired of a much larger section of floodplain habitat adjacent to the Penticton Channel. Once the proposed parcel is secured, ONA will be able to reconnect the off-channel habitat with the Okanagan River. The total cost of the project is $456,514 (in Canadian dollars). The sponsor requested $59,676 (in Canadian dollars) from HCP Tributary Funds. ***The Rock Island Tributary Committee approved funding for this project.***

VI. Funding Policies and Procedures Document

During the November meeting, the Committees reviewed the requirement of using General Salmon Habitat Program (GSHP) "draft" applications. In November, the Committees agreed that "draft" GSHP applications are not required outside the Salmon Recovery Funding Board (SRFB) process. The Committees directed Tracy Hillman to modify the language in the Tributary Committees Policies and Procedures for Funding Projects document to reflect that the Committees will not require draft GSHP applications outside the SRFB process. Tracy shared with the Committees the edits he made to Sections 3.4 and 5.1. The Committees reviewed and approved the edits to those sections.

VII. Middle Entiat Restoration Project Update

Joe Connor with Bonneville Power Administration (BPA) joined the Committees at 11:30 am to discuss the status of the Middle Entiat River Restoration Project. Joe described the history of the project and their attempts to secure an agreement with Chelan-Douglas Land Trust (CDLT) on liability. In short, BPA developed 12 different draft agreements, all of which were rejected by CDLT. As a result, BPA is redirecting Entiat funds to improve habitat in the Wenatchee and Methow River basins. Chelan County is currently trying to secure an agreement with CDLT. If that happens, some level of restoration work may occur in the Middle Entiat Project Area.

Members of the Committees voiced their concerns about CDLT demanding compensation for liability insurance on restoration projects implemented on their lands. Paying for liability insurance reduces the amount of funding available to do restoration work and it does not comport with the Committees' desire to support acquisitions and conservation easements where restoration work is needed. In the past, the

Committees have provided funds to CDLT for acquisitions because the Committees understood that CDLT would allow restoration to take place on those parcels. Given CDLT's recent reluctance to allow restoration work on their properties without liability compensation, the Committees are reevaluating their support of protection projects within the Upper Columbia Region.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in November and December:

   Rock Island Plan Species Account:

   - $37.50 to Clifton Larson Allen for Rock Island financial administration in November 2016.
   - $839.61 to Cascade Columbia Fisheries Enhancement Group for the Permitting Nutrient Enhancement in the Chiwawa River Project.
   - $2,663.80 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection Project.

   Rocky Reach Plan Species Account:

   - $37.50 to Clifton Larson Allen for Rocky Reach financial administration in November 2016.
   - $4,318.54 to the Okanogan Conservation District for the Similkameen RM 3.8 Rehabilitation project.

2. During the September meeting, members of the Committees identified possible funded projects they would like to visit in 2017 (see Item #2 on page 4 of the September meeting notes). Given the long list of possible projects, Tracy Hillman asked the Committees if they would like to refine the list so the tour would take no more than two days (one day for Okanogan/Methow projects and one day for Entiat/Wenatchee projects). Chris Fisher recommended each member identify five projects they would like to visit. During the January meeting, members will combine their lists and identify which projects will be selected for a field visit in 2017.

IX. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 12 January 2017 at Grant PUD in Wenatchee. Trout Unlimited asked to discuss the Beaver Reintroduction Project with the Committees in January.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

APPENDIX D
LIST OF ROCKY REACH HCP COMMITTEE MEMBERS

Rocky Reach Mid-Columbia HCP Committees, 2016

Policy Committee

Name	Organization
John Ferguson (Chairman)	Anchor QEA, LLC
Randy Friedlander	Colville Confederated Tribes
Keith Truscott	Chelan PUD
Ritchie Graves	National Marine Fisheries Service
Jessica Gonzales (Jan-Oct) Jim Craig (Nov-Dec)	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
Jeff Korth	Washington Department of Fish and Wildlife
Bob Rose	Yakama Nation

Hatchery Committee

Name	Organization
Tracy Hillman (Chairman)	BioAnalysts, Inc.
Kirk Truscott	Colville Confederated Tribes
Alene Underwood	Chelan PUD
Craig Busack (Jan) Justin Yeager (Feb-Dec)	National Marine Fisheries Service
Bill Gale (Jan-Oct) Matt Cooper (Nov-Dec)	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
Steve Hays	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	Yakama Nation

APPENDIX E
STATEMENT OF AGREEMENT FOR HATCHERIES COMMITTEES

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.

APPENDIX F
STATEMENTS OF AGREEMENT FOR COORDINATING COMMITTEES

Final
Rocky Reach Habitat Conservation Plan
Coordinating Committees

Statement of Agreement

Closure of Rocky Reach Adult Fishway
Orifice Gates

(Approved July 26, 2016)

Agreement Statement

The Rocky Reach HCP Coordinating Committee (CC) agree to close orifice gates 1, 2, 3, 16, 18, and 20 of the Rocky Reach Adult Fishway in August 2016 to better achieve a one foot differential elevation at the Right Powerhouse Entrance (RPE). Upon the orifice gate closure, Chelan PUD Fishway Attendants will monitor in-ladder hydraulic conditions to ensure the fishway hydraulics are responding as expected to the gate closures. Chelan PUD Fishway Attendants will also conduct daily tailrace observation to see if adult fish are congregating in the immediate vicinity of the ladder entrances. Additionally, Chelan PUD will compile historical daily fish count data for comparison to current daily fish counts, and will distribute the data to the CC weekly through the end of the fish counting season. If results are observed in either fishway hydraulics or fish count data that are substantively inconsistent with historic or expected results, the CC will be notified within 24 hours to discuss the potential remedies, including reopening orifice gates in the Rocky Reach Adult Fishway. Absent any unexpected results that require consideration from the CC, the orifice gates will remain closed in subsequent fish passage seasons.

Background

In order to meet the 1 foot adult fishway differential target at the RPE under low tailwater elevations, one of three operational changes need to be implemented:1) restrict flow through the rotary gates at the RPE; 2) restrict flow to the Left Powerhouse Entrance (LPE) and middle spillway entrance (MSE) using wing gates located at the upstream end of the LPE channel and upstream end of the tunnel leading to the MSE; or 3) provide additional water through sluice gates in diffuser chambers along the collection channel. Option 1 is not applicable since operation of the rotary gates has been restricted. Options 2 and 3 can accomplish the desired goal, but hydraulic conditions in the trifurcation pool (option 2) or a decrease in water velocity through the collection channel (option 3) can result, both of which could effect adult passage in the Rocky Reach Adult Fishway. The closing of orifice gates 1, 2, 3, 16, 18, and 20 would result in the ability to provide adequate flow to the RPE entrance under decreased tailwater elevations without restricting flows at other entrances or reducing velocities inside the fishway.

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 29, 2016)

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 on June 21, 2016, and agree that 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 2019) at Rock Island and Rocky Reach and to continue to evaluate or monitor study design, tag technology, and life history information to better understand future survival study feasibility by 2019.

Background

In June, 2016, the HCP CCs were presented key information on subyearling summer Chinook including statistical survival models, applicable advancements in active-tag technology, and subyearling life history since 2013.

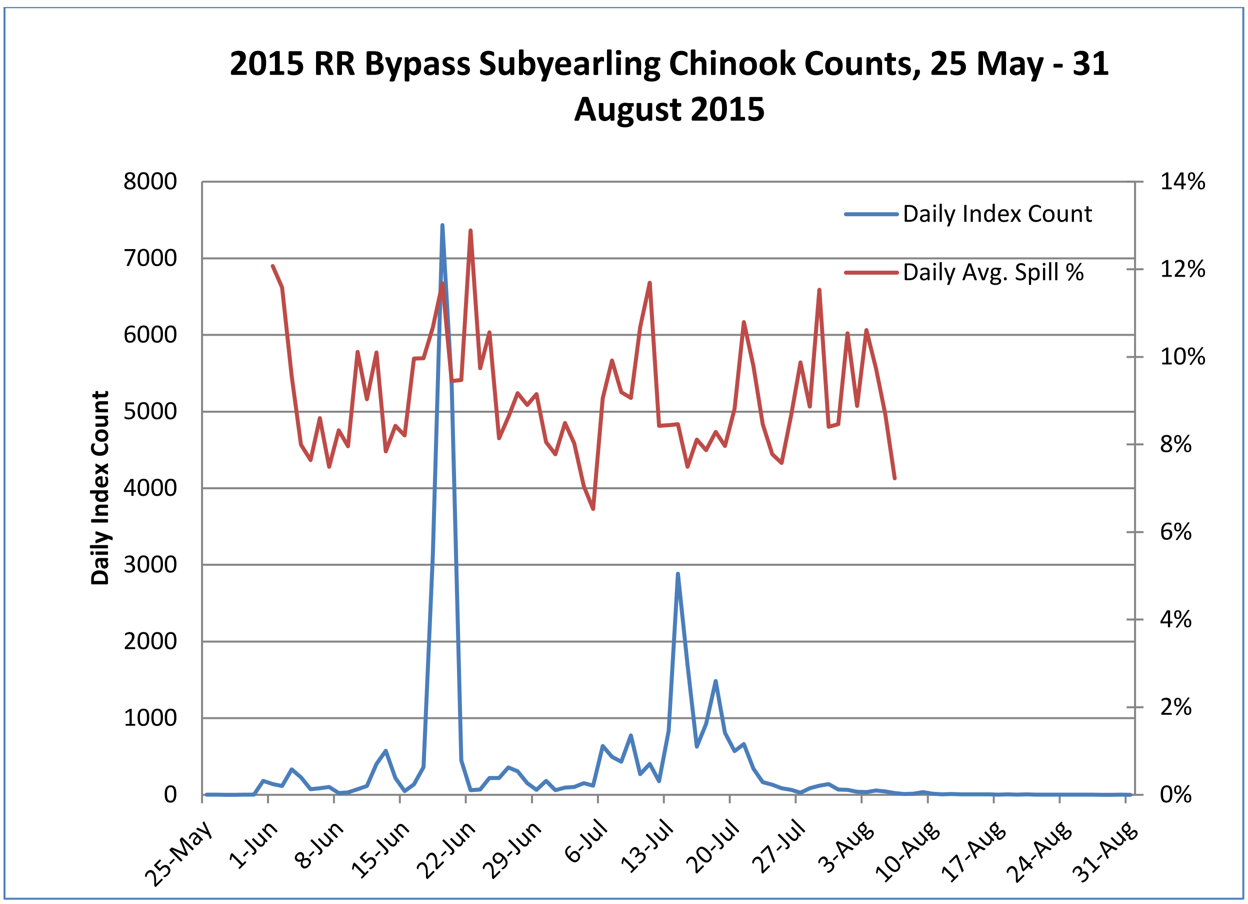
Current statistical survival models cannot calculate project survival as they are currently unable to address active and non-active migrants. Acoustic tag technology remains insufficient to conduct project survival studies required by the HCPs. Tag miniaturization resulting in smaller batteries and reduced 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 yet unknown proportions of migrant vs. non-migrant juvenile fish in the population remain impediments to project survival estimations for subyearling Chinook.

APPENDIX G
CHELAN PUD ROCKY REACH AND ROCK ISLAND HCPS FINAL 2015 FISH SPILL REPORT

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2015 Fish Spill Report

<u>2015 ROCKY REACH</u>
Summer Spill

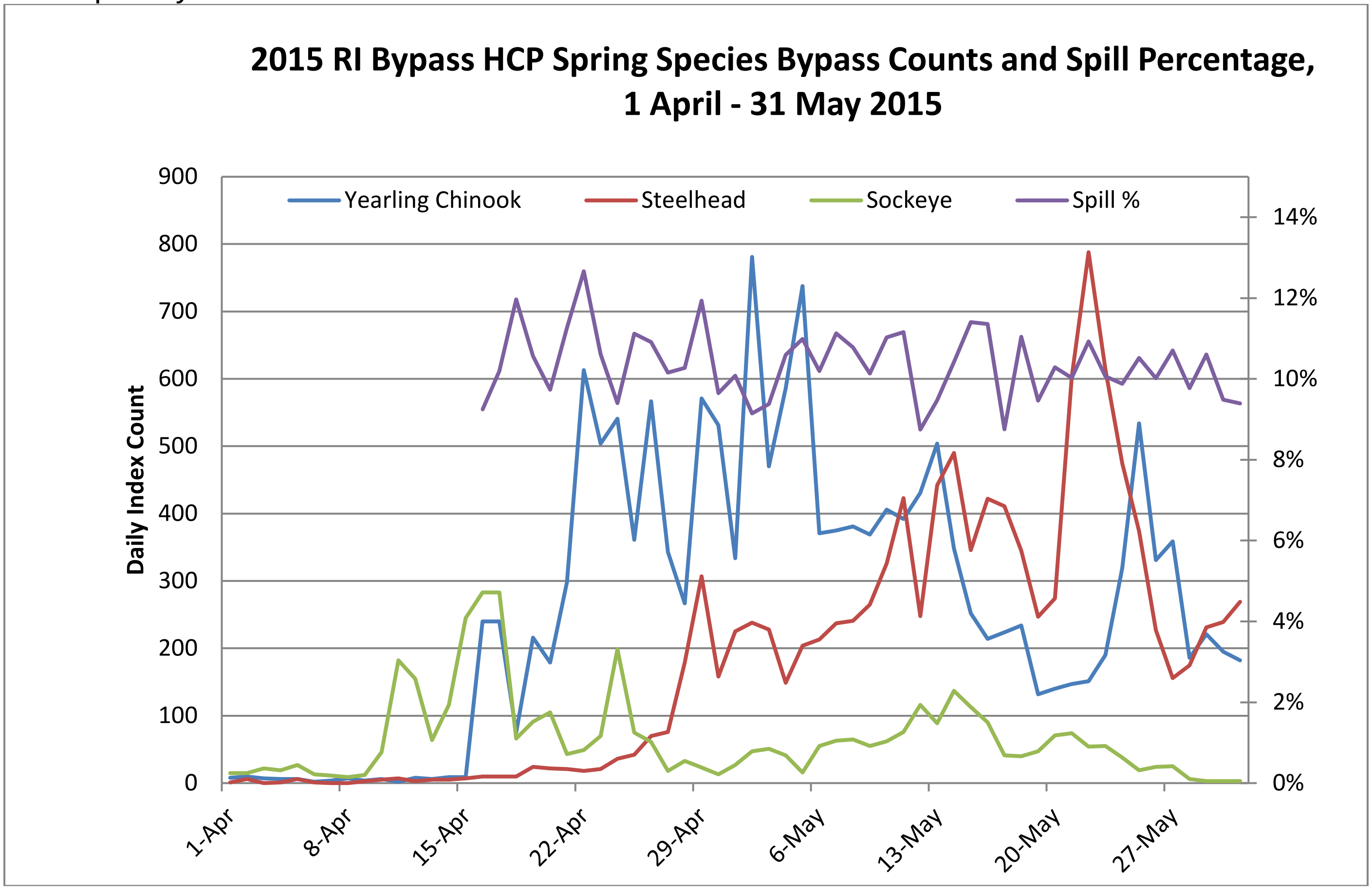
Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	1 June, 0001 hrs
Spill stop date:	7 August, 2400 hrs
95% Est. passage date:	4 August
Percent of run with spill:	99.1% on 7 August (estimated as of 31 August)
Cumulative index count:	37,104 subyearling Chinook (as of 31 August)
Summer spill percentage:	9.00% (8.88% fish spill, plus 0.12% forced spill)
Avg river flow at RR:	100,901 cfs (1 June - 7 August)
Avg spill rate at RR:	9,086 cfs (1 June - 7 August)
Total spill days:	68



2015 ROCK ISLAND

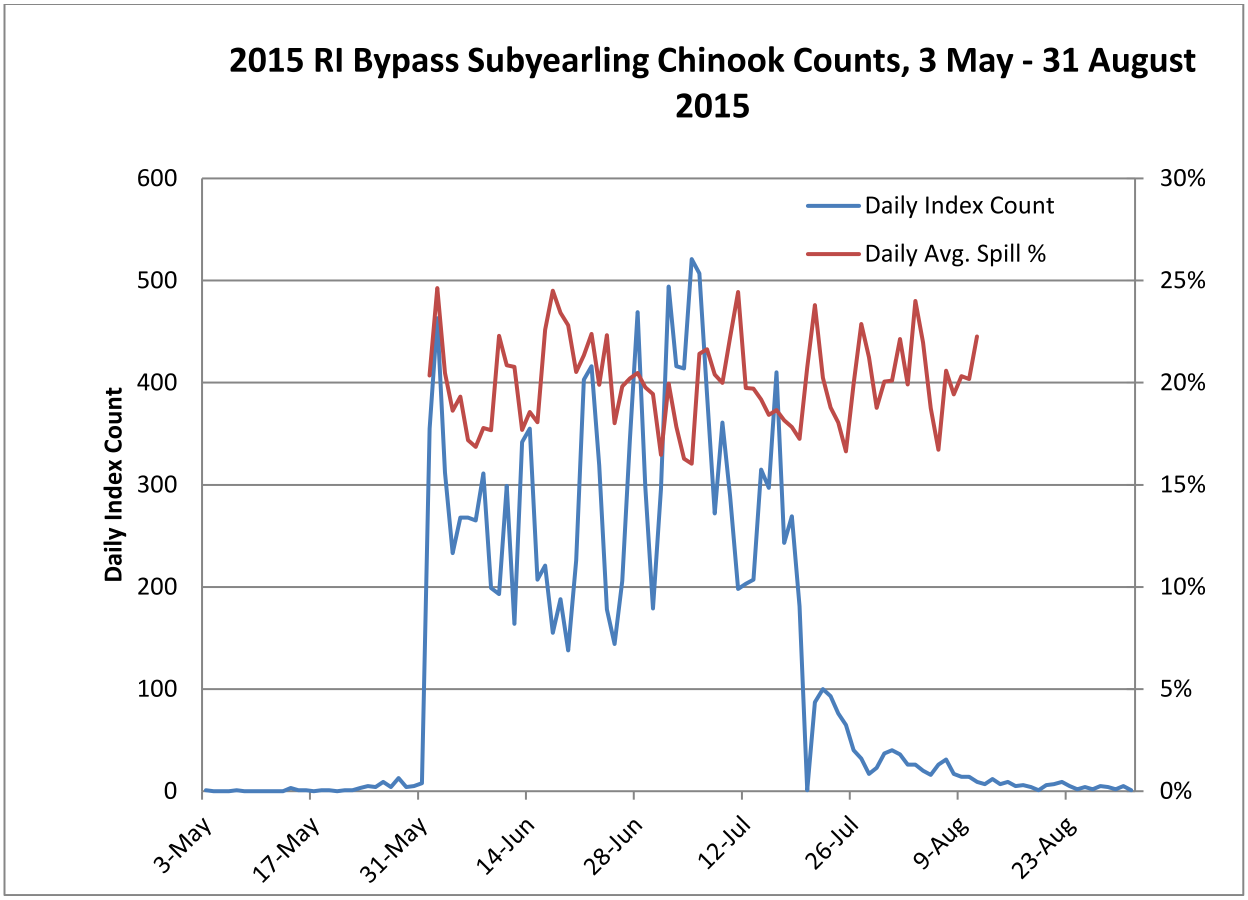
Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	16 April, 0001 hrs
Spill stop date:	31 May, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	Yearling Chinook - 99.4%; steelhead - 99.6%; sockeye - 76.6%
Cumulative index count:	16,762 yearling Chinook**;** 12,549 steelhead**;** 4,128 sockeye
Spring spill percentage:	10.29% fish spill
Avg river flow at RI:	108,333 cfs (16 April – 31 May)
Avg spill flow at RI:	11,144 cfs (16 April – 31 May)
Total spill days:	46



Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	1 June, 0001 hrs
Spill stop date:	11 August, 2400 hrs
95% Est. passage date:	2 August
Percent of run with spill:	Subyearling Chinook 99.2% (estimated as of 31 August)
Cumulative index count:	15,349 subyearling Chinook (as of 31 August)
Summer spill percentage**:**	19.86% fish spill
Avg river flow at RI:	102,557 cfs (1 June - 11 August)
Avg spill flow at RI:	20,370 cfs (1 June - 11 August)
Total spill days:	72



Juvenile Index Counts 2004-2015 from the Rocky Reach Juvenile Fish Bypass Sampling Facility and Rock Island Bypass Trap Smolt Monitoring Program (SMP)
1 April – 31 August.

Table 1. Rocky Reach Juvenile Bypass index sample counts, 2005-2015

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015
Sockeye	17,575	239,185	169,937	136,206	40,758	724,394	67,879	384,224	199,497	553,645	**53,575**
Steelhead	5,821	4,329	4,532	8,721	6,309	4,931	5,683	4,902	2,528	5,270	**4,157**
Yearling Chinook	27,611	23,461	18,080	38,394	18,946	33,840	24,400	95,207	29,018	15,871	**32,220**
Subyearling Chinook	10,978	19,996	13,496	11,820	11,944	59,751	17,246	5,774	22,073	22,327	**37,104**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2005-2015

Species	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014***	**2015**
Sockeye	1,991	34,604	16,410	38,965	4,926	37,404	18,697	46,788	25,111	38,596	**4,128**
Steelhead	15,974	26,930	18,482	22,780	17,636	17,194	28,408	16,957	15,099	28,299	**12,549**
Yearling Chinook	14,797	37,267	23,714	22,562	9,225	11,802	26,407	25,759	28,324	26,429	**16,762**
Subyearling Chinook	18,710	27,106	15,686	15,940	8,189	23,205	27,397	27,298	17,170	34,527	**15,349**

***** 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 H
GRANT PUD'S TARGET HRR PROPOSAL

Target HRRs

On February 17, 2016, the HCP-HCs agreed to use the following methods for calculating and assessing HRR targets, as revised during the HCP-HC 2/17 meeting. Grant PUD (PRCC Hatchery Sub-Committee) also voiced support for this methodology.

The HC/HSC agreed to the following HRR targets:

1. Use the estimated 40th percentile HRR target during 5-year evaluation periods.
2. Use varying degrees of action depending upon the number of years that the HRR deviates from the target; green light (below 40 percentile for 2 years or less, no action) and red light (below 40 percentile for 3 years or more, investigate cause of performance issue and potentially adapt program if cause can be attributed to hatchery program).
3. Each program will have its own HRR target with the following exceptions:
    - Nason Creek will use the Chiwawa spring Chinook target because there is no data for the Nason Creek program to calculate its target.
    - Methow spring Chinook and Chewuch spring Chinook will use the higher of their two targets, because they are both MetComp stock and should be assessed together.

APPENDIX I
2016 ROCKY REACH AND ROCK ISLAND HCP ACTION PLAN FINAL

2016 Rocky Reach and Rock Island
HCP Action Plan *Final*

COORDINATING COMMITTEE

Activity	Jan 2016			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	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 2015 RR Bypass Evaluation Report				D				F																												
Deliver 2016 RR Bypass Operations Plan				D					F																											
Deliver 2015 RI Bypass Evaluation Report				D					F																											
Deliver 2016 RIS Bypass Operations Plan				D				F																												
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring and Report										S																										C
Northern Pikeminnow Ladder Trapping RI/RR																S								C												
Subyearling Chinook Workshop																		C																		
Deliver 2016 RI/RR Fish Passage Plan					D			F																												
Deliver 2016 RR/RI Spill Plan							D			F																										
Deliver 2016 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												
2015 HCP Annual Report							D			F																										

HATCHERY COMMITTEE

Activity	Jan 2016			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	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
2015 Hatchery M & E Report								D								F																				
2017 Hatchery M & E work plans																						D						F								
Dryden Water Quality Monitoring (Year 5)							S						C																							
Dryden TMDL check-in		S			C																															
Feasibility Chilled Reuse System at EB						S																														
Chelan Hatchery Rehabilitation Design	S																																			
Continuation of Methow Sp. Ch. Review																																				
Steelhead Residualism Plan - *Draft*										S																										F
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							
Receive Methow spring Chinook Permit (anticipated)															C																					
Receive Wenatchee Steelhead Permit (anticipated)																			C																	

TRIBUTARY COMMITTEE

Activity	Jan 2016			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	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 J
2016 WENATCHEE STEELHEAD RELEASE PLAN (BROOD YEAR 2015)

FINAL Memorandum

Date: March 3rd, 2016

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Chris Moran (WDFW), McLain Johnson (WDFW) and Catherine Willard (CPUD)

Re: 2016 Wenatchee Steelhead Release Plan (Brood Year 2015)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin in 2015 as part of the Rock Island and Rocky Reach HCP requirements. As of February, approximately 199,454 Wenatchee summer steelhead (91,538 HxH and 107,916 WxW) are on station at the Facility.

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa Acclimation Facility ("Facility") (Figure 1) following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank Hatchery to the Facility in November and released in April through May. The Facility consists of three, in line circular, dual-drain tanks within an enclosed building and are operated on a partial water reuse system (RAS). The two outer tanks hold steelhead during rearing and the center tank is used solely for receiving fish that are allowed to move from the outer tanks to the center tank during release. Fish are not provided the opportunity to move to the center tank until gates are removed (typically April 20th). When the center tank contains a pre-determined number of fish for a release, fish are loaded into a hatchery truck and truck-planted at one of five release locations. This "screening" method has been used to differentiate between apparent active migrants (fish that move from the outer tanks to the center tank) from apparent non-active migrants (fish that do not move from the outer tank to the center tank).

In addition to the circular vessels, there are three traditional flow-through raceways (RCY) located outside. The smaller of the three, Raceway Three (RCY3) is used to rear steelhead when it is not needed for rearing "high ELISA" spring Chinook juveniles. Raceways One (RCY1) and Two (RCY2) are located adjacent to each other. The wall between the two raceways contains a gated opening that when removed, allows fish to move between the raceways. In addition to removing the gate, the water is lowered in the receiving pond (typically April 20th) to establish a directional flow that apparent active migrant fish may cue to. Similar to the RAS vessels, this set-up allows for a screening method that attempts to differentiate between apparent active- and apparent non-active migrants. When RCY1 contains the pre-determined number of fish suitable for release, fish are loaded into a transport truck and truck-planted at one of five release locations. Historically, this screening method has been termed a volitional release but is currently termed a screening method as this more accurately describes the end result of the action.

2016 Release Strategy Objectives

- Evaluate best hatchery management practices for hatchery releases to optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (Draft NMFS Wenatchee River Steelhead Section 10 Permit).
- Assess hatchery release practices to inform development of a residualism baseline for the Wenatchee steelhead program consistent with the Draft NMFS Wenatchee River Steelhead Section 10 Permit DRAFT Steelhead Residual Management Plan.
- Utilize data collected from the 2016 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. 2013).

Methods

The 2016 release strategy will evaluate the effectiveness of the screening method, and the role of rearing vessel (RAS versus FT), and brood origin on fish performance (e.g., juvenile survival and SARS); the 2016 release plan methodology is a repeat of the 2015 release plan. Additionally, a similar evaluation of this screening method (termed volitional release) was conducted in 2013, where approximately 20,000 passive integrated transponder (PIT) tagged juvenile steelhead were utilized for detailed monitoring and evaluation of post release performance. For 2016, the release numbers and locations identified in Table 1 will build on the 2013 and 2015 release data and enable a more thorough investigation of the screening methodology at the program level.

- 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.

Release Timing

Wagner et al. (1963) suggested that the optimal release date of hatchery steelhead is equal to the peak of the wild steelhead emigration in the same watershed. Additionally the Draft NMFS Wenatchee River Steelhead Section 10 Permit states the following "The Permit Holders will release hatchery origin smolts at 6 fish per pound when fish are ready to emigrate directly to the ocean and during the period in which natural origin smolts out-migrate from the Wenatchee Basin". Based on the last five years of Lower Wenatchee smolt trap outmigration data, natural origin Wenatchee steelhead emigration peaks the first week of May. In 2013 survival to McNary Dam for Wenatchee hatchery steelhead juveniles was found to be negatively related to release date ($r=-0.506$, $p=0.04$) and positively related to juveniles detected in the Wenatchee Basin after July 1 (Figure 1). In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase smolt to smolt survival, all fish located at the Facility will be released by May 8th; fish acclimated at Blackbird Island Pond will be allowed to volitionally move out of the pond through the end of June (after which time the pond outlet will be closed as in years past).

Release Location

In an effort to reduce potential steelhead residualism, consistent with objectives of this steelhead release plan and found in the Draft NMFS Wenatchee River Steelhead Section 10 permit, two historic hatchery steelhead release locations, RKM 15.6 of the Chiwawa River and RKM 19.3 of Nason Creek, will be eliminated for the 2016 release. Hausch and Melnychuk (2012) completed a meta-analysis of hatchery practices and residualization of hatchery steelhead and found that releases of fish located closer to a confluence with a major river produced fewer residuals than those located further upstream. The remaining release locations, one each in Nason Creek, Chiwawa River, upper Wenatchee River, and the lower Wenatchee River are included in Table 1 below.

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2013). Additionally, assessment of smolt index and precocial maturation will be conducted via non-lethal sampling from Raceways 1 and 2 (n=200 "first movers"; n=200 "late movers", n= 200 "non-movers") and the two RAS vessels (n=200 "first movers"; n=200 "late movers", n= 200 "non-movers").

Table 1. Steelhead release numbers and locations, 2016.

Vessel	Origin[1]	Estimated Number Released	Estimated # PIT-tagged	Destination	rkm	Screened or non-screened method
RAS1	WxW	6,136	1,100	Nason	7.0	Non-screened
RCY1	Mixed	20,768	2,100	Nason	7.0	Screened
RAS2	WxW	6,342	1,100	Nason	7.0	Screened
RCY2	Mixed	20,769	2,100	Nason	7.0	Non-screened
		54,015		**Total**		
RAS1	WxW	6,136	1,100	U. Wenatchee	79.2	Non-screened
RCY1	Mixed	34,333	3,470	U. Wenatchee	79.2	Screened
RAS2	WxW	6,343	1,100	U. Wenatchee	79.2	Screened
RCY2	Mixed	34,334	3,470	U. Wenatchee	79.2	Non-screened
		81,146		**Total**		
RCY2	Mixed	19,652	1,990	Chiwawa	11.4	Non-screened
RCY1	Mixed	19,652	1,990	Chiwawa	11.4	Screened
		39,304		**Total**		
RCY1	Mixed	TBD		L. Wenatchee	40.2	Non-movers
ELISA	HxH	24,969	2,520	Blackbird	40.5	N/A

[1]Mixed = HxH and WxW.
[2]Both forced and volitional releases will occur April 20 - May 8; any remaining non-migrants will be released by May 8.

Figure 1. Chiwawa Acclimation Facility site description.

REFERENCES

Hausch, S. J., and M. C. Melnychuk. 2012. Residualization of hatchery steelhead: a meta-analysis of hatchery practices.

Hillman, T., T. Kahler, G. Mackey, J. Murauskas, A. Murdoch, K. Murdoch, T. Pearsons, and M. Tonseth. 2013b. Monitoring and evaluation plan for PUD Hatchery Programs, 2013 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee, WA.

Partridge, F.E. 1986. Effect of steelhead smolt size on residualism and adult return rates. Idaho Department of Fish and Game, Boise, Idaho.

Wagner, H. 1968. Effect of stocking time on survival of steelhead trout, *Salmo gairdnerii*, in Oregon. Transactions of the American Fisheries Society 97:374-379.

APPENDIX K
GENE FLOW MANAGEMENT STANDARDS

Final Gene Flow Management Standards

(Approved by Douglas PUD, Chelan PUD, NMFS, WDFW, USFWS, YN, and CCT via email on March 18, 2016. Grant PUD also indicated support.)

Charlene Hurst and Craig Busack

NMFS March 3 proposal (not supported by all parties)

This proposal used a PUD PNI function (PUD PNI = 0.8(1-e^(-0.006x))) based on wild run size as the basis of managing gene flow for the PUD program. As wild run size increased, the PUD PNI target also increased (Table 1). Management of gene flow for the WNFH consists of management to a constant pHOS value of 0.2.

Table 1. Sliding scale that informed the PUD PNI Function for our discussion on March 3, 2016.

Wild Run (X)	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)
300	0.75	0.4	0.2	0.67	0.67	0.5
500	0.8	0.4	0.2	0.68	0.76	0.52
900	1	0.3	0.2	0.78	0.80	0.58
1500	1	0.25	0.2	0.8	0.80	0.6
2000	1	0.25	0.2	0.8	0.80	0.6
2500	1	0.25	0.2	0.8	0.80	0.6

PUD March 3 counter-proposal (not supported by all parties)

The PUDs felt that it would not be feasible to meet the PUD PNI target consistently because their ability to remove enough fish to obtain a PUD pHOS of less than 0.4 is limited. Thus, the new management target of a constant minimum PUD PNI of 0.67 was proposed when wild run size in the Methow Basin is **≥ 300** (different scales apply when run size is < 300; see spreadsheet). Managing to a PNI target versus a pNOB or pHOS target means that a variety of pNOB and pHOS levels can be combined to reach the same PNI target (see examples from Table 2). NMFS expects that the PUD pHOS will typically not fall below 0.4 (due to removal constraints), thus the minimum pNOB needed to achieve a PUD PNI of 0.67 is 0.75.

Table 2. Examples of PNOB and pHOS values that would result in a PUD PNI of 0.67 or higher.

Wild Run (x)	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	Overall PNI (3-pop)
> 300	0.75	0.4	0.2	≥0.67	0.5
> 300	0.8	0.4-0.42	0.2	≥0.67	0.5-0.52
> 300	0.85	0.4-0.45	0.2	≥0.67	0.5-0.53
> 300	0.9	0.4-0.47	0.2	≥0.67	0.5-0.54
> 300	0.95	0.4-0.5	0.2	≥0.67	0.5-0.55
> 300	1	0.4-0.53	0.2	≥0.67	0.5-0.55

USFWS Proposal (approved by all parties on March 18, 2016)

On Friday March 4, NMFS and the USFWS discussed another option for management of Spring Chinook Salmon gene flow in the Methow basin. This option keeps the PUD management targets the same as NMFS proposal from March 3, 2016 based on the sliding scale (table 1), but further reduces the pHOS of WNFH as natural runs increase (Table 3). The extraction rate analysis done by the USFWS (see spreadsheet) also addresses the PUD concerns about meeting gene flow targets, because it demonstrates that removing greater than 78% of the fish from the PUD program only occurs when returns are large, *and* when the SAR is high (~1%; see Excel spreadsheet).

Table 3. Proposed changes (marked in red font) to the USFWS program.

Wild Run (x)	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)
300	0.75	0.4	0.2	0.67	0.67	0.5
500	0.8	0.4	0.2	0.68	0.76	0.52
900	1	0.3	0.15	0.78	0.80	0.62
1500	1	0.25	0.1	0.8	0.80	0.69
2000	1	0.25	0.1	0.8	0.80	0.69
2500	1	0.25	0.1	0.8	0.80	0.69

For several reasons, this is now NMFS' preferred option for gene flow management for Methow spring Chinook. Although the PUD pHOS decreases below what the PUDs stated was feasible at our last meeting, the USFWS analysis clearly shows that extraction rates are within feasible ranges (see Excel spreadsheet); in fact there is virtually no difference in extraction rates between the PUD proposal and the FWS proposal until the natural run gets very large (900 NORs has rarely been reached in recent years) or SAR improves dramatically over what we have experienced in the past. Although this proposal does call for an increased PUD PNI as the wild run increases, above the 0.67 minimum proposed by the PUDs at our March 3, meeting, NMFS feels that basing that PUD PNI function on the above scale in Table 3 ensures it is a reasonable management target.

We recognize, however, that it is an aggressive scale, and that meeting the gene flow standards may be challenging. As we have previously stated, the permits will recognize the challenges associated with adult management in the Methow and will be written to allow flexibility in meeting targets during the first few years of implementation

APPENDIX L
METHOW SPRING CHINOOK GENE FLOW ANALYSIS SPREADSHEET

	Spawners/Broodstock		
Sources	Natural Population	PUD Program	WNFH Program
Natural	0.55	1	0
PUD Program Returnees	0.3	0	0.75
WNFH Program Returnees	0.15	0	0.25
Total (each column must add to 1.0)	1	1	1

	NMFS	Applicant
PUD part pHOS	0.30	0.35
WNFH part pHOS	0.15	0.21

PNI	0.62
Overall pHOS	0.45

> 300 wild run; assume 75% Methow fish in WNFH broodstock

ORIGINAL - not supported by all parties

green shaded areas can be adjusted by the user

															Estimated Total HOR return for SAR's @ 400k WNFH and 224k PUD							
															400	224	1000	560	2000	1120	4000	2240
Wild Run	NOB	NOS	HOS	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"	Total Run	Max # PUD	Max # WNFH	% WNFH Removal @ .1% SAR	% PUD Removal @ .1% SAR	% WNFH Removal @ .25% SAR	% PUD Removal @ .25% SAR	% WNFH Removal @ .5% SAR	% PUD Removal @ .5% SAR	% WNFH Removal @ 1% SAR	% PUD Removal @ 1% SAR
300	98	203	810	0.75	0.6	0.2	0.57	0.57	0.45	0.75	0.50	1,013	608	203	49%	10%	80%	0%	90%	46%	95%	73%
500	104	396	594	0.8	0.4	0.2	0.68	0.70	0.52	0.50	0.33	990	396	198	51%	12%	80%	29%	90%	65%	95%	82%
900	130	770	770	1	0.3	0.2	0.78	0.78	0.58	0.38	0.29	1,540	462	308	23%	0%	69%	18%	85%	59%	92%	79%
1500	130	1,370	1,121	1	0.25	0.2	0.8	0.80	0.6	0.31	0.27	2,491	623	498	0%	0%	50%	0%	75%	44%	88%	72%
2000	130	1,870	1,530	1	0.25	0.2	0.8	0.80	0.6	0.31	0.27	3,400	850	680	0%	0%	32%	0%	66%	24%	83%	62%
2500	130	2,370	1,939	1	0.25	0.2	0.8	0.80	0.6	0.31	0.27	4,309	1,077	862	0%	0%	14%	0%	57%	4%	78%	52%
							a	0.8														
							b	0.0042														

PUD PROPOSED - not supported by all parties

Wild Run	NOB	NOS	HOS	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"	Total Run	Max # PUD	Max # WNFH	% WNFH Removal @ .1% SAR	% PUD Removal @ .1% SAR	% WNFH Removal @ .25% SAR	% PUD Removal @ .25% SAR	% WNFH Removal @ .5% SAR	% PUD Removal @ .5% SAR	% WNFH Removal @ 1% SAR	% PUD Removal @ 1% SAR
300	98	203	304	0.75	0.4	0.2	0.67	NA-constant ≥ 0.67	0.5	0.50	0.33	506	203	101	75%	55%	90%	64%	95%	82%	97%	91%
500	104	396	594	0.8	0.4	0.2	0.68	NA-constant ≥ 0.67	0.52	0.50	0.33	990	396	198	51%	12%	80%	29%	90%	65%	95%	82%
900	130	770	1,155	1	0.4	0.2	0.72	NA-constant ≥ 0.67	0.55	0.50	0.33	1,925	770	385	4%	0%	62%	0%	81%	31%	90%	66%
1500	130	1,370	2,055	1	0.4	0.2	0.72	NA-constant ≥ 0.67	0.55	0.50	0.33	3,425	1,370	685	0%	0%	32%	0%	66%	0%	83%	39%
2000	130	1,870	2,805	1	0.4	0.2	0.72	NA-constant ≥ 0.67	0.55	0.50	0.33	4,675	1,870	935	0%	0%	6%	0%	53%	0%	77%	17%
2500	130	2,370	3,555	1	0.4	0.2	0.72	NA-constant ≥ 0.67	0.55	0.50	0.33	5,925	2,370	1,185	0%	0%	0%	0%	41%	0%	70%	0%

FWS PROPOSED (NMFS PREFERED OPTION) - Approved on March 18, 2016

Wild Run	NOB	NOS	HOS	PUD pNOB	PUD pHOS	WNFH pHOS	PUD PNI (2-pop)	PUD PNI Function	Overall PNI (3-pop)	PUD "pHOS"	WNFH "pHOS"	Total Run	Max # PUD	Max # WNFH	% WNFH Removal @ .1% SAR	% PUD Removal @ .1% SAR	% WNFH Removal @ .25% SAR	% PUD Removal @ .25% SAR	% WNFH Removal @ .5% SAR	% PUD Removal @ .5% SAR	% WNFH Removal @ 1% SAR	% PUD Removal @ 1% SAR
300	98	203	304	0.75	0.4	0.2	0.67	0.67	0.5	0.50	0.33	506	203	101	75%	55%	90%	64%	95%	82%	97%	91%
500	104	396	594	0.8	0.4	0.2	0.68	0.76	0.52	0.50	0.33	990	396	198	51%	12%	80%	29%	90%	65%	95%	82%
900	130	770	630	1	0.3	0.15	0.78	0.80	0.62	0.35	0.21	1,400	420	210	48%	6%	79%	25%	90%	63%	95%	81%
1500	130	1,370	738	1	0.25	0.1	0.8	0.80	0.69	0.28	0.13	2,108	527	211	47%	6%	79%	6%	89%	53%	95%	76%
2000	130	1,870	1,007	1	0.25	0.1	0.8	0.80	0.69	0.28	0.13	2,877	719	288	28%	0%	71%	0%	86%	36%	93%	68%
2500	130	2,370	1,276	1	0.25	0.1	0.8	0.80	0.69	0.28	0.13	3,646	912	365	9%	0%	64%	0%	82%	19%	91%	59%

APPENDIX M
2016 ROCKY REACH JUVENILE FISH BYPASS SYSTEM OPERATIONS PLAN
FINAL PLAN

2016 Rocky Reach Juvenile Fish Bypass System Operations Plan

Final Plan

Prepared By:

Lance Keller

Public Utility District No. 1 of Chelan County
P.O. Box 1231
327 North Wenatchee Avenue
Wenatchee, Washington 98801

January 2016

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.

2016 Evaluation Requirements

Run-of-river fish collected at the Juvenile Sampling Facility (JSF) 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 stocks and identification of marked individuals:
    a. PIT tags
    b. Fin clips

4. 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

2016 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 Condition:
    a. First 100 fish of each species are examined for condition:
        i. Descale
        ii. Injury
        iii. Mortality

3. 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.

4. 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 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 both intake screens in units C1 and 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) *above* 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)

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. Using 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 condition (first 100 fish per species).
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
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 the 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.

3. If we accumulate many fish during each "index" sample period, we will only evaluate species composition in the first three periods. In the final period, we will evaluate descale and injury, regardless of the number of fish. However, we will be attentive to any injury or descale that may be present among the fish in each of the first three periods. We need to allow enough time (between samples) to gather all species composition information, so that we have representative information on daily passage.

Diversion Screen and Trashrack Cleaning (Units 1 and 2):
During the last week of March, the trashracks in front of Units 1 and 2 (six 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 2016 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 2016 biological evaluations.

Task	Deadline
Present 2016 study plan to Committee	**Winter 2015-2016**
Committee discussion/comments on study plan	**Jan. 27, 2016-Mar. 24, 2016**
Pre-season JFB operations testing (marked fish releases prior to 1 April)	March 15, 2016-March 31, 2016
Begin biological evaluation of JFB	April 1, 2016
Complete 2016 biological evaluation	August 31, 2016
Present 2016 evaluation report to Committee	**December 31, 2016**
Committee comments on 2016 report	**February 1, 2017**
Present 2016 report to Committee	March 1, 2017

****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.

APPENDIX N
2016 FISH SPILL PLAN ROCK ISLAND AND ROCKY REACH DAMS

2016 Fish Spill Plan

Rock Island and Rocky Reach Dams

Public Utility District No. 1 of Chelan County

Prepared By:

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Public Utility District No. 1 of Chelan County
Wenatchee, Washington

Final

January 29, 2016

Introduction and Summary

In 2016, 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 2020. Rocky Reach 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 2016 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 2016, 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 2016, 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 2016, 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 2016.

Rocky Reach Spring Juvenile Fish Bypass Operations

Rocky Reach will operate its JFBS continuously through the spring outmigration period, beginning 1 April 2016. 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 in addition to the JFBS operation, 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.

Sampling protocols at the Rocky Reach bypass system in 2016 will remain consistent with those used in 2004-2015. 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 2016 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 2004-2015) 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 2016 will remain consistent with previous years, 2004-2015.

Table 2. Fish spill percentages and spill shape for the Rocky Reach spill program, 2016.

Project	Season	Daily Spill Average	Within-Day Spill Levels	Duration (# of hours each day)	Time of Day	Spill Shape %
Rocky Reach	Spring	none	--	--	--	--
Rocky Reach	Summer*	9%	Med	1	00:00-01:00	9.0%
			Low	6	01:00-07:00	6.0%
			Med	2	07:00-09:00	9.0%
			High	6	09:00-15:00	12.0%
			Med	9	15:00-00:00	9.0%

*Spill for subyearling Chinook

2016 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 (2004-2015), and from the Rock Island bypass trap, (2002-2015). At Rocky Reach Dam, the subyearling Chinook run generally begins the first week of June, with the one-percentile passage date on 31 May (mean date for years 2004-2015). Rocky Reach subyearling passage reaches the 95th percentile, on average, around 8 August (2004-2015, range: 21 July to 24 August).

Rock Island Dam juvenile salmon and steelhead sampling from the Smolt Monitoring Program (SMP; 2002-2015) 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 spring spill start date for 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 7 August (range: 22 July to 19 August, 2002-2015).

Table 3. Spill percentages, bypass operation dates, and mean passage percentile dates (2002-2015) 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	4/17, 5/30	4/16, 5/29	5/6, 5/25	5/31, 8/8
RR Bypass Operating?	Yes 4/1 – 8/31	Yes 4/1 – 8/31	Yes 4/1 – 8/31	Yes 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, 6/8	4/15, 6/4	4/17, 6/8	6/2, 8/7
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 2016 Spring Spill Operations

In 2016, 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.

Rock Island 2016 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 2016 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 2004-2015).

Table 4. Spill percentages and hourly spill shape for the Rock Island spring and summer fish spill program, 2016.

Project/Season	Daily Spill Average	With-in Day Spill Levels	Duration (# of hours each day)	Time of Day	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 fish spill coordinator 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.

Literature Cited

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APPENDIX O
FINAL HATCHERY M&E PLAN
APPENDICES

Appendix 2

In February of 2016, the HC/HSC agreed to HRR Targets from ideas developed by HETT:

1. Use the estimated 40% HRR Target during 5-year evaluation periods.
2. Use varying degrees of action depending on the numbers of years that annual HRR deviates from Target.
   2a. Green Light (below Target for ≤ 2 years)
   2a. Red Light (below Target for > 2 years)
3. Each program will have its own HRR target (with the following exceptions).
   3a. Nason Creek spring Chinook will use Chiwawa Target (there are no data to calculate its Target)
   3b. Methow and Chewuch spring Chinook will use the greater of their two Targets (they are MetComp stock and evaluated similarly)

Species	Owner	Program (Hatchery)	Basin (Purpose)	Smolt Release[1]	5 YR HRR[2]
Steelhead	CCPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	123,650	6.9
Steelhead	CCPUD	Eastbank (Chiwawa)	Wenatchee (Safety Net)	123,650	6.9
Steelhead	DCPUD	Wells (Wells)	Columbia (Safety Net)	160,000	26.5
Steelhead	DCPUD	Wells (Wells)	Methow (Safety Net)	100,000	26.5
Steelhead	DCPUD	Wells (Wells)	Twisp (Conservation)	48,000	26.5
Steelhead	GCPUD	Wells (Omak)	Okanogan (Conservation)	100,000	7.3 [3]
SUM Chinook	CCPUD	Eastbank (Chelan Falls)	Chelan (Conservation)	176,000	5.7
SUM Chinook	CCPUD	Eastbank (Chelan Falls)	Chelan (Harvest)	400,000	5.7
SUM Chinook	CCPUD, GCPUD	Eastbank (Dryden)	Wenatchee (Conservation)	500,000	5.7
SUM Chinook	DCPUD	Wells (Wells)	Columbia (Harvest)	320,000	3.0
SUM Chinook	GCPUD	Eastbank (Carlton)	Methow (Conservation)	200,000	3.0
SUM Chinook	CCT	Chief Joseph	Okanogan (Harvest)	1,100,000	8.6
SPR Chinook	CCPUD	Eastbank (Chiwawa)	Wenatchee (Conservation)	144,026	6.7
SPR Chinook	CCPUD, DCPUD, GCPUD	Wells (Methow)	Methow (Conservation)	193,765	3.8
SPR Chinook	DCPUD, GCPUD	Wells (Twisp)	Methow (Conservation)	30,000	2.7
SPR Chinook	GCPUD	Eastbank (Nason)	Wenatchee (Conservation)	149,114	6.7

1 Release goal established by HCPs and adjusted by HC

2 Derived from Annual Reports (McLain Johnson received raw data from Tracy Hillman)

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	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 prespawn 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-introduced 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.

	Run Escapement Goal	PNOB Conservation Program	PNOB Safety Net Program	PHOS	PNI
Above TWD	1094	1.0	0.0	Varies	Varies
Below TWD	406	n/a	n/a	< 0.10	< 0.67
Basin Total	1500	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) Summer Chinook

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 $\geq$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

Management Targets for the 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 A4.1, 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 A4.1. 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

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 A6.1. Size, Coefficient of Variation (CV), and Condition Factor (K) Targets at Release of Upper Columbia River Hatchery Programs.

Hatchery	Species	Life Stage	Basin	FPP	CV	K-factor
Methow	Spring Chinook	Yearling	Methow	15	<10	TBD
Methow	Spring Chinook	Yearling	Twisp	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Columbia	15	<10	TBD
Chief Joseph	Spring Chinook	Yearling	Okanogan	15	<10	TBD
Chiwawa	Spring Chinook	Yearling	Wenatchee	18	<10	TBD
Nason	Spring Chinook	Yearling	Wenatchee	18-24	<10	TBD
Winthrop	Spring Chinook	Yearling	Methow	17	<10	TBD
Leavenworth	Spring Chinook	Yearling	Wenatchee	17	<10	TBD
Wells	Steelhead	Yearling	Columbia	6	<10	TBD
Wells	Steelhead	Yearling	Methow	6	<10	TBD
Wells	Steelhead	Yearling	Twisp	6	<10	TBD
Wells	Steelhead	Yearling	Omak	5-8	<10	TBD
Wells	Steelhead	Yearling	Okanogan	5-8	<10	TBD
Winthrop	Steelhead	Two year	Methow	4-6	<10	TBD
Chiwawa	Steelhead	Yearling	Wenatchee	6	9.0	TBD
Wells	Summer Chinook	Subyearling	Columbia	50	<7	TBD
Wells	Summer Chinook	Yearling	Columbia	10	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Columbia	50	<7	TBD
Chief Joseph	Summer Chinook	Subyearling	Okanogan	50	<7	TBD
Chelan Falls	Summer Chinook	Yearling	Chelan	10-22	9.0	TBD
Entiat	Summer Chinook	Yearling	Entiat	17	<10	TBD
Carlton	Summer Chinook	Yearling	Methow	13-17	<12	TBD
Chief Joseph	Summer Chinook	Yearling	Columbia	10	<7	TBD
Chief Joseph	Summer Chinook	Yearling	Okanogan	10	<7	TBD
Dryden	Summer Chinook	Yearling	Wenatchee	18	9.0	TBD
Priest	Fall Chinook	Subyearling	Columbia	50	<10	TBD
Ringold	Fall Chinook	Subyearling	Columbia	50	<10	TBD

APPENDIX P
CHELAN COUNTY PUD HATCHERY MONITORING AND EVALUATION IMPLEMENTATION PLAN 2017

Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2017

Prepared by:

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July 2016

Contents

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: 2013 Update"* (Hillman et al. 2013) and the "*Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Programs*" (Murdoch and Peven 2005).

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 2017. Additionally, monitoring and evaluation activities for Lake Wenatchee sockeye in 2017 are included in this document. As monitoring tasks are completed in 2016 and are evaluated for their efficacy, methodologies to accomplish the tasks defined in the 2017 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 NFMS Section 10(a)(1)(A) permits 18121 and 1395 and Section 10(a)(1)(B) permit 1347. All activities conducted under this Implementation Plan shall adhere to all terms and conditions as specified in the referenced permits. 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. 2013. 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.

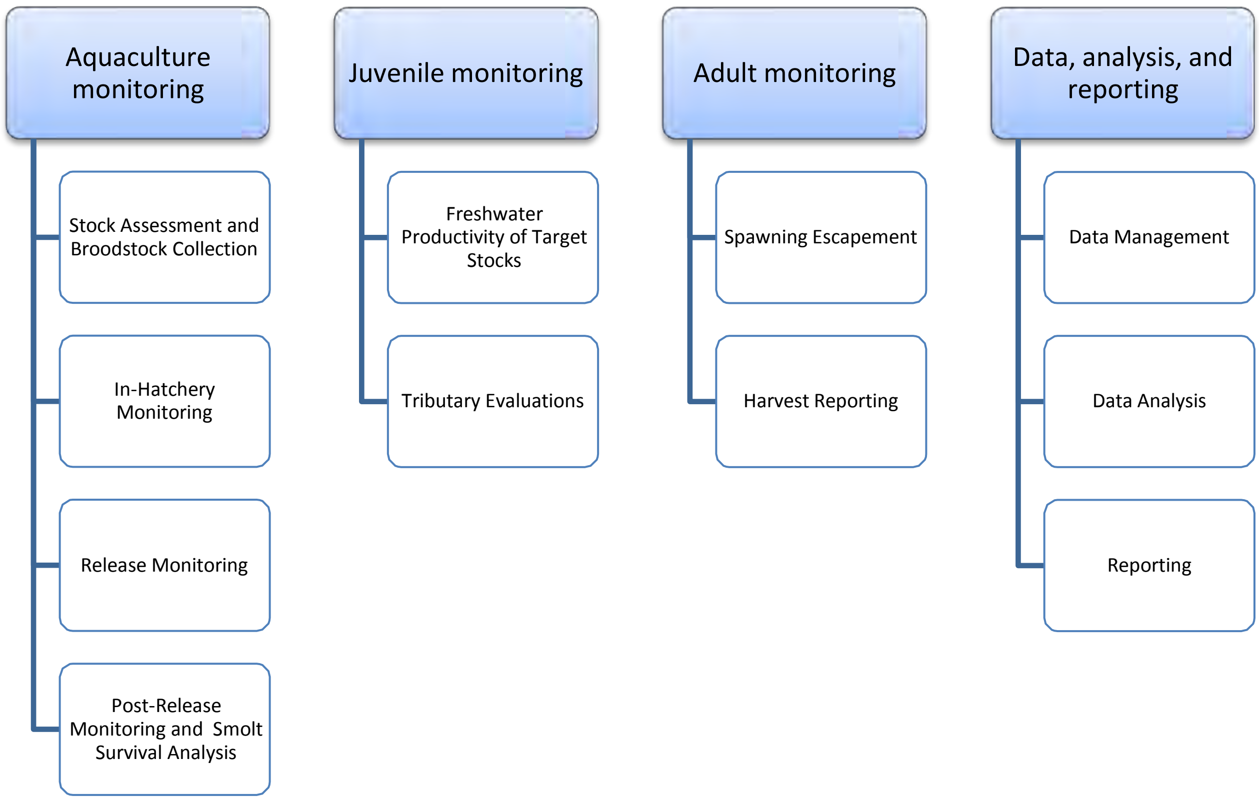

Figure 1. The four components of the hatchery monitoring and evaluation program and the study design elements within each component.

Table 1. Study design elements performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2013.

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	WDFW	WDFW
	5, 8	In-hatchery monitoring	WDFW CPUD[2]	WDFW CPUD[2]	WDFW Biomark3	WDFW CPUD[2]	WDFW CPUD[2]
	9	Release monitoring	WDFW	WDFW	WDFW	WDFW	WDFW
	9	Post-release monitoring and smolt survival analysis	WDFW	WDFW	WDFW	WDFW	WDFW
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
	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 addressed at the next 10 year HCP check-in.
[2]CPUD crews will PIT tag in-hatchery fish.
[3]Biomark will PIT tag in-hatchery fish.
[4]In 2017, 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. 2013). Table 2 below provides a summary of the variables to be measured in 2017 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. 2013) objectives and the associated measured variables for the aquaculture monitoring component.

Objectives	Measured Variables *(Applicable Study Component(s))*
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 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*)
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.	• 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*)
Objective 8: 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*)
Objective 9: 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 Broodstock Collection Protocol approved annually by the HCP-HC and relevant permits. Data collection during broodstock collection will be consistent with Murdoch and Peven (2005). A representative sample of fish trapped throughout the entire run, either collected for broodstock or released back to the river, will be sampled for origin, age, sex, size, and migration timing. Biological sampling of all fish trapped will include presence of internal (CWT or PIT) and external (VIE) tags or marks, scales, length, and sex (determined by ultrasound). PIT tags will be injected into all target species (Chinook and steelhead), whether collected for broodstock or released back to the river to monitor for potential fallbacks. All non-target species will be enumerated daily. Measures of central tendency and spread will be calculated and reported for each metric.

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. Life stage specific in-hatchery survival and growth rates, disease monitoring, and an estimate of the number of fish released will be collected and analyzed according to Murdoch and Peven (2005). Additional data to be collected includes individual lengths and weights of juveniles during monthly sampling, and the weight of gonadal mass and body of spawned broodstock. Measures of the central tendency and spread will be calculated and reported for each metric.

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 as an Addendum to this Plan. 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 (Table 3) at Eastbank Hatchery approximately two to four weeks before the fish are transferred to acclimation ponds or in the spring prior to release. 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.

Program	Release goals	Number of fish PIT tagged[1]	PIT tag rate (%)
Chiwawa spring Chinook	144,026	10,000	6.9
Wenatchee steelhead	247,300	20,000	8.0
Wenatchee summer Chinook	318,816 (CPUD Program) 181,184 (GPUD Program)	20,600[2]	4.1
Methow spring Chinook	60,516	5,000	8.3
Chelan Falls summer Chinook	576,000	10,000	1.7

[1] Additional PIT tagging may take place for Chelan PUD approved studies and/or comparisons.

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 Murdoch and Peven (2005), 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. 2013). 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 Murdoch and Peven (2005), 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. Monitoring of steelhead released in the Wenatchee River sub-basin will occur during loading of fish into transport trucks, unless fish are released directly into the Chiwawa River. Steelhead will pass through a series of PIT-tag antennas, each connected to a data logger, thereby allowing the creation of a PIT-tag observation file for each truckload of steelhead consisting of unique tag records. The release location (stream and rkm), release type (volitional or forced), and hatchery group (HxH or WxW) will be recorded for each tag file created. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. However, because PIT-detection efficiency during loading will not be 100%, 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 Murdoch and Peven (2005), 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. Should PIT tagging occur, a monitored release strategy consistent with other Chinook stocks (i.e., Chiwawa Spring Chinook) will be implemented. 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 (Murdoch and Peven 2005). 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 Murdoch and Peven (2005). 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. 2013). Table 4 below provides a summary of the variables to be measured in 2017 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. 2013) 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, parr [where appropriate], 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 newly 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.

Specific actions to monitor the freshwater productivity of supplemented spring Chinook salmon in the Methow sub-basin have yet to be determined. As these become available, the plan will be amended and presented to the HC by December.

3.2 Tributary Evaluations

Chiwawa River

Snorkel surveys will be utilized to estimate parr abundance within the Chiwawa subwatershed during the summer. This approach has been used in the Chiwawa subwatershed since 1992. In parallel to addressing Objective 2, additional juvenile data can help to assess the habitat carrying capacity in each tributary. This information can add value to the overall M&E plans and help inform management decisions.

Sampling will follow a stratified random sampling design. Landscape classification will be used to stratify streams in the Chiwawa subwatershed that support juvenile Chinook salmon. In the Chiwawa subwatershed, WDFW found that classification "explained" most of the variability in fish numbers caused by geology, land type, valley bottom type, stream state condition, and habitat type (Hillman 2013). The same classification method was used to identify sections of the Little Wenatchee River (reference area) that corresponded to discrete reaches in the supplemented subwatersheds, but that had no release of hatchery Chinook. Consistent with previous efforts, habitat types within each land-class or reach will be identified and quantified annually. At least three units of each habitat type within each reach will be randomly selected for estimating densities of salmon and trout. Thus, overall sampling consists of a stratified-random sampling design, which increases the accuracy and precision of population estimates.

Densities of salmon and trout will be estimated in August and September by direct underwater observation within the randomly-selected habitat units. Underwater methods will follow those described by Thurow (1994), Dolloff et al. (1996), and O'Neal (2007). Habitat surface areas and volumes will be estimated during fish sampling. Numbers of fish counted will be adjusted for detection probabilities using the models published in Hillman et al. (1992). For each habitat type within a state type and reach stratum, the mean density of salmon and trout will be calculated as the ratio of mean numbers to mean area or volume sampled (Cochran 1977). Total numbers of fish will be estimated per habitat type within a state type and reach stratum as the product of mean density of fish in a given habitat type, times total area or volume of that habitat type within the stratum (Cochran 1977). Total numbers of fish within the supplemented subwatershed will be estimated as the sum of all population numbers per habitat type in state type/reach strata. Bootstrapping methods will be utilized to estimate variance and percent errors (based on 95% confidence interval) for total numbers of fish.

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 2017under 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. 2013) 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 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 Murdoch and Peven (2005). 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 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.

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 in Murdoch and Peven (2005). 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.

In addition, 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 Murdoch and Peven (2005). 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. Weekly ground-based census counts and the true number of redds (determined via intensive surveys) will be compared in order to generate observer efficiency. River characteristics (e.g., channel width, water depth, discharge, visibility, and habitat complexity), observer experience, and survey effort will be incorporated into a model to predict observer efficiency in all river reaches. Predicted redd generate observer efficiency for each river reach will be used to adjust ground-based redd counts to estimate the total reach redd count. Ground-based surveys will also be used to estimate redd life for each river reach. The estimated spawner abundance in the Wenatchee River and an associated level of precision will be calculated using the estimated total redd count for each reach, mean redd life, and the sex ratio of the population similar to methods described in Millar et al. (2012). Salmon carcass data collected during spawning ground surveys will be consistent with Murdoch and Peven (2005). 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 (Murdoch and Peven 2005). 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: 2013 Update (Hillman et al. 2013). 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 2017(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 proposed 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

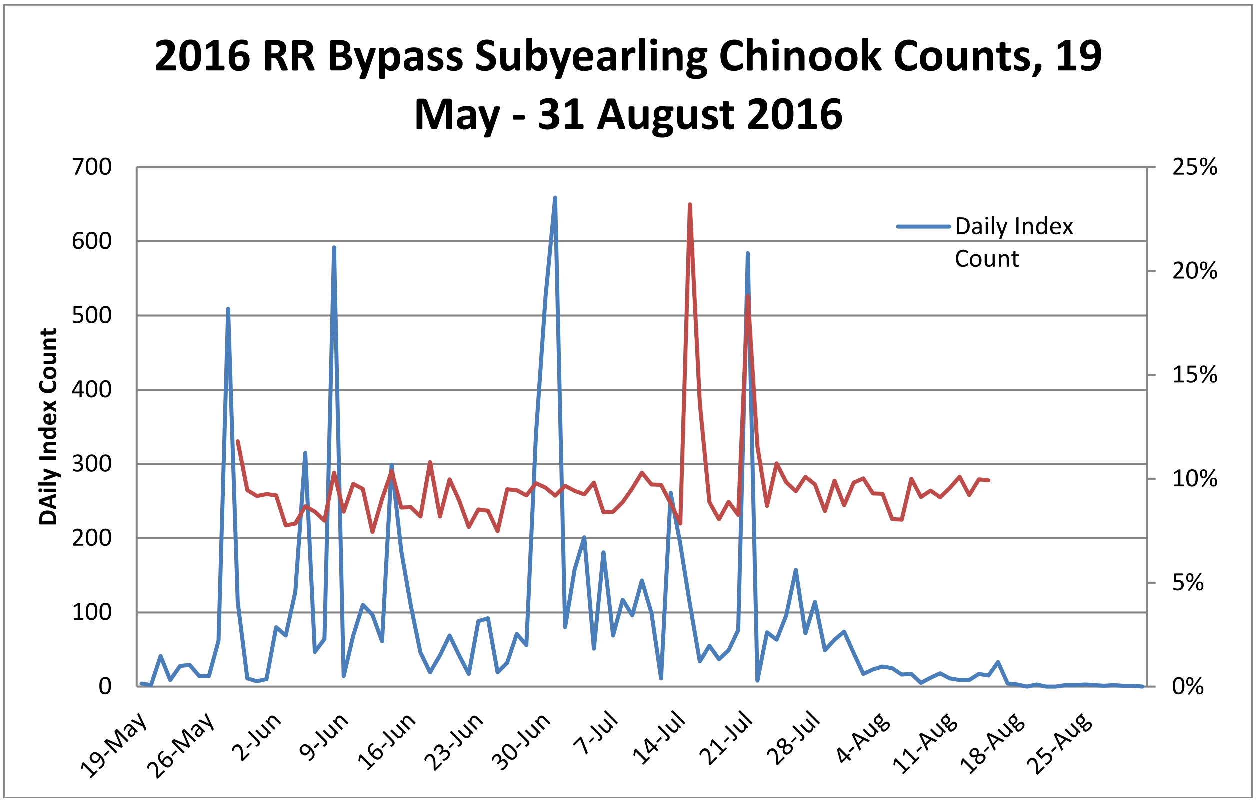
Tributary	River mile of PIT tag array
Mission Creek	0.54
Peshastin Creek	1.91
Chumstick Creek	0.31
Icicle River	0.26
Chiwaukum Creek	0.24
Chiwawa River	0.58
Nason Creek	0.52
Little Wenatchee River	1.74
White River	1.65

APPENDIX Q
CHELAN PUD ROCKY REACH AND ROCK ISLAND HCPS FINAL 2016 FISH SPILL REPORT

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2016 Fish Spill Report

<u>2016 ROCKY REACH</u>
Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	29 May, 0001 hrs
Spill stop date:	15 August, 2400 hrs
95% Est. passage date:	30 July
Percent of run with spill:	91.4% on 15 August (estimated as of 31 August)
Cumulative index count:	8,905 subyearling Chinook (as of 31 August)
Summer spill percentage:	9.49% (9.00% fish spill, plus 0.49% forced spill)
Avg river flow at RR:	115,590 cfs (29 May - 15 August)
Avg spill rate at RR:	10,971 cfs (29 May - 15 August)
Total spill days:	79

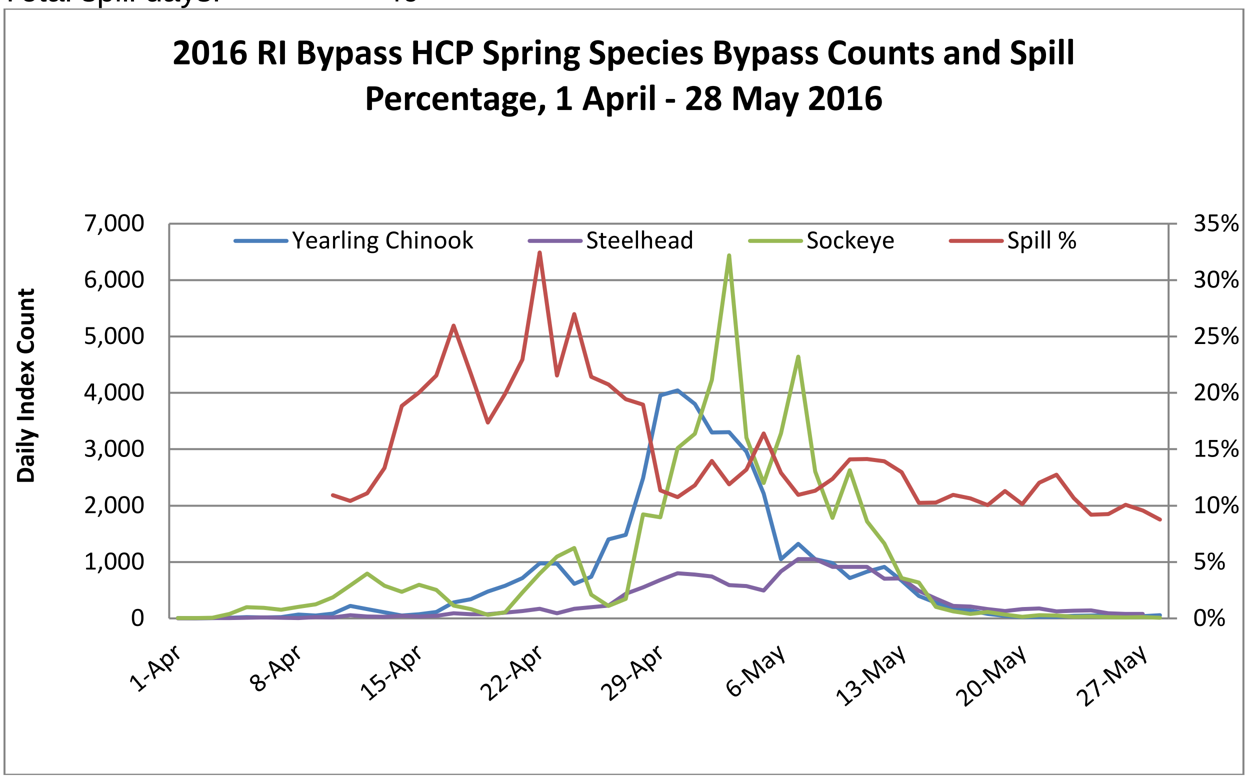


Chelan PUD was closely watching the subyearling run timing to initiate spill in 2016. On May 28 DART estimated that 3.30% of the overall subyearling run had passed Rocky Reach, and Chelan initiated spill at 0000 hours on May 29. This run timing estimate is updated as additional index data is collected daily, and the passage percentage estimated on May 28 was adjusted from 3.30% to 7.99% at the end of the 2016 index season. When compared to the estimated passage value on May 27 of 2.28%, the passage estimate increased 5.71% from May 27 to May 28, resulting in Chelan PUD missing the 95% passage target by 1 day. Chelan analyzed available PIT tag info, river flow data, and river temperature data to attempt to determine subyearling travel time to Rocky Reach, but no definitive travel time was determined. Caution will be used going forward in the 2017 Rocky Reach summer spill season

2016 ROCK ISLAND

Spring Spill

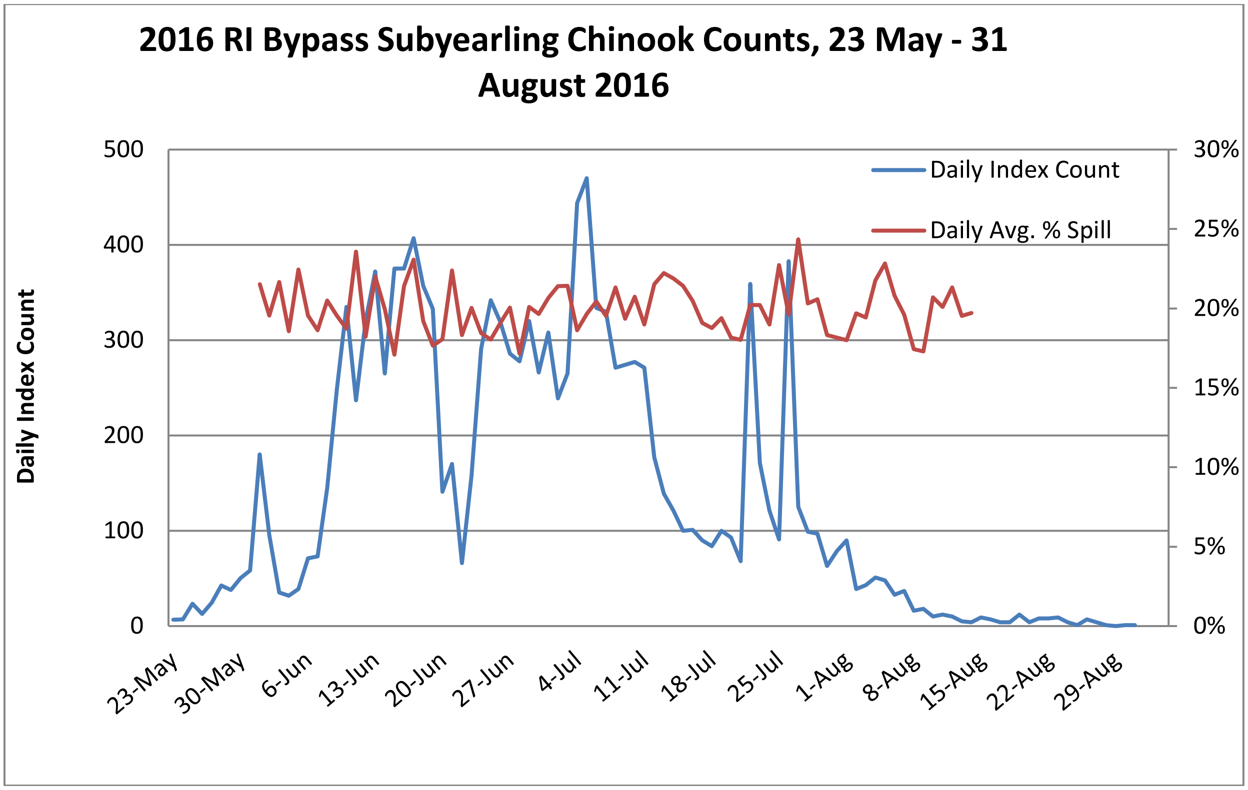
Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	10 April, 0001 hrs
Spill stop date:	28 May, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	Yearling Chinook - 99.5%; steelhead - 99.7%; sockeye – 98.1%
Cumulative index count:	44,784 yearling Chinook**;** 17,663 steelhead**;** 56,638 sockeye
Spring spill percentage:	15.59% (9.95% fish spill, plus 5.64% forced spill)
Avg river flow at RI:	160,343 cfs (10 April – 28 May)
Avg spill flow at RI:	25,005 cfs (10 April – 28 May)
Total spill days:	49



Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	29 May, 0001 hrs
Spill stop date:	11 August, 2400 hrs
95% Est. passage date:	26 July
Percent of run with spill:	99.3% (estimated as of 31 August)
Cumulative index count:	13,270 subyearling Chinook (as of 31 August)
Summer spill percentage**:**	19.90% (19.87% fish spill, plus 0.03% forced spill)
Avg river flow at RI:	120,671 cfs (29 May - 11 August)

Avg spill flow at RI: 24,012 cfs (29 May - 11 August)
Total spill days: 75



Juvenile Index Counts 2006-2016 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, 2006-2016

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015	2016
Sockeye	239,185	169,937	136,206	40,758	724,394	67,879	384,224	199,497	553,645	53,575	**1,374,418**
Steelhead	4,329	4,532	8,721	6,309	4,931	5,683	4,902	2,528	5,270	4,157	**1,478**
Yearling Chinook	23,461	18,080	38,394	18,946	33,840	24,400	95,207	29,018	15,871	32,220	**41,676**
Subyearling Chinook	19,996	13,496	11,820	11,944	59,751	17,246	5,774	22,073	22,327	37,104	**8,905**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2006-2016

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015	2016
Sockeye	34,604	16,410	38,965	4,926	37,404	18,697	46,788	25,111	38,596	4,128	**56,638**
Steelhead	26,930	18,482	22,780	17,636	17,194	28,408	16,957	15,099	28,299	12,549	**17,663**
Yearling Chinook	37,267	23,714	22,562	9,225	11,802	26,407	25,759	28,324	26,429	16,762	**44,784**
Subyearling Chinook	27,106	15,686	15,940	8,189	23,205	27,397	27,298	17,170	34,527	15,349	**13,270**

***** 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 R
FINAL NOTES OF THE JUNE 21, 2016, SUBYEARLING CHINOOK SALMON PASSAGE SURVIVAL WORKSHOP

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees and Priest Rapids Coordinating Committee	**Date:**	August 30, 2016
From:	John Ferguson, HCP Coordinating Committees Chairman		
Cc:	Kristi Geris		
Re:	Final Notes of the June 21, 2016, Subyearling Chinook Salmon Passage Survival Workshop		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees and Priest Rapids Coordinating Committee (PRCC) convened a Subyearling Chinook Salmon Passage Survival Workshop at the Red Lion Hotel, in SeaTac, Washington, on Tuesday June 21, 2016, from 9:00 a.m. to 4:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

I. Welcome

A. Workshop Introduction: Purpose and Goals (John Ferguson and Denny Rohr)

John Ferguson (HCP Coordinating Committees Chairman) welcomed the HCP Coordinating Committees and PRCC. Ferguson said the purpose of today's workshop is to update information discussed during the last Subyearling Chinook Salmon Workshop, which was held in November 2009. He said Chelan PUD also has a Statement of Agreement (SOA) that maintained subyearling Chinook salmon in Phase III (Additional Juvenile Studies) status until 2016. He said language in the 3-year SOA, which was approved in 2013, requires Chelan PUD to assess improvements in tag technology and survival study designs to evaluate survival study feasibility at the expiration of the SOA. He said information discussed during this workshop will dictate how Chelan PUD moves forward with regard to subyearling Chinook salmon survival studies.

Ferguson said, in January 2016, he and Denny Rohr (PRCC Facilitator; D. Rohr and Associates), and Chelan, Douglas, and Grant PUDs began discussing what to address during this workshop, and these discussions culminated into today's agenda. He said the HCP Coordinating Committees and PRCC will further discuss today's topics tomorrow and determine a path forward for subyearling Chinook salmon in the Mid-Columbia Basin. Lastly, Ferguson thanked all of the speakers for attending. Rohr added he is looking forward to the day's discussions and also thanked everyone for joining.

II. Fish Passage Survival Model Updates

A. Fish Passage Survival Model Updates (John Skalski)

John Skalski (Columbia Basin Research, University of Washington) provided a presentation titled, Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies (Attachment B), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris (Anchor QEA, LLC) on June 15, 2016. *(Note: An updated version of Skalski's presentation was distributed following the workshop on June 22, 2016.)*

In this presentation, Skalski reviewed a paired release-recapture study design, including minimal requirements and model assumptions. He reviewed estimating residualization in subyearling Chinook salmon for a single release and paired release. He provided an overview of subyearling studies, including those conducted by U.S. Army Corp of Engineers (USACE) and Grant PUD, and a study conducted at Lower Monumental Dam. Lastly, Skalski discussed passive integrated transponder (PIT)-tag reach survival estimates. Skalski's analyses determined it is not possible to separate active migrants from non-active migrants and provided his opinion that given what is estimable, a statistical solution to addressing subyearling residualization in the survival estimation models does not exist at this time. Instead, Skalski provided recommendations on how best to study active migrants, including what to expect and how to adjust for increased sample size. Additional discussions were as follows.

<u>Assumption #11: No handling or tag effects that could distort survival studies</u> (slide 23)
Bob Rose (Yakama Nation [YN]) asked how much time can pass before these concerns become issues. Skalski said tagger effects are time and distance dependent, as explained on slide 24. Rose said he does not recall studies within the Federal Columbia River Power

System (FCRPS) addressing this. Skalski said, if possible, tagger effects are always addressed. He said, for example, small differences may not be statistically detectable; however, paired releases can account for differences to a small degree. He said, from an agency perspective, this is a favorable approach (negatively biased; also see slides 25 and 26).

Estimating Residualism (slide 30)
Rose asked why not release R_1 to R_3 groups between the dams. Skalski said this is an option; however, this still would not sort out the two pieces.

Overview of the Virtual/Paired-Release Design (slide 41)
Rose asked if the design assumes fish are active migrants, and Skalski said this is correct. Rose asked about size selection, and Skalski said study fish are presumed to be 95 millimeters (mm) in length or more, with no high grading. John Ferguson asked how far downstream are the R_3 paired releases, and Skalski said 20 to 30 kilometers (km). Steve Hemstrom (Chelan PUD) asked if some probability of residualism is built into the design, and Skalski said that is correct.

Recommendations (continued) (slide 57)
Curt Dotson (Grant PUD) questioned how much water can be covered by conducting mobile surveys. Lance Keller (Chelan PUD) also noted that time of year will affect results. Ferguson said, with regard to the shortfalls of PIT-tag studies in estimating residualism, he suggested pairing acoustic-tags with PIT tags to obtain a more robust sample. Skalski said this is possible, and it has been done; however, he asked what can be gleaned with these results. He said this provides confirmation but not correction.

III. Snake River Chinook Salmon Life History Patterns

A. Snake River Chinook Salmon Life History Patterns (Billy Connor)

Billy Connor (U.S. Fish and Wildlife Service [USFWS]) provided a presentation titled, An Update on the Migratory Behavior and Trends in Age at Ocean Entry of Natural-origin Chinook Salmon from the Snake River Basin (Attachment C), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Connor reviewed what has been learned about contemporary movement behaviors and how those behaviors are changing as the abundance of juveniles has increased. He also reviewed the trend in age-at-ocean entry of returning adults because behaviors have changed. A conceptual model based on generalizations from these empirical data indicates density-dependent behaviors, coupled with management actions and ocean conditions, affected a large change in smolt-to-adult return ratios (SARs) for age-0 entrants, whereas the density-dependent decrease in age-1 entrants was compensated for by modest improvements in SARs influenced by management and ocean conditions. Additional discussions were as follows.

Research Hypotheses (H_1 and H_2) (slide 17)
Bob Rose said he would presume if smolt growth decreases with smaller fish, there would be later passage and higher residualism. Connor clarified that smolts from the warmer spawning areas left earlier, and these areas have more fish, more competition, and less space. John Ferguson said, typically, smaller fish residualize longer to grow larger; however, this model indicates the opposite is true due to density dependence. Connor said this is correct.

Conceptual Model (slide 25)
Steve Hemstrom asked if the conceptual model found any correlation to river flow. Connor said there are no data available yet to address this question.

IV. Subyearling Chinook Life History Diversities Observed in the Mid-Columbia

A. Post-Emergent Behavior of Subyearling Chinook in the Wells Reservoir and Implications for the Measurement of Passage Survival through the Wells Project (Tom Kahler)

Tom Kahler (Douglas PUD) provided 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 D), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Kahler reviewed subyearling studies conducted by Douglas PUD in the Wells Reservoir from 2011 to 2014. He reviewed seining locations, size composition, and emigration to Rocky Reach, McNary, John Day, and Bonneville dams, including reach-specific travel times and travel times sorted by length at tagging. Based on these 4 years of studies, four key findings were concluded. First, subyearling Chinook salmon are abundant and available to beach seining from early-May through early-July; however, these fish are increasingly difficult to capture with this technique from mid-July on. Second, 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 they can be captured. Third, subyearling Chinook salmon exhibit a continuum of migration timing, with passage at downstream projects occurring from spring until termination of bypass operations in mid-November, with few detected as yearlings. Fourth, an examination of travel rates and fish size reveals complex patterns that appear to indicate two classes of fish: 1) emigrants encompassing the full size range of detected individuals; and 2) a rearing class generally comprising the smaller two-thirds of detected fish. Kahler also noted, that during these studies, Douglas PUD was unable to tag a representative sample of the run at large. Additional discussions were as follows.

<u>Size Composition 2011</u> (slide 11)
John Ferguson asked about the size of the PIT-tags. Kahler said 12-mm tags were used for this study.

<u>Smallest Fish by Capture Date</u> (slide 15)
Kirk Truscott (Colville Confederated Tribes [CCT]) asked if fish size varied by seining location. Kahler said yes, and he noted that fish size also varied at each site by date, as evidenced by the clusters of data points for the 2012 and 2013 tagging efforts. He said, generally, Methow River fish were smaller than Okanogan River fish.

<u>Proportion of Tagged Fish Detected at any Downstream Project during Bypass Operations</u> (slide 32)
Billy Connor asked if there was a difference in dam operations (e.g., period of spill versus no spill). Kahler said, by the time tagging started, Chelan PUD projects were in summer spill. He said Wells Dam is in bypass operations all summer, and the only difference is the number of turbines operating.

<u>General</u>

John Rohrback (CCT) asked about recaptures. Kahler said there were recaptures at different sites. He said, at Gebber's Landing, sampling would occur throughout multiple days. He said sampled fish were held overnight, tagged, and then held overnight again prior to release. He said, after those fish were released, they would return and some would be recaptured again. He said recaptures were also obtained in the Wells Dam forebay, as well as other sites.

Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) asked if fish were detected the following spring (as yearlings). Kahler said very few, and he added that detection continued at the FCRPS dams into late-November each year, and even into early December 1 year. He said it is unknown whether any fish migrated as yearlings in late-winter prior to the activation of the bypass systems at those projects.

Bob Rose asked Connor, if hatcheries release larger fish, or if fish are released later, could this influence strength and motivation to migrate more quickly. Connor said size and timing of release affect migratory disposition. He added, for example, Lyons Ferry fall Chinook salmon subyearlings are reared under a fast growth regime to produce smolts that are larger in May compared to their natural-origin counterparts. He also said the growth regime influences the migratory behavior of the hatchery smolts; on average, hatchery-origin smolts migrate faster than natural-origin smolts.

B. Juvenile (and Adult) Subyearling Chinook Salmon Life History Information from the Okanogan River and Wells Pool (Casey Baldwin)

Casey Baldwin (CCT) provided a presentation titled, Juvenile and Adult Subyearling Chinook Life History Information from the Okanogan River and Wells Pool (Attachment E), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Baldwin reviewed subyearling studies conducted by the CCT from the Okanogan River and Wells Reservoir from 2014 to 2016. He reviewed rotary screw trap and beach seining locations, tagging constraints (largely due to fish size and water temperature), fish size at tagging, travel times and distribution of detections, and SARs. Based on these data, Baldwin considered whether adult returns can be evaluated to determine if life history characteristics, such as run timing and age structure, are the same. In 2014 and 2015, passage data at Bonneville Dam indicated similar run timing for PIT-tagged and run-at-large summer Chinook salmon (passing Bonneville Dam between

June and August). With regard to age structure, there was too much variance with the limited data to detect a statistical difference, but the age-class proportions of the returns of tagged fish from beach seining generally matched those from the run at-large samples (stock assessment, hatchery broodstock, and carcasses). Furthermore, the question remains whether tagged subyearlings are representative of untagged subyearlings.

C. The Life History of Subyearling Migrants from the Entiat River (Tom Desgroseillier)

Tom Desgroseillier (USFWS) provided a presentation titled, Life-History of Subyearling Chinook Migrants from the Entiat River (Attachment F), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Desgroseillier summarized Entiat River subyearling Chinook salmon out-migration and overwinter rearing within the Columbia River. This included a comparison between summer and spring subyearling Chinook salmon runs and SARs. Overwinter rearing was evaluated based on PIT-tag detections from Entiat River rotary screw traps and at Rocky Reach, McNary, John Day, and Bonneville dams. These data indicate that subyearling Chinook salmon exhibit a high level of plasticity in life history expressions. Among the listed spring run, subyearling Chinook salmon emigrated to the Columbia River from July through November, with the highest proportion observed migrating in October and November. Between 2010 and 2014, subyearling out-migrants represented 55% of the total spring Chinook salmon emigrant production; however, this life history is 3.3 times less likely to contribute to the adult life-stage than yearling migrants. Lastly, both spring- and summer-run subyearling Chinook salmon overwinter within the Columbia River.

D. Comparing the Migration Patterns and Timing of Yearling Spring Chinook Salmon and Subyearling Summer Chinook Salmon through the Mainstem Columbia River Using Available PIT-Tag Data (Peter Graf)

Peter Graf (Grant PUD) provided a presentation titled, Comparing the Migration Patterns of Yearling Spring Chinook and Subyearling Summer Chinook Salmon through the Mainstem Columbia River using Available PIT-Tag Data (Attachment G), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Graf reviewed a comparison of travel times between spring-run yearling and summer-run subyearling Chinook salmon using PIT-tag data obtained from the PIT-Tag Information System (PTAGIS) in the Upper Columbia River. These data were then evaluated to determine if they fit a 'type,' or migration pattern developed for Snake River summer/fall Chinook salmon juveniles. These types include: ocean-type (enters saltwater as subyearling, first winter in ocean); reservoir-type (delayed seaward migration, overwinter in reservoirs); or stream-type (overwinters in streams, seaward migration, and ocean entry as a yearling). The data indicated that Upper Columbia yearling spring Chinook salmon follow a predictable migration pattern, whereas Upper Columbia subyearling summer Chinook salmon express individual variation in life histories. The latter also appeared to follow three distinct migration 'types' similar to Snake River summer/fall Chinook salmon. The data also indicate there appears to be delayed migration in the Upper Columbia River, and fish size may not be a reliable predictor of 'type.' Additional discussions were as follows.

Travel Rate by 'Type' (slide 39)
Bob Rose suggested translating this travel rate and standardizing by water particle travel time to see what results.

General
Casey Baldwin noted that these data are not as straightforward when studying tributary fish. John Rohrback also noted there can be lower detection efficiency for certain groups, which introduces biases. Graf agreed there could be biases.

E. The Life-History Strategies of Upper Columbia Summer/Fall Chinook as Determined by Scale Analysis of Returning Adults (Andrew Murdoch)

Andrew Murdoch provided a presentation about Life-History Strategies of Upper Columbia Summer/Fall Chinook as Determined by Scale Analysis of Returning Adults (Attachment H), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Murdoch reviewed 2013 to 2015 data for Wenatchee River subyearling Chinook salmon. Based on cumulative emigration timing and mean size at capture, the data indicate that, in general, fish are too small to PIT-tag. Graphs were also reviewed depicting natural spawners by juvenile life history in the Wenatchee, Methow, and Okanogan rivers (based on carcass data). Wenatchee and Methow river data indicate a general increasing trend in subyearlings, some variation in yearlings, and a big decrease in reservoir-reared fish, which dominated the returns through return-year 2000. Murdoch said he does not know if this shift is a result of increased or decreased survival of one group or the other. Okanogan River data are slightly different, showing a more pronounced dominance of subyearlings beginning in 2001 and more variability between the three types in prior years. Lastly, the data indicate no significant trends in the last 10 years. Additional discussions were as follows.

General

Steve Hemstrom noted that summer/fall Chinook salmon in the Upper Columbia River travel the same distance as yearlings and seem to be dealing with conditions much better. He questioned, from an Endangered Species Act perspective, how are they accomplishing this. Murdoch said, because those fish cannot be tagged, there are no data to make this comparison. He said there could be something happening in the hydrosystem; however, there is no way of knowing. He said tools are limited; however, there are options to conduct a more in-depth investigation, such as mass marking or Strontium marks. He also suggested using different marks through time, and then examining otoliths to evaluate ocean entry. He said these methods are currently being discussed.

Casey Baldwin noted the high percentage of ocean-type fish taking weeks to months to migrate, particularly in the Okanogan River, and asked if those fish might be reservoir-reared or subyearlings. Murdoch said Lance Campbell (WDFW) is investigating when these fish truly enter salt water by analyzing calcium in otiliths. Baldwin said there are two groups of reservoir-reared fish: 1) those that are slowly moving downstream; and 2) those that overwinter. Murdoch said a subyearling can be a mover or slower mover, but does not overwinter in fresh water. Peter Graf said, based on the PIT-tag data he presented, a substantial number of fish move in December, which would be ocean-type in terms of adults, because they are not migrating the following year. Murdoch said any reservoir-reared fish will be a year-1 something.

BREAK FOR LUNCH

V. Discussion

A. Discussion (John Ferguson and Denny Rohr)

John Ferguson opened the floor for discussion and comments.

Billy Connor said he appreciated the discussions so far. He said, regarding compliance (with the respective PUD agreements and licenses), if this means meeting specific project goals (e.g., use acoustic tags and evaluate project-by-project survival), he believes this is the correct direction to head. He said travel times have always been a big topic and added he believes the graphs Tom Kahler shared depicting two distinct groups of migraters are completely accurate. Connor said he is unsure about the effects of flow on migration. He said the Independent Scientific Advisory Board conducted studies on travel times, which indicated it is not how fast fish move through the reservoirs, it is more about the conditions they experience that effect SARs. He suggested to instead focus on smaller tag sizes and evaluate big-picture concepts for parr, fry, and smolts.

Steve Hemstrom questioned whether a difference in survival can be assessed against project effects. Tom Desgroseillier said SARs are much lower for subyearlings, which was the impetus to evaluate overwintering. He suggested reviewing known fish overwintering in the reservoir compared to yearling out-migrants to identify more information about fish overwintering in the reservoir.

Andrew Murdoch said he is interested in smolt trap operations, noting that from the spawning tributaries, the vast majority of subyearlings enter the Columbia River as fry. He said he is interested in determining the size distribution for subyearlings in the hydrosystem. He said he understands how PIT-tag data can be useful; however, he also thinks these data may not be representative of the entire population. He suggested gaining a better understanding of the characteristics of sub-populations in each project, and then determining the unknowns.

Bob Rose said sometimes the correct answers are not found because the correct questions are not being asked. He asked if there are other questions needing to be answered before the compliance question can realistically be asked. He also noted the population seems to be doing quite well, which allows more time to address these questions. Murdoch agreed the subyearling populations are doing well and suggested taking advantage of the abundance of fish.

Jeff Korth (WDFW) suggested considering what effects snowpack and the amount and timing of discharge in the tributaries may have on conditions for subyearlings that may prompt them to migrate into the reservoirs in the first place. He added that ocean conditions and survival are among other possible questions. Connor said runoff level and timing affect movement from riverine habitat into reservoirs by affecting temperature. He explained that water temperature can become warm early during years with little snowpack. He said subyearlings will typically respond to such warming by moving downstream into reservoirs earlier than would be the case during high-snowpack years. He said low flow years can correspond with low rates of freshwater survival and with El Niño conditions that reduce survival in saltwater.

Rose asked about an effective method to collect those fish after they are in the reservoir. Connor suggested using a lampara net, so long as velocities are not too high. He said USFWS owns a lampara net, if anyone is interested in borrowing it. He said USFWS also owns a large boat specially equipped to use this net. He explained that the net is deployed in a circle between two boats, with a rope attached to the stern of the first boat. Then a hydraulic winch is used to bring the net in. He said a lampara net is more fish-friendly than a purse sein. He said the USFWS boat is located in Cook, Washington. Marty Leidtke (U.S. Geological Survey [USGS]) added that USGS also has a smaller boat equipped for lampara nets.

Kirk Truscott said about 100,000 subyearlings are needed to conduct paired-release survival studies, and the likelihood of obtaining that many subyearlings is low. Kahler said the HCPs indicate compliance is passage survival; however, he asked how passage versus non-passage should be defined. Kirk Truscott suggested that passage should be defined as when fish are in the tributary and not in the project area. Kahler asked about fish using the project area for rearing, but not migrating. Curt Dotson agreed and asked for clarification on an active migrant versus a non-active migrant. Hemstrom also noted predation as a project effect and asked how to address that. *(Note: Hemstrom later clarified that his statement was an observation more than a question. He said no other juvenile HCP Plan Species requires the amount of time to outmigrate, and spring outmigrants are also much more certain to migrate. He said the more time a tagged subyearling Chinook salmon spends in a reservoir due to natural behavior of "longer rearing periods," the more likely for predation to have a larger survival effect on that fish, and hence the resulting Project Survival Estimate. He explained that the way the HCPs are set up to measure Project survival, Project effect, subyearling studies will incorporate reservoir predation mortality as a "Project effect," which occurs on subyearlings during their longer rearing in reservoirs. He said the HCPs assume historical survival in the river reaches, which are now reservoirs, should have been 100%. He said No-Net-Impact must provide for net 100% survival, which means historically, before dams were constructed, no predation mortality would have occurred on subyearling summer run Chinook salmon rearing for longer periods in riverine locations in the mainstem Columbia River. He said in reality, even historically, these "non-active" or slow migrant fish because of their behavior, likely historically suffered some natural predation mortality from native predators (e.g., pikeminnow, sturgeon, bull trout). He said mortality is now assumed to be a Project-related mortality effect. He said predation is likely reduced for faster migrating sockeye salmon, steelhead, and yearling Chinook salmon. He said secondly, there is no precise way to determine for a rearing tagged subyearling that is not acoustically detected at a dam, whether or not it suffered predation in a reservoir or whether the tag battery expired prior to detection.)*

VI. Availability of Study Fish

A. *Grant PUD Subyearling Survival and Behavior Pilot Studies: Application of Age-0 Fall Chinook Salmon (Peter Graf)*

Peter Graf provided a presentation titled, Grant PUD Subyearling Survival Pilot Studies: Application of Age-0 Fall Chinook (Attachment I), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Graf reviewed pilot studies from 2001 to 2003 that were focused on dam passage survival using PIT tags in the Priest Rapids and Wanapum reservoirs. He also reviewed a study from 2008 that focused on survival estimates for Priest Rapids Dam and Reservoir using HTI acoustic tags in the Priest Rapids Reservoir. Lastly, he reviewed a study from 2009 focused on migration estimates and mortality using Juvenile Salmon Acoustic Telemetry System (JSATS) tags in the Priest Rapids Reservoir. In summary, the pilot studies found that subyearlings traveled slower than other species, and reservoir delay was observed in all studies. Delay in reservoir forebays often resulted in violations of the assumption of downstream mixing and releases from Priest Rapids Hatchery displayed ocean-type behavior. Additional discussions were as follows.

General

Curt Dotson said, although subyearlings traveled slower than other species of salmonids studied within the Priest Rapids Project, the difference is not as dramatic as observed in other studies. He asked if this might be relative to size, because Grant PUD's study fish were larger than most of the fish tagged upstream. Graf said the authors of the studies described this as two behaviors. Dotson asked if this might be equivalent to the two observed behaviors (emigrants and rearing fish) depicted in Tom Kahler's presentation, and Graf said that is correct. Graf added that the sockeye salmon used in this study were comparable in size to the subyearlings used in this study; however, the sockeye salmon migration times were much faster.

John Ferguson asked about the fish size of subyearlings passing through the Wanapum and Priest Rapids bypass systems. Tom Dresser (Grant PUD) said one study conducted by Battelle in the Priest Rapids project area, which evaluated habitat use of subyearlings in the Wanapum Dam tailrace from April to July, found fish size to be between 50 to low-90s mm. He said this is consistent with what Kahler found in the Wells Pool. Dresser also said he believes these fish were fall subyearlings because fall Chinook salmon spawn in the Wanapum Dam tailrace.

Kirk Truscott asked if subyearlings are ever captured during gatewell dipping, and if so, were they sampled. Dotson said this has occurred in the past during summer months; however, gatewell dipping is strictly salvage (i.e., no sampling). Kirk Truscott asked if there have been any active tag studies informing whether these subyearlings are mid reservoir or shoreline oriented in migration. Dotson said this information may be available in raw data; however, not in a report. Kirk Truscott said, if subyearlings are shoreline-orientated, this may cause issues because there are a lot of backwater areas and complex habitat, which may result in longer migration times.

B. Subyearling Data from the Rocky Reach Juvenile Bypass System (Lance Keller)

Lance Keller provided a presentation titled, Subyearling Chinook Data Collected from the Rocky Reach Juvenile Bypass System (Attachment J), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Keller reviewed an overview of the Rocky Reach Juvenile Fish Bypass System (RRJFBS) and a summary of available subyearling Chinook salmon data, including abundance, run composition, run timing, and fish size. These data reveal high variability in the daily index counts at the RRJFBS and two runs of subyearlings past Rocky Reach Dam (hatchery and unknown). The hatchery group consisted of fish migrating past Rocky Reach Dam in late-May to early-July and a large number of fish in an initial passage pulse. This group also consisted of larger fish sizes compared to the unknown group. The unknown group consisted of fish migrating past Rocky Reach Dam in late-June through August, with variable elongated passage. This group consisted of smaller fish sizes than the hatchery group; however, fish size did increase later in the passage season. Graphs throughout the presentation included a horizontal orange line at 95 mm, signifying a possible minimum fork length for subyearlings, should an active tag survival study be carried out. A vertical purple line was also present in each graph signifying when 18°C water temperatures were observed in the Rocky Reach Reservoir, which exceed the temperature threshold for conducting fish surgeries. The graphs depicted that with varying abundance numbers, size variation in hatchery and unknown fish, and the annual date at which 18°C water temperature is achieved, the ability to collect and tag a representative sample of juvenile subyearling Chinook salmon for a project survival study becomes increasingly difficult. Additional discussions were as follows.

<u>2010 Counts and Run Timing / 2010 Average Length Based on Origin</u> (slide 6)

Andrew Murdoch asked if Chelan PUD collects fish smaller than 80 mm before May. Keller said Chelan PUD collects fry prior to May; however, these fish are currently not identified to the species level. Mike Tonseth (WDFW) noted on the '2010 Average Length Based on Origin' graph, at the front end of the unknown group, a large amount of those fish are dominated by releases from Turtle Rock, which is why there is a huge peak at that time. Alene Underwood (Chelan PUD) noted that the last Turtle Rock release was in 2011.

<u>2011 Counts and Run Timing / 2011 Average Length Based on Origin</u> (slide 7)
Casey Baldwin asked what fish length is considered a fry. Keller said 75 mm, so the fish depicted in the graphs are greater than 75 mm.

C. Results of Wells Reservoir Fish Collection Studies (Tom Kahler)
Tom Kahler provided a presentation titled, A Draft Review of Historic and Recent Data on Subyearling Chinook Availability in Wells Reservoir (Attachment K), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Kahler reviewed several pieces of historical subyearling data ranging from 1969 through the 1980s, including purse seine, beach seine, and fyke net data. Based on these various data, subyearlings begin passing Wells Dam when they are approximately 40 to 50 mm in length. The data cannot tell us whether fish are entrained or actively migrating; regardless, fish of this size range pass Wells Dam starting around the beginning May. The beach seine data are not necessarily representative of what fish are passing Wells Dam; however, these data may reflect what may be observed in the tributaries. The data indicate all size classes are migrating (or at least entrained). Finally, data from the Hanford Reach corroborate the data from the Wells Reservoir indicating that a very small proportion of the subyearling Chinook salmon use the shoreline from April through June. The size distribution of those captured in the nearshore matches that of those captured offshore in April and May; however, in June, the offshore catches lack the smaller size classes still present in nearshore catches, and the nearshore catches lack the largest size classes that dominate offshore catches. Additional discussions were as follows.

<u>April 12 to 23, McGee et al. 1983</u> (slide 9)
Kahler said this slide shows a distribution from purse seining. Jim Craig (USFWS) asked if this includes night and day catches, and Kahler said this includes only night catches.

<u>May 16 to 29, Purse Seine versus Beach Seine</u> (slide 25)

Curt Dotson asked about the mesh size on the purse seine and where the beach seine was deployed in the water column. Kahler said the beach seine was shoreline oriented, and the purse seine was not specifically set up to capture subyearlings.

General

Dotson said once a certain water temperature is reached, subyearlings tend to move offshore into deeper water. Bob Rose asked if deeper water is synonymous with cooler water, and Kahler said this is not true in the Wells Reservoir.

VII. Discussion

A. Discussion (John Ferguson and Denny Rohr)

John Ferguson suggested considering the effects of climate change on differential run timing, fish numbers, growth, and conducting a compliance test. No other comments were discussed at this time.

VIII. Tagging Effects and Available Tags and Detection Equipment

A. Barotrauma (Alison Colotelo)

Alison Colotelo (Pacific Northwest National Laboratory [PNNL]) provided a presentation titled, Understanding Barotrauma in Fish Passing Hydro Structures (Attachment L), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Colotelo reviewed barotrauma due to rapid decompression, simulating rapid decompression, laboratory testing, probability of mortality or injury, acclimation depth effects on barotrauma, identification of acclimation depth of subyearlings, and effects of transmitters on barotrauma. In summary, barotrauma is primarily caused by the expansion and rupture of the swim bladder during rapid decompression. The ratio of acclimation to nadir pressure is the most important factor in determining the likelihood of barotrauma for juvenile Chinook salmon. Fish acclimated deeper in the water column are more susceptible to barotrauma. Tagged fish are more susceptible to barotrauma. Additional discussions were as follows.

Probability of Mortality or Injury (slide 11)

John Ferguson said 20.9% expected mortality seems high, noting that field studies indicate only 10 to 15% expected mortality. He asked if this percentage is regarding unburdened fish. Colotelo replied, if fish acclimated to the surface are directly injected into the water, there is a lower rate of pressure change. Therefore, there will be a lower susceptibility to injury than the untagged population of subyearlings migrating through the system, which reside deeper in the water column. Ferguson noted that some papers indicate fish can self-adjust. Colotelo said those papers may have assumed those fish were acclimated to a deep depth when passing through the turbine. She said fish have the ability to burp to reduce susceptibility to barotrauma; however, the physiological state of the fish and depth of natural buoyance is unknown. She said the worst-case scenario is assumed in the lab.

<u>General</u>

Steve Hemstrom asked if the underside of the turbine blade is the area of greatest pressure, and Colotelo said that is correct. Colotelo added that assumptions are made where fish are passing, until it is known exactly where fish pass.

Denny Rohr asked if subyearlings tend to acclimate deeper in the water column before passing turbines, and Colotelo said that is what was found in the Snake River.

Bob Rose asked if the bubbles found in the eyes and gills are related to the swim bladder. Colotelo said Battelle conducted studies and found when the swim bladder explodes, it pushes gas through the vasculature. Ferguson suggested that fish can regulate their swim bladder through their vascular system. Colotelo said younger fish have less developed system for regulating the size of the swim bladder through their vascular system.

Casey Baldwin asked whether there are changes to growth or survival for fish subjected to barotrauma in which the swim bladder does not explode. Colotelo said, in lab tests, fish have been euthanized after a couple of days, so Battelle has not evaluated delayed effects. She said fish can recover from small ruptures; however, no work has been conducted on long-term effects.

Lance Keller asked if tag expulsion has been observed in the lab. Colotelo said tag loss is not common with the standard USACE tag and suture practices; however, with future injectable transmitters, Battelle will evaluate tag expulsion. She said it is important to consider whether a fish died from passing the turbine or if the tag was just expelled.

B. Tag Hardware (Curt Dotson)

Curt Dotson provided a presentation titled, Types of Tags that are Presently on the Market (Attachment M), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Dotson reviewed five different tag vendors and their tag technology available to date. He noted that battery life is dependent on ping rate, and the larger the tag, the longer the battery life. He said PNNL is now working to release injectable tags.

C. Tagging Effects (Marty Leidtke)

Marty Leidtke provided a presentation titled, Tagging and Tag Effects in Subyearling Chinook Salmon (Attachment N), which was distributed to the HCP Coordinating Committees and PRCC by Kristi Geris following the workshop on June 22, 2016. In this presentation, Leidtke reviewed potential issues with tagging and tagging-related impacts to subyearling Chinook salmon, including elevated water temperatures, disease, tag effects, and tag operations and tagger effects. In summary, Leidtke said tagging subyearlings for telemetry studies can be challenging; however, mitigation can be executed at several levels. Small tags for small fish will not resolve all concerns. Lastly, studies can be executed reliably with a well-planned and executed approach to tagging. Leidtke recommended using prophylactic treatments immediately after tagging to control disease and fungal risk. She also recommended removing sutures from tagged fish prior to release. Additional discussions were as follows.

<u>General</u>

Bob Rose asked if USGS has evaluated implications of injectable acoustic tags, and Leidtke said not specifically. Leidtke said the USGS parent facility has worked with PIT-tag injection needles.

Andrew Murdoch asked about the new suture location. Leidtke said the new position is parallel and adjacent to the old position, off the mid-ventral line by a couple of millimeters.

Alison Colotelo said Battelle is considering, for fish less than 90 mm, a small incision to inject a tag and not using sutures to close it, and then testing the fish through a swim chamber to determine whether the tags stay in. She said these tests should be ready this winter. Leidtke suggested monitoring that closely. She said a good tagger can have a fish off the surgery table in 1.5 minutes and questioned whether injecting the tag is much faster. She said, if one suture ensures a tag will not be expelled, this may be worth considering. Colotelo said the injectable tag is already developed. She said the tag has a battery capability to last more than 120 days, and PNNL is considering sending the tag out to manufacturers. She said USACE also is producing a 20-day injectable, and another tag in development will be smaller than 12 mm, with a battery life of 20 days. She said more information on the latter should be available in July 2016.

IX. Conclusions and Discussion

A. Conclusions and Discussion (John Ferguson and Denny Rohr)

John Ferguson and Denny Rohr thanked the speakers for their time and presentations. Ferguson asked HCP Coordinating Committees and PRCC members to think about a path forward to discuss during tomorrow's HCP and PRCC meetings.

X. List of Attachments

Attachment A	List of Attendees
Attachment B	Considerations in the Design and Analysis of Subyearling Chinook Salmon Survival Compliance Studies (Skalski)
Attachment C	An Update on the Migratory Behavior and Trends in Age at Ocean Entry of Natural-origin Chinook Salmon from the Snake River Basin (Connor)
Attachment D	Post-emergence Behavior of Subyearling Summer/Fall Chinook in Wells Reservoir and Implications for the Measurement of Passage Survival through the Wells Hydroelectric Project (Kahler et al.)
Attachment E	Juvenile and Adult Subyearling Chinook Life History Information from the Okanogan River and Wells Pool (Baldwin et al.)
Attachment F	Life-History of Subyearling Chinook Migrants from the Entiat River (Desgroseillier)
Attachment G	Comparing the Migration Patterns of Yearling Spring Chinook and Subyearling Summer Chinook Salmon through the Mainstem Columbia River using Available PIT-Tag Data (Graf)
Attachment H	Life-History Strategies of Upper Columbia Summer/Fall Chinook as Determined by Scale Analysis of Returning Adults (Murdoch)
Attachment I	Grant PUD Subyearling Survival Pilot Studies: Application of Age-0 Fall Chinook (Graf)
Attachment J	Subyearling Chinook Data Collected from the Rocky Reach Juvenile Bypass System (Keller)
Attachment K	A Draft Review of Historic and Recent Data on Subyearling Chinook Availability in Wells Reservoir (Kahler and McGee)
Attachment L	Understanding Barotrauma in Fish Passing Hydro Structures (Colotelo)
Attachment M	Types of Tags that are Presently on the Market (Dotson)
Attachment N	Tagging and Tag Effects in Subyearling Chinook Salmon (Leidtke)

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Denny Rohr	D. Rohr and Associates
Lance Keller*	Chelan PUD
Steve Hemstrom*	Chelan PUD
Keith Truscott	Chelan PUD
Alene Underwood	Chelan PUD
Tom Kahler*	Douglas PUD
Peter Graf	Grant PUD
Tom Dresser†	Grant PUD
Curt Dotson†	Grant PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*†	U.S. Fish and Wildlife Service
Billy Connor	U.S. Fish and Wildlife Service
Tom Desgroseillier	U.S. Fish and Wildlife Service
Jeff Korth*†	Washington Department of Fish and Wildlife
Mike Tonseth	Washington Department of Fish and Wildlife
Andrew Murdoch	Washington Department of Fish and Wildlife
Kirk Truscott*†	Colville Confederated Tribes
Casey Baldwin	Colville Confederated Tribes
John Rohrback	Colville Confederated Tribes
Tom Skiles†	Columbia River Inter-Tribal Fish Commission
Bob Rose*†	Yakama Nation
Marty Leidtke	U.S. Geological Survey
John Skalski	University of Washington, Columbia Basin Research
Alison Colotelo	Pacific Northwest National Laboratory

Notes:
* Denotes Coordinating Committees member or alternate
† Denotes Priest Rapids Coordinating Committee member or alternate

APPENDIX S
FINAL UPPER COLUMBIA RIVER 2016 BY SALMON AND 2017 BY STEELHEAD HATCHERY PROGRAM MANAGEMENT PLAN AND ASSOCIATED PROTOCOLS FOR BROODSTOCK COLLECTION, REARING/RELEASE, AND MANAGEMENT OF ADULT RETURNS

STATE OF WASHINGTON
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April 14, 2016

To: HCP HC and PRCC HSC

From: Mike Tonseth, WDFW

Subject: **FINAL UPPER COLUMBIA RIVER 2016 BY SALMON AND 2017 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 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 (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, Grant County Public Utility Districts (PUDs), and ACOE and are operated by the Washington Department of Fish and Wildlife (WDFW), with the exception of 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).

This protocol is intended to be a guide for 2016 collection of salmon (2016BY) and steelhead (2017BY) 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), 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 2016, no age-2 or 3 males will be incorporated into spring or summer Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only).

- Use of ultrasonography to determine the sex of each fish retained for brood to ensure achieving the appropriate number of females for program production (does not include Priest Rapids Hatchery).

- Utilization of genetic sampling/assessment to differentiate Twisp River and Methow River Basin natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir and Methow FH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components for the GPUD, CPUD and DPUD programs.

- Collection of only hatchery adult steelhead at Wells Dam/Hatchery for the Lower Methow safety-net (WFH/MFH), and Wells Hatchery Okanogan and mainstem Columbia safety-net programs.

- Collection of spring Chinook for the Nason Creek and Chiwawa programs using combination of Tumwater Dam and the Chiwawa Weir.

- Targeted collection of 100% of the Wenatchee summer Chinook and Wenatchee hatchery origin steelhead broodstock at Dryden Dam to reduce the number of activities that may contribute to delays in fish passage at Tumwater Dam (some adult collections at Tumwater may be necessary if sufficient adults cannot be acquired at Dryden Dam).

- Targeted collection of 100% of the natural origin steelhead broodstock at Tumwater Dam.

- Collection of summer Chinook broodstock from the Eastbank outfall, sufficient to meet a 576K yearling juvenile Chelan Falls program. Summer Chinook collections at Wells Dam may be used to support the Chelan Falls program if broodstock collection efforts at EB Hatchery fall short and if a facility use agreement between CPUD and DPUD can be worked out.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net on-station-released smolts (up to 14 adults). The remainder of the broodstock (46) will be WNFH returns collected at WNFH (or by angling/trapping/tangle netting 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 2017.

- Summer Chinook collections at Wells Dam to support the CJH program may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the YN, Yakima River summer Chinook program.

- Targeted collection of 1,000 adipose present, non-coded wire tagged fall Chinook from the PRD OLAFT.

- Targeted collection of about 400 adipose present, non-coded wire tagged fall Chinook using hook and line efforts in the Hanford Reach.

- Juvenile releases, unless otherwise noted in this document, will follow past conventional practices for each of the respective programs.

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 2016 Broodstock Collection Protocols are:

Appendix A: 2016 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2017 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

Methow River Basin

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) Permit 1196.

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 with natural origin fish. 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 33.3% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch program; 11.8% for the Twisp program). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish

Health 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 (unless adult holding is not yet available due to the Wells modernization project, in which case fish will be held at Methow FH pending results), 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 (combined, these make up the entire Methow Basin spring Chinook population) will be released back into the Columbia River. Based on the broodstock-collection schedule at Wells Dam (3-day/week, 16 hours/day, up to 48 hours per week cumulatively), extraction of natural-origin spring Chinook is expected to be approximately 33% or less.

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%. Trapping at the Winthrop NFH will be included, if needed, as a result of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2016 is estimated at 3,452 spring Chinook, including 2,763 hatchery and 689 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.
The following broodstock collection protocol was developed based on BKD management

strategies, projected return for BY 2016 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Appendix A.

The 2016 aggregate Methow spring Chinook broodstock collection will target up to 122 adult spring Chinook (16 Twisp, 106 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 5% of the CWT tagged hatchery adults and 19% 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 2016 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 42% of the CWT tagged hatchery adults and 81% 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 2016 aggregate Methow broodstock collection will total 104 natural origin spring Chinook. Broodstock collected for the aggregate Methow 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 1196. The Grant/Douglas/Chelan PUD 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.

Table 1. Brood year 2011-2013 age class-at-return projection for wild spring Chinook above Wells Dam, 2016.

Brood year	**Smolt Estimate**		**Age-at-return**									
			Twisp Basin					**Methow Basin**				
	Twisp[1]	Methow Basin[2]	Age-3	Age-4	Age-5	Total	SAR[3]	Age-3	Age-4	Age-5	Total	SAR[4]
2011	10,047	36,344	9	79	**13**	101	0.0101	68	394	**101**	563	0.0155
2012	12,277	35,976	11	**97**	16	124	0.0101	67	**389**	100	556	0.0155
2013	24,605	36,242	**22**	194	33	249	0.0101	**67**	393	102	562	0.0155
Estimated 2016 Return			**22**	**97**	**13**	**132**		**67**	**389**	**101**	**557**	

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 *Mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2008; David Grundy, personal communication).*
4 *Mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2002-2008; David Grundy, personal communication).*

Table 2. Brood year 2011-2013 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2016.

	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	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**
%Total				41.5%				80.8%				49.4%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				5.0%				19.2%				7.8%
Winthrop (MetComp)	383	1,028	67	**1,478**					383	1,028	67	**1,478**
%Total				53.5%								42.8%
Total	585	1,911	267	**2,763**	89	486	114	**689**	674	2,397	381	**3,452**

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: Hatchery	Number of Adults: Wild	**Total**		
Chelan PUD	60,516		16F/16M	**32**		
Douglas PUD	29,123		8F/8M	**16**		
Grant PUD	134,126		37F/37/M	**74**		
Total	**223,765**		**61F/61/M**	**122**		
By program		Number of Adults: Hatchery	Number of Adults: Wild	**Total**	Collection location	Mating protocol
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**52F/52M**	**104**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**61F/61M**	**122**		

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 20, 2016. However, the West ladder trap will not be operational May 14 until June 1, and implementation of a Douglas PUD bull trout study in 2016 will require further modifications of the spring Chinook trapping schedule at Wells Dam. Spring Chinook broodstock collection and stock assessment sampling activities authorized through the 2016 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 and bull trout collection in Appendix D (pages 36 and 37). 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 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 Well FH (or immediately transferred to Methow FH taking into account the status of adult holding during the modernization project) pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or transferred to WNFH.

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 22. The trap may be operated up to five days per week/24 hours per day (provided it is manned during active trapping).

Trapping at the Methow Outfall trap and Winthrop NFH ladder operations will run concurrent with the Twisp Weir. Pending development of an adult management plan for spring Chinook in the Methow basin, hatchery-origin adults captured at the Methow Outfall (surplus to the Methow Hatchery program) will be transferred to the WNFH for incorporation into WNFH brood as supported by the HGMP's of both facilities.

<u>Steelhead</u>

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations such as at Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, WNFH volunteer trap, Okanogan River Basin and angling in Methow River (Table 5). Generally incubation/rearing occur for the Methow safety net, Okanogan, and Columbia River release at Wells Fish Hatchery (FH) with incubation/early rearing at Methow Hatchery for the Twisp conservation program. The USFWS collects broodstock via hook-and-line in the Methow Basin, returns to WNFH and surplus fish removed at Methow Hatchery and the Twisp Weir.

Specific program brood sources are structured as follows:

Wells Hatchery – Twisp River Release

The Wells Hatchery Twisp River release is a locally collected Twisp wild broodstock conservation program. Adults are collected in the spring of the current spawn year at the Twisp 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 activities at the Twisp Weir, Methow Hatchery, WNFH, and through hatchery fish intercepted during natural origin brood hook and line collection for the USWFS Winthrop conservation program. As a backup to potential collection shortfalls in the Methow safety net program as a result of uncertainties in spring collection efficiencies, a portion of the Methow program will be augmented with collection of hatchery origin adults (30) occurring in the fall at Wells Dam. These fall-collected Wells stock fish will be considered surplus to any spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use returns to Wells Hatchery and may be augmented with adult returns to the Methow Hatchery and Winthrop FH if needed to fulfill the program. To ensure the safety-net programs (Methow and Okanogan) have broodstock, a portion of the broodstock requirement (60 adults) will be collected at Wells Dam in the fall of 2016, and held at Wells Hatchery (Table 5). These fall-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural origin fish collected through hook and line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, hatchery origin returns to WNFH will be prioritized, followed by excess hatchery returns to Methow Hatchery. 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.

Okanogan River releases

The Okanogan River uses a combination of natural origin adults collected in Omak Creek and hatchery origin adults collected in Omak Creek or elsewhere in the Okanogan Basin through CCT collection efforts. As a backup to potential collection shortfalls in the Okanogan, a portion of the Okanogan program will be augmented with collection of hatchery origin adults (30) occurring in the fall at Wells Dam. These fall-collected Wells stock fish will be considered surplus to any spring-collected Methow and Okanogan broodstock, and eggs and/or fry from these surplus broodstock may be utilized for other programs in the upper Columbia.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2017 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
Twisp Conservation	Methow Hatchery (incubation); Wells Hatchery (rearing)	Douglas PUD	Twisp Acclimation Pond	48,000	Twisp WxW
Methow Safety-Net	Wells Hatchery	Douglas PUD	Methow Hatchery	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	Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH	Up to 200,000	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River above Twisp, volunteers to WNFH, and tangle netting in Spring Creek.
Omak Creek	Wells Hatchery	Grant PUD	Omak Creek	Up to 40,000[1]	Okanogan Basin/Omak Creek (up to 16 wild or hatchery)
Okanogan	Wells Hatchery	Grant PUD	Okanogan Basin	Up to 90,000[1]	42 Wells Stock collected at Wells Dam/Hatchery or at tributary locations in the Okanogan Basin operated by the CCT

[1] The Grant PUD programs will total 100,000 smolts, +-10% (58 broodstock). Broodstock collection number, origin, location, and smolt numbers will be consistent with those detailed in National Marine Fisheries Service (NMFS) letter to Randall Friedlander (CCT) and Jeff Grizzel (GPUD) dated February 27, 2014 and detailed in Table 4 and Table 5 herein.

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 2016/2017 to meet production objectives absent a preseason forecast at the present time.

For the 2017 brood steelhead programs operating above Wells Dam, a total of 350 adults (152 natural origin and 198 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 on hand in the event tributary based collection efforts fall short of targets, trapping at Wells Dam and/or Wells FH will selectively retain up to 257 hatchery origin steelhead (west [and east, as necessary] ladder and volunteer trap collection; Table 5).

Twisp Conservation Program

In the spring of 2017, 26 wild steelhead will be targeted at the Twisp Weir and transferred to the Methow Hatchery for spawning, incubation, and early rearing (up to 60-d post feeding to facilitate viral testing of progeny resulting from live spawning females for the YN kelt reconditioning program), after which they will be moved to Wells Hatchery for the balance of rearing (Table 5).

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 the Twisp Weir and moved to Wells Hatchery for spawning. No less than 46 hatchery adults will be targeted at WNFH and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). Up to 30 hatchery origin Wells stock collected and held at the Wells Hatchery will be used as a final option if broodstock collection at the Twisp Weir, and WNFH and MH traps are unsuccessful (Table 5). If needed, WNFH HO fish identified through PIT tag detections, collected at the MFH outfall may be transferred to WNFH for use in the Spawning Channel Evaluation Project rather than retained for broodstock. Coordination between USFWS and WDFW hatchery staff will occur during the season to determine prioritization.

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will 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 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.

Okanogan Hatchery/Endemic Program

Fifty-eight (58) adult steelhead will be targeted in the Okanogan Basin, including up to 16 natural-origin adults collected from Omak Creek for a 40K endemic program operated by the CCT and funded by GCPUD as part of their 100K UCR steelhead mitigation obligation (Table 5). Additionally, up to 30 hatchery adult steelhead will be targeted at Wells Dam/Hatchery as a back-up collection contingency due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5).

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Number of backup adults[2]	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild				Hatchery	Wild
DPUD Columbia R.	96		Wells FH/Dam Wells Dam		Methow FH	96	
DPUD Methow R.	60		Twisp weir (14) Methow FH (46)	Up to 30	WNFH[3] Wells Dam	90	
DPUD Twisp R.		26	Twisp weir	NA	NA		26
GPUD Okanogan R.	0-58[6]	0-58[7]	Omak Cr. Okanogan R. Wells FH[5]	30	Wells Dam	0-88	0-58
USFWS Methow R.		110	Methow R. WNFH[4]	NA	Methow FH		110
Total (PUD programs)	**156-214**	**26-84**		**60**		**186-273**	**26-84**
Total (All programs)	**156-214**	**136-194**		**60**		**186-274**	**136-194**

[1] Assumes a 1:1 sex ration (see table 6).
[2] All backup broodstock are hatchery origin adults.
[3] May include hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH.
[4] May also include excess hatchery origin adults collected at Methow FH and the Twisp Weir.
[5] Spring collection of hatchery origin steelhead as needed to meet program shortfall for the Okanogan Program.
[6] Dependent upon number of NOR broodstock collected in the Okanogan Basin to achieve 58 total broodstock for the Okanogan program.
[7] Depending upon NOR abundance, trapping efficiency, and issuance of a new Section 10 Permit for the Okanogan steelhead program to allow, up to 100% wild collected in the Okanogan Basin to achieve program broodstock target.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2017 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	48F/48M		**96**	Wells Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	30F/30M		**60**[4]	Twisp Weir, MFH, WNFH, Wells Dam	1:1
DPUD Twisp R.	48,000		13F/13M	**26**	Twisp Weir	2x2 Factorial
GPUD Okanogan R.[3]	100,000	21F/21M	8F/8M	**58**[5]	Okanogan R./Omak Creek	1:1/2x2[7]
USFWS	200,000		55F/55M	**110**[6]		
Total[4]	**608,000**	**99F/99M**	**76F/76M**	**350**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow hatchery 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.
[3] Okanogan Basin releases, including Omak Creek is100,000 smolts as part of GCPUD's 100K summer steelhead obligation and targets 58 adults in the Okanogan Basin, including up to 16 natural origin adults to fulfill the Okanogan Basin Production of 100,000 smolts comprised of natural origin and locally-adapted steelhead returning to the Okanogan River. Upon issuance of a new Section 10 permit for the Okanogan Steelhead

program, up to 58 natural origin steelhead may be collected in the Okanogan Basin to fulfill the broodstock target, consistent with the Section 10 Permit provisions. Retention of progeny from these fish will be dependent upon success of CCT trapping efforts in Okanogan Basin tributaries.
[4] Up to an additional 30 hatchery adults will be collected at Well FH as a fall back to shortfalls in collections at the Twisp Weir, MFH.
[5] Up to an additional 29 hatchery origin adults will be collected at Wells Dam as backup to potential 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 crosses within the Okanogan. The Okanogan endemic program (WxW) will utilize a minimum 2x2 factorial mating to minimize potential negative effects associated with a small effective population size.

Overall collection for the PUD programs will be 299 fish (a combination of program specific and back-up adults; Table 5) 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 run-timing of hatchery and natural origin steelhead at Wells Dam and the Twisp Weir. Trapping at the Wells Dam ladders will occur between 01 August and 31 October, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September on the west ladder (Appendix D). Operational criteria and dates for the Twisp Weir are still under construction.

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.

Surplus UCR Juvenile Steelhead Management

In the event excess juvenile are produced from the over-collection efforts to support the Methow safety net and /or Okanogan safety net programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met.

2. Used to support any shortfalls in the Wells Columbia River release provided fish health and/or marking requirements for the program can be met.

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 and/or CCT fishery managers).

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.

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 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012, and 2013 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 2016, up to 106 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 53 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.

Should use of Wells Dam be needed to meet any shortfalls in broodstock for summer/fall Chinook programs occurring in the Okanogan Basin, 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.

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		53F/53M	**106**	Wells Dam	1:1
Total	**200,000**		**106**	**106**		

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,
- 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 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.

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 following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

WDFW will target 494 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs, and up to 174 for the YN 275K-350K green egg request for the Yakima summer Chinook program (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 11 and terminate by August 31.

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams have traditionally been supported through adult broodstock collections at the Wells Hatchery volunteer channel. For 2016, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Eastbank Outfall (EBO) using in-channel seining/netting beginning July 1 (or earlier if summer Chinook are detected in the outfall) through September 15. Collection efforts in the EBO in 2013 and 2014 were sufficient to meet the adult requirements for the Chelan Falls program (in 2015 only 56% of the program was met through EBO collections – the balance was attained through broodstock collected at the CJH volunteer trap). 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 from the Wells Volunteer channel (contingent on agreement between Chelan and Douglas PUD) or other HCP approved location to make up the difference. The 2016 broodstock target for the Chelan Falls program is 350 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

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 2016.

Program	Production target	Number of Adults[2]		Total	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	95F/95M		**190**	Wells VC[3]	1:1
Wells 0+	484,000	152F/152M		**304**	Wells VC[3]	1:1
Chelan Falls 1+	576,000	175F/175M		**350**	EB outfall	1:1
Yakama Nation	350,000[1]	87F/87M		**174**	Wells VC[3]	NA
Total	**1,730,000**	**544F/544M**		**1,018**		

[1] The YN request is for between 275K and 350K green eggs to support the Yakima River summer Chinook program.
[2] 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.
[3] Wells Hatchery volunteer channel trap.

Wenatchee River Basin

In 2016 the Eastbank Fish Hatchery (FH) is expecting to 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 2016 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 80 natural origin spring Chinook (Table 10). The spring Chinook production obligation 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 142 adults (70 natural origin and 72 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2016 is estimated at 2,101 spring Chinook, including 1,359 hatchery and 752 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%.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2016.

	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	306	146	**452**	102	18	**150**	510	242	**752**
Estimated hatchery return	1,236	113	**1,349**				1,236	113	**1,349**
Total	1,542	256	**1,801**	102	18	**150**	**1,746**	**355**	**2,101**

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	144,026	18F/18M	40F/40M	**80**[1]	Chiwawa Weir and Tumwater Dam[4]	2x2 factorial
Nason Conservation	125,000	0	35F/35M	**78**[2]	Tumwater Dam[4]	2x2 factorial
Nason Safety net	98,670	36F/36M[3]	0	**72**	Tumwater Dam	1:1
Total	**367,969**	**108**	**150**	**266**[2]		

[1] Includes 36 hatchery origin adults (represents ~50% of the adult target) to ensure the Chiwawa production goal is met if insufficient NO adults are collected).
[2] Includes ~10% additional NO fish to account for fish that may assign back to the White River spawning aggregate. No more than 70 NO fish will be retained for spawning.
[3] Due to the lack of returning hatchery fish from the Nason program (first age-4 returns are expected in 2017), Chiwawa hatchery fish will be collected to satisfy the Nason Cr. safety net program.
[4] 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).

Chiwawa River Conservation Program Broodstocking:

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 30 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 of adults needed to meet the Chiwawa Conservation program (up to ~70 total or ~35 females) would be collected at the Chiwawa Weir.
    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 15 through August 1 (not to exceed 15 cumulative trapping days). 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.

- In the absence of adequate redd count data (i.e. until 2018) to calculate the 10% threshold, if after 15-days of weir operation, 67 bull trout encounters, or 15 August, the NO broodstock target is not reached, the balance of the mitigation obligation will be met through hatchery fish already retained for the Chiwawa program at TWD.
- Additionally, no more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS. Sufficient redd data to calculate a five year average is expected to be available as early as 2018.
- To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program, HO adults (presently estimated at 50% 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.
- 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 (2011-2015) with conversion rates from Bonneville Dam.

	Detections at Bonneville Dam		Detections at Tumwater Dam			
Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2011	16	115	12	0.750	81	0.704
2012	7	60	5	0.714	52	0.867
2013	2	29	2	1.000	22	0.759
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
Mean	8.0	62.4	5.2	0.660	42.4	0.687
Geomean	6.6	56.1	3.7	0.569	37.6	0.671

Nason Creek Conservation Program Broodstocking:

- Up to ~78 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 70 NO adults 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.
    - 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 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..
    - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the lowest assignment probabilities will be return to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- Up to ~72 HO spring Chinook adults 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.

Nason Creek spring Chinook Rearing/Release Strategy:

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 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 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.

**NOTE: Due to the uncertainty of having a reliable surface water intake structure (compromised by heavy bedload movement during fall [2015] and winter [2016] freshets) at the Nason Creek Acclimation Facility in time for acclimation of this brood year, alternate rearing strategies and/or locations may need to be considered by the HSC.

Steelhead

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 1395 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 138 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 68 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. 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 females 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.

Table 12. Number of broodstock needed for the combined 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	34F/34M	**68**	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**	**68**	**138**		

[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 2016 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2016 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2011, 2012 and 2013 spawn escapement to the Wenatchee River indicate sufficient summer Chinook will 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 dam 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 270 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 135 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 27 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.

Table 13. Number of broodstock needed for the combined 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		86F/86M	**172**		
Grant PUD	181,816		49F/49M	**98**		
Total	**500,001**		**135F/135M**	**270**	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 2016 up to 1,000 adipose present, non-coded wire tagged (high proportion of natural origin) fall Chinook adults will be targeted at the OLAFT). Additional NO adults targeted as a continued pilot evaluation through hook-and-line angling efforts in the Hanford Reach 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 400 adults may be collected through the hook-and-line efforts. 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, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from either hook-and-line caught broodstock or OLAFT collections will be prioritized for PRH programs (i.e. OLAFT and Hanford Reach angler caught fish will be externally marked, 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 OLAFT and angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,219 females will need to be collected (3,536 spawned) 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, hook-and-line efforts on the Hanford Reach, and/or the Priest Rapids Dam off ladder trap (OLAFT; 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 from BY 2015 become available, the PRCC-HSC may choose to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: the PRD off ladder trap (OLAFT – operated 4-days per week/8 hrs/day to collect up to 1,000 presumed NOR's), hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), and the Priest Rapids Hatchery volunteer channel trap.

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 $\geq$ 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.

4) Only adipose present, non-CWT males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only progeny of adipose present, non-wired fish encountered through hook-and-line angling and at the OLAFT will be prioritized for retention into the program.

6) Broodstock collected from the OLAFT and by hook-and-line will exclude age-2 and to the degree possible age-3 fish (<75 cm) 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 (e.g. collection of 1 in 5 age-3 fish for broodstock from the OLAFT).

7) All gametes of fish spawned from hook-and-line broodstocking efforts and/or OLAFT collections will be incorporated into the PRH based program.

8) Real time otolith reading and an alternative mating strategy will be implemented in 2016 similar to 2015 unless the PRCC-HSC agrees that the PNI objective in 2016 can be met without implementing 1x4 matings. Otoliths from males from the OLAFT and ABC collections will be collected during the peak spawning week and read prior to spawning. If the male is natural origin, then it will be spawned with 4 females, otherwise it will be spawned with two.

9) All eggs or juveniles leaving PRH (including surplus) will have a unique otolith mark so that returning adults can be identified.

10) 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.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,176F/1,088M	**3,264**		
ACOE-PRH	1,700,000	661F/331M	**992**		
ACOE – Ringold[1]	3,500,000	1,360F/680M	**2,040**		
Total	**10,799,504**	**4,197F/2,099M**	**6,296**		

Collection location	Estimated number of adults: Hatchery	Estimated number of adults: Wild	Total		
Priest Rapids Hatchery	**3,372F/1,358M**	**117F/49M**	**4,896**	PRH volunteer trap	1:2
OLAFT[2]	**307F/153M**	**360F/180M**	**1,000**	PRD off-ladder trap	1:2, 1:4
ABC[3]	**23F/45M**	**113F/219M**	**400**	Hanford Reach	1:2, 1:4
Total	**3,702F/1,556M** (5,258; 83.5%)	**590F/448M** (1,038; 16.5%)	**6,296**		

[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 2015. 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 and H/W were derived through otolith results from 2012 and 2014.

Appendix A

2016 Biological Assumptions for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Program	Mean Values for 2010-2014								Mean Values 2008-2012 Brood
	ELISAs		Fecundity		Prespawn Survival				
	H	W			H		W		
	≥ 0.12	≥ 0.2	H	W	M	F	M	F	G-E-R Survival
Methow SPC	0.333	0.006	3,663	4,181	0.974	0.996	0.983	1.000	0.892
Twisp SPC	0.118	0.028	3,379	4,014	1.000	1.000	1.000	0.923	0.907
Twisp SHD	[redacted]	[redacted]	[redacted]	5,334	[redacted]	[redacted]	1.000	0.981	0.713
Wells SHD	[redacted]	[redacted]	5,739	5,938	0.954	0.950	na	na	0.620
Okanogan Safety Net	[redacted]	[redacted]	5,739	[redacted]	[redacted]	0.950	[redacted]	[redacted]	0.620
Wells SUC 1+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Wells SUC 0+	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.796
YN Green Eggs	0.012	0.000	4,183	4,552	0.944	0.966	na	na	0.849
Methow SUC	0.000	0.010	[redacted]	4,721	[redacted]	[redacted]	0.980	0.960	0.837
Chelan Falls 1+	0.051	[redacted]	4,372	[redacted]	0.985	0.944	[redacted]	[redacted]	0.844
Wenatchee SUC	0.000	0.010	[redacted]	4,902	[redacted]	[redacted]	0.974	0.955	0.796
Wenatchee SHD	[redacted]	[redacted]	5,866	5,790	0.972	0.913	0.962	0.943	0.658
Nason SPC[b]	0.113	0.035	[redacted]	4,647	[redacted]	[redacted]	0.990	0.971	0.812
Chiwawa SPC	0.115	0.027	3,889	4,689	0.991	0.991	0.988	0.973	0.812
Priest Rapids FAC 0+	[redacted]	[redacted]	3,719	[redacted]	0.820	0.861	[redacted]	[redacted]	0.825
ACOE @PRH	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.825
ACOE @Ringold	[redacted]	[redacted]	3,719	[redacted]	0.825	0.838	[redacted]	[redacted]	0.781

[1] Fecundities, ELISA's and prespawn survival values are based upon only three years data due to the shift in broodstock collection location from the Wells volunteer channel to the Eastbank Outfall.
[2] Green egg to release survival is based upon survival performance of fish acclimated and released from the Chiwawa program. Spring 2016 will be the second juvenile release from the Nason Creek program.
[3] Green egg to release survival.

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								
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	2018	15	Volitional

					Tonasket Pond			
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
2017	Wenatchee HxH (CPUD)	25,000	Ad + CWT	Estimated	Wenatchee R. at BBP	2018	6	Volitional

				2,022 PIT[7]				
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 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 3,851 (935 natural origin [24.3%] and 2,915 hatchery origin [75.7%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 3,517 Chiwawa spring Chinook are to reach Tumwater Dam in 2016, of which about 655 (18.6%) and 2,915 fish (81.4%) are expected to be natural and hatchery origin spring Chinook, respectively. Additionally, about 162 natural origin spring Chinook are expected back to Nason Creek with the balance 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 2016. Estimates were generated by recently developed run prediction and pre-spawn mortality models (WDFW unpublished data).

	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	306	146	**452**	102	48	**150**	510	242	**752**
Estimated hatchery return	1,236	113	**1,349**				1,236	113	**1,349**
Total	1,542	259	**1,801**	102	48	**150**	**1,746**	**355**	**2,101**

[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 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 1.8 times the expected number of Natural Origin Returns (NORs; 3 times the number of NOR's in the Chiwawa River). The combined HO and NO returns will represent about 2 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 2016. The conservation fishery is estimated to remove up to 358 HOR Chiwawa adults (Table 3) which will require additional adult management to occur at TWD.

Additional Adult Management

2016 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks), and unknown hatchery origin adults (ad-/cwt-) and up to about 78% of the age-4 and age-5 hatchery origin adults (about 481 males and 565 females according to current models, Table 2). In addition to the conservation fishery, approximately 108 HO and 150 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, the balance will be surplused at TWD and used for tribal and/or food bank disbursements or nutrient enhancement projects (Table 3).

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2016.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	436	729	189	94	376	**283**
Males[4]	316	620	127	14	433	**141**
Sub-total		1,349	316	108	809	**424**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.80**
Expected pHOS						**0.25**

[1] Wild broodstock needs of 80 wild NO fish (40 females/40 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.
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD and through the conservation fishery.
[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 283 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Estimated returns of Icicle Hatchery, Chiwawa Hatchery, and Chiwawa wild adults and estimated number of adults removed through adult management activities in the Wenatchee Basin in 2016.

	Estimated Returns			
	Icicle	Chiwawa HO	Chiwawa NO	Total
Estimated return	5,986	1,349	452	7,787
% of return[3]	0.769	0.173	0.058	
Harvest at 2% take limit[1]	1,192	358	9[2]	1,559
	Estimated Chiwawa Hatchery Fish Removed			
	Fishery	Broodstock	TWD removal	Total
Number of HO adults removed by method[3]	358	108	688	1,154

[1] For Wenatchee River fishery area only. Does not include Icicle River fishery harvest.
[2] While included as harvest, it is NO incidental hooking mortality associated with HO fish removal.
[3] Only includes age-4 and age-5 adults

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at Tumwater Dam or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Methow Spring Chinook

Pre-season estimates project a total of 3,452 (689 natural origin [7.8%] and 2,763 hatchery origin [92.2%]) spring Chinook back to Methow Basin. Of the 2,763 hatchery returns, about 1,148 are estimated to be from the conservation program with the balance of 1,478 from the WNFH safety net program (Table 4).

Table 4. Brood year 2010-2012 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2016.

	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	182	771	195	**1,148**	67	389	101	**557**	249	1,160	296	**1,705**
%Total				41.5%				80.8%				49.4%
Twisp	20	112	5	**137**	22	97	13	**132**	42	209	18	**269**
%Total				5.0%				19.2%				7.8%
Winthrop (MetComp)	383	1,028	67	**1,478**					383	1,028	67	**1,478**
%Total				53.5%								42.8%
Total	585	1,911	267	**2,763**	89	486	114	**689**	674	2,397	381	**3,452**

Some level of adult management will be required to limit the number of hatchery spring Chinook on the spawning grounds. Because a conservation fishery is not yet possible under current permit limitations, adult management will need to occur through operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH).

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 WNFH will operate their return channel to support removal of excess safety net fish. MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH 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.

Specific actions are as follows:

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.
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 2016. 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. Tentatively, 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 coupled with fish counts, will be used in conjunction with fish counts at Wells Dam 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 and Winthrop FH 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 will cease at Methow Hatchery if:
        1. Removal of MFH and WNFH origin adults meets the targets established (in this document and as adjusted in-season), or
        2.
        3. 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 will cease at Winthrop Hatchery if:
        1. Removal of WNFH and MFH origin adults meets the targets established (in this document and as adjusted in-season), 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 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 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 284 NO spawners. Based upon the sliding PNI scale for NO run sizes <300 fish, the initial goal for 2016 will be to manage for a minimum spawning escapement of 500 spawners; to achieve this, an estimated 79.3% of the hatchery returns (1,377 HO fish) will need to be removed (Table 5). This will result in approximately 216 hatchery origin spawners on the spawning grounds after accounting for prespawn mortality.

Table 5. Calculated targets and projected adult management results for Methow spring Chinook in 2016.

Wild Spawning Escapement	pNOB[2]	pHOS	PNI Target[3]	Allowable Hatchery Spawners	Hatchery surplus	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawning escapement
284[1]	1.00	0.432	0.607	216	165 MH	472	0.793[4]	500
					1,212 WNFH			
				Adjusted for Pre-spawn loss	Total Surplus			
				514	1,377			

[1] Adjusted for prespawn mortality. Includes about 57 NO fish expected to go into the Twisp River basin.
[2] pNOB of conservation program only.
[3] Based on 3-pop model and assumes a minimum of 75% conservation program adults for WNFH broodstock.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value includes hatchery adults needed to meet WNFH and Okanogan 10(j) production components.

In-season assessment of the magnitude 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 Permit 1196.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at the Twisp Weir (primarily as an action related to the steelhead RSS to meet a 1:1 hatchery:wild spawning composition upstream of the weir), the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations.

A more detailed run forecast will be available in September 2016. Adult management plans will be finalized then and appended to this document.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2016, 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:** Throughout all trapping activities described in this plan, the two PIT tag antennae arrays within the Tumwater Dam ladder (weir 15 and 18, see Appendix 2), will be monitored by WDFW and Chelan PUD and detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at weir 15 and last detection at weir 15 or weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish encountering weir 15. 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) **Improved Fish Handling Efficiency**: Several infrastructure improvements at Tumwater allow WDFW and other operators to cycle through sampled fish more quickly. These improvements consist of an additional holding tank and an improved conveyance system between the trap and holding tank. The facility improvements and additional staffing by WDFW (3 operators instead of 2) during peak spring Chinook and sockeye passage (i.e. June 1 and July 15), will ensure that the trapping denil is operated constantly allowing unimpeded passage through the trap. Historically, the trapping denil has been periodically shut down while fish were being processed.

3) **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).

4) **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.

5) **Planned Tumwater trapping operations from September 1 until mid-December:** The trap will return to a 24 hours/7day/week manned or unmanned active trapping for steelhead and Coho broodstock collection and adult steelhead management. During this time period bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will continue to be implemented.

6) **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.

7) Planned Tumwater trapping operations from mid-February through May: The trap will return to a 24 hours/7day/week manned or unmanned active trapping for adult steelhead management and spawner escapement tagging. 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.

8) **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.

9) **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 2016. 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					
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 2016 brood will end in June 2016. However it is anticipated that adult management will occur for the 2017 brood 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 2016, 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 five days per week, 24 hours per day beginning July 1 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 2016. 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
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.
[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 5d/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 5d/week 24hr/day 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.

Wells Dam Ladder and Hatchery Volunteer Traps

Ongoing construction at Wells Hatchery will affect the availability of the West ladder trap at Wells Dam during the 2016 spring Chinook run. Operation of that trap is scheduled to cease on the evening of May 13, and not resume until June 1. Additionally, implementation of a Douglas PUD bull trout study in 2016 will require modifications to the trapping schedule at Wells Dam. For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps is summarized in Table 3):

1). **East Ladder Trap:** Trapping on the East ladder may begin May 1 for spring Chinook broodstock collection and, until May 23, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week. Collection of bull trout for Douglas PUD's bull trout study will begin May 23 at the East ladder trap and the trap will be operated 7 days per week, 10 hours per day from May 23 to July 8, or until 30 bull trout are tagged. Within the period of 7-days-per-week bull trout trapping, East ladder trap operation may follow the 16-hours-per-day schedule on 3 days per week to facilitate the collection of spring Chinook broodstock. During the remainder of each week during bull trout trapping, East ladder trap operators will bypass spring Chinook unless needed to meet broodstock collection quotas. Upon completion of bull trout collection, operation of the East ladder trap will return to the normal 3-days-per-week/16-hours-per-day schedule until the resumption in use of the West ladder trap. Following the resumption in use of the West 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 construction activities on the hatchery modernization preclude use of either the West ladder or volunteer traps.

For all species except coho after September 26, when the West ladder trap is operational, and the East ladder trap is used, it may begin as early as May 1 and 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. 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.

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.

2). **West Ladder Trap:** The West ladder may begin as early as May 1 for spring Chinook broodstock collection and will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week for all species except coho after September 26. The West ladder trap will not be operational beginning May 14 through the end of May, resuming normal operation on June 1. During this outage in trap operation on the West ladder, the gate in Pool 40 may be closed (mimicking trap operation) a maximum 3-day per week/16 hours per day or 48 cumulative hours per week to facilitate collection of spring Chinook on the East ladder. Outside of the period of bull trout trapping on the East ladder, the West ladder trap will run concurrent with any trapping activities occurring at the East ladder trap. While operating the West ladder trap from June 1 through July 8, operators may retain bull trout for tagging only if the 30-fish target for the bull trout study has not been achieved. 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.

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 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 3. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, bull trout tagging, and/or reproductive success activities anticipated to be conducted at Wells Dam in 2016. Blue denotes steelhead, brown spring Chinook, pink summer Chinook, 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		15 Jul					
Sp Chinook run comp					1 May		15 Jul					
Bull trout tagging (East)					23 May		8 Jul					
Su. Chin BS 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	
SHD pHOS mgt.[6]		15 Feb				15 June			1 Sep			15 Dec
Su. Chin BS collection[4]							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] 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.

[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock will follow an up to 3d/week 16hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2016 brood will end in June 2016. However it is anticipated that adult management will occur for the 2017 brood beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2016, WDFW and Douglas PUD are proposing the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Specific operation details for the Methow Hatchery volunteer trap and Twisp Weir are still being worked through. Once those details have been fleshed out more thoroughly, this section will be updated.

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 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 2016. Blue denotes steelhead, brown spring Chinook, and green Coho.

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				1-30 Apr								
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 2016 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 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 Trap (OLAFT) in 2016. Blue denotes steelhead, purple fall Chinook, and orange sockeye.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chin. BS collection[2]									1 Sep		15 Nov	
Fall Chinook Run Comp.[3]									1 Sep		15 Nov	
Sockeye BS Collection						22 Jun	10 Jul					

[1] Steelhead VSP monitoring targets 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] To acquire the target 1,000 adipose present, non-CWT adult fall Chinook for broodstock, the OLAFT is operated up to 5 days per week, 8 hours per day. Three of the five days are concurrent with the SHD VSP monitoring. The trap is opened to passage each night.
[3] Fall Chinook run composition runs concurrent with SHD VSP monitoring and/or fall Chinook broodstock collection activities.
[4] 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. 2016 Columbia River at mouth salmon and steelhead returns – actual and forecast.

			2015 Forecast	2015 Return	2016 Forecast
Spring Chinook	**Upper Columbia**	**Total**	**27,500**	**37,500**	**27,600**
	Upper Columbia	*Wild*	*4,500*	*5,800*	*5,000*
Summer Chinook	**Upper Columbia**	**Total**	**73,000**	**126,900**	**93,300**
Fall Chinook	**Upriver Bright - URB**		**518,300**		
Sockeye	Wenatchee		106,700	139,900	57,800
	Okanogan		285,500	370,900	41,700
	Total Sockeye		**392,200**	**510,800**	**99,500**

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD

The Final 2016 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 2016 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

2016 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

2016 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

DRAFT
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.

<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.

APPENDIX T
MONITORING AND EVALUATION OF THE CHELAN AND GRANT COUNTY PUDS HATCHERY PROGRAMS 2015 ANNUAL REPORT

MONITORING AND EVALUATION OF THE CHELAN AND GRANT COUNTY PUDs HATCHERY PROGRAMS

2015 ANNUAL REPORT

September 1, 2016

Prepared by:

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Prepared for:

HCP Hatchery Committees and the PRCC Hatchery Sub-Committee

Wenatchee and Ephrata, WA

Citation: Hillman, T., M. Miller, M. Johnson, C. Moran, J. Williams, M. Tonseth, C. Willard, S. Hopkins, B. Ishida, C. Kamphaus, T. Pearsons, and P. Graf. 2016. Monitoring and evaluation of the Chelan and Grant County PUDs hatchery programs: 2015 annual report. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

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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 2015 to collect the data needed to monitor the effects 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: Bill Gale, USFWS; Craig Busack, Justin Yeager, and Lynn Hatcher, National Marine Fisheries Service (NMFS); Catherine Willard and Alene Underwood, Chelan PUD; Tom Scribner and Keely Murdoch, the Yakama Nation; Mike Tonseth, WDFW; Kirk Truscott, Colville Tribes; Mike Schiewe, Anchor QEA (former Chair); and Tracy Hillman, BioAnalysts (current Chair). This report also includes monitoring efforts funded by Grant County Public Utility District (Grant PUD). Grant PUD helps fund the spring and summer Chinook monitoring programs. 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. 2013). Technical aspects of the monitoring and evaluation program were developed by the Hatchery Evaluation Technical Team (HETT), which consisted of the following scientists: Carmen Andonaegui, WDFW; Matt Cooper, USFWS; Peter Graf, Grant PUD; Steve Hays, Chelan PUD; Tracy Hillman, BioAnalysts; Tom Kahler, Douglas PUD; Russell Langshaw, Grant PUD; Greg Mackey, Douglas PUD; Joe Miller, formerly Chelan PUD; Josh Murauskas, formerly Chelan 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 comprehensive reports.

Most of the work reported in this paper was funded by Chelan and Grant PUDs. 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 also 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 tenth 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 (Mackey et al. 2014; Pearsons et al. 2012).

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).

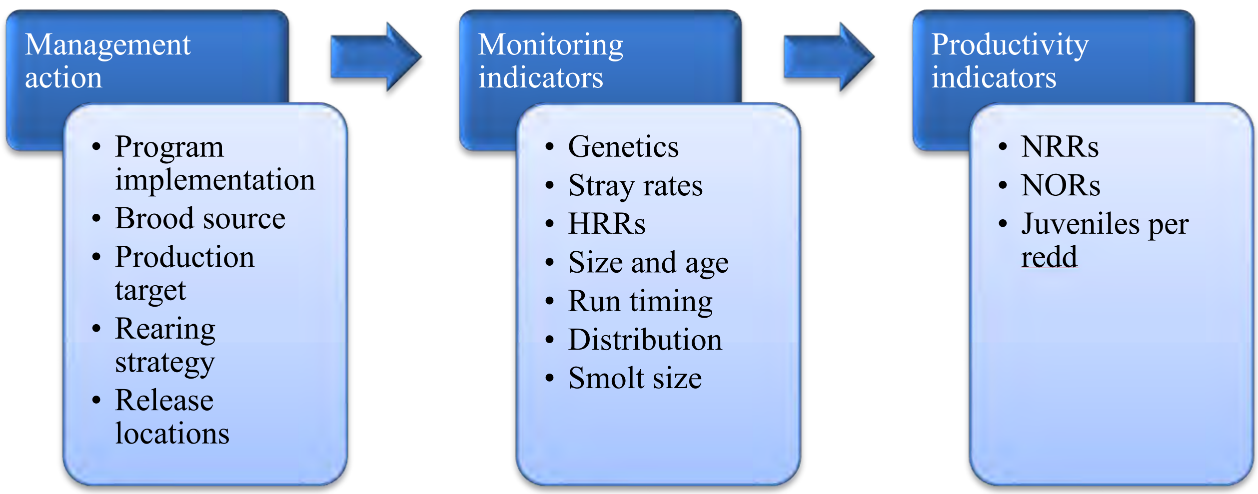

Figure 1.1. Relationship of indicators to the assessment of propagation programs. Management actions affect monitoring indicators, which influence productivity indicators. Monitoring indicators may be used to hypothesize the magnitude of influence on productivity.

Attending each objective is one or more testable hypotheses (see Hillman et al. 2013). 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. 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 1.2 shows the categories of indicators associated with each component of monitoring.

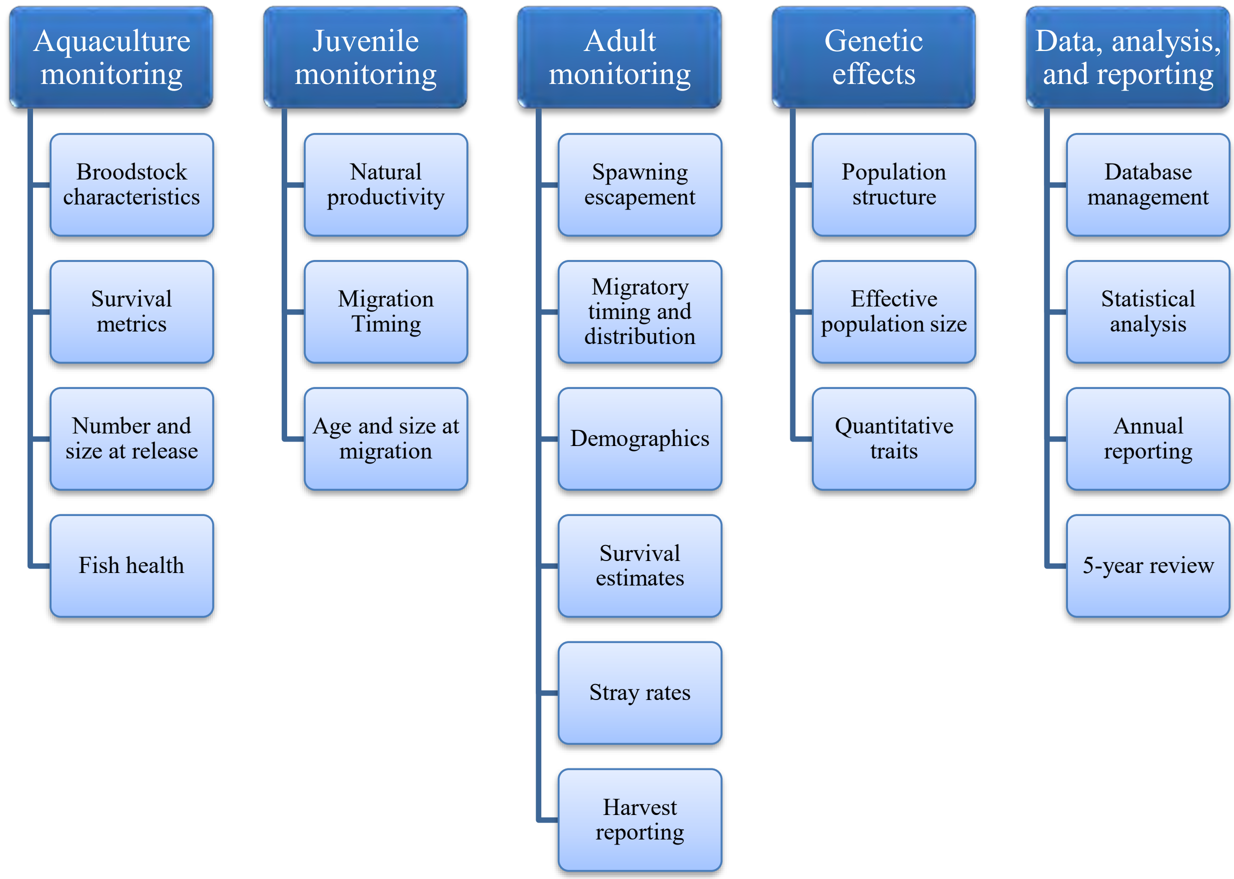

Figure 1.2. Overview of monitoring and evaluation plan categories and components (not including regional objectives).

Throughout each five-year monitoring period, annual reports will be generated that describe the monitoring and evaluation data collected during a specific year. This is the tenth annual report developed under the direction of the Hatchery Committees. The purpose of this report is to describe monitoring activities conducted in 2015. 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 reports). To the extent currently possible, we have included information collected before 2015.

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. 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).
2. ESA Section 10(a)(1)(A) Permit No. 18121, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered 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 2004).
3. ESA Section 10(a)(1)(A) Permit No. 18118, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered 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 2004).
4. ESA Section 10(a)(1)(A) Permit No. 18120, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered 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 2004).
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 endangered 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).

SECTION 2: SUMMARY OF METHODS

Sampling in 2015 followed the methods and protocols described in Hillman et al. (2013). 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. 2013).

2.1 Broodstock Collection and Sampling

Methods for collecting broodstock are described in the Annual Broodstock Collection Protocols (Appendix A in WDFW 2015). 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 2015 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 2015.

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
1-June	6	4					
8-June	10	6					
15-June	14	10					
22 June	20	16		48			
29 June	22	18	90	60	10	1	1
6 Jul	20	18	80	26	20	1	1
13 Jul	10	6	70	34	20	1	2
20 Jul			50	30	16	1	3
27 Jul			40	26	10	2	3
3 Aug			20	18	6	1	3
10 Aug				8	4	4	3
17 Aug				2	4	6	4
24 Aug					4	4	6
31 Aug					2	3	4
7 Sep					2	3	2
14 Sep						6	6
21 Sep						8	6
28 Sep						8	5
5 Oct						6	5
12 Oct						5	4
19 Oct						2	4
26 Oct						2	4
26 Oct						2	4
Total	**102**	**158**	**350**	**252**	**98**	**64**	**66**

[a] Chiwawa NOR spring Chinook (n = up to 80) were collected from the Chiwawa Weir with no specific weekly objectives generated, which is consistent with the Broodstock Collection Protocols. 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 13 July proportionate to run timing. For 2015, HOR Chiwawa spring Chinook were collected for the Nason spring Chinook safety net program.

Table 2.2. Biological and trapping assumptions associated with collecting broodstock for the Chelan and Grant PUD Hatchery Programs.[1]

Assumptions	Wenatchee Steelhead	Chiwawa Spring Chinook	Nason Spring Chinook (Conservation)	Nason Spring Chinook (Safety Net)	Wenatchee Summer Chinook	Chelan Falls Summer Chinook	Methow Summer Chinook
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	130 adults (not to exceed 33% of population)	80 adults (not to exceed 33% of NOR population)	70 adults (not to exceed 33% of population)	66 adults	252 adults (not to exceed 33% of the population)	350 adults	100 adults (not to exceed 33% of the population)
Trapping period	1 July-14 Nov	1 June – 15 July (Tumwater) 15 June-1 Aug (Chiwawa Weir)	1 June – 15 July	1 June – 15 July	22 June – 15 Sept	29 June – 15 Sep	29 June – 30 Aug
# days/week	5	7 (Tumwater) Not to exceed 15 cumulative trapping days (Chiwawa Weir)	7	7	5	7	3
# hours/day	24	24 (Tumwater) 24 up/24 down (Chiwawa Weir)	24	24	24	24	16
Broodstock composition	49% wild; 51% WxW (hatchery)	69% wild; 31% hatchery	100% wild	100% hatchery	100% wild	100% hatchery	100% wild
Trapping site	Dryden Dam for WxW hatchery; Tumwater for wild. (Tumwater	Tumwater Dam and Chiwawa Weir	Tumwater Dam	Tumwater Dam	Dryden Dam (Tumwater will be used if weekly quota not achieved at	Eastbank Outfall	Wells Dam east or west ladder

[1] Throughout this document, "HxH" refers to hatchery by hatchery crosses and "WxW" refers to wild by wild crosses.

Assumptions	Wenatchee Steelhead	Chiwawa Spring Chinook	Nason Spring Chinook (Conservation)	Nason Spring Chinook (Safety Net)	Wenatchee Summer Chinook	Chelan Falls Summer Chinook	Methow Summer Chinook
	will be used if weekly quota not achieved for WxW (hatchery) at Dryden Dam)				Dryden Dam)		

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 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. (2013). 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. (2013). 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. 2013).

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

Life stage	Standard survival rate (%)
Unfertilized egg-to-release	81

Nearly all hatchery fish from each stock were marked (adipose fin clip) or tagged (coded-wire tag) in 2015. Different combinations of marks and tags were used depending on the stock. In addition, Chelan PUD personnel PIT tagged 10,200 juvenile hatchery Chiwawa spring Chinook (5,100 WxW and 5,100 HxH Chinook) and 5,010 juvenile Nason Creek WxW spring Chinook; 23,216 Wenatchee steelhead (12,101 WxW steelhead and 111,115 HxH steelhead); and 10,000 Chelan River summer Chinook, 5,000 Methow (Carlton) summer Chinook, and 21,000 Wenatchee summer Chinook. 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. The goal of the program is that 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 met 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	10[a]
Methow Summer Chinook	200,000	163 (9.0)	45.4	15
Chelan Falls Summer Chinook (yearlings)	576,000	161 (9.0)	45.4	10[b]
Chiwawa Spring Chinook	144,026	155 (9.0)	37.8	18
Nason Spring Chinook	223,670	155 (9.0)	37.8	24
Wenatchee Steelhead	247,300	191 (9.0)	75.6	6

[a]An experimental release size of 30-45 grams (10-15 FPP) is in place for brood years 2012-2014.
[b]An experimental release size of 20-45 grams (10-22 FPP) is in place for brood years 2012-2014.

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. (2013).

A smolt trap was located on the Wenatchee River near the town of Cashmere at RM 8.3 (Lower Wenatchee Trap), in Nason Creek about 0.6 miles upstream from the mouth, in the White River, and in the Chiwawa River about 0.4 miles upstream from the mouth (Chiwawa Trap). All traps operated throughout the smolt migration period. The Chiwawa Trap operated between 25 February and 24 November 2015. The Nason Creek Trap operated from 1 March to 18 July and from 20 October through November in 2015. The White River trap operated from 1 March through November 2015. The Lower Wenatchee Trap operated between 30 January and 28 June 2015. 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 199 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).

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 smolt 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 of Chinook salmon 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 screw traps (e.g., fish passage during times when trapping is not possible).

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 2015.

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

Reach/stratum	River miles (RM)	Number of randomly selected sites
5	8.9-10.8	5
6	10.8-11.8	6
7	11.8-20.0	28
8	20.0-25.4	24
9	25.4-28.8	12
10	28.8-31.1	21
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	11
Unnamed stream on USGS map		
1	0.0-0.1	1
Big Meadow Creek		
1	0.0-1.0	14
Alder Creek		
1	0.0-0.1	2
Brush Creek		
1	0.0-0.1	4
Clear Creek		
1	0.0-0.1	4

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, 2015.

Sampling location	Target sample size		
	Wild spring Chinook	Wild steelhead	Wild Sockeye
Chiwawa Trap	2,500-8,000	500-2,000	NA
Nason Creek Trap	2,500-8,000	500-2,000	NA
Lower Wenatchee Trap	500-1,000	50-250	3,000-5,000
Chiwawa Remote Sampling	3,000	NA	NA
Nason Remote Sampling	3,000	NA	NA

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. Fecundity was estimated from females collected for broodstock using an electronic egg counter. 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. (2013). Information collected during spawning surveys included spawn time, redd distribution, 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.

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 (funded by BPA). 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.

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[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.

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
	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	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-Falls
White River	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 and index areas surveyed for summer Chinook redds in the Wenatchee River basin.

Code	Reach	River mile	Index/reference area (RM)
W1	Mouth to Sleepy Hollow Br	0.0-3.3	River Bend to Sleepy Hollow Br (1.7-3.3)
W2	Sleepy Hollow Br to L. Cashmere Br	3.3-9.5	L. Cashmere Br to Old Monitor Br (7.1-9.5)
W3	L. Cashmere Br to Dryden Dam	9.5-17.8	Williams Canyon to Dryden Dam (15.5-17.8)
W4	Dryden Dam to Peshastin Br	17.8-20.0	Dryden Dam to Peshastin Br (17.8-20.0)
W5	Peshastin Br to Leavenworth Br	20.0-23.9	Irrigation Flume to Leavenworth Br (22.8-23.9)
W6	Leavenworth Br to Icicle Rd Br	23.9-26.4	Icicle to Boat Takeout (24.5-25.6)
W7	Icicle Rd Br to Tumwater Dam	26.4-30.9	Icicle Br to Penstock Br (26.4-28.7)
W8	Tumwater Dam to Tumwater Br	30.9-35.6	Swiftwater Campgd to Tumwater Br (33.5-35.6)
W9	Tumwater Br to Chiwawa River	35.6-47.9	Swing Pool to Railroad Tunnel (36.7-39.3)
W10	Chiwawa River to Lake Wenatchee	47.9-54.2	Swamp to Bridge (52.7-53.6)

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, 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
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. Fish per redd ratios were estimated as the ratio of males to females sampled at broodstock collection sites and monitoring sites (e.g., Dryden Dam). 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[3] 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. 2013) 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. (2013) and in "White Papers" developed by the Hatchery

[3] Adult sockeye that were tagged at Bonneville Dam and detected at Tumwater Dam were included in the mark-recapture analyses.

Evaluation Technical Team (HETT) (see Appendices in Hillman et al. 2012). The abundance of 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	66	125,000	6.7
Wenatchee Summer Chinook	278	500,001	5.7
Methow Summer Chinook	100	200,000	3.0
Wenatchee Steelhead	130	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 2009.

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 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. Wild by wild (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 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.

Prior to 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, spawning has occurred at Eastbank Fish Hatchery. 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 HxW crosses have occurred 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 2014 and 2015 brood years of Wenatchee steelhead, which were collected at Dryden and Tumwater dams. The 2014 brood begins the tracking of the life cycle of steelhead released in 2015. The 2015 brood is included because juveniles from this brood are still maintained within the hatchery.

Origin of Broodstock

A total of 135 Wenatchee steelhead from the 2013 return (2014 brood) were collected at Dryden and Tumwater dams (Table 3.1). About 48% of these were natural-origin (adipose fin present, no CWT, and no elastomer tags) fish and the remaining 52% were hatchery-origin (elastomer tagged and/or CWT and adipose fin absent) adults. Origin was determined by analyzing scales and/or otoliths. The total number of steelhead spawned from the 2014 brood was 132 adults (48.5% natural-origin and 51.5% hatchery-origin).

A total of 136 steelhead were collected from the 2014 return (2015 brood) at Dryden and Tumwater dams; 76 (56%) natural-origin (adipose fin present, no CWT, and no elastomer tags) and 60 (44%) hatchery-origin (elastomer tagged and adipose present or CWT and adipose fin present) adults. A total of 110 steelhead were spawned; 52.7% were natural-origin fish and 47.3% were hatchery 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 that died before spawning, and numbers of steelhead spawned, 1998-2015. Unknown origin fish (i.e., undetermined by scale analysis, no elastomer, CWT, or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish killed at spawning and surplus broodstock.

Brood year	Wild steelhead					Hatchery steelhead					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1998	35	0	0	35	0	43	4	2	37	0	72
1999	58	5	1	52	0	67	1	2	64	0	116
2000	39	2	1	36	0	101	9	12	60	20	96
2001	64	5	8	51	0	114	5	6	103	0	154
2002	99	0	1	96	2	113	1	0	64	48	160
2003	63	10	4	49	0	92	2	0	90	0	139
2004	85	3	0	75	7	132	1	0	61	70	136
2005	95	8	0	87	0	114	7	1	104	2	191
2006	101	5	0	93	3	98	0	0	69	29	162
2007	79	0	2	76	1	97	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	Prespawn loss[a]	Mortality	Number spawned	Number released	
2008	104	0	3	77	22	107	0	28	54	25	131
2009	101	2	0	86	13	107	1	4	73	29	159
2010	106	1	1	96	8	105	2	23	75	5	171
2011	104	8	1	91	4	104	13	2	70	0	161
Average[b]	***81***	***4***	***2***	***71***	***4***	***100***	***3***	***7***	***70***	***18***	***142***
Median	***95***	***3***	***1***	***77***	***2***	***105***	***2***	***2***	***67***	***13***	***147***
2012	63	3	0	59	1	66	0	1	65	0	124
2013	63	8	1	49	5	84	9	7	68	0	117
2014	65	0	1	64	0	70	0	2	68	0	132
2015	76	5	0	58	13	60	0	8	52	0	110
Average[c]	***67***	***4***	***1***	***58***	***5***	***70***	***2***	***5***	***63***	***0***	***121***
Median	***64***	***4***	***1***	***59***	***3***	***68***	***0***	***5***	***67***	***0***	***121***

[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 2014 brood year, both natural-origin and hatchery steelhead consisted primarily of 2-salt adults (Table 3.2). For the 2015 brood year, natural-origin steelhead consisted primarily of 2-salt adults and hatchery steelhead consisted almost equally of 1 and 2-salt adults (Table 3.2).

Table 3.2. Percent of hatchery and wild steelhead of different ages (saltwater ages) collected from broodstock, 1998-2015.

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
2005	Wild	22.1	77.9	0.0

Brood year	Origin	Saltwater age		
		1	2	3
	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	50.8	49.2	0.0
Average	***Wild***	***44.3***	***54.7***	***1.0***
	Hatchery	***52.2***	***47.8***	***0.0***
Median	***Wild***	***41.6***	***55.0***	***0.5***
	Hatchery	***48.2***	***51.9***	***0.0***

There was little difference between mean lengths of hatchery and natural-origin steelhead in the 2014 and 2015 brood years (Table 3.3). Natural-origin fish were on average 1 to 3 cm larger than hatchery-origin fish of the same age.

Table 3.3. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, 1998-2015; 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	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
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	-
	Hatchery	59	30	3	76	29	5	-	0	-
Average	***Wild***	***63***	***33***	***5***	***76***	***40***	***5***	***78***	***1***	***1***
	Hatchery	***61***	***43***	***4***	***73***	***40***	***4***	***-***	***0***	***-***

Sex Ratios

Male steelhead in the 2014 brood year made up about 49% of the adults collected, resulting in an overall male to female ratio of 0.96:1.00 (Table 3.4). For the 2015 brood year, males made up about 50% of the adults collected, resulting in an overall male to female ratio of 1.00:1.00. On average (1998-2015), 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, 1998-2015. 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
2015	34	42	0.81:1.00	34	26	1.31:1.00	1.00:1.00
Total	***620***	***778***	***0.80:1.00***	***880***	***796***	***1.11:1.00***	***0.95:1.00***

Fecundity

Fecundities for Wenatchee steelhead in brood years 2014 and 2015 averaged 5,839 and 5,895 eggs per female, respectively (Table 3.5). Mean fecundities for the 2014 and 2015 brood years were also greater than the 5,678 eggs per female assumed in the broodstock protocol.

Table 3.5. Mean fecundity of wild, hatchery, and all female steelhead collected for broodstock, 1998-2015.

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

Brood year	Mean fecundity		
	Wild	Hatchery	Total
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
Average	***5,831***	***5,762***	***5,819***
Median	***5,804***	***5,644***	***5,807***

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%. In 2012, the egg take target was reduced to 305,309, which is needed 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 3.6). Since 2011, the target has been reached or exceeded 100% of the time (Table 3.6).

Table 3.6. Numbers of eggs taken from steelhead broodstock, 1998-2015.

Brood year	Number of eggs taken
1998	224,315
1999	303,083
2000	280,872
2001	549,464
2002	503,030
2003	532,708
2004	408,538
2005	672,667
2006	546,382

Brood year	Number of eggs taken
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
Average (2012-present)	***357,691***
Median (2012-present)	***355,550***

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 2014. In March 2015, about 28,000 HxH steelhead were transferred to Blackbird Pond near Leavenworth for acclimation on Wenatchee River water. Fish were acclimated for 41d before a volitional release was initiated on 21 April. The remainder stayed at the Chiwawa Acclimation Facility until they were volitionally and forced released from the facility during late April to early-May.

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 3.7).

Table 3.7. Water source and mean acclimation period for Wenatchee steelhead, brood years 1998-2015.

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
		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

Brood year	Release year	Parental origin	Water source	Number of Days
		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
		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

Brood year	Release year	Parental origin	Water source	Number of Days
		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	Wenatchee	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	Wenatchee	168-171

[a] Steelhead over wintered 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.

The release of 2014 brood Wenatchee steelhead achieved 107% of the 247,300 target goal with about 264,758 smolts released into the Wenatchee and Chiwawa rivers and Nason Creek (Table 3.8). Distribution of juvenile steelhead released in each of the three streams was determined by the mean proportion of steelhead redds in each basin. About 32.2% and 13.2% 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 (10.6%) and the Wenatchee River upstream from the dam (43.9%).

Table 3.8. Numbers of steelhead smolts released from the hatchery, brood years 1998-2014. 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
Average (2011-present)		***237,499***
Median (2011-present)		***239,420***

Numbers marked

Wenatchee hatchery steelhead from the 2014 brood were marked with coded wire tags (CWT) in the snout. About 49.4% of the juveniles released were also adipose fin clipped (Table 9).

Table 3.9. Release location and marking scheme for the 1998-2014 brood Wenatchee steelhead.

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	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

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	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
	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

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	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
	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

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	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
	Nason Creek	H x H	0.996	AD/CWT	0.996	29,931

Numbers PIT tagged

Table 3.10 summarizes the number of hatchery steelhead of different parental origins that have been PIT-tagged and released into the Wenatchee River basin.

Table 3.10. Summary of PIT-tagging activities for Wenatchee hatchery steelhead, brood years 2006-2014.

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

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
	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 Brood Wenatchee WxW Summer Steelhead—A total of 10,100 Wenatchee WxW summer steelhead were PIT tagged at Chelan Hatchery on 8-15 September 2015. These fish were tagged in raceways #2 through #6. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 89 mm in length and 8.5 g at time of tagging.

In March 2016, an additional 2,001 WxW summer steelhead were tagged at the Chiwawa Acclimation Facility. 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 163-168 mm in length and 53.0-57.0 g at time of tagging.

2015 Brood Wenatchee HxH Summer Steelhead—A total of 11,115 Wenatchee HxH summer steelhead were tagged PIT at Eastbank Hatchery on 31 August – 28 September 2015. These fish were tagged in raceway #3. Fish were not fed during tagging or for two days before and after tagging. Fish tagged in early September averaged 75 mm in length and 5.2 g. Those tagged on 28 September averaged 81 mm in length and 7.3 g.

Fish size and condition at release

With the exception of the Blackbird Pond release, all 2014 brood steelhead were trucked and released as yearling smolts in April and May 2015. The Blackbird Pond group was released volitionally beginning on 21 April. Both WxW and HxH fish did not meet the targets for length, weight, or coefficient of variation (CV) for fork length (Table 3.11). The HxH group was combined with the WxW group in Pond 2 once they were transferred to Chiwawa Acclimation Facility. The HxH fish were smaller than the WxW fish, both at transfer and at release.

Table 3.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of steelhead smolts released from the hatchery, brood years 1998-2014. Size targets are provided in the last row of the table.

Brood year	Release year	Parental origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
1998	1999	H x H	201	11.1	92.3	5
		H x W	190	12.8	76.9	6
		W x W	173	12.0	55.3	8
1999	2000	H x H	181	8.9	70.6	6
		H x W	187	7.2	75.3	6
		W x W	184	11.3	71.5	6
2000	2001	H x H	218	15.2	122.4	4
		H x W	209	10.6	107.5	4
		W x W	205	10.7	100.9	5
2001	2002	H x H	179	17.4	67.0	7
		H x W	192	15.6	82.8	6
		W x W	206	11.6	102.6	4
2002	2003	H x H	194	13.1	83.0	6
		H x W	191	13.0	77.4	6
		W x W	180	19.1	70.3	7
2003	2004	H x H	191	14.4	73.1	6
		H x W	199	12.9	83.9	5
		W x W	200	11.1	90.1	5
2004	2005	H x H	204	11.3	87.2	6
		H x W	202	13.5	71.9	5
		W x W	198	12.4	76.6	6
2005	2006	H x H	215	12.6	116.6	4
		H x W	198	11.8	86.3	5
		W x W	189	15.4	55.3	6
2006	2007	H x H (early)	213	12.1	109.6	4
		H x W (late)	186	11.8	68.3	7
		W x W	178	11.1	58.6	8

Brood year	Release year	Parental origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2007	2008	H x W (early)	192	17.4	77.1	6
		H x W (late)	179	19.3	63.8	7
		W x W	183	12.3	62.8	7
2008	2009	H x W (early)	184	11.6	68.0	7
		H x W (late)	186	11.6	73.5	6
		W x W	181	13.0	59.7	8
2009	2010	H x W (early)	197	11.3	84.2	5
		H x W (late)	192	11.1	72.7	6
		W x W	190	9.6	70.5	6
2010	2011	H x H	183	14.1	68.9	4
		W x W	188	10.5	68.1	7
2011	2012	H x H	NA	NA	NA	NA
		W x W	156	17.1	45.2	10
2012	2013	H x H / W x W	150	16.1	40.8	11
		H x H / W x W	157	16.4	45.0	10
		W x W	156	18.7	49.0	9
2013	2014	H x H / W x W	157	14.5	49.4	9
		H x H	127	16.2	26.8	17
		W x W	162	20.4	55.8	8
2014	2015	H x H / W x W	152	15.4	40.9	11
		H x H	145	13.5	36.6	12
		W x W	162	15.3	50.6	9
Targets			***191***	***9.0***	***75.6***	***6***

Survival Estimates

Overall survival of Wenatchee steelhead (WxW and HxH) from green (unfertilized) egg to release was below the standard set for the program. This is largely because of lower unfertilized egg to eyed egg survival, and 100 days after ponding survival (Table 3.12).

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 3.12. Hatchery life-stage survival rates (%) for steelhead, brood years 1998-2014. 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
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
Average	***94.0***	***98.3***	***79.6***	***92.6***	***96.8***	***94.2***	***91.2***	***97.5***	***67.2***
Median	***96.3***	***100.0***	***80.3***	***93.0***	***96.6***	***94.6***	***90.1***	***99.1***	***67.2***
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 2014 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. Volitional and non-migratory released fish were released into Nason Creek, Chiwawa River, and the Wenatchee River. The 2014 WxW Wenatchee steelhead were treated for bacterial cold-water disease at Chelan Hatchery in August 2014. The mixed population of WxW and HxH 2014 Wenatchee steelhead was also treated for bacterial cold-water disease in February 2015 at Chiwawa Acclimation Facility.

3.4 Natural Juvenile Productivity

During 2015, 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 10,208 (±11%) age-0 (<100 mm) and 754 (±26%) age-1+ (100-200 mm)[4] steelhead/rainbow were estimated in the Chiwawa River basin in August 2015 (Table 3.13 and 3.14). During the survey period 1992-2015, 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 3.13 and 3.14; Figure 3.1). The number of age-1+ steelhead/rainbow counted in 2015 was the lowest number recorded during the more than 20-year survey period. Numbers of all fish counted in the Chiwawa River basin are reported in Appendix A.

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 3.13. Total numbers of age-0 steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2015; 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**

4 A steelhead/rainbow trout larger than 200 mm (8 in) was considered a resident trout.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
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**
Average	***11,153***	***49***	***1,231***	***694***	***16***	***2,160***	***84***	***58***	***14***	***15,171***
Median	***8,464***	***0***	***1,090***	***641***	***0***	***1,987***	***58***	***54***	***0***	***14,073***

Table 3.14. Total numbers of age-1+ steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2015; 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**
Average	***7,450***	***38***	***353***	***254***	***0***	***407***	***2***	***0***	***2***	***8,442***

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
Median	***7,200***	***0***	***257***	***183***	***0***	***210***	***0***	***0***	***0***	***8,448***

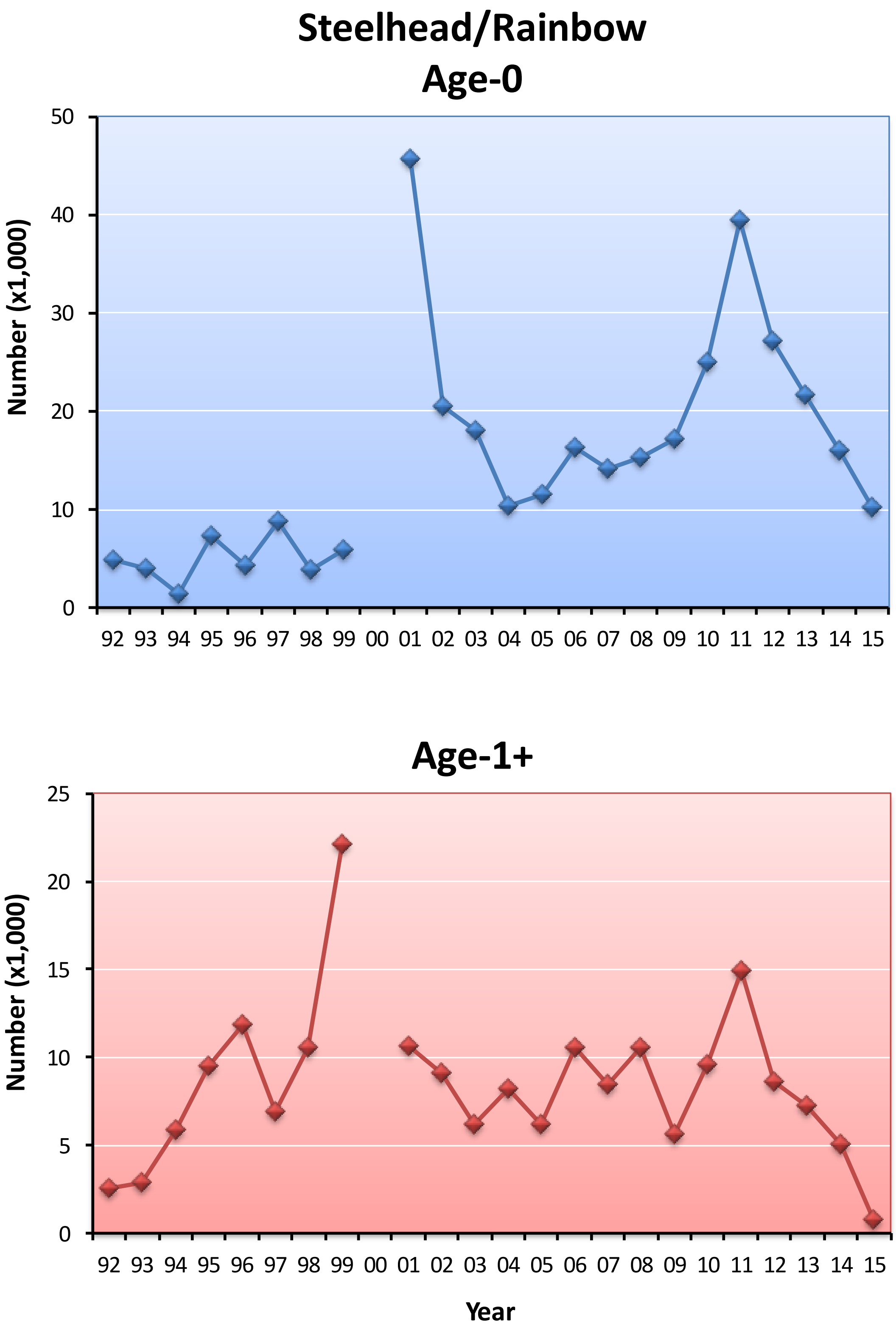


Figure 3.1. Numbers of subyearling and yearling steelhead/rainbow trout within the Chiwawa River basin in August 1992-2015; ND = no data.

Emigrant and Smolt Estimates

Numbers of steelhead smolts and emigrants were estimated at the Chiwawa, Nason, and Lower Wenatchee traps in 2015.

Chiwawa Trap

The Chiwawa Trap operated between 25 February and 24 November 2015. During the trapping period, the trap was inoperable for 29 days due to high or low river discharge, debris, and major hatchery releases. The trap operated in two different positions based on season and river discharge; lower position until 30 June and an upper position after 1 July. Monthly captures of all fish collected at the Chiwawa Trap are reported in Appendix B.

A total of 259 wild steelhead/rainbow smolts and transitionals, 3,151 hatchery smolts, transitionals, and parr, and 3,004 wild parr and fry were captured at the Chiwawa Trap. Most (77%) of the hatchery steelhead were collected in May, while most (86%) of the wild steelhead smolts were captured in April and May (Figure 3.2). Although steelhead/rainbow parr and fry emigrated throughout the sampling period, peaks in emigration were observed in May through June, August, and October through November (Figure 3.2). Of the total number of wild steelhead captured, 92% were classified as parr and fry. Because of low and inconsistent capture rates, no mark-recapture efficiency trials could be conducted with steelhead/rainbow at the Chiwawa Trap to estimate steelhead emigration.

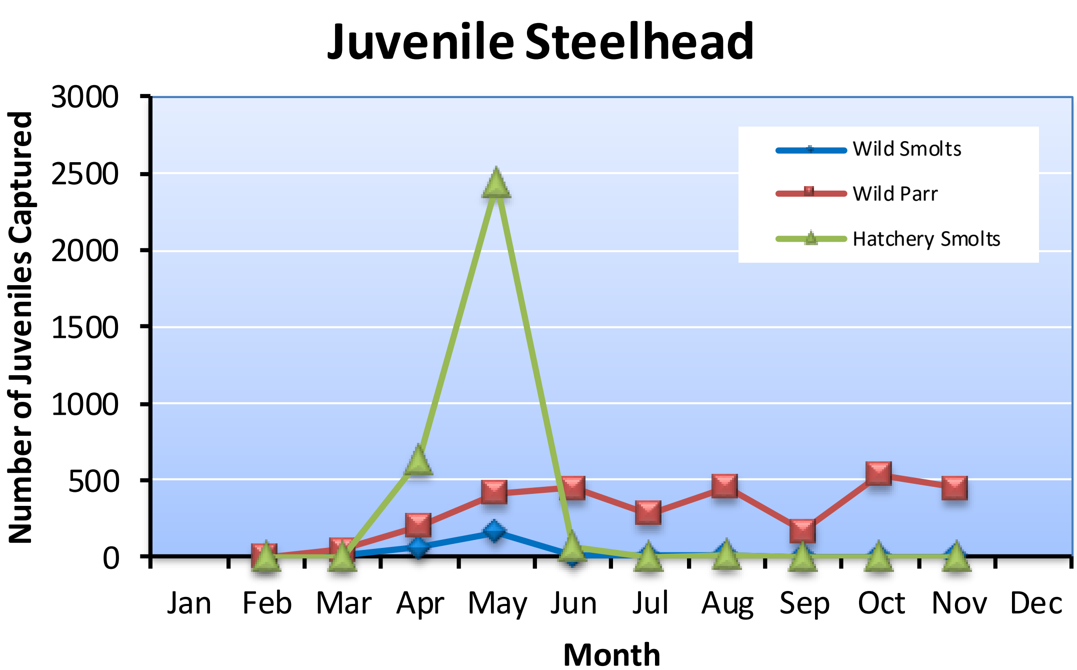


Figure 3.2. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Chiwawa Trap, 2015.

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2015. During the nine-month sampling period the trap was inoperable for 105 days because of low discharge and ice accumulation. The trap captured a total of 12 wild steelhead smolts, 448 hatchery steelhead smolts, 388 wild steelhead parr, and 30 wild steelhead fry. The estimated wild steelhead emigration for brood year 2012 was 25,566 (± 6,020). Egg-to-emigrant survival rate for brood year 2012 steelhead was 3.0% and the egg-to-emigrant survival rate for brood year 2011 was 0.9%. Productivity, measured as emigrants-per-redd, was 162.

Lower Wenatchee Trap

The Lower Wenatchee Trap operated between 30 January and 28 June 2015. During that time period the trap was inoperable for five days because of too high and low river discharge, debris, elevated river temperatures, and large hatchery releases. During the sampling period, a total of 100 wild steelhead parr and fry, 231 wild steelhead smolts, and 2,288 hatchery steelhead were captured at the trap. Because of the low numbers of steelhead encountered daily 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 that 8,632 (±45,053) steelhead emigrated out of the Wenatchee during the trapping season. Figure 3.3 shows the monthly captures of steelhead collected at the Lower Wenatchee Trap. All fish captured in the trap are reported in Appendix B.

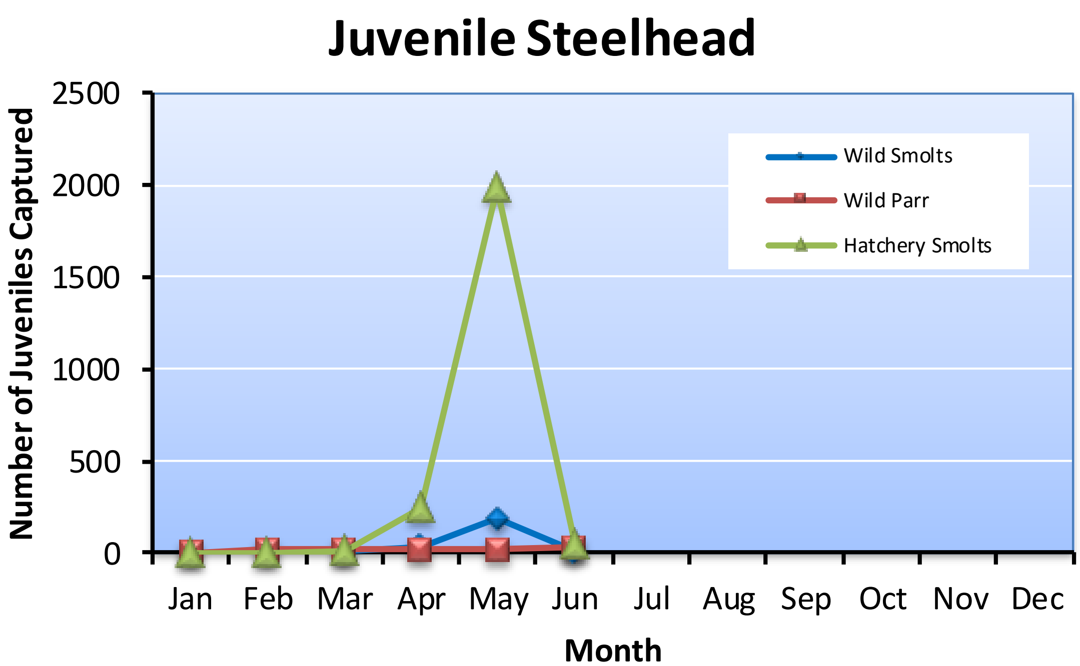


Figure 3.3. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Lower Wenatchee Trap, 2015.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 2,476 juvenile steelhead/rainbow trout (2,474 wild and two hatchery) were PIT tagged and released in 2015 in the Wenatchee River basin (Table 3.15a). Most of these were tagged at the Chiwawa Trap. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 3.15a. Numbers of wild and hatchery steelhead/rainbow trout that were captured, tagged, and released at different locations within the Wenatchee River basin, 2015. Numbers of fish that died or shed tags are also given.

Sampling Location	Species and Life Stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
Chiwawa Trap	Wild Steelhead	3,262	6	1,795	23	0	1,795	0.69
	Hatchery Steelhead	3,152	2	1	0	0	1	0.00
	Total	**6,414**	**8**	**1,796**	**23**	**0**	**1,796**	**0.36**
Nason Creek Trap	Wild Steelhead	444	1	383	2	1	383	0.45
	Hatchery Steelhead	448	0	0	1	0	0	0.22
	Total	**892**	**1**	**383**	**3**	**1**	**383**	**0.34**
White River Trap	Wild Steelhead	6	0	6	0	0	6	0.00
	Hatchery Steelhead	0	0	0	0	0	0	--
	Total	**6**	**0**	**6**	**0**	**0**	**6**	**0.00**
Lower Wenatchee Trap	Wild Steelhead	311	0	290	2	0	290	0.64
	Hatchery Steelhead	2,288	0	1	0	0	1	0.00
	Total	**2,599**	**0**	**291**	**2**	**0**	**291**	**0.08**
Total:	**Wild Steelhead**	**4,023**	**7**	**2,474**	**27**	**1**	**2,474**	**0.67**
	Hatchery Steelhead	**5,888**	**2**	**2**	**1**	**0**	**2**	**0.02**
Grand Total:		**9,911**	**9**	**2,476**	**28**	**1**	**2,476**	**0.28**

Numbers of steelhead/rainbow PIT-tagged and released as part of CSS and PUD studies during the period 2006-2015 are shown in Table 3.15b.

Table 3.15b. Summary of the numbers of wild and hatchery steelhead/rainbow trout that were tagged and released at different locations within the Wenatchee River basin, 2006-2015.

Sampling Location	Species and Life Stage	Numbers of PIT-tagged steelhead/rainbow released									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chiwawa Trap	Wild Steelhead	1,366	832	1,431	1,127	930	1,012	1,011	1,228	1,186	1,795
	Hatchery Steelhead	0	3	2	1	2	1	2	0	3	1
	Total	**1,366**	**835**	**1,433**	**1,128**	**932**	**1,013**	**1,013**	**1,228**	**1,189**	**1,796**
Chiwawa River (Angling or Electrofishing)	Wild Steelhead	33	167	94	35	99	0	0	0	23	0
	Hatchery Steelhead	1	47	35	43	64	0	0	0	0	0
	Total	**34**	**214**	**129**	**78**	**163**	**0**	**0**	**0**	**23**	**0**
Upper Wenatchee Trap[1]	Wild Steelhead	21	37	24	46	69	82	70	43	0	0
	Hatchery Steelhead	0	0	0	0	0	0	0	0	0	0
	Total	**21**	**37**	**24**	**46**	**69**	**82**	**70**	**43**	**0**	**0**
	Wild Steelhead	1,167	1,335	2,154	753	1,557	805	1,087	1,998	838	383

Sampling Location	Species and Life Stage	Numbers of PIT-tagged steelhead/rainbow released									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Nason Creek Trap	Hatchery Steelhead	0	0	0	0	0	0	538	0	0	0
	Total	**1,167**	**1,335**	**2,154**	**753**	**1,557**	**805**	**1,625**	**1,998**	**838**	**383**
Nason Creek (Angling or Electrofishing)	Wild Steelhead	174	452	255	459	318	0	0	0	0	0
	Hatchery Steelhead	26	75	87	197	32	0	0	0	0	0
	Total	**200**	**527**	**342**	**656**	**350**	**0**	**0**	**0**	**0**	**0**
White River Trap	Wild Steelhead	0	0	0	12	10	5	5	6	5	6
	Hatchery Steelhead	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**12**	**10**	**5**	**5**	**6**	**5**	**6**
Upper Wenatchee (Angling or Electrofishing)	Wild Steelhead	413	1,001	21	7	30	0	0	0	0	0
	Hatchery Steelhead	2	64	26	23	9	0	0	0	0	0
	Total	**415**	**1,065**	**47**	**30**	**39**	**0**	**0**	**0**	**0**	**0**
Middle Wenatchee (Angling or Electrofishing)	Wild Steelhead	0	0	981	867	1,517	0	0	850	0	0
	Hatchery Steelhead	0	0	11	5	57	0	0	2	0	0
	Total	**0**	**0**	**992**	**872**	**1,574**	**0**	**0**	**852**	**0**	**0**
Lower Wenatchee (Angling or Electrofishing)	Wild Steelhead	0	0	102	69	0	0	0	0	0	0
	Hatchery Steelhead	0	0	10	9	0	0	0	0	0	0
	Total	**0**	**0**	**112**	**78**	**0**	**0**	**0**	**0**	**0**	**0**
Peshastin Creek (Angling or Electrofishing)	Wild Steelhead	0	0	0	92	307	0	0	0	0	0
	Hatchery Steelhead	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**92**	**307**	**0**	**0**	**0**	**0**	**0**
Lower Wenatchee Trap	Wild Steelhead	131	461	285	227	465	0	0	613	133	290
	Hatchery Steelhead	0	0	0	1	0	0	0	0	4	1
	Total	**131**	**461**	**285**	**228**	**465**	**0**	**0**	**613**	**137**	**291**
Total:	**Wild Steelhead**	**3,305**	**4,285**	**5,347**	**3,694**	**5,302**	**1,904**	**2,173**	**4,738**	**2,185**	**2,474**
	Hatchery Steelhead	**29**	**189**	**171**	**279**	**164**	**1**	**540**	**2**	**7**	**2**
Grand Total:		**3,334**	**4,474**	**5,518**	**3,973**	**5,466**	**1,905**	**2,713**	**4,740**	**2,192**	**2,476**

[1] 2013 was the last year that the Upper Wenatchee Trap operated.

3.5 Spawning Surveys

Surveys for steelhead redds were conducted during March through early June, 2015, 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 D and Truscott et al. 2015 for details).

Redd Counts

A total of 249 steelhead redds were counted in the Wenatchee River and the lower portions of select tributaries in 2015 (Table 3.16). 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 D). Thus, evaluation of trends in redd counts is appropriate only before 2014.

Table 3.16. Numbers of steelhead redds estimated within different streams/watersheds within the Wenatchee River basin, 2001-2015; NS = not surveyed. Redd counts from 2004-2013 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.

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**
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**

[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 D).

Redd Distribution

Steelhead redds were not evenly distributed among survey reaches on the Wenatchee River in 2015 (Table 3.17). About 78.1% of the spawning in the Wenatchee River occurred upstream from Tumwater Dam (Table 3.17).

Table 3.17. Numbers and percentages of steelhead redds counted within different reaches on the Wenatchee River during March through early June, 2015; CV = coefficient of variation.

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	NA	0.0
Wenatchee 2 (W2)	Index	2	3	1.50	1.0

Reach	Reach type	Number of redds counted	Expanded redd counts		Percent of redds within stream/watershed
			Estimated	CV	
Wenatchee 3 (W3)	Non-index	1	2	0.30	0.6
Wenatchee 4 (W4)	Non-index	0	0	NA	0.0
Wenatchee 5 (W5)	Non-index	5	10	0.22	3.2
Wenatchee 6 (W6)	Index	54	53	0.88	17.0
Wenatchee 6 (W6)	Non-index	0	0	NA	0.0
Wenatchee 7 (W7)	NS	NS	NS	NS	NS
Wenatchee 8 (W8)	Index	9	10	0.95	3.2
Wenatchee 9 (W9)	Index	81	102	0.91	32.8
Wenatchee 9 (W9)	Non-index	4	6	0.15	1.9
Wenatchee 10 (W10)	Index	99	120	0.65	38.6
Wenatchee 10 (W10)	Non-index	3	5	0.13	1.6
Total		**258**	**311**	**0.42**	**100.0**

Spawn Timing

Steelhead began spawning during the first week of March in the Wenatchee River. Spawning activity appeared to begin once the mean daily stream temperature reached about 5.5ºC and was observed in water temperatures ranging from 3.7-8.8ºC. Steelhead spawning peaked during the third week of April in the Wenatchee River (Figure 3.4).

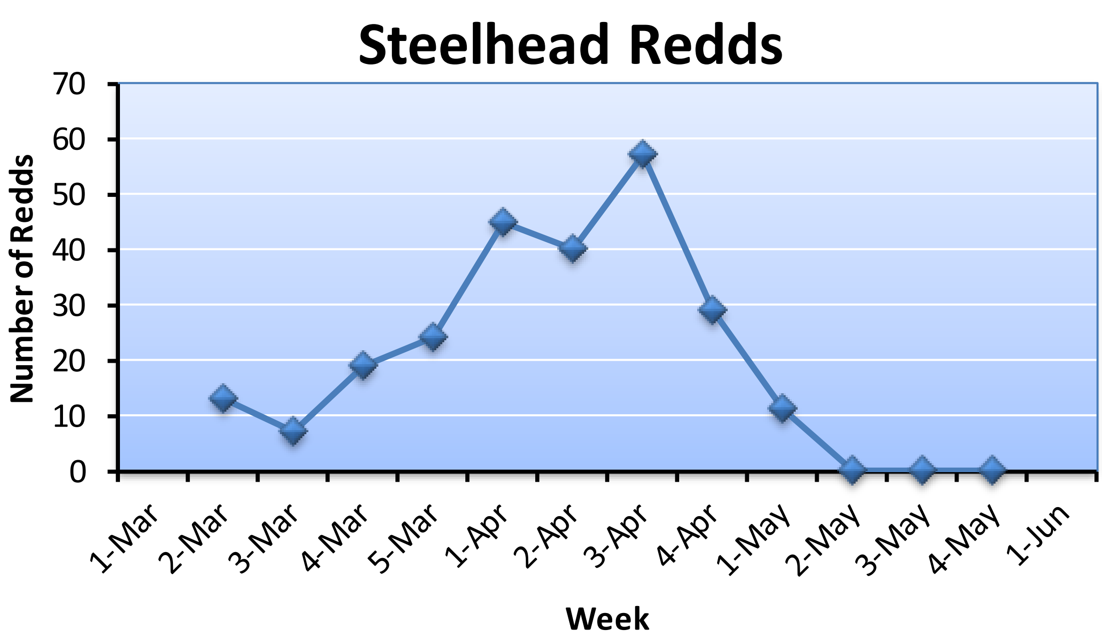


Figure 3.4. Numbers of steelhead redds counted during different weeks on the Wenatchee River, March through early June 2015.

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). Beginning in 2014, escapement in tributaries was estimated using PIT-tag mark-recapture techniques (Truscott et al. 2015; Table 3.18), while observer efficiency expanded redd counts were used to estimate escapement in the mainstem Wenatchee River (Appendix D). Total redd counts were also used to estimate escapement in the lower portions of the main tributaries (downstream from the PIT interrogation sites).

Table 3.18. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within tributaries of the Wenatchee River, brood year 2015. Escapement estimates were based on PIT-tag mark-recapture techniques (Truscott et al. 2015). CV = coefficient of variation and NA = no available.

Tributary	Natural-origin steelhead		Hatchery-origin steelhead	
	Estimate	CV	Estimate	CV
Mission Creek	71	0.28	23	0.49
Peshastin Creek	206	0.16	40	0.37
Chumstick Creek	38	0.39	0	NA
Icicle Creek	83	0.25	52	0.32
Chiwaukum Creek	48	0.34	12	0.72
Chiwawa River	168	0.21	168	0.23
Nason Creek	237	0.15	68	0.29

The estimated fish per redd ratio for steelhead in 2015 was 1.78 (Table 3.19). Multiplying this ratio by the total number of redds estimated in the Wenatchee River upstream from Tumwater Dam resulted in a spawning escapement of 422 steelhead (Table 3.19). Adding this estimate to the mark-recapture estimates of tributary escapement (248 hatchery + 453 wild = 701) indicates that 1,123 (CV = 0.299) escaped to spawning areas upstream from Tumwater Dam in 2015. The estimated spawning escapement is greater than fish observed at Tumwater Dam, and may be attributed to error bounds of the redd expansion and tributary estimate (see Appendix D).

Table 3.19. 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

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		
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***
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
Average[c]	***937***	***1.74***	***178***	***5.5***	***183.5***	***981***	***1.04***
Median	***937***	***1.74***	***178***	***5.5***	***183.5***	***981***	***1.04***

[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. Prior to 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 are tagged with CWTs. In addition, about 18,808 of the 2014 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 3.5). Most steelhead passed Tumwater Dam during July through October and April. The highest proportion of both wild and hatchery fish migrated during October.

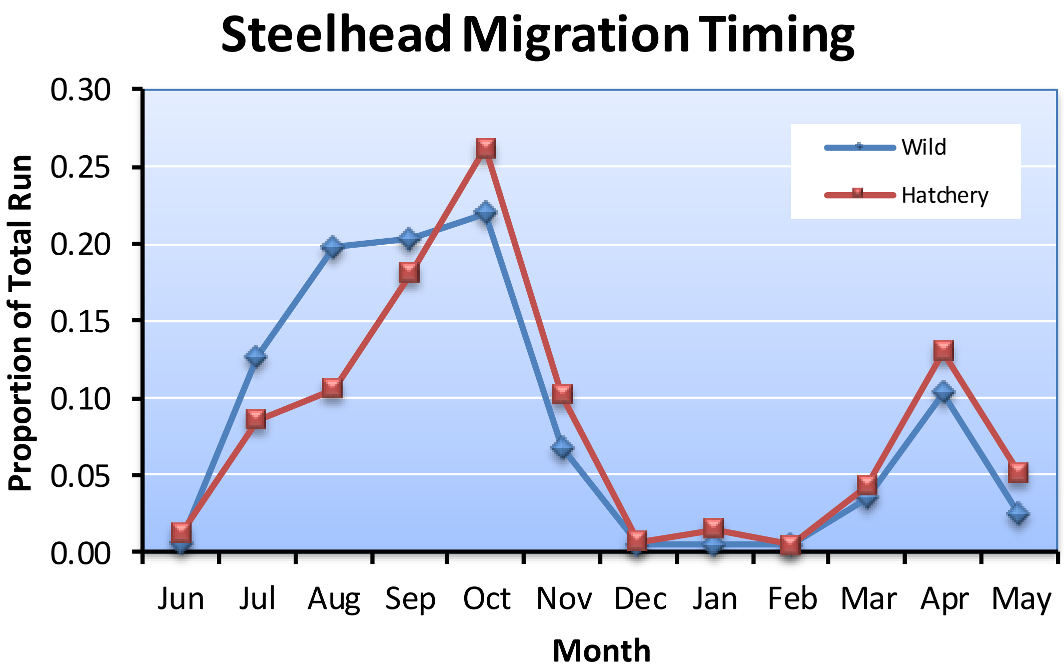


Figure 3.5. Proportion of wild and hatchery steelhead sampled at Tumwater Dam for the combined brood years of 1999-2015.

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.

Overall, there was little difference in migration timing of wild and hatchery fish at Tumwater Dam (Table 3.20a and b; Figure 3.5). For both the summer-autumn and winter-spring migration periods, wild and hatchery steelhead arrived at the dam during the same week. The mean and median migration timing for wild and hatchery steelhead were also similar. However, during the summer-autumn migration period, on average, wild steelhead appeared to end their migration about one-two weeks earlier than hatchery steelhead.

Table 3.20a. 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), 1999-2015. The average week is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. The presence of eroded fins and/or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater Dam. 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	1112	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	1133	13	16	19	16	229
2010	Wild	31	37	45	38	648	11	15	18	15	171
	Hatchery	31	40	45	40	1207	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	1431	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
Average	***Wild***	***30***	***36***	***43***	***37***	***554***	***12***	***15***	***18***	***15***	***117***
	Hatchery	***30***	***38***	***44***	***38***	***655***	***12***	***16***	***18***	***15***	***218***
Median	***Wild***	***30***	***36***	***43***	***37***	***642***	***13***	***15***	***18***	***15***	***108***
	Hatchery	***31***	***39***	***44***	***38***	***610***	***12***	***16***	***18***	***16***	***214***

Table 3.20b. 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), 1999-2015. The average month is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. The presence of eroded fins and/or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater Dam. 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	1112	3	4	5	4	377
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

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
2009	Wild	7	9	11	9	338	3	4	5	4	87
	Hatchery	7	8	11	9	1133	3	4	5	4	229
2010	Wild	8	9	11	9	648	3	4	5	4	171
	Hatchery	8	10	11	10	1207	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	1431	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
Average	***Wild***	***7***	***9***	***10***	***9***	***554***	***3***	***4***	***4***	***4***	***117***
	Hatchery	***8***	***9***	***11***	***9***	***655***	***3***	***4***	***5***	***4***	***218***
Median	***Wild***	***7***	***9***	***10***	***9***	***642***	***3***	***4***	***4***	***4***	***108***
	Hatchery	***8***	***9***	***10***	***9***	***610***	***3***	***4***	***5***	***4***	***214***

Age at Maturity

Nearly all steelhead broodstock collected at Tumwater and Dryden dams lived in saltwater 1 to 2 years (saltwater age) (Table 3.21). Very few saltwater age-3 fish returned and those that did were 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 3.6).

Table 3.21. Proportions of wild and hatchery steelhead broodstock of different ages collected at Tumwater and Dryden dams, brood years 1998-2015. Age represents the number of years the fish lived in salt water.

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

Brood year	Origin	Saltwater age			Sample size
		1	2	3	
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
	Hatchery	0.29	0.71	0.00	68
2015	Wild	0.16	0.83	0.02	63
	Hatchery	0.51	0.49	0.00	60
Average	***Wild***	***0.44***	***0.54***	***0.02***	***75***
	Hatchery	***0.55***	***0.45***	***0.00***	***90***
Median	***Wild***	***0.46***	***0.53***	***0.01***	***72***
	Hatchery	***0.49***	***0.51***	***0.00***	***98***

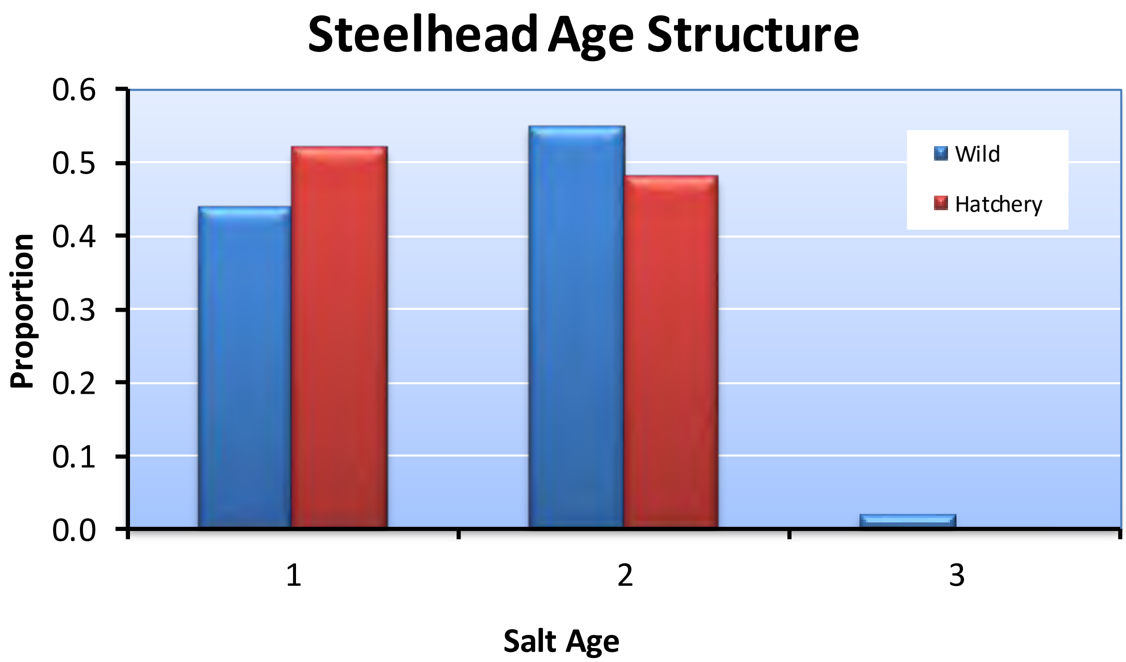


Figure 3.6. Proportions of wild and hatchery steelhead of different saltwater ages sampled at Tumwater Dam for the combined years 1998-2015.

Size at Maturity

On average, hatchery steelhead collected at Tumwater and Dryden dams were about 2 to 3 cm smaller than wild steelhead (Table 3.22).

Table 3.22. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, brood years 1998-2015; 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	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
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	-
	Hatchery	59	30	3	76	29	5	-	0	-
Average	***Wild***	***63***	***33***	***5***	***76***	***40***	***5***	***78***	***1***	***1***
	Hatchery	***61***	***43***	***47***	***73***	***40***	***4***	***-***	***0***	***-***
Median	***Wild***	***63***	***29***	***5***	***76***	***33***	***5***	***77***	***1***	***1***
	Hatchery	***61***	***36***	***4***	***73***	***35***	***4***	***-***	***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% (NOAA 2008; TAG 2008). WDFW regulates steelhead harvest in the Upper Columbia. Under certain conditions, WDFW may allow a harvest on hatchery steelhead (adipose fin clipped fish). The intent is to reduce the number of hatchery steelhead that exceed habitat seeding levels in spawning areas and to increase the proportion of wild steelhead in spawning populations.

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 3.23). Based on mark-recapture estimates, naturally produced steelhead made up about 62.5% of the escapement in 2015. Importantly, the abundance of hatchery fish in the upper Wenatchee Basin was regulated through surplusing at Tumwater Dam. A total of 645 hatchery steelhead were surplused at the dam resulting in the passage of 1,009 steelhead over the dam in 2015. Natural-origin steelhead comprised 69.4% (N = 700) of the steelhead that passed the dam.

Table 3.23. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within the Wenatchee River, brood years 2014-2015. Escapement estimates were based on PIT-tag mark-recapture techniques (Truscott et al. 2015).

Tributary	Natural-origin steelhead		Hatchery-origin steelhead	
	2014	2015	2014	2015
Mission Creek	94	71	31	23
Peshastin Creek	226	206	6	40
Chumstick Creek	78	38	7	0
Icicle Creek	76	83	45	52
Chiwaukum Creek	37	48	9	12
Chiwawa River	142	168	103	168
Nason Creek	190	237	148	68
Wenatchee River	340	252	251	298
Total	***978***	***1,103***	***545***	***661***

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 brood return. These data only provide estimates for brood years 2005 through 2011, because later brood years are still rearing in the ocean. The most recent completed brood year is 2011. The target for brood year stray rates should be less than 5%.

Based on PIT-tag analyses, about 3.2% of brood year 2011 was last detected in streams outside of the Wenatchee River basin. Brood year 2011 was the first brood year overwinter acclimated at the Chiwawa Acclimation Facility and this may have resulted in the observed reduction in stray rate. On average, for brood years 2005 through 2011, about 21% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River basin (Table 3.24). 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 3.24 should be considered rough estimates because they are not based on confirmed spawning (only last detections).

Table 3.24. 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 2005-2011. Estimates were based on last detections of PIT-tagged hatchery steelhead. Percent strays should be less than 5%.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	76	75.5	0	0.0	27	24.5	0	0.0
2006	72	61.7	1	0.9	43	37.4	0	0.0
2007	171	60.6	0	0.0	110	39.4	0	0.0
2008	79	88.8	0	0.0	10	11.2	0	0.0
2009	185	84.3	0	0.0	35	15.7	0	0.0
2010	79	81.4	0	0.0	18	18.6	0	0.0
2011	120	96.8	0	0.0	4	3.2	0	0.0
Average	***112***	***78.4***	***0***	***0.1***	***35***	***21.4***	***0***	***0.0***
Median	***79***	***81.4***	***0***	***0.0***	***27***	***18.6***	***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 E). 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 time period and showed no temporal trend.

It is important to note that no new information will be reported on genetics until the next five-year report (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.[5] The larger the 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).

[5] 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.

For brood years 2001-2015, PNI values were less than 0.67 (Table 3.25), suggesting that the hatchery environment has a greater influence on adaptation of Wenatchee steelhead than does the natural environment.

Table 3.25. Proportionate Natural Influence (PNI) values for the Wenatchee steelhead supplementation program for brood years 2001-2015. 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]
	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
2006	253	210	0.45	93	69	0.57	0.57
2007	145	115	0.44	76	58	0.57	0.58
2008	168	279	0.62	77	54	0.59	0.50
2009	171	545	0.76	86	73	0.54	0.43
2010	524	970	0.65	96	75	0.56	0.48
2011	351	472	0.57	91	70	0.57	0.51
2012	381	209	0.35	59	65	0.48	0.59
2013	322	148	0.31	49	68	0.42	0.59
2014	476	363	0.46	64	68	0.48	0.54
2015	639	484	0.43	58	52	0.53	0.57
Average	***382***	***408***	***0.50***	***74***	***72***	***0.51***	***0.52***
Median	***355***	***363***	***0.46***	***76***	***68***	***0.54***	***0.51***

[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. The PNI estimates are appropriate for steelhead spawning upstream from Tumwater Dam. They may not represent PNI for steelhead spawning downstream from Tumwater Dam.
[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; 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 3.26).[6] Over the ten 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

[6] 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.

Dam ranged from 0.001 to 0.038. Average travel time from the release sites to McNary Dam ranged from 14 to 100 days.

Some of the variation in survival rates and travel time was related to release location, type of release, and rearing scenario. For example, on average, steelhead released in the Chiwawa River appeared to have higher survival rates to McNary Dam than did steelhead released in the lower and upper Wenatchee River or Nason Creek. Within the Chiwawa River, steelhead identified as "movers" had the highest survival rates to McNary Dam, while those identified as "non-screened" had the lowest survival. For steelhead released into Nason Creek and the Wenatchee River, fish released from circulars had higher survival rates than those released from raceways. On average, steelhead released from Blackbird Pond had lower survival rates to McNary Dam than those released from circulars. Based on the available data, SARs varied little among the release locations or rearing scenarios.

Travel time from release to McNary Dam varied among release locations and rearing scenario. In general, steelhead released into the Chiwawa River and Nason Creek appeared to travel more quickly to McNary Dam than did steelhead released into the Wenatchee River. Of those released into the Chiwawa River, steelhead released volitionally from raceways appeared to travel to McNary Dam more quickly than those forced released; although there are few replicates and differences in travel times are small. On average, steelhead released from Blackbird Pond took about twice as long to reach McNary Dam than did steelhead released from circulars. In contrast, there appeared to be little differences in travel times for steelhead reared in raceways or circulars that were released into Nason Creek.

Table 3.26. 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 2005-2013. 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)

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 (%)
2006	NA	NA	NA	NA	NA	NA	NA	NA
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	Chiwawa 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)	80.4 (11.7)	0.010 (0.002)
	Wenatchee	WxW	Volitional	Rohlfing	566	0.443 (0.187)	78.1 (8.6)	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)	17.9 (17.4)	0.006 (0.001)
	Wenatchee	HxH	Volitional	Chiwawa Circ	10,031	0.413 (0.043)	21.6 (66.1)	0.001 (0.000)
2011	Chiwawa	WxW	Volitional	RCY	3,603	0.407 (0.056)	15.1 (8.3)	NA
	Nason	WxW	Volitional	RCY	4,065	0.334 (0.042)	20.9 (60.9)	NA
	Wenatchee	WxW	Non-movers	Circular	1,122	0.354 (0.228)	40.6 (89.1)	NA
	Wenatchee	WxW	Non-movers	RCY	2,395	0.368 (0.084)	22.7 (57.0)	NA
	Wenatchee	WxW	Volitional	Blackbird	2,099	0.660 (0.016)	48.2 (90.0)	NA
	Wenatchee	WxW	Volitional	Circular	7,206	0.277 (0.042)	31.6 (74.3)	NA
	Wenatchee	WxW	Volitional	RCY	4,422	0.327 (0.032)	15.2 (25.6)	NA
	All	WxW	NA	Circular	1,628	0.055 (0.016)	--	NA
	All	WxW	NA	RCY	3,479	0.289 (0.034)	--	NA
2012	Chiwawa	HxH	Volitional	RCY	2,891	0.407 (0.057)	15.2 (7.2)	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	WxW	Forced	Circular	4,271	0.378 (0.065)	25.0 (33.1)	NA
	Nason	WxW	Volitional	Circular	5,404	0.364 (0.048)	24.9 (31.6)	NA
	L. Wenatchee	HxH	Forced	RCY	587	0.164 (0.074)	52.2 (114.7)	NA
	U. Wenatchee	HxH	Volitional	RCY	2,224	0.573 (0.138)	18.7 (8.4)	NA
	U. Wenatchee	HxH	Forced	RCY	1,969	0.603 (0.140)	24.7 (42.5)	NA
	Wenatchee	HxH	Volitional	Blackbird	1,658	0.428 (0.092)	--	NA
	All	HxH	NA	RCY	769	0.455 (0.291)	--	NA
	All	WxW	NA	Circular	5,397	0.327 (0.049)	25.4 (45.0)	NA
2013	Chiwawa	Mixed	Volitional	RCY	1,567	0.354 (0.063)	15.2 (7.0)	NA
	Nason	Mixed	Volitional	RCY	3,796	0.447 (0.115)	20.2 (9.4)	NA
	Nason	Mixed	Volitional	Circ or RCY	308	0.146 (0.053)	17.4 (2.9)	NA
	Nason	WxW	Non-movers	Circular	74	0.000 (-)	0.0 (-)	NA
	Nason	WxW	Volitional	Circular	1,286	0.192 (0.063)	18.4 (6.4)	NA
	L. Wenatchee	Mixed	Non-movers	RCY	3,275	0.317 (0.131)	35.3 (69.5)	NA
	U. Wenatchee	Mixed	Volitional	RCY	2,862	0.457 (0.080)	16.3 (9.7)	NA
	Wenatchee	HxH	Volitional	Blackbird	819	0.337 (0.128)	--	NA
	All	HxH	NA	RCY	907	0.000 (-)	--	NA
	All	WxW	NA	Circ or RCY	232	0.000 (-)	--	NA
2014	Chiwawa	Mixed	Movers	RCY	793	0.754 (0.497)	27.7 (7.6)	NA
	Chiwawa	Mixed	Non-screen	RCY	915	0.358 (0.230)	25.0 (8.1)	NA
	Nason	Mixed	Movers	RCY	1,553	0.212 (0.082)	28.4 (29.4)	NA
	Nason	Mixed	Non-screen	RCY	1,653	0.075 (0.017)	24.2 (7.1)	NA
	Nason	WxW	Movers	Circular	949	0.291 (0.148)	21.3 (8.2)	NA
	Nason	WxW	Non-screen	Circular	873	0.369 (0.190)	20.8 (6.9)	NA
	L. Wenatchee	Mixed	Non-movers	RCY	2,596	0.133 (0.025)	16.0 (7.1)	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	0.340 (0.102)	16.7 (6.6)	NA
	Wenatchee	HxH	Volitional	Blackbird	1,814	0.221 (0.054)	--	NA
	All	Mixed	NA	Circ or RCY	1,884	0.119 (0.034)	--	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 1998-2011, NRR for summer steelhead in the Wenatchee River basin averaged 0.66 (range, 0.13-3.10) if harvested fish were included in the estimate (Table 3.27).

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. 2013). The target value of 6.9 includes harvest. In nearly all years, HRRs were greater than NRRs (Table 3.27). HRRs exceeded the estimated target value of 6.9 in 10 of the 14 years.

Table 3.27. 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 1998-2011.

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
Average	***146***	***2,410***	***2160***	***1005***	***14.24***	***0.66***
Median	***140***	***2,027***	***1,288***	***803***	***10.02***	***0.43***

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 will be 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 3.28). For brood years 2011 to present, SARs (to Bonneville Dam) averaged 0.0057 (Table 3.28).

Table 3.28. 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
Average	***27,924***	***0.0057***
Median	***27,924***	***0.0057***

[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 2014 broodstock for Wenatchee summer steelhead at Dryden and Tumwater dams began on 1 July and ended on 4 October 2013 at Dryden Dam and 8 October 2013 at Tumwater Dam consistent with the collection period identified in the 2013 broodstock collection protocol. The broodstock collection achieved a total collection of 135 steelhead, including 65 natural-origin steelhead.

About 1,338 steelhead were handled and released (or surplused) at Tumwater and Dryden dams during brood year 2014 Wenatchee steelhead broodstock collection. Most were hatchery-origin fish handled at Tumwater Dam and ultimately surplused to meet the pHOS objective upstream from Tumwater Dam. 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 42 spring Chinook salmon were captured and released unharmed immediately upstream from the trap facility. Consistent with ESA Section 10 Permit 1395 impact minimization measures, all ESA species handled were subject of water-to-water transfers.

Hatchery Rearing and Release

The 2014 brood Wenatchee steelhead reared throughout all life stages without significant mortality (defined as >10% population mortality associated with a single event). However, the 2014 brood had poor fertilization to eyed-egg survival combined with somewhat low eyed-egg to ponding survival resulting in an unfertilized-to-release survival of 70.8%, which was less than the program target of 81% (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 2014 brood steelhead smolt release in the Wenatchee River basin totaled 264,758 smolts, representing about 107.1% 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 1395. As specified in ESA Section 10 Permit 1395, 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 Permits 1196, 1347, 1395, 18118, 18119, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There was no NPDES violations reported at PUD Hatchery facilities during the period 1 January 2014 through 31 December 2014. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2014 are provided in Appendix F.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1395, 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 2003). 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 2015 emigration complied with take provisions in the Section 10 permit and are detailed in Table 3.29. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 1395 Section B.

Table 3.29. Estimated take of Upper Columbia River steelhead resulting from juvenile emigration monitoring in the Wenatchee River basin, 2015. 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	35,042	NA	NA	259	3,151	2,624	380	6,414	
Encounter rate	NA	NA	NA	NA	NA	0.0899	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	5	1	29	11	46	
Mortality rate	NA	NA	NA	NA	0.0193	0.0003	0.0111	0.0289	0.0072	0.02
Lower Wenatchee Trap										
Population	NA	264,758	NA	NA	231	2,288	75	25	2,619	
Encounter rate	NA	NA	NA	NA	NA	0.0086	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	2	0	0	0	2	
Mortality rate	NA	NA	NA	NA	0.0087	0.000	0.0000	0.0000	0.0008	0.02
Wenatchee River Basin Total										
Population	NA	264,758	NA	NA	490	5,439	2,699	405	9,033	
Encounter rate	NA	NA	NA	NA	NA	0.0205	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	7	1	29	11	48	
Mortality rate	NA	NA	NA	NA	0.0143	0.0002	0.0108	0.0272	0.0053	0.02

[a] 2015 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 2015, as authorized by ESA Section 10 Permit No. 1395. 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. 1395 (NMFS 2003). 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 2003). The 2013-2014 run-cycle report (BY 2014) for stock assessment sampling at Priest Rapids Dam was compiled under provisions of ESA Section 10 Permit 1395. Data and reporting information are included in Appendix G.

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. Since 2006, 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. 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. Therefore, this section presents the history of the program and tracks the juveniles from the 2011 brood that were released as parr into Lake Wenatchee in 2012. Some of these fish began their smolt migrations in 2013.

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	256
2011	204	0	8	196	0	0	0	0	0	0	196
Average	***263***	***18***	***10***	***203***	***33***	***6***	***0***	***0***	***5***	***1***	***210***
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	56	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 during the life 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 during the life 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 only 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 during the life 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	243,260
2011	2012	0.9690	5,074	241,918
Average		***0.9379***	***11,994[b]***	***211,255***
Median		***0.9561***	***14,764[b]***	***200,938***

[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 during the life of the 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 during the life 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 was terminated in 2012, there are no disease-monitoring results.

4.4 Natural Juvenile Productivity

Sockeye smolt abundance was estimated at a 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.

Emigrant and Smolt Estimates

The Lower Wenatchee Trap operated between 30 January and 28 June 2015. During that time period the trap was inoperable for five days because of high and low river discharge, debris, elevated river temperature, and major hatchery releases. During the eight-month sampling period, a total of 4,178 wild juvenile sockeye were captured at the Lower Wenatchee Trap. No hatchery juvenile sockeye were captured in 2015. A significant relationship between trap efficiency and river discharge was created ($R^2 = 0.52$, $P < 0.043$). Using this model, the number of juvenile sockeye emigrants was estimated at 1,065,614 (±238,901; 95% CI) during the 2015 trapping season (Table 4.11). Figure 4.1 shows the monthly captures of sockeye collected at the Lower Wenatchee Trap in 2015. All fish captured in the Lower Wenatchee trap are reported in Appendix B.

Table 4.11. Estimated numbers of wild and hatchery sockeye smolts that emigrated from Lake Wenatchee during run years 1997-2011; ND = no data. Estimates for the run 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.

Run 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

Run year	Numbers of sockeye smolts	
	Wild smolts	Hatchery smolts
2004	5,771,187	216,023
2005	723,413	122,399
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	No program
2014	1,275,027	No program
2015	1,065,614	No program
Average	***1,709,925***	***116,235[b]***
Median	***1,065,614***	***121.511[b]***

[a] Estimates refined based on PIT tag survival to McNary Dam.
[b] Summary statistics were calculated for years in which hatchery fish were being released (1997-2011).

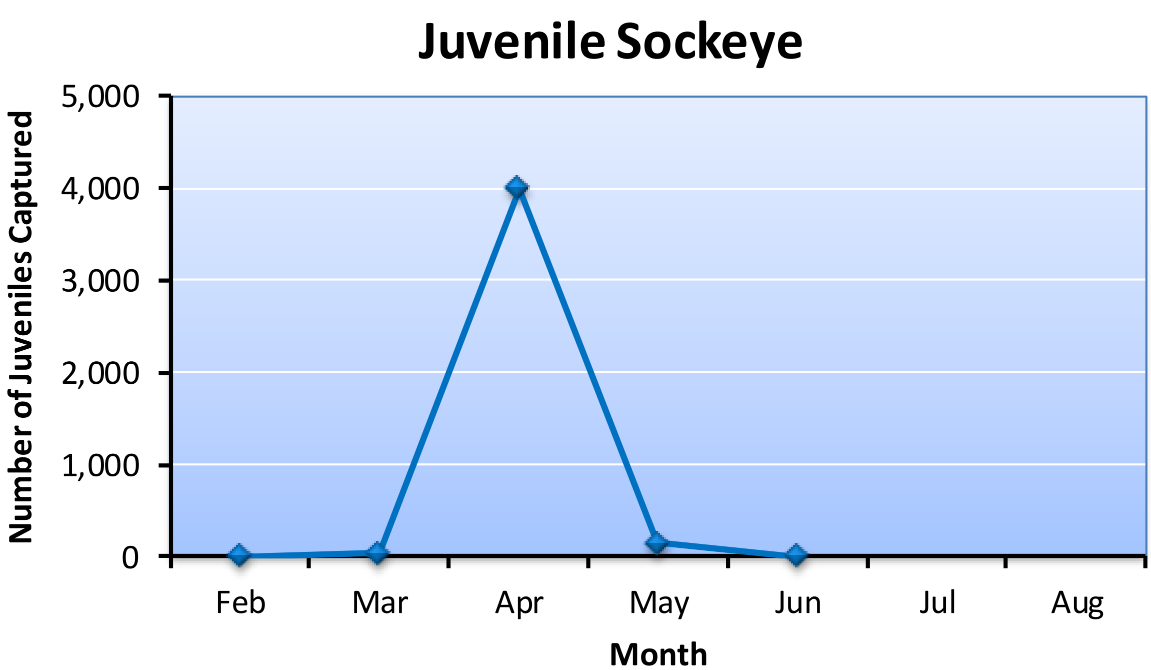


Figure 4.1. Monthly captures of wild sockeye salmon smolts at the Lower Wenatchee Trap, 2015.

Age classes of wild sockeye smolts were determined from a length frequency analysis based on scales collected randomly each year since 1997 (Table 4.12). 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, 1997-2015; ND = no data. Estimates for the run 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.

Run year	Proportion of wild smolts			Total wild emigrants
	Age 1+	Age 2+	Age 3+	
1997	0.075	0.906	0.019	55,359
1998	0.955	0.037	0.008	1,447,259
1999	0.619	0.381	0.000	1,944,966
2000	0.599	0.400	0.001	985,490
2001	0.943	0.051	0.006	39,353
2002	0.961	0.039	0.000	729,716
2003	0.740	0.026	0.000	5,439,032
2004	0.929	0.071	0.000	5,771,187
2005	0.230	0.748	0.022	723,413
2006	0.994	0.006	0.000	1,266,971
2007	0.996	0.004	0.000	2,797,313
2008	0.804	0.195	0.001	549,682
2009	0.927	0.073	0.000	355,549
2010	0.963	0.036	0.001	3,958,888
2011	0.786	0.214	0.000	1,500,730
2012	ND	ND	ND	ND
2013	0.933	0.067	0.000	873,096
2014	0.924	0.076	0.000	1,275,027
2015	TBD	TBD	TBD	1,065,614
Average	***0.786***	***0.194***	***0.003***	***1,709,924***
Median	***0.927***	***0.067***	***0.000***	***985,490***

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 the 2012 brood year (a year where brood was not collected), a linear relationship with post-orbital to hypural length as the independent variable was used to calculate average fecundity of sockeye sampled at Tumwater Dam ($r^2 = 0.40$, $P < 0.01$). Smolts for brood years 1995-2009 were based on captures at the Upper Wenatchee Trap. No smolt estimates are available for brood year 2010. Smolt estimates for brood years since 2012 are derived from captures made at the Lower Wenatchee Trap. Egg-smolt survival rates for brood years 1995-2013 have ranged from 0.012 to 0.212 (mean = 0.087).

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 1995-2013; NA = not available.

Brood year	Number of females	Mean fecundity	Total eggs	Numbers of wild smolts				Egg-smolt survival
				Age 1+	Age 2+	Age 3+	Total	
1995	2,136	2,295	4,902,120	4,174	53,549	0	57,723	0.012
1996	3,767	2,664	10,035,288	1,382,133	741,032	985	2,124,150	0.212
1997	5,404	2,447	13,223,588	1,203,934	394,196	236	1,598,366	0.121
1998	2,024	2,813	5,693,512	590,309	2,007	0	592,316	0.104
1999	513	2,319	1,189,647	37,110	28,459	0	65,569	0.055
2000	11,413	2,673	30,506,949	701,257	1,414,148	0	2,115,405	0.069
2001	21,685	2,960	64,187,600	4,024,884	409,754	15,915	4,450,553	0.069
2002	17,226	2,856	49,197,456	5,361,433	541,113	0	5,902,546	0.120
2003	2,158	3,511	7,576,738	166,385	7,602	0	173,987	0.023
2004	15,469	2,505	38,749,845	1,259,369	11,189	275	1,270,833	0.033
2005	5,867	2,718	15,946,506	2,786,123	107,243	0	2,893,366	0.181
2006	2,747	2,656	7,296,032	442,164	25,919	1,507	469,590	0.064
2007	2,001	3,115	6,232,804	329,629	142,916	594	473,139	0.076
2008	11,775	2,555	30,084,691	3,814,226	320,567	NA	4,134,794	0.137
2009	3,939	2,459	9,684,965	1,179,569	NA	0	NA	NA
2010	11,918	2,785	33,190,467	NA[a]	58,497	0	NA	NA
2011	9,722	2,970	28,873,491	816,836[b]	96,902	0	913,738	0.032
2012	14,753	2,745	40,496,573	1,178,125[b]	--	0	--	--
2013	9,477	2,732	25,891,164	--	--	0	--	--
Average	***8,105***	***2,725***	***22,261,023***	***1,578,795***	***272,193***	***1,084***	***1,815,738***	***0.087***
Median	***5,404***	***2,673***	***15,946,506***	***1,203,934***	***96,902***	***0***	***913,738***	***0.069***

[a] There is no emigrant estimate for trapping during 2012.
[b] Emigrant estimates are derived from captures at the Lower Wenatchee Trap.

Juvenile survival rates for hatchery sockeye salmon are provided in Table 4.14. Release-smolt survival rates for brood years 1995-2009 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 1995-2009.

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

Brood year	Number of eggs	Number of parr released	Date of release	Estimated number of smolts	Egg-smolt survival	Release-smolt survival
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

[a] There is no emigrant estimate for the 2010 or 2011 brood years.

PIT Tagging Activities

A total of 3,922 wild juvenile sockeye salmon were PIT tagged and released in 2015 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 2006-2015 are shown in Table 4.15. See Appendix C 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, 2006-2015.

Sampling Location	Numbers of PIT-tagged sockeye salmon released							
	2008	2009	2010	2011	2012	2013	2014	2015
Upper Wenatchee Trap	3,165	3,683	10,006	--	--	--	--	--
Lower Wenatchee Trap	0	0	0	0	0	0	4,821	3,922

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 switched to monitoring the abundance and productivity of the natural population. Thus, spawn time estimating and carcass surveys were discontinued.

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 the White River and Little Wenatchee watersheds (see Appendix H for more details).

Mark-Recapture Estimates

Spawning escapement of sockeye salmon in 2015 was estimated using mark-recapture methods. This method relied on PIT tags to estimate sockeye spawning escapement (see Appendix H for more details).

Using mark-recapture methods, the estimated total escapement of sockeye in the Upper Wenatchee River basin in 2015 was 24,200 (Table 4.16). About 83% 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 2009-2015. 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	4,115	20,097	24,212
Average	***45,337***	***6,989***	***2,934***	***22,183***	***25,116***
Median	***35,821***	***6,262***	***2,431***	***19,542***	***21,604***

[a] Spawning escapements in 2011 and 2013 were calculated using AUC counts and a regression model.

The spawning escapement of 24,200 Wenatchee sockeye was greater than the overall average of 17,535 (Table 4.17).

Table 4.17. Spawning escapements for sockeye salmon in the Wenatchee River basin for return years 1989-2015; 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**

Return year	Escapement estimation method	Spawning escapement		
		Little Wenatchee	White	Total
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**
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	4,115	20,097	**24,212**
Average		***2,549***	***17,213***	***18,965***
Median		***2,487***	***15,670***	***20,248***

4.6 Carcass Surveys

As described earlier, carcass surveys were not conducted in 2015. 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**
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**

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
	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**
	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***

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
	Hatchery	*18*	*0*	*0*	*61*	*2*	*81*
Median	*Wild*	*112*	*0*	*0*	*2,936*	*21*	*3,137*
	Hatchery	*4*	*0*	*0*	*22*	*0*	*32*

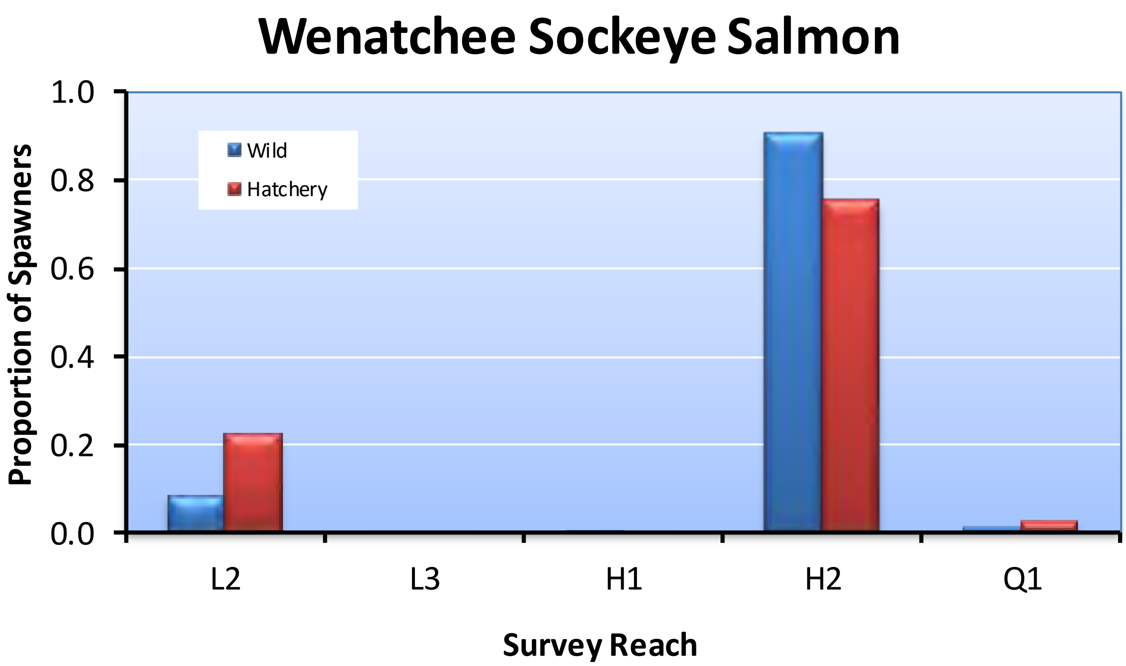


Figure 4.2. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, pooled data from 1993-2013. Reach codes are described in Table 2.9; L = Little Wenatchee, H = White River, and Q = Napeequa River.

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, 1998-2015. 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.

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
2014	Wild	194	13-Jul	199	18-Jul	210	29-Jul	201	20-Jul	97,670

Survey year	Origin	Sockeye Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
	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	49,650
	Hatchery	181	30-Jun	199	18-Jul	212	31-Jul	200	19-Jul	1,785
Average	***Wild***	***200***		***205***		***217***		***207***		***24,391***
	Hatchery	***200***		***208***		***224***		***210***		***795***
Median	***Wild***	***199***		***204***		***215***		***206***		***19,818***
	Hatchery	***199***		***206***		***221***		***210***		***521***

[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, 1998-2015. 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
	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

Survey year	Origin	Sockeye Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	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	49,650
	Hatchery	26	29	31	29	1,785
Average	***Wild***	***29***	***30***	***31***	***30***	***24,391***
	Hatchery	***29***	***30***	***32***	***30***	***795***
Median	***Wild***	***29***	***30***	***31***	***30***	***19,818***
	Hatchery	***29***	***30***	***32***	***31***	***521***

[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.

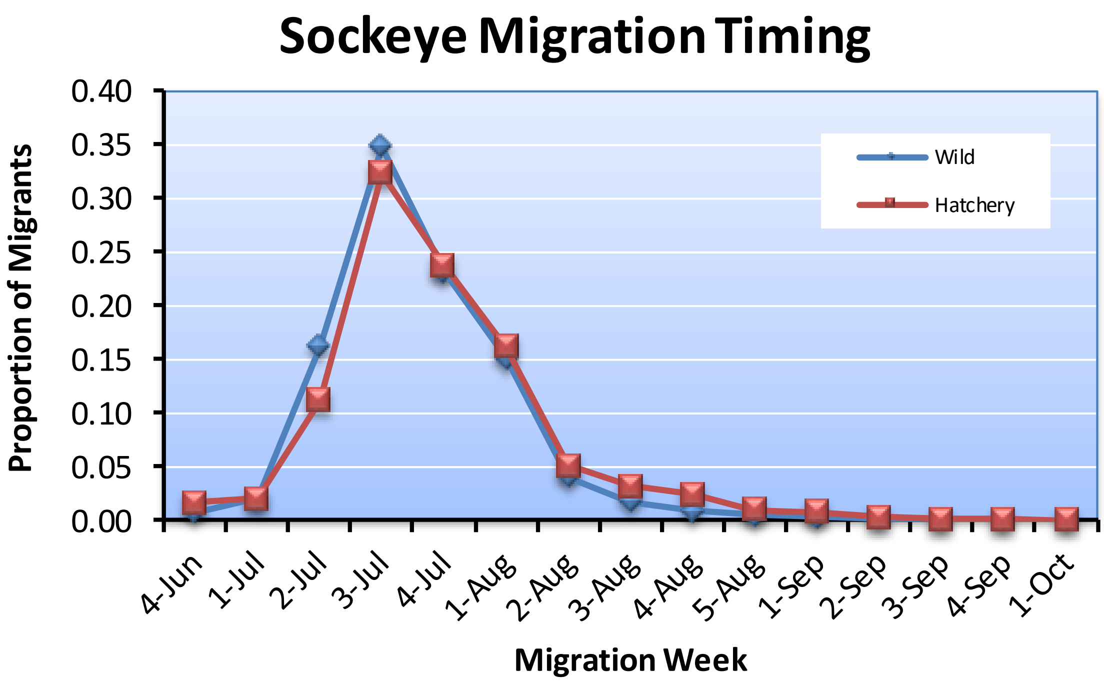


Figure 4.3. Proportion of wild and hatchery sockeye observed (using video) passing Tumwater Dam each week during their migration period late-June through early-October; data were pooled over survey years 1998-2015.

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.

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 (2013-2014).

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

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
1999	Wild	0.00	0.00	0.18	0.73	0.10	0.00	113
	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	0.001	0.00	1,335
	Hatchery	0.00	0.03	0.97	0.00	0.00	0.00	35
Average	***Wild***	***0.00***	***0.00***	***0.69***	***0.30***	***0.01***	***0.00***	***161***
	Hatchery	***0.00***	***0.01***	***0.90***	***0.09***	***0.00***	***0.00***	***80***
Median	***Wild***	***0.00***	***0.00***	***0.71***	***0.29***	***0.00***	***0.00***	***26***
	Hatchery	***0.00***	***0.00***	***0.88***	***0.12***	***0.00***	***0.00***	***31***

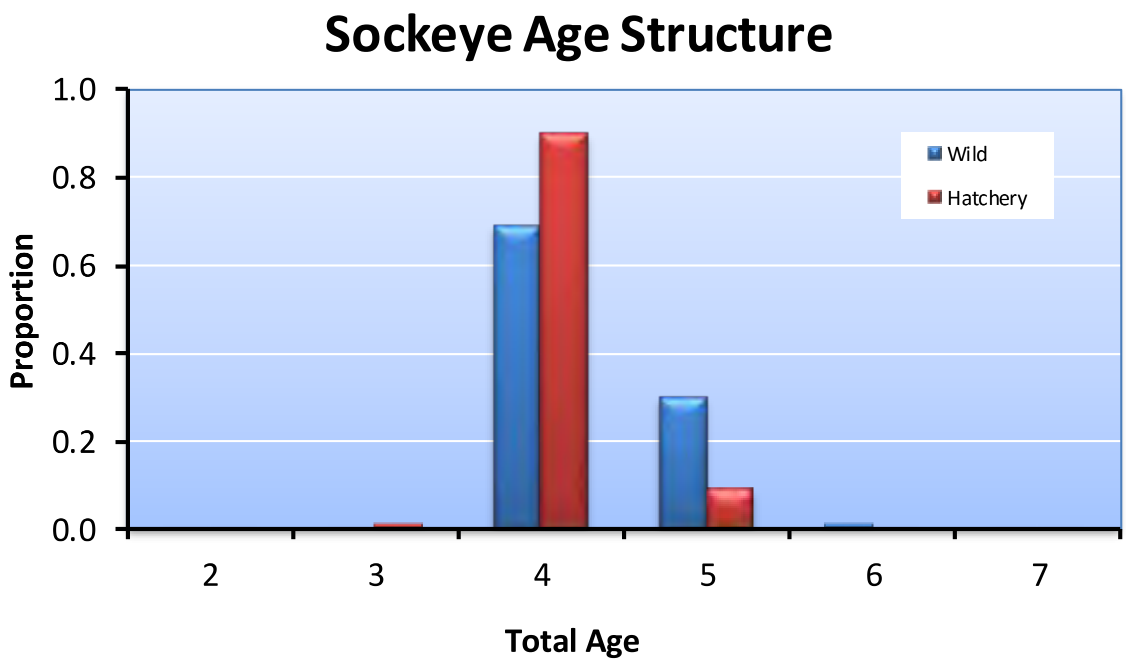


Figure 4.4. Proportions of wild and hatchery sockeye salmon of different total ages sampled at Tumwater Dam and on spawning grounds in the Wenatchee River basin for the combined years 1994-2014.

Size at Maturity

Although sample sizes are small, wild and hatchery sockeye were similar in size in 2015 (Table 4.22). In addition, the pooled data indicate that there is little difference in mean sizes of hatchery and wild sockeye salmon sampled in the Wenatchee River basin (Table 4.22). Analyses for the five-year 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, 1994-2014; 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

Survey year	Origin	Sample size	Sockeye length (POH; cm)			
			Mean	SD	Minimum	Maximum
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
	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	898	43	2	37	53
	Hatchery	51	43	2	39	47
Pooled	***Wild***	***4,506***	***43***	***3***	***31***	***53***
	Hatchery	***1.728***	***45***	***4***	***30***	***65***

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, 1989-2009.

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
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	3 (2)	61 (41)	7 (5)	79 (53)	147
2006	2 (0)	124 (23)	2 (0)	409 (76)	535
2007	2 (2)	96 (80)	13 (11)	9 (8)	118
2008	0 (0)	82 (20)	10 (2)	322 (78)	414
2009	1 (0)	31 (15)	3 (1)	177 (83)	211
Average	***0 (0)***	***47 (62)***	***3 (2)***	***108 (36)***	***159***
Median	***0 (0)***	***23 (80)***	***1 (0)***	***5 (8)***	***39***

[a] Includes the Lake Wenatchee fishery.

Table 4.24. Estimated number and percent (in parentheses) of wild Wenatchee sockeye captured in different fisheries, 1989-2010.

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

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
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 (6)	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)	1,189 (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)	15 (3)	383 (73)	527
2004	0 (0)	1,559 (24)	174 (3)	4,825 (74)	6,558
2005	0 (0)	2,498 (44)	198 (3)	2,996 (53)	5,692
2006	0 (0)	2,844 (52)	135 (2)	2,505 (46)	5,484
2007	0 (0)	1,536 (57)	214 (8)	960 (35)	2,710
2008	0 (0)	5,066 (25)	596 (3)	13,544 (72)	19,206
2009	0 (0)	1,240 (19)	88 (1)	5,336 (80)	6,664
Average	***0 (0)***	***1,273 (61)***	***108 (2)***	***2,081 (36)***	***3,462***
Median	***0 (0)***	***937 (56)***	***15 (2)***	***383 (36)***	***954***

[a] Includes the Lake Wenatchee fishery.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. In addition, PIT tagging of hatchery sockeye, which began with brood year 2005, allows estimation of stray rates by brood return. Targets for strays based on return year (recovery year) outside the Wenatchee River basin should be less than 5%. The target for brood year strays should also be less than 5%.

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 4.25). However, sockeye from brood years 2006 and 2007 strayed into the Entiat River and a few into the Methow River (non-target streams) and a non-target hatchery (Umpqua Trap) (Table 4.25). Stray rates of Wenatchee sockeye from brood year 2006, 2008, and 2009 exceeded the target of 5%.

Table 4.25. 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). Percent stays should be less than 5%.

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	97.4	1	0.4	56	2.2	0	0.0
2008	86	90.5	0	0.0	9	9.6	0	0.0
2009	11	73.3	0	0.0	4	26.6	0	0.0
Average	***131***	***92.1***	***1***	***0.8***	***14***	***6.9***	***0***	***0.1***
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-tag analyses, on average, about 11% of the hatchery sockeye returns were last detected in streams outside the Wenatchee River basin (Table 4.26). The numbers in Table 4.26 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 wandered or 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 4.26. 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 for brood years 2005-2011. Estimates were based on last detections of PIT-tagged hatchery sockeye. Percent strays should be less than 5%.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	166	92.2	0	0	14	7.8	0	0
2006	440	94.6	0	0	25	5.4	0	0
2007	192	95.0	0	0	10	5.0	0	0
2008	127	89.4	0	0	15	10.6	0	0
2009	41	82.0	0	0	9	18.0	0	0
2010	53	100.0	0	0	0	0.0	0	0
2011	63	71.6	0	0	25	28.4	0	0
Average	***155***	***89.3***	***0***	***0***	***14***	***10.7***	***0***	***0***
Median	***127***	***92.2***	***0***	***0***	***14***	***7.8***	***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 I). 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.

It is important to note that no new information will be reported on genetics until the next five-year report (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. 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).

The PNI values for the life of the program (brood years 1989-2011) are shown in Table 4.27. Throughout the program, PNI was consistently greater than 0.67. The hatchery program was terminated in 2012.

Table 4.27. Proportionate Natural Influence (PNI) values for the Wenatchee sockeye supplementation program for brood years 1989-2015. 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
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

Brood year	Escapement[a]			Broodstock			PNI[b]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
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	81,803	1,840	0.02	NP	NP	NP	NP
2015	49,650	1,785	0.03	NP	NP	NP	NP
Average	***44,233***	***1,121***	***0.02***	***NP***	***NP***	***NP***	***NP***
Median	***36,506***	***1,071***	***0.02***	***NP***	***NP***	***NP***	***NP***

[a] Proportions of natural-origin and hatchery-origin spawners were determined from video tape at Tumwater Dam.

[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; 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 4.28).[7] 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.

Table 4.28. 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	0.315 (0.038)	196.7 (7.3)	0.034 (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.

[7] 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.

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 1989-2009, NRR in the Wenatchee averaged 1.55 (range, 0.13-5.74) if harvested fish were not included in the estimate and 1.84 (range, 0.14-6.88) if harvested fish were included in the estimate (Table 4.29).

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. 2013). The target value of 5.4 includes harvest. HRRs exceeded NRRs in 13 or 14 of the 21 years of data depending on if harvest was or was not included in the estimates (Table 4.29). Hatchery replacement rates for Wenatchee sockeye have equaled or exceeded the estimated target value of 5.4 in five of the 21 years (Table 4.29).

Table 4.29. 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, 1989-2009.

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
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	30,149	1.45	1.09
2005	207	14,011	460	20,793	2.22	1.48	606	26,486	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	13,663	4.02	5.74	1,037	16,370	4.55	6.88
2008	260	23,023	808	38,245	3.11	1.66	1,314	57,451	5.05	2.50

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
2009	261	13,488	2,092	22,202	8.02	1.65	2,488	28,867	9.53	2.14
Average	***239***	***15,383***	***648***	***15,761***	***2.72***	***1.55***	***820***	***19,223***	***3.45***	***1.84***
Median	***228***	***14,011***	***401***	***16,165***	***1.27***	***0.86***	***423***	***17,120***	***1.45***	***1.09***

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 4.30).

Table 4.30. Parr-to-adult ratios (PAR) and smolt-to-adult ratios (SAR) for Wenatchee hatchery sockeye salmon, brood years 1990-2007; 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
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	2,488	0.0109	0.0156

Brood year	Number of parr released	Number of smolts	Estimated adult recaptures	PAR	SAR
Average	***208,271***	***116,235***	***820***	***0.0047***	***0.0077***
Median	***197,195***	***121,843***	***423***	***0.0017***	***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.

Spawning Surveys

Sockeye spawning ground surveys conducted in the Wenatchee River basin during 2015 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 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. Prior to 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 hatchery-origin Chiwawa spring Chinook are collected at Tumwater Dam, while the Chiwawa Weir is used to collect natural-origin brood for the Chiwawa spring Chinook program. Broodstock collection occurs from May through 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. They are released volitionally from the Chiwawa Acclimation Facility during April the following year.

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. The Wenatchee spring Chinook safety-net program is now part of the Nason Creek spring Chinook program. 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 new ESA Section 10 permits in 2013, it is anticipated that beginning in 2014, adult management (i.e., removal of excess hatchery-origin adults at dams, traps, and weirs, and in conservation fisheries) will be implemented to achieve pHOS and PNI goals for the Wenatchee spring Chinook programs.

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 2013-2015 Chiwawa spring Chinook broodstock, which were collected at the Chiwawa Weir and at Tumwater Dam, consistent with methods in the broodstock collections protocols (Tonseth 2013, 2014, and 2015). Some information for the 2015 return is not available at this time (e.g., age structure and final origin determination). This information will be provided in the 2016 annual report.

Origin of Broodstock

Natural-origin adults made up between 31.3% and 100.0% of the Chiwawa spring Chinook broodstock for return years 2013-2015 (Table 5.1). Natural and hatchery-origin adults were collected at Tumwater Dam and the Chiwawa Weir for return year 2015. Early run timing of spring Chinook in 2015 required initiating broodstock collections about two weeks earlier than usual. Broodstock were trapped at Tumwater Dam from mid-May through mid-July 2015, and at the Chiwawa Weir from mid-June through late-July. Hatchery-origin broodstock were collected at Tumwater Dam in 2015 to meet the Nason Creek Safety Net requirements. 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 10 hatchery-origin fish collected in 2015 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, 1989-2015. 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	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	28	0	0	28	0	0	0	0	0	0	28
1990	19	1	0	18	0	0	0	0	0	0	18
1991	32	0	5	27	0	0	0	0	0	0	27
1992	113	0	0	78	35	0	0	0	0	0	78
1993	100	3	3	94	0	0	0	0	0	0	94
1994	9	0	1	8	0	4	0	0	4	0	12
1995	No Program										
1996	8	0	0	8	0	10	0	0	10	0	18
1997	37	0	5	32	0	83	1	3	79	0	111
1998	13	0	0	13	0	35	1	0	34	0	47
1999	No Program										
2000	10	0	1	9	0	38	1	16	21	0	30
2001	115	2	0	113	0	267	8	0	259	0	372
2002	21	0	1	20	0	63	1	11	51	0	71
2003	44	1	2	41	0	75	2	20	53	0	94
2004	100	1	16	83	0	196	30	34	132	0	215
2005	98	1	6	91	0	185	3	1	181	0	279
2006	95	0	4	91	0	303	0	29	224	50	315
2007	45	1	1	43	0	124	2	18	104	0	147

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	
2008	88	2	3	83	0	241	5	16	220	0	303
2009	113	6	11	96	0	151	3	37	111	0	207
2010	83	0	6	77	0	103	0	5	98	0	175
2011	80	0	0	80	0	101	2	6	93	0	173
Average[b]	***60***	***1***	***3***	***54***	***2***	***94***	***3***	***9***	***80***	***2***	***134***
Median[b]	***45***	***0***	***1***	***43***	***0***	***75***	***1***	***3***	***53***	***0***	***94***
2012	75	1	1	73	0	41	3	0	38	0	111
2013	170	5	0	70	95	52	1	50	0	1	70
2014[d]	61	0	0	61	0	203	1	68	134	0	195
2015[e]	81	1	7	72	1	47	0	3	37	7	109
Average[c]	***97***	***2***	***2***	***69***	***24***	***86***	***1***	***30***	***52***	***2***	***121***
Median[c]	***78***	***1***	***1***	***71***	***1***	***50***	***1***	***27***	***38***	***1***	***110***

[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 recruits were collected in case the program fell short on natural-origin recruits. 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 2013 and 2014 returns, most adults, regardless of origin, were age-4 Chinook (Table 5.2). A larger percentage of the age-5 Chinook were natural-origin fish, whereas a larger percentage of the age-3 fish were hatchery-origin fish.

Table 5.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 1991-2014.

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

Return year	Origin	Total age			
		2	3	4	5
	Hatchery	0.0	50.0	50.0	0.0
1997	Wild	0.0	0.0	87.5	12.5
	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
Average	***Wild***	***0.0***	***5.7***	***63.5***	***30.8***

Return year	Origin	Total age			
		2	3	4	5
	Hatchery	***0.0***	***11.8***	***66.1***	***13.0***
Median	***Wild***	***0.0***	***1.5***	***70.2***	***24.3***
	Hatchery	***0.0***	***1.9***	***71.2***	***1.8***

[a] Comprised of age results for both Chiwawa and Nason Creek obligations.

There was little difference in mean lengths between hatchery and natural-origin broodstock of age-4 and age-5 Chinook in 2013; however, age-5 natural-origin Chinook in 2014 were larger than hatchery-origin broodstock (Table 5.3).

Table 5.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 1991-2014; 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												
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

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	-	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
Average	***Wild***	***47***	***0***	***-***	***53***	***3***	***5***	***80***	***39***	***6***	***95***	***10***	***7***
	Hatchery	***-***	***0***	***-***	***56***	***11***	***6***	***81***	***81***	***7***	***93***	***8***	***6***

[a] Comprised of age results from HOR's used for both Chiwawa and Nason Creek obligations.

Sex Ratios

Male spring Chinook in the 2013-2015 return years made up 49.1%, 49.2%, and 53.5%, respectively, of the adults collected. This resulted in overall male to female ratios of 0.96:1.00, 0.97:1.00, and 1.15:1.00, respectively (Table 5.4). For the 2015 return year, natural-origin and hatchery-origin fish both consisted of a slightly higher proportion of males than females (Table 5.4).

Table 5.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 1989-2015. 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
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
Total	***790***	***812***	***0.97:1.00***	***1101***	***1220***	***0.90:1.00***	***0.93:1.00***

[a] Comprised of HOR's used for both Chiwawa and Nason Creek obligations.

Fecundity

Mean fecundities for the 2013-2015 returns of spring Chinook ranged from 4,045-4,847 eggs per female (Table 5.5). These fecundities were generally more than the overall average of 4,684 eggs per female, but were close to the expected fecundity of 4,400 eggs per female assumed in the broodstock protocols. For the 2015 return year, natural-origin Chinook produced more eggs per female than did hatchery-origin fish. This could be attributed to differences in size and age of hatchery and natural-origin fish described above (Tables 5.2 and 5.3).

Table 5.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 1989-2015; 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
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
Average	***4,837***	***4,478***	***4,684***
Median	***4,734***	***4,479***	***4,624***

* Individual fecundities were not tracked with females until 1997.
[a] Estimated as the mean of fecundities two years before and two years after 1992.

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, 169,442 eggs have been required to achieve a release goal of 144,026 smolts for the Chiwawa spring Chinook Program. Between 1989 and 2015, the egg take goal was reached only in 2001 and 2015 (Table 5.6). The green egg takes for 2013-2015 brood years were 97.4%, 99.7%, and 109.0% of program goals, respectively.

ESA Permit 18121 sets limits on the percentage of the total run and natural-origin fish in the broodstock to meet the conservation program. Applying these criteria to the low total abundance of spring Chinook salmon to the Chiwawa River basin and the low abundance of natural-origin fish returning to the basin has resulted in the program not meeting production goals.

Table 5.6. Numbers of eggs taken from spring Chinook broodstock, 1989-2015; 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
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***

Return year	Number of eggs taken for the Chiwawa Program
2012	250,695
2013	165,047
2014	163,358
2015	184,734
Average (2012-present)	***192,371***
Median (2012-present)	***176,871***

Number of acclimation days

Early rearing of the 2013 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 2013 brood, fish were acclimated for 196 to 203 days on Chiwawa River water (Table 5.7).

Table 5.7. Number of days spring Chinook broods were acclimated and water source, brood years 1989-2013; 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
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

Brood year	Release year	Transfer date	Release date	Number of days and water source		
				Total	Chiwawa	Wenatchee
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

[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 2013 brood Chiwawa spring Chinook program achieved 102.4% of the 144,026 target goal with about 147,480 smolts being released volitionally into the Chiwawa River in 2015 (Table 5.8).

Table 5.8. Numbers of spring Chinook smolts tagged and released from the hatchery, brood years 1989-2013. 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).

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				

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
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
		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

[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] Brood years 2012 to present are not adipose fin clipped (they receive CWT only).

Numbers tagged

The 2013 brood Chiwawa spring Chinook were 98% CWT (Table 5.8).

In 2015, a total of 10,200 spring Chinook from the 2014 brood were PIT tagged at Eastbank Hatchery on 6-10 July. Both the HxH and WxW fish were tagged and released into raceway #11A. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 83 mm in length and 7.0 g at time of tagging. These fish were transferred to the Chiwawa Acclimation Facility in October 2015. These fish will be released in the Chiwawa River during spring 2016.

Table 5.9 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into the Chiwawa River.

Table 5.9. Summary of PIT-tagging activities for Chiwawa hatchery spring Chinook, brood years 2005-2013.

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
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

[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 2013 brood were released as yearling smolts between 13 and 20 April 2015. Size at release was equal to the target of 18 fpp established for the program. The CV for fork length was 9% short of the target (Table 5.10).

Table 5.10. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood years 1989-2013. 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

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
		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
		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
Average		***139***	***6.9***	***35.0***	***17***
Median		***139***	***6.7***	***34.3***	***13***
Targets		***155***	***9.0***	***37.8***	***18***

[a] Forced release group.
[b] Volitional release group.

Survival Estimates

Overall survival of Chiwawa spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 5.11). There was higher than expected survivals throughout most stages, except for eyed-egg to ponding, contributing to increased program performance. Pre-spawn survival of adults was also above the standard set for the program.

Table 5.11. Hatchery life-stage survival rates (%) for spring Chinook, brood years 1989-2013. 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
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

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							
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
Average	***97.9***	***97.9***	***93.1***	***97.0***	***98.5***	***98.0***	***91.8***	***94.5***	***83.1***
Median	***98.6***	***100.0***	***93.2***	***98.0***	***99.1***	***98.9***	***95.4***	***98.2***	***85.2***
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.

5.3 Disease Monitoring

Results of 2015 adult broodstock bacterial kidney disease (BKD) monitoring indicated that nearly all females had ELISA values less than 0.199. About 98.2% of females had ELISA values less than 0.120, which would have required about 1.8% of the progeny to be reared at densities not to exceed 0.06 fish per pound (Table 5.12).

For the 2013 brood, mortalities resulting from external fungal infections began increasing shortly after transfer to the Chiwawa Acclimation Facility. A formalin drip treatments was used to control the infection. No significant health issues were encountered for the remainder of juvenile rearing.

Table 5.12. Proportion of bacterial kidney disease (BKD) titer groups for the Chiwawa spring Chinook broodstock, brood years 1996-2015. 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					

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)
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	0.0829	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
Average	***0.5553***	***0.3122***	***0.0390***	***0.0542***	***0.7173***	***0.2827***
Median	***0.7222***	***0.1840***	***0.0227***	***0.0182***	***0.8480***	***0.1520***

[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 2015, 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 111,224 (±7%) subyearling and 620 (±43%) yearling spring Chinook were estimated in the Chiwawa River basin in August 2015 (Table 5.13 and 5.14). During the survey period 1992-2015, 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 5.13 and 5.14; Figure 5.1). Numbers of all fish counted in the Chiwawa River basin are reported in Appendix A.

Table 5.13. Total numbers of subyearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2015; 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**
Average	***76,450***	***315***	***2,372***	***1,802***	***82***	***1,249***	***50***	***53***	***28***	***82,078***
Median	***73,478***	***90***	***2,085***	***1,506***	***49***	***1,013***	***28***	***28***	***0***	***79,902***

Table 5.14. Total numbers of yearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2015; 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**

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
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**
Average	***242***	***3***	***8***	***21***	***0***	***4***	***0***	***0***	***0***	***276***
Median	***66***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***79***

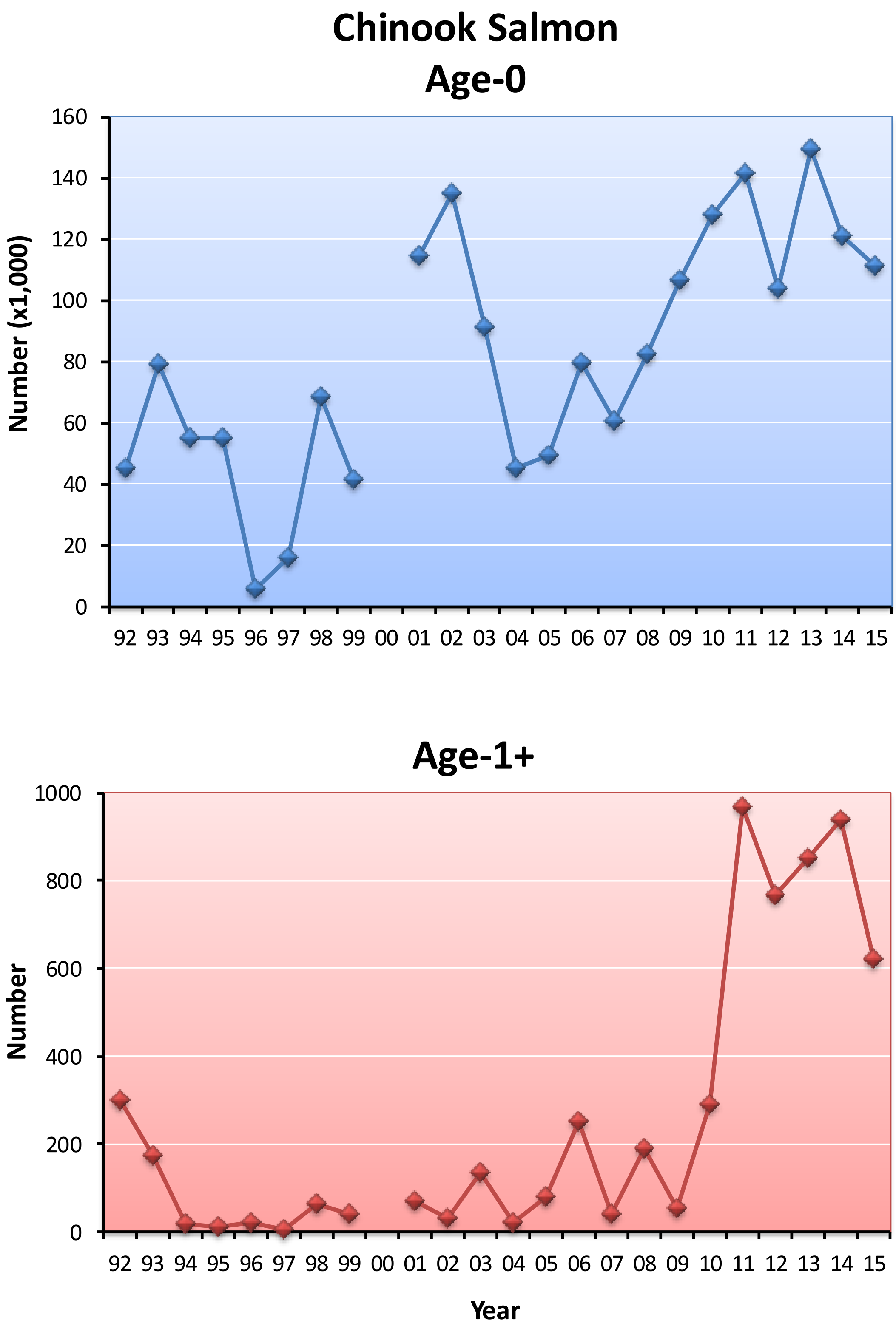


Figure 5.1. Numbers of subyearling and yearling Chinook salmon within the Chiwawa River Basin in August 1992-2015; ND = no data.

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 least abundant in glides and riffles. Most Chinook associated closely with woody debris in multiple channels. These sites (multiple channels) made up 16% of the total area of the Chiwawa River basin, but they provided habitat for 63% of all subyearling Chinook in the basin in 2015. In contrast, riffles made up 53% of the total area, but provided habitat for only 5% of all juvenile Chinook in the Chiwawa River basin. Pools made up 24% of the total area and provided habitat for 31% of all juvenile Chinook in the basin. Virtually no 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 Nason Creek and the Little Wenatchee River (Figure 5.2). Within both the Chiwawa River and its reference areas, pools and multiple channels consistently had the highest densities of juvenile Chinook.

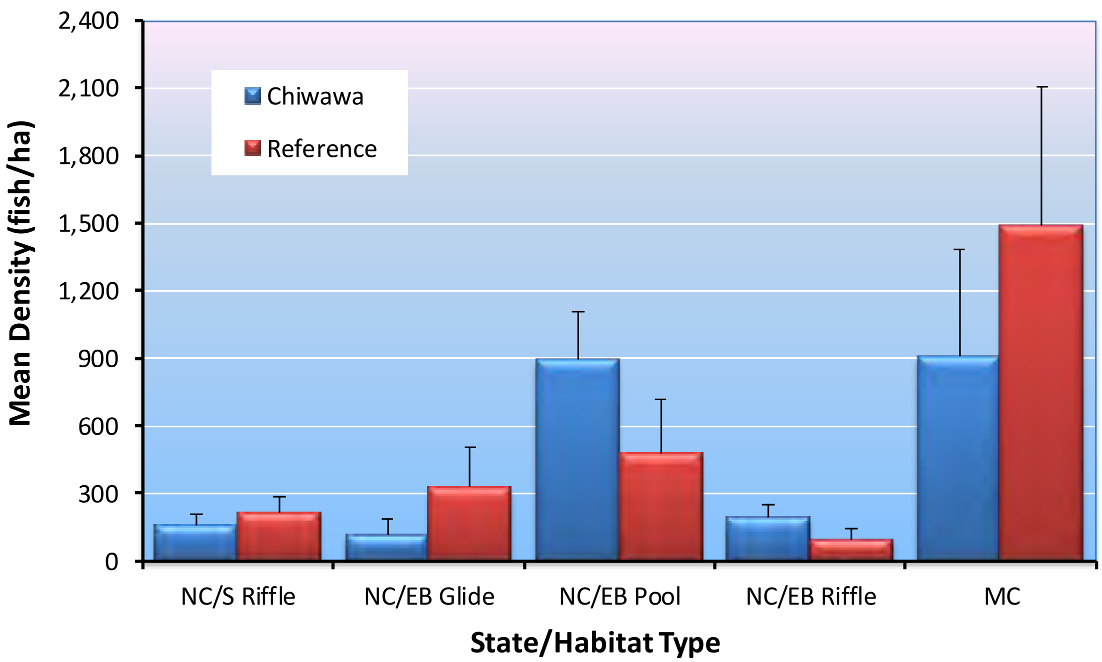


Figure 5.2. Comparison of the 22-year means of subyearling spring Chinook densities within state/habitat types in reaches 3 and 8 of the Chiwawa River and their matched reference areas on Nason Creek and the Little Wenatchee River. NC = natural channel; S = straight channel; EB = eroded banks; MC = multiple 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 2015.

Chiwawa Trap

The Chiwawa Trap operated between 25 February and 24 November 2015. During that time period the trap was inoperable for 29 days because of high and low river flows, debris, and major hatchery releases. The trap operated in two different positions based on season and river discharge; lower position until 30 June and an upper position after 1 July. Daily trap efficiencies were estimated from two regression models depending on trap position and 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 B.

Wild yearling spring Chinook (2013 brood year) were primarily captured from March through May 2015 (Figure 5.3). A significant relationship between trap efficiency and river flow could not be found, therefore a pooled trap efficiency was used and the total number of wild yearling Chinook emigrating from the Chiwawa River was estimated at 39,396 (±8,399). Combining the total number of subyearling spring Chinook (73,695 ±8,464) that emigrated during the fall of 2014 with the total number of yearling Chinook (39,396 ±8,399) that emigrated during 2015, and the number of estimated Chinook that were not trapped (55,971), resulted in a total emigrant estimate of 180,037 spring Chinook for the 2013 brood year (Table 5.15). The method for estimating emigration during the non-trapping period is explained in Appendix B.

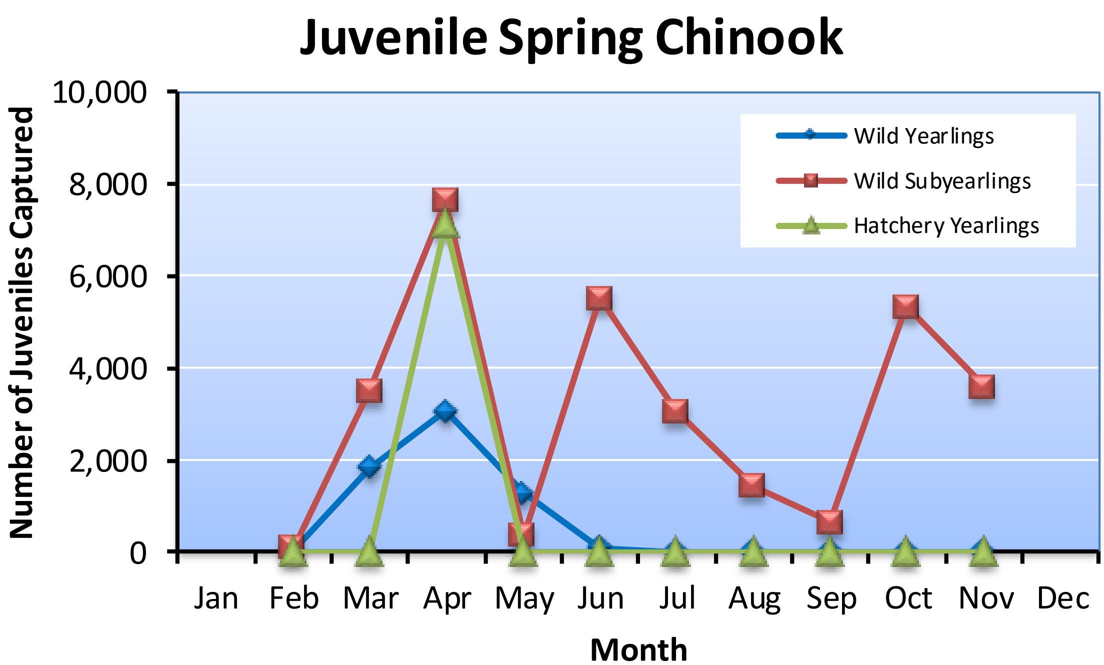


Figure 5.3. Monthly captures of wild subyearling, wild yearling, and hatchery yearling spring Chinook at the Chiwawa Trap, 2015.

Table 5.15. Numbers of redds and juvenile spring Chinook at different life stages in the Chiwawa River basin for brood years 1991-2015; NS = not sampled.

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	28,334	44,562
1998	41	218,325	41,629	23,068	25,923
1999	34	166,090	NS	10,661	15,649
2000	128	642,944	114,617	40,831	55,685
2001	1,078	4,984,672	134,874	86,482	546,266
2002	345	1,605,630	91,278	90,948	184,279
2003	111	648,684	45,177	16,755	33,637
2004	241	1,156,559	49,631	72,080	116,158
2005	332	1,436,564	79,902	69,064	177,659
2006	297	1,284,228	60,752	45,050	107,972
2007	283	1,256,803	82,351	25,809	86,006
2008	689	3,163,888	106,705	35,023	120,184
2009	421	1,925,233	128,220	30,959	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	3,412,184	149,563	34,334	109,413
2013	714	3,367,224	121,240	39,396	180,091
2014	485	1,961,825	111,224	-	-
Average	***324***	***1,466,346***	***82,078***	***37,399***	***100,629***
Median	***290***	***1,270,516***	***79,902***	***35,023***	***75,774***

[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 (2014 brood year) were captured between February and November 2015. Based on capture efficiencies estimated from the flow model for both the upper trap position and lower position, the total number of wild subyearling (fry and parr) Chinook from the Chiwawa River basin was 153,038 (±17,101). Removing fry from the estimate, a total of 77,510 (±9,074) subyearling parr emigrated from the Chiwawa River basin in 2015. Although subyearling parr migrated during all months of sampling, the majority (82%) migrated during March, April, June, October, and November (Figure 5.3).

Yearling spring Chinook sampled in 2015 averaged 93 mm in length, 8.8 g in weight, and had a mean condition of 1.09 (Table 5.16). These size estimates were similar to the overall mean of yearling spring Chinook sampled in previous years (overall means: 93 mm, 9.1 g, and condition of 1.08). Subyearling spring Chinook sampled in 2015 at the Chiwawa Trap averaged 71 mm in length, averaged 4.2 g, and had a mean condition of 1.10 (Table 5.16). In general, subyearlings were a little smaller than previous years (overall means, 76 mm, 5.3 g, and condition of 1.09).

Table 5.16. Mean fork length (mm), weight (g), and condition factor of subyearling (excluding fry) and yearling spring Chinook collected in the Chiwawa Trap, 1996-2015. 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)
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)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
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)
Average	***Subyearling***	***5,257***	***76 (12)***	***5 (2.3)***	***1.10 (0.16)***
	Yearling	***3,531***	***93 (8)***	***9 (2.7)***	***1.08 (0.12)***
Median	***Subyearling***	***3,816***	***75 (11)***	***5 (2.2)***	***1.11 (0.11)***
	Yearling	***3,035***	***94 (8)***	***9 (2.6)***	***1.09 (0.10)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Lower Wenatchee Trap

The lower Wenatchee Trap operated in a new location beginning in 2013. Hence, historic flow-discharge relationships are invalid and new models to estimate trap efficiency are being developed for all species.

The Lower Wenatchee Trap operated between 30 January and 28 June 2015. During that time period the trap was inoperable for five days because of high and low river discharge, debris, elevated river temperature, and major hatchery releases. During the sampling period, a total of 1,559 wild yearling Chinook, 252,293 wild subyearling Chinook (mostly summer Chinook), and 9,921 hatchery yearling Chinook were captured at the Lower Wenatchee Trap. Based on capture efficiencies using the flow efficiency model, the total number of wild yearling Chinook that emigrated past the Lower Wenatchee Trap was 58,595 (±6,731). Monthly captures of all fish collected at the Lower Wenatchee Trap are reported in Appendix B.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 20,663 wild juvenile Chinook (12,982 subyearling and 7,681 yearlings) were PIT tagged and released in 2015 in the Wenatchee River basin (Table 5.17a). Most of these (82.9%) were tagged at the Chiwawa trap. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 5.17a. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2015. Numbers of fish that died or shed tags are also given.

Sampling Location	Species and Life Stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
Chiwawa Trap	Wild Subyearling Chinook	31,152	169	10,471	414	0	10,471	1.33
	Wild Yearling Chinook	6,350	218	6,204	44	0	6,204	0.69

Sampling Location	Species and Life Stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
	Total	**37,502**	**387**	**16,675**	**458**	**0**	**16,675**	**1.22**
Chiwawa River (Electrofishing)	Wild Subyearling Chinook	1,103	0	1,054	20	0	1,054	1.81
	Wild Yearling Chinook	0	0	0	0	0	0	--
	Total	1,103	0	1,054	20	0	1,054	1.81
Nason Creek Trap	Wild Subyearling Chinook	548	0	219	9	0	219	1.64
	Wild Yearling Chinook	152	0	142	5	0	142	3.29
	Total	**700**	**0**	**361**	**14**	**0**	**361**	**2.00**
Nason Creek (Electrofishing)	Wild Subyearling Chinook	1,143	10	1,089	46	0	1,089	4.02
	Wild Yearling Chinook	0	0	0	0	0	0	--
	Total	1,143	10	1,089	46	0	1,089	4.02
White River Trap	Wild Subyearling Chinook	162	1	150	0	1	149	0.00
	Wild Yearling Chinook	34	0	34	0	0	34	0.00
	Total	**196**	**1**	**184**	**0**	**1**	**183**	**0.00**
Lower Wenatchee Trap	Wild Subyearling Chinook	252,293	83	0	282	0	0	0.11
	Wild Yearling Chinook	1,559	1	1,301	17	0	1,301	1.09
	Total	**253,852**	**84**	**1,301**	**299**	**0**	**1,301**	**0.12**
Total:	**Wild Subyearling Chinook**	**286,401**	**263**	**12,983**	**771**	**1**	**12,982**	**0.27**
	Wild Yearling Chinook	**8,095**	**219**	**7,681**	**66**	**0**	**7,681**	**0.82**
Grand Total:		***294,496***	***482***	***20,664***	***837***	***1***	***20,663***	***0.28***

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2006-2015 are shown in Table 5.17b.

Table 5.17b. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2006-2015. ND = no data because the trap was removed.

Sampling Location	Species and Life Stage	Numbers of PIT-tagged Chinook salmon released									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chiwawa Trap	Wild Subyr Chinook	5,130	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471
	Wild Yearling Chinook	2,793	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204
	Total	**7,923**	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**
Chiwawa River (Angling or Electrofishing)	Wild Subyr Chinook	111	20	43	128	531	0	3,181	3,017	1,032	1,054
	Wild Yearling Chinook	0	0	0	3	4	0	0	0	0	0
	Total	**111**	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**
Upper Wenatchee Trap	Wild Subyr Chinook	0	15	0	37	3	1	1	0	ND	ND
	Wild Yearling Chinook	81	1,434	159	296	486	714	75	94	ND	ND
	Total	**81**	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**ND**	**ND**
Nason Creek Trap	Wild Subyr Chinook	1,434	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219
	Wild Yearling Chinook	365	577	894	185	364	147	357	237	456	142

Sampling Location	Species and Life Stage	Numbers of PIT-tagged Chinook salmon released									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Total	**1,799**	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**
Nason Creek (Angling or Electrofishing)	Wild Subyr Chinook	68	6	4	701	595	0	0	0	1,816	1,089
	Wild Yearling Chinook	1	7	0	13	3	0	0	0	0	0
	Total	**69**	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**
White River Trap	Wild Subyr Chinook	0	0	0	441	143	144	285	374	156	149
	Wild Yearling Chinook	0	0	0	265	359	65	180	22	49	34
	Total	**0**	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**
Upper Wenatchee (Angling or Electrofishing)	Wild Subyr Chinook	0	61	1	0	2	0	0	0	0	0
	Wild Yearling Chinook	27	0	0	0	0	0	0	0	0	0
	Total	**27**	**61**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**
Middle Wenatchee (Angling or Electrofishing)	Wild Subyr Chinook	0	0	65	284	233	0	0	0	0	0
	Wild Yearling Chinook	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**65**	**284**	**233**	**0**	**0**	**0**	**0**	**0**
Lower Wenatchee (Angling or Electrofishing)	Wild Subyr Chinook	0	0	0	0	0	0	0	0	0	0
	Wild Yearling Chinook	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Peshastin Creek (Angling or Electrofishing)	Wild Subyr Chinook	0	0	0	0	1	0	0	0	0	0
	Wild Yearling Chinook	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
Lower Wenatchee Trap	Wild Subyr Chinook	0	0	2	0	0	0	0	0	36	0
	Wild Yearling Chinook	522	1,641	506	468	917	0	0	1,712	1,506	1,301
	Total	**522**	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**
Total:	**Wild Subyr Chinook**	**6,743**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**
	Wild Yearling Chinook	**3,789**	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**
Grand Total:		***10,532***	***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***

Freshwater Productivity

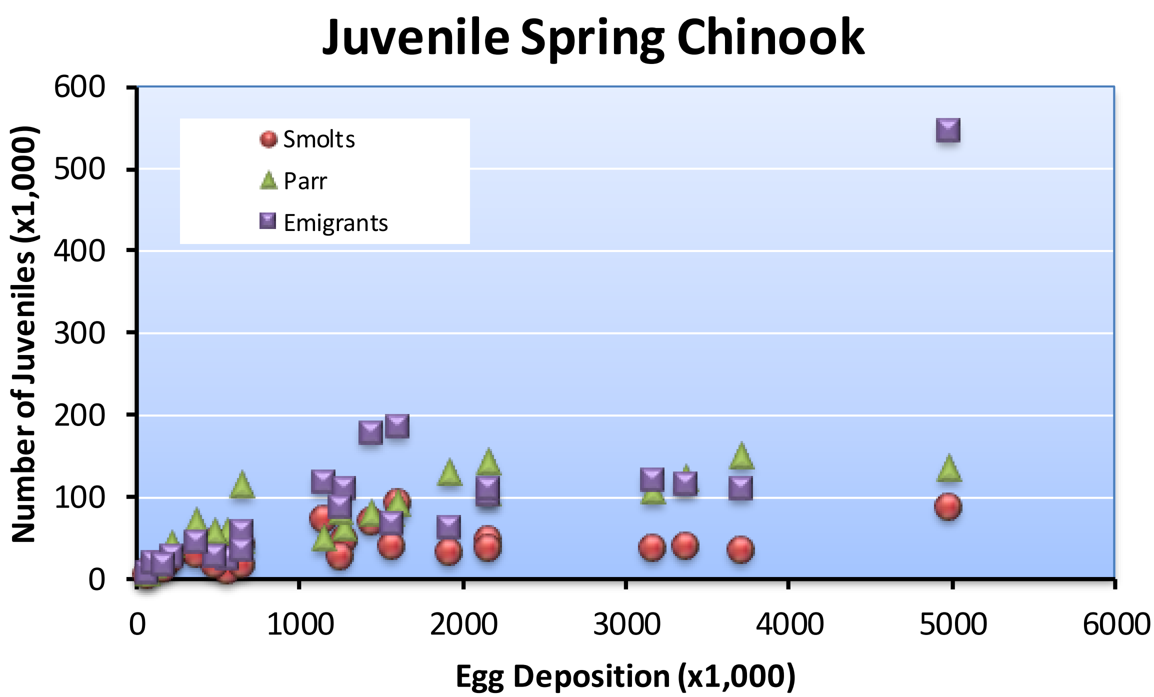
Both productivity and survival estimates for different life stages of spring Chinook in the Chiwawa River basin are provided in Table 5.18. Estimates for brood year 2013 fall within the ranges estimated over the period of brood years 1991-2013. During that period, freshwater productivities ranged from 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 5.18. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Chiwawa River basin for brood years 1991-2014; ND = no data. These estimates were derived from data in Table 5.15.

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
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	241	208	535	5.6	86.4	4.8	12.4
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	--	--	5.7	--	--	--
Average	***393***	***216***	***371***	***8.1***	***52.7***	***4.5***	***7.8***
Median	***282***	***152***	***335***	***6.5***	***39.3***	***3.4***	***7.6***

[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 5.4). 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.



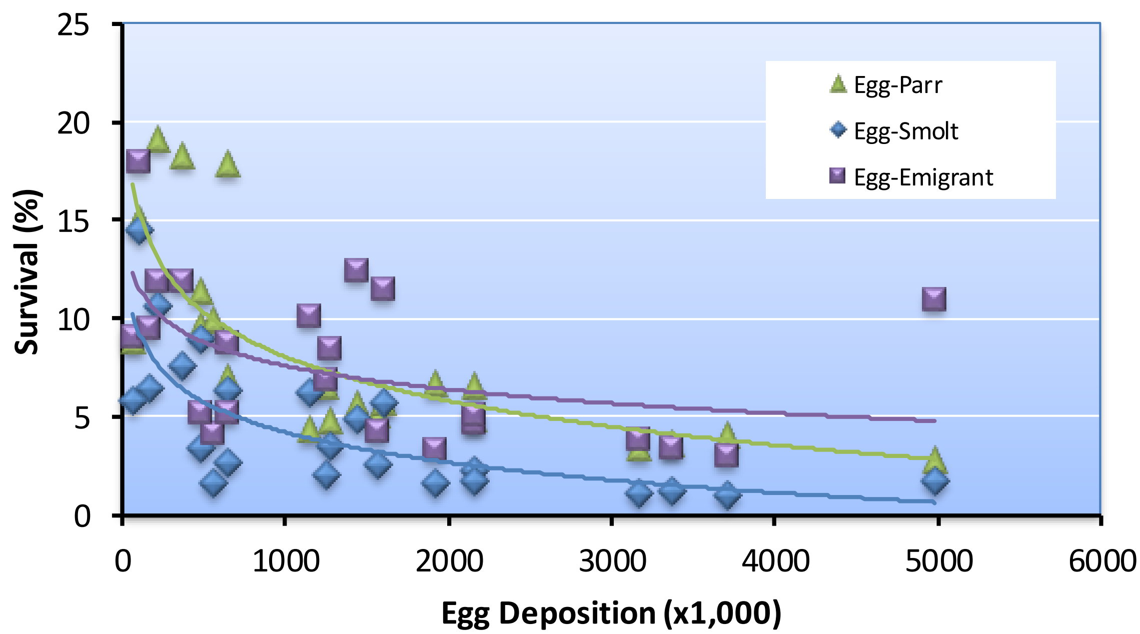


Figure 5.4. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Chiwawa spring Chinook, brood years 1991-2013. Smolts represent yearling Chinook produced within the Chiwawa River basin.

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).[8] 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 C in Hillman et al. 2012 for a detailed description of methods). This model explains most of the information contained in the juvenile spring Chinook data (see Appendix A).

Based on the smooth hockey stick model, the population carrying capacity for spring Chinook parr in the Chiwawa River basin is 110,747 parr (95% CI: 93,130 – 135,644) (Figure 5.5). The capacity for spring Chinook smolts is 45,815 (95% CI: 34,050 – 57,412) (Figure 5.6). 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.

[8] 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.

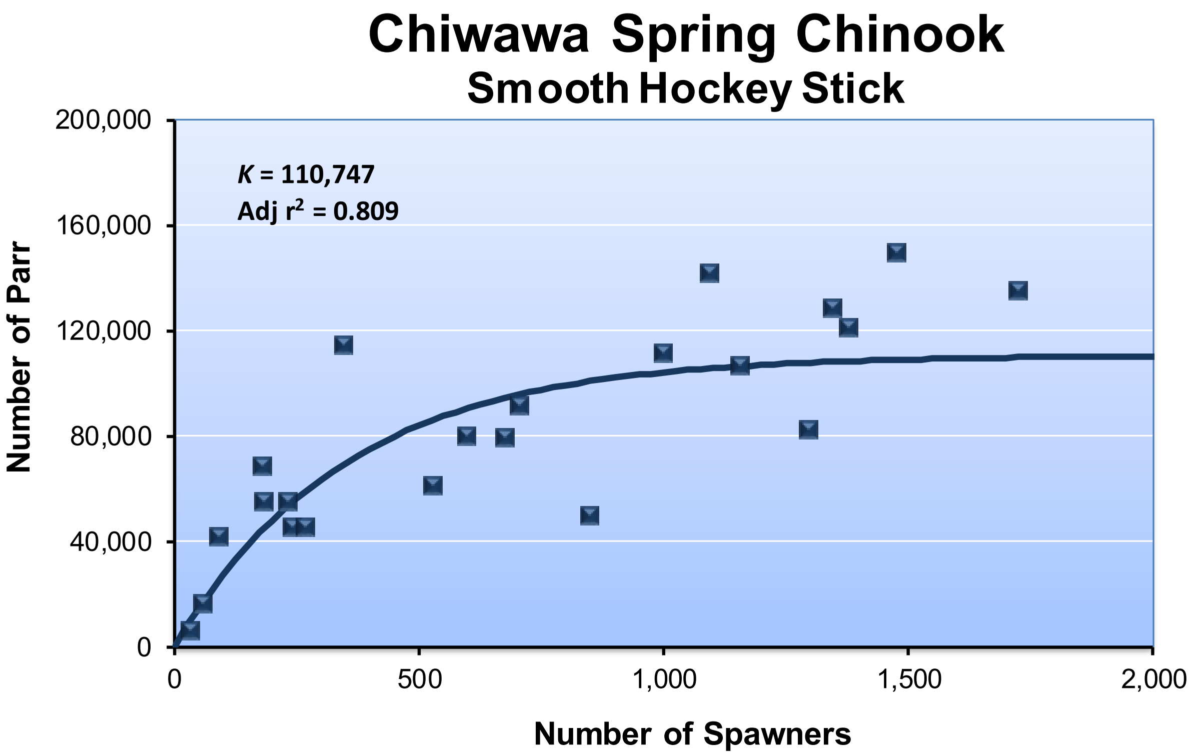


Figure 5.5. Relationship between spawners and number of parr produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data.

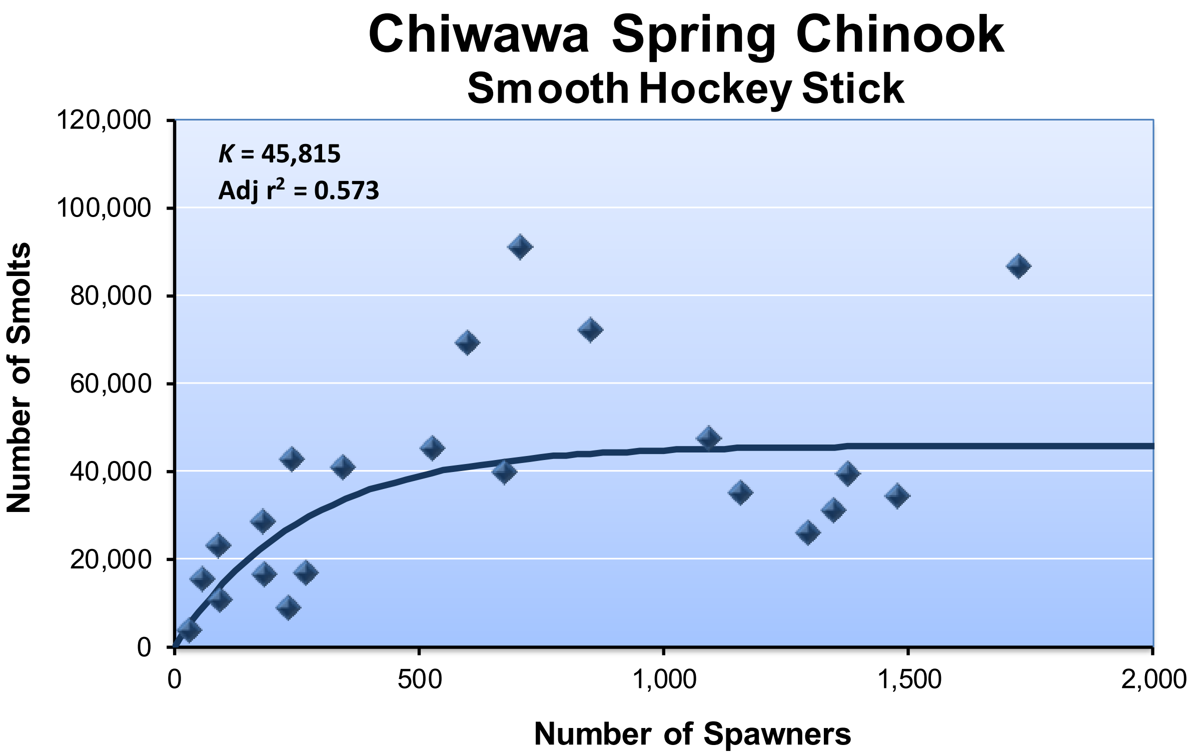


Figure 5.6. Relationship between spawners and number of yearling smolts produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data.

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 5.19; Figure 5.7). This was also apparent in the estimates of population carrying capacity (Figure 5.8). 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 5.19. 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	SE	*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	28174.86	34,022	163	625	0.562
7	10.47	70.66	173.00	1918.57	35,362	173	613	0.567
8	10.40	13.26	206.97	41705.63	32,750	207	474	0.513
9	10.43	16.70	190.98	96463.71	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	246309.06	66,371	154	1,291	0.653
12	11.31	71.48	150.98	2254.06	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

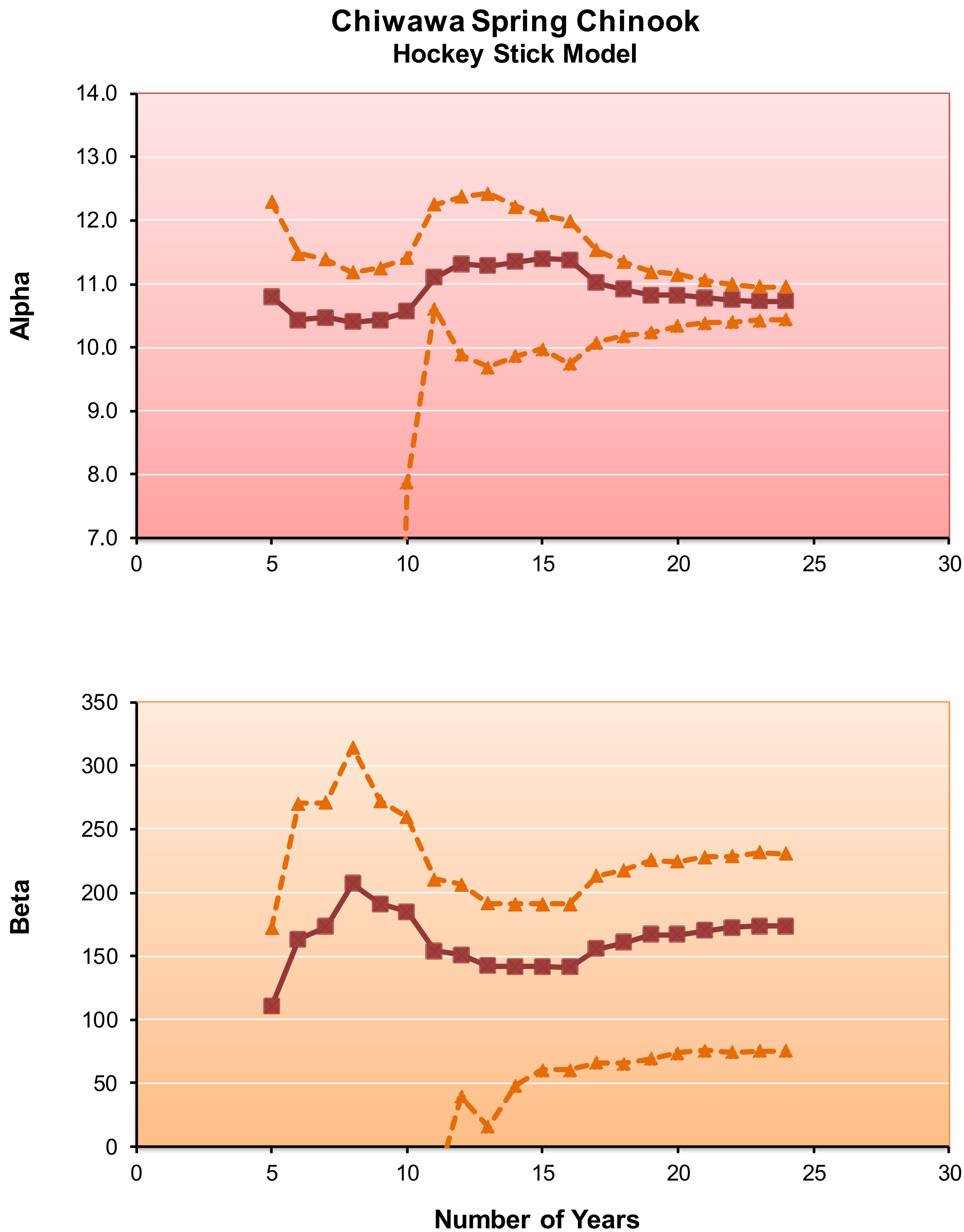


Figure 5.7. Time series of alpha and beta parameters and 95% confidence intervals for the smooth hockey stick model that was fit to Chiwawa spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

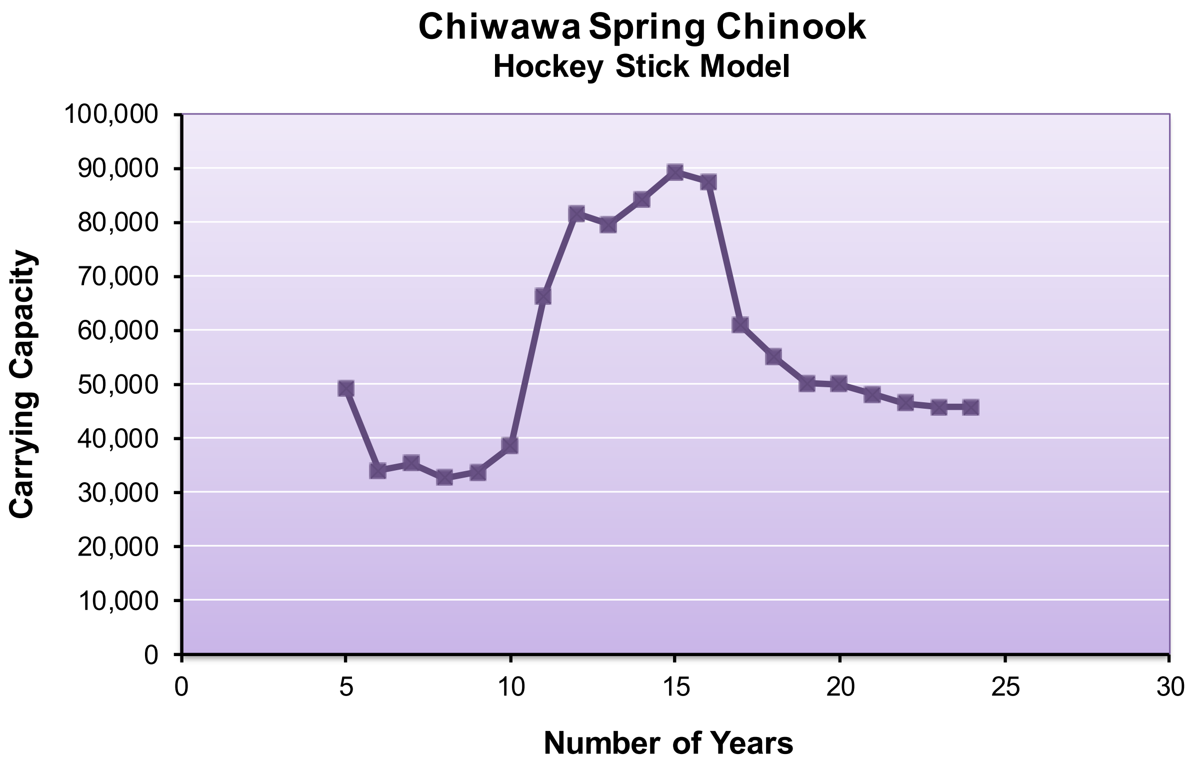


Figure 5.8. Time series of population carrying capacity estimates derived from fitting the smooth hockey stick model to Chiwawa spring Chinook smolt and spawning escapement data.

5.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during August through September, 2015, in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin 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 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. WDFW is currently developing a method to estimate spawning escapement using the area-under-the-curve (AUC) method (Millar et al. 2012). Model development is currently underway.

Redd Counts

A total of 923 spring Chinook redds were counted in the Wenatchee River basin in 2015 (Table 5.20). This is higher than the average of 665 redds counted during the period 1989-2014 in the Wenatchee River basin. Most spawning occurred in the Chiwawa River (58.8% or 543 redds) (Table 5.20; Figure 5.9). Nason Creek contained 9.2% (85 redds), Icicle Creek contained 14.3% (132 redds), White River contained 7.6% (70 redds), Little Wenatchee contained 3.0% (28 redds), the Upper Wenatchee River 6.0% (55 redds), and Peshastin Creek contained 1.1% (10 redds).

Table 5.20. Numbers of spring Chinook redds counted within different streams/watersheds within the Wenatchee River basin, 1989-2015. 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 total or average calculations. WDFW began full implementation of adult management in 2014.

Sample 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	239	169	13	22	46	30	55	**574**
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**
Average	***329***	***144***	***28***	***35***	***48***	***70***	***10***	***674***
Median	***297***	***103***	***28***	***26***	***36***	***40***	***4***	***588***

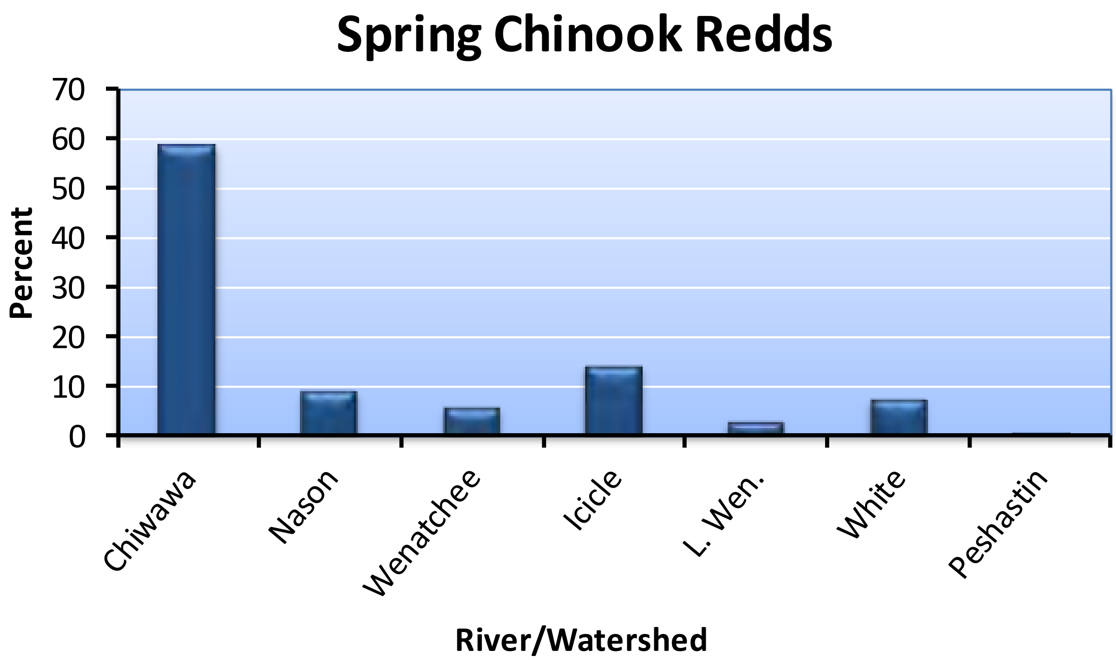


Figure 5.9. Percent of the total number of spring Chinook redds counted in different streams/watersheds within the Wenatchee River basin during August through September, 2015.

Redd Distribution

Spring Chinook redds were not evenly distributed among reaches within survey streams in 2015 (Table 5.21). Most of the spawning in the Chiwawa River basin occurred in Reaches 1 through 6. About 73% 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 40% of the Nason Creek redds. In the Little Wenatchee River, about 89% of all spawning occurred in Reach 3 (RKM 9.2-14.0; Lost Creek to Falls). On the White River, 90% of the spawning occurred in Reach 3 (RKM 20.3-23.3; Napeequa River to Grasshopper Meadows). About 78% of all the spawning in the Wenatchee River occurred upstream from the mouth of the Chiwawa River. In Icicle Creek, about 73% of spawning occurred in Reach 2 (RKM 4.9-6.7; Hatchery to Sleeping Lady). All the spawning in Peshastin Creek occurred above Camas Creek (RKM 9.0).

Table 5.21. Numbers and proportions of spring Chinook redds counted within different streams/watersheds within the Wenatchee River basin during August through September, 2015. NS = not surveyed. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of redds	Proportion of redds within stream/watershed
Chiwawa	Chiwawa 1 (C1)	173	0.32
	Chiwawa 2 (C2)	222	0.41
	Chiwawa 3 (C3)	22	0.04
	Chiwawa 4 (C4)	35	0.06
	Chiwawa 5 (C5)	33	0.06

Stream/watershed	Reach	Number of redds	Proportion of redds within stream/watershed
	Chiwawa 6 (C6)	52	0.10
	Chiwawa 7 (C7)	2	0.00
	Phelps 1 (S1)	NS	--
	Rock 1 (R1)	3	0.01
	Chikamin 1 (K1)	1	0.00
	Total	**543**	**1.00**
Nason	Nason 1 (N1)	15	0.18
	Nason 2 (N2)	23	0.27
	Nason 3 (N3)	34	0.40
	Nason 4 (N4)	13	0.15
	Total	**85**	**1.00**
Little Wenatchee	Little Wen 2 (L2)	3	0.11
	Little Wen 3 (L3)	25	0.89
	Total	**28**	**1.00**
White	White 2 (H2)	4	0.06
	White 3 (H3)	63	0.90
	White 4 (H4)	2	0.03
	Napeequa 1 (Q1)	1	0.01
	Panther 1 (T1)	0	0.00
	Total	**70**	**1.00**
Wenatchee River	Wen 9 (W9)	12	0.22
	Wen 10 (W10)	43	0.78
	Chiwaukum (U1)	0	0.00
	Total	**55**	**1.00**
Icicle	Icicle 1 (I1)	10	0.08
	Icicle 2 (I2)	96	0.73
	Icicle 3 (I3)	26	0.20
	Total	**132**	**1.00**
Peshastin	Peshastin 1 (P1)	0	0.00
	Peshastin 2 (P2)	10	1.00
	Ingalls (D1)	0	0.00
	Total	**10**	**1.00**
Grand Total		***923***	***1.00***

Spawn Timing

Spring Chinook began spawning during the first week of August in the Chiwawa and White rivers, the second week of August in Nason Creek, and the end of August in Icicle Creek, Peshastin Creek, Little Wenatchee River, and the Wenatchee River (Figure 5.10). Spawning peaked the first week of September in Icicle Creek and Peshastin Creek. The Chiwawa River, White River, and the Little

Wenatchee River experienced peak spawning during the second week of September. Spawning in the Chiwawa River may have peaked during the first week of September, but because of wildfires, no surveys were conducted in the Chiwawa River basin at that time. Spawning in the Wenatchee River and Nason Creek peaked the third week of September. All spawning was completed by the end of September.

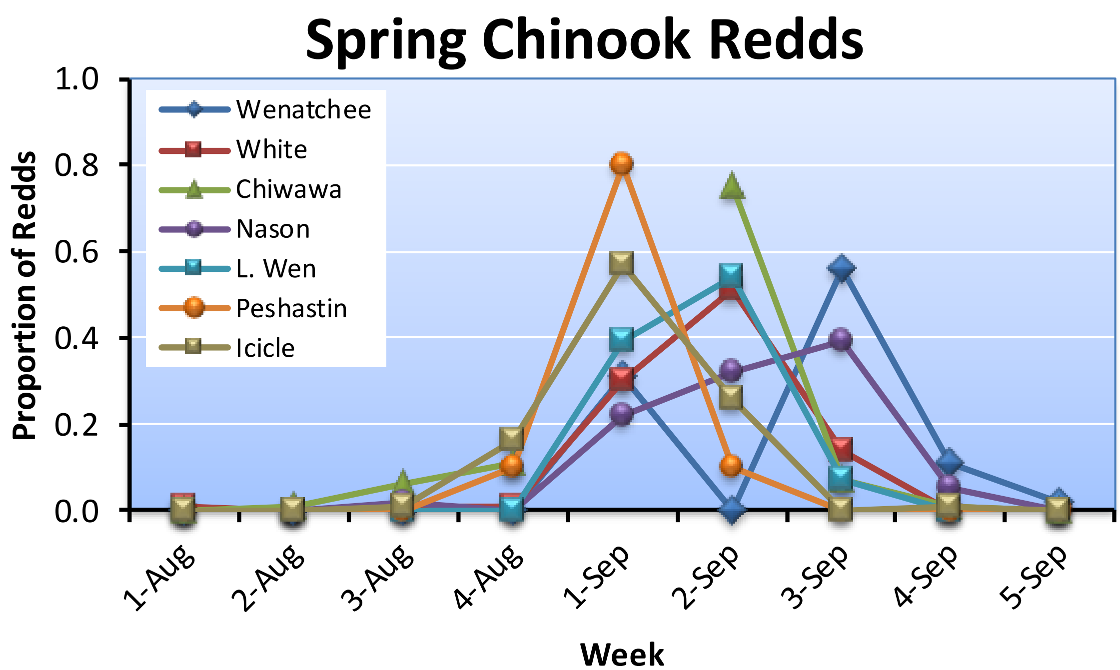


Figure 5.10. Proportion of spring Chinook redds counted during different weeks in different sampling streams within the Wenatchee River basin, August through September 2015.

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. The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2015 was 1.78 (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 1.92 (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 1,663 spring Chinook (Table 5.22). The Chiwawa River basin had the highest spawning escapement (967 Chinook), while Peshastin Creek had the lowest (19 Chinook).

Table 5.22. Number of redds, fish per redd ratios, and total spawning escapement for spring Chinook in the Wenatchee River basin, 2015. 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	543	1.78	967
Nason	85	1.78	151

Sampling area	Total number of redds	Fish/redd	Total spawning escapement*
Upper Wenatchee River	55	1.78	98
Icicle	132	1.92	253
Little Wenatchee	28	1.78	50
White	70	1.78	125
Peshastin	10	1.92	19
Total	***923***	**--**	***1,663***

* Spawning escapement estimate is based on total number of 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 1,663 spring Chinook in 2015 was greater than the overall average of 1,476 spring Chinook (Table 5.23). The escapement in the Chiwawa River basin in 2015 was 3.8 times the escapement in Icicle Creek, the second most abundant escapement in the Wenatchee River basin (Table 5.23).

Table 5.23. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2015; 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	2.27	54	NA	**1,449**
1990	2.24	571	231	67	49	81	2.24	112	9	**1,120**
1991	2.33	242	156	42	49	96	2.33	93	2	**680**
1992	2.24	676	181	78	78	85	2.24	83	0	**1,181**
1993	2.20	233	491	134	145	189	2.20	117	11	**1,320**
1994	2.24	184	60	16	7	13	2.24	34	0	**314**
1995	2.51	33	18	0	5	3	2.51	23	0	**82**
1996	2.53	58	83	8	30	3	2.53	30	3	**215**
1997	2.22	182	122	18	33	33	2.22	73	2	**463**
1998	2.21	91	64	18	11	0	2.21	24	0	**208**
1999	2.77	94	22	8	3	6	2.77	17	0	**150**
2000	2.70	346	270	24	22	100	2.70	184	0	**946**
2001	1.60	1,725	598	118	166	349	1.60	141	277	**3,374**
2002	2.05	707	603	86	86	131	2.05	502	219	**2,334**
2003	2.43	270	202	29	36	58	2.43	44	146	**785**
2004[a]	3.56/3.00	851	507	39	66	138	1.79	54	98	**1,753**
2005	1.80	599	347	115	155	257	1.75	14	5	**1,492**
2006	1.78	529	271	37	55	48	1.80	90	18	**1,048**
2007	4.58	1,296	463	101	92	55	1.86	32	20	**2,059**
2008	1.68	1,158	565	64	52	302	1.77	205	37	**2,383**
2009	3.20	1,347	534	125	173	16	2.72	87	41	**2,323**
2010	2.18	1,094	410	83	72	102	2.72	422	14	**2,197**
2011	4.13	2,032	702	124	83	50	2.66	325	69	**3,385**
2012	1.68	1,478	694	72	144	123	1.90	378	19	**2,908**
2013	1.93	1,378	409	98	104	33	1.75	187	7	**2,216**

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
2014	2.06	999	237	52	54	47	2.01	424	0	**1,813**
2015	1.78	967	151	50	125	98	1.92	253	19	**1,663**
Average	***--***	***735***	***319***	***63***	***76***	***97***	***--***	***148***	***39***	***1,476***
Median	***--***	***676***	***270***	***64***	***66***	***81***	***--***	***90***	***10***	***1,449***

[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, 2015, in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin 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 450 spring Chinook carcasses were sampled during August through September in the Wenatchee River basin (Table 5.24). Most were sampled in the Chiwawa River basin (61% or 275 carcasses) and Icicle Creek (15% or 67 carcasses) (Figure 5.11). A total of 43 carcasses were sampled in Nason Creek, 25 in the upper Wenatchee River, 25 in the White River, 12 in the Little Wenatchee River, and 3 in Peshastin Creek.

Table 5.24. Numbers of spring Chinook carcasses sampled within different streams/watersheds within the Wenatchee River basin, 1996-2015.

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	**671**
2014	320	68	15	8	19	44	0	**474**
2015	275	43	12	25	25	67	3	**450**
Average	***234***	***148***	***16***	***18***	***34***	***42***	***13***	***505***
Median	***225***	***135***	***13***	***13***	***21***	***38***	***2***	***469***

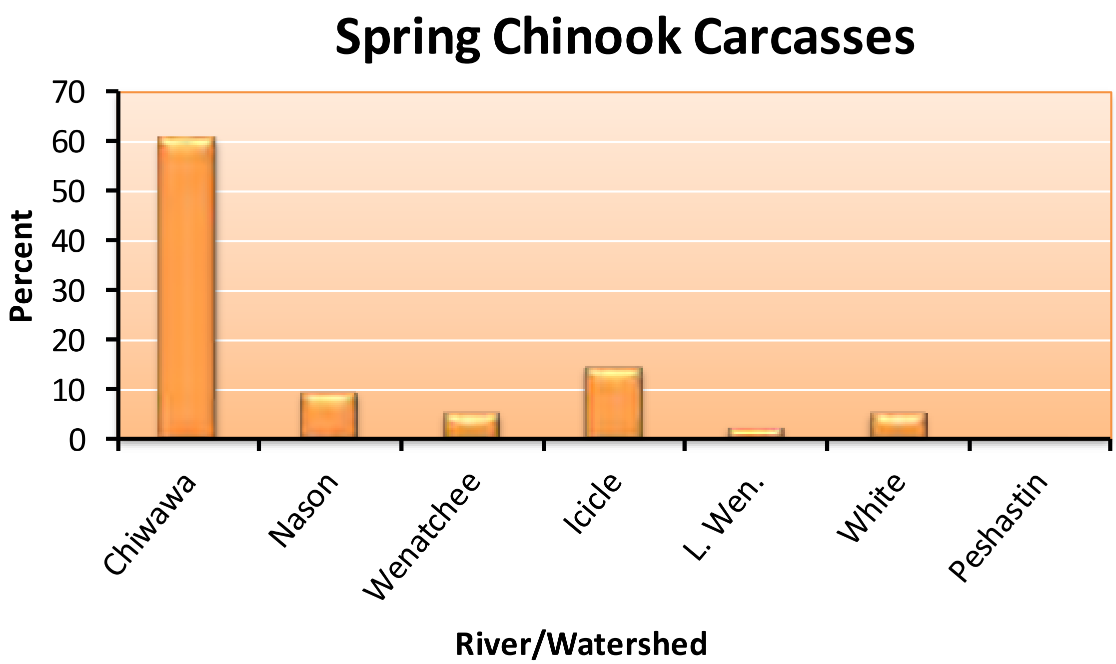


Figure 5.11. Percent of the total number of spring Chinook carcasses sampled in different streams/watersheds within the Wenatchee River basin during August through September, 2015.

Carcass Distribution and Origin

Spring Chinook carcasses were not evenly distributed among reaches within survey streams in 2015 (Table 5.25). Most of the carcasses (75%) in the Chiwawa River basin occurred in Reaches 1 and 2 (downstream from Rock Creek). In Nason Creek, most carcasses (63%) were collected in Reach 3 and the fewest (5%) in Reach 4. All of the carcasses in the Little Wenatchee River were sampled in Reach 3 (Lost Creek to Rainy Creek). On the White River, most (80%) occurred in Reach 3 (Napeequa River to Grasshopper Meadows). On the Wenatchee River, 84% of the carcasses were found upstream from the confluence of the Chiwawa River and 16% were found downstream from the confluence. Most of the carcasses in Icicle Creek (67%) were found in Reach 2 (Hatchery to Sleeping Lady). All the carcasses in Peshastin Creek were found in Reach 2.

Table 5.25. Numbers and proportions of carcasses sampled within different streams/watersheds within the Wenatchee River basin during August through September, 2015. 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)	79	0.29
	Chiwawa 2 (C2)	126	0.46
	Chiwawa 3 (C3)	13	0.05
	Chiwawa 4 (C4)	21	0.08
	Chiwawa 5 (C5)	18	0.07
	Chiwawa 6 (C6)	18	0.07
	Chiwawa 7 (C7)	0	0.00
	Phelps 1 (S1)	NS	--
	Rock 1 (R1)	0	0.00
	Chikamin 1 (K1)	0	0.00
	Total	**275**	**1.00**
Nason	Nason 1 (N1)	10	0.23
	Nason 2 (N2)	4	0.09
	Nason 3 (N3)	27	0.63
	Nason 4 (N4)	2	0.05
	Total	**43**	**1.00**
Little Wenatchee	Little Wen 2 (L2)	0	0.00
	Little Wen 3 (L3)	12	1.00
	Total	**12**	**1.00**
White	White 2 (H2)	5	0.20
	White 3 (H3)	20	0.80
	White 4 (H4)	0	0.00
	Napeequa 1 (Q1)	0	0.00
	Panther 1 (T1)	0	0.00
	Total	**25**	**1.00**
Wenatchee River	Wen 9 (W9)	4	0.16
	Wen 10 (W10)	21	0.84
	Chiwaukum 1	0	0.00
	Total	**25**	**1.00**
Icicle	Icicle 1 (I1)	7	0.10
	Icicle 2 (I2)	45	0.67
	Icicle 3 (I3)	15	0.22
	Total	**67**	**1.00**
Peshastin	Peshastin 1 (P1)	0	0.00
	Peshastin 2 (P2)	3	1.00
	Ingalls (D1)	0	0.00

Stream/watershed	Reach	Number of carcasses	Proportion of carcasses within stream/watershed
	Total	**3**	**1.00**
Grand Total		**450**	**1.00**

Of the 272 carcasses sampled in the Chiwawa River basin in 2015, 66% were hatchery fish (Table 5.26). In the Chiwawa River basin, the spatial distribution of hatchery and wild fish was not equal (Table 5.26). A larger percentage of hatchery fish were found in the lower reaches (C1 and C2; i.e., Mouth to Rock Creek) than were wild fish. This general trend was also apparent in the pooled data (Figure 5.12).

Table 5.26. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Chiwawa River basin, 1993-2015. 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**
	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**

Survey year	Origin	Survey Reach									Total
		C-1	C-2	C-3	C-4	C-5	C-6	C-7	Chikamin	Rock	
	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	15	37	6	12	12	13	0	0	0	**95**
	Hatchery	64	89	7	9	6	5	0	0	0	**180**
Average	***Wild***	***10***	***25***	***4***	***9***	***6***	***6***	***0***	***0***	***0***	***61***
	Hatchery	***57***	***57***	***5***	***8***	***5***	***7***	***0***	***2***	***2***	***143***
Median	***Wild***	***8***	***21***	***3***	***6***	***4***	***2***	***0***	***0***	***0***	***45***
	Hatchery	***46***	***40***	***2***	***5***	***4***	***5***	***0***	***0***	***1***	***128***

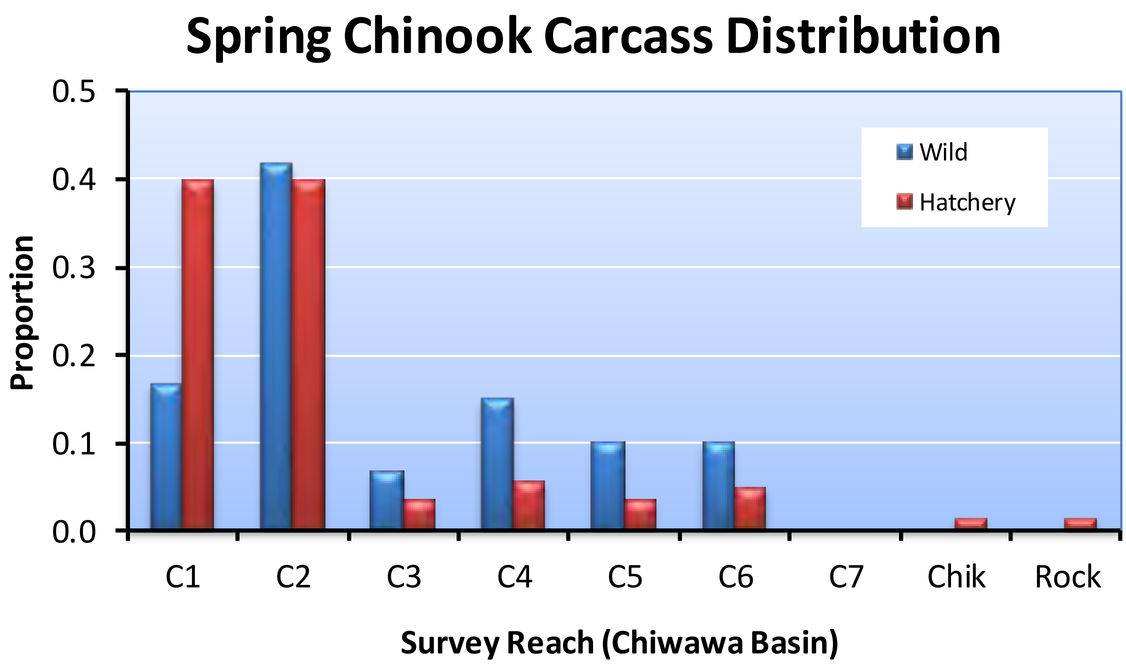


Figure 5.12. Distribution of wild and hatchery produced carcasses in different reaches in the Chiwawa River basin, 1993-2015; Chik = Chikamin Creek and Rock = Rock Creek. Reach codes are described in Table 2.8.

Sampling Rate

Overall, 27% of the estimated total spawning escapement of spring Chinook in the Wenatchee River basin was sampled in 2015 (Table 5.27). Sampling rates among streams/watershed varied from 16 to 28%.

Table 5.27. Number of redds and carcasses, total spawning escapement, and sampling rates for spring Chinook salmon in the Wenatchee River basin, 2015.

Sampling area	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chiwawa	543	275	967	0.28
Nason	85	43	151	0.28
Upper Wenatchee	55	25	98	0.26
Icicle	132	67	253	0.26
Little Wenatchee	28	12	50	0.24
White	70	25	125	0.20
Peshastin	10	3	19	0.16
Total	***923***	***450***	***1,663***	***0.27***

Length Data

Mean lengths (POH, cm) of male and female spring Chinook carcasses sampled during surveys in the Wenatchee River basin in 2015 are provided in Table 5.28. The average size of males and females sampled in the Wenatchee River basin was 63 cm.

Table 5.28. 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, 2015.

Stream/watershed	Mean lengths (cm)	
	Male	Female
Chiwawa	63 (8.5)	63 (4.4)
Nason	59 (9.9)	61 (4.7)
Upper Wenatchee	61 (7.6)	61 (4.6)
Icicle	67 (9.5)	64 (4.2)
Little Wenatchee	62 (9.2)	61 (5.2)
White	62 (7.3)	64 (4.9)
Peshastin	--	60 (2.9)
Total	***63 (9.0)***	***63 (4.5)***

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 2015, there was a difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 5.29a and b; Figure 5.13). Hatchery fish arrived at the dam earlier than did wild fish. On average, however, early in the migration, wild Chinook arrived at Tumwater Dam slightly earlier than hatchery fish, but by the end of the migration, both were arriving at about the same time. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 5.13).

Table 5.29a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2015. 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

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	
	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
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
Average	Wild	***168***	-	***183***	-	***198***	-	***183***	-	***954***
	Hatchery	***171***	-	***184***	-	***197***	-	***185***	-	***2,579***
Median	Wild	***171***	-	***186***	-	***201***	-	***185***	-	***993***

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	
	Hatchery	***175***	**-**	***186***	**-**	***197***	**-**	***187***	**-**	***2,659***

Table 5.29b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2015. 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

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	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
Average	Wild	***25***	***27***	***29***	***27***	***954***
	Hatchery	***25***	***27***	***29***	***27***	***2,579***
Median	Wild	***25***	***27***	***29***	***27***	***993***
	Hatchery	***25***	***27***	***29***	***27***	***2,659***

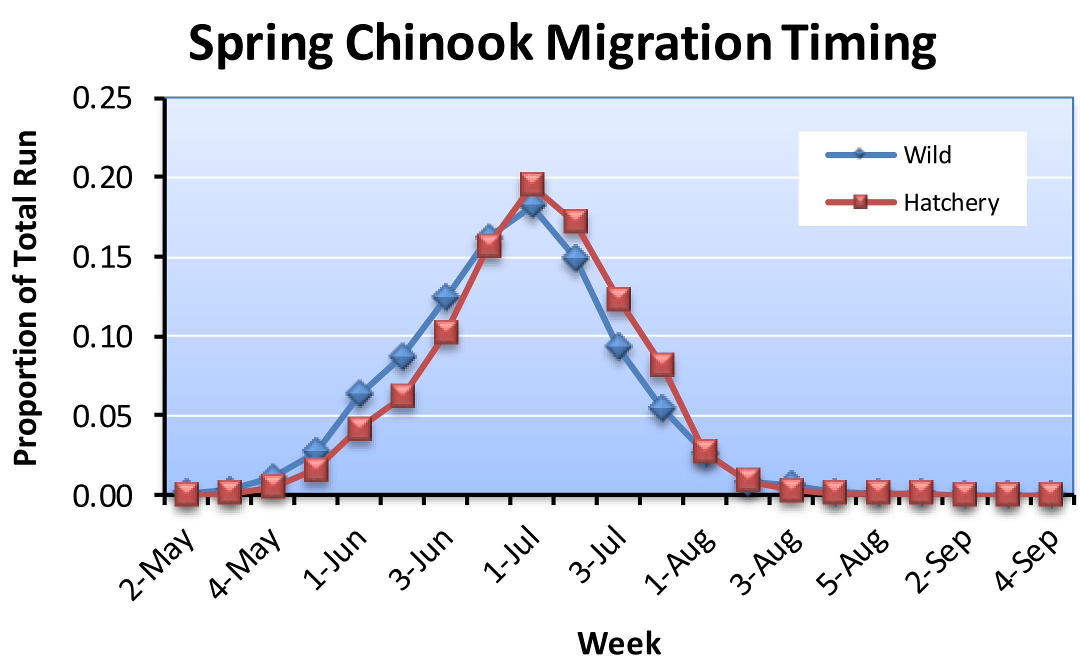


Figure 5.13. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2015.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1994-2015 in the Chiwawa River basin were age-4 fish (total age) (Table 5.30; Figure 5.14). On average, hatchery fish made up a higher percentage of age-3 Chinook than did wild fish. In contrast, 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 5.30. Proportions of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Chiwawa River basin, 1994-2015.

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	95
	Hatchery	0.00	0.07	0.92	0.01	0.00	180
Average	***Wild***	***0.00***	***0.04***	***0.75***	***0.21***	***0.00***	***61***
	Hatchery	***0.00***	***0.11***	***0.83***	***0.06***	***0.00***	***149***
Median	***Wild***	***0.00***	***0.03***	***0.75***	***0.22***	***0.00***	***50***
	Hatchery	***0.00***	***0.08***	***0.90***	***0.03***	***0.00***	***128***

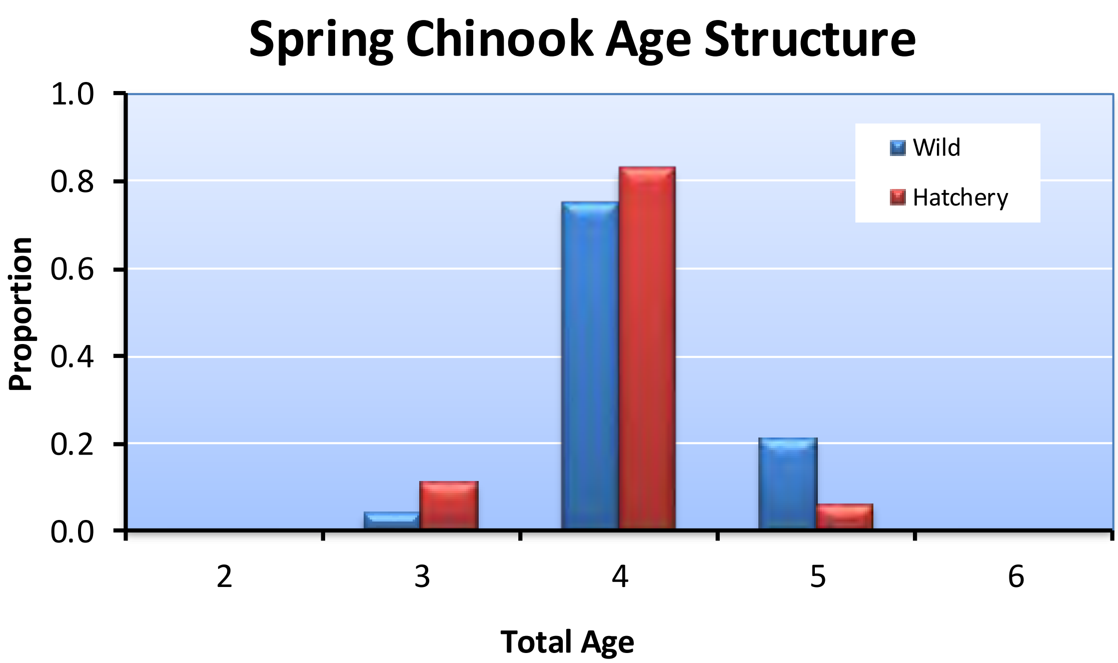


Figure 5.14. Proportions of wild and hatchery spring Chinook of different total ages sampled at the Chiwawa Weir and on spawning grounds in the Chiwawa River basin for the combined years 1994-2014.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed slightly in length (Table 5.31). Differences were usually no more than 1-3 cm between hatchery and wild fish of the same age.

Table 5.31. 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, 1994-2014. Return years 2004-2014 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				
	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)		

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	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				
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)

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	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 (41)	63 ±5 (56)	63 ±4 (120)
	5	75 ±7 (6)	71 ±1 (1)	69 ±6 (9)	73 ±1 (1)
	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 5.32). The largest harvests occurred on the 1997, 1998, and 2004-2009 brood years.

Table 5.32. Estimated number and percent (in parentheses) of hatchery-origin Chiwawa spring Chinook captured in different fisheries, brood years 1989-2010; NP = no hatchery program.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1989	3 (13)	5 (21)	0 (0)	16 (67)	24
1990	0 (0)	0 (0)	0 (0)	18 (100)	18
1991	0 (0)	3 (100)	0 (0)	0 (0)	3
1992	0 (0)	1 (100)	0 (0)	0 (0)	1
1993	3 (75)	1 (25)	0 (0)	0 (0)	4
1994	0 (0)	0 (0)	0 (0)	0 (0)	0
1995	NP	NP	NP	NP	NP
1996	0 (0)	2 (100)	0 (0)	0 (0)	2
1997	1 (0)	193 (51)	68 (18)	115 (31)	377

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1998	10 (5)	47 (24)	12 (6)	126 (65)	195
1999	NP	NP	NP	NP	NP
2000	0 (0)	17 (74)	0 (0)	6 (26)	23
2001	36 (64)	8 (14)	1 (2)	11 (20)	56
2002	12 (17)	11 (15)	22 (31)	26 (37)	71
2003	18 (21)	29 (35)	11 (13)	26 (31)	84
2004	3 (1)	188 (40)	31 (7)	253 (53)	475
2005	18 (14)	31 (24)	6 (5)	74 (57)	129
2006	32 (4)	469 (60)	77 (10)	201 (26)	779
2007	14 (3)	180 (43)	74 (18)	151 (36)	419
2008	8 (1)	298 (21)	41 (3)	1,047 (75)	1,394
2009	8 (2)	85 (23)	69 (18)	215 (57)	377
2010	0 (0)	370 (64)	45 (8)	163 (28)	578
Average	***8 (11)***	***97 (42)***	***23 (7)***	***122 (35)***	***250***
Median	***3 (1)***	***23 (30)***	***9 (4)***	***26 (31)***	***78***

[a] Includes the Wanapum fishery and the Icicle and Wenatchee fisheries when they occurred.

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 target for brood year stray rates should be less than 5%.

The percentage of the spawning escapement made up of hatchery-origin Chiwawa spring Chinook in non-target spawning areas within the Wenatchee River basin has been high in some years and exceeded the target of 10% (Table 5.33). Chiwawa spring Chinook have strayed into spawning areas on Nason Creek, the White River, the Little Wenatchee River, and the Upper Wenatchee River. On average, Chiwawa spring Chinook made up the highest percentage of the spawning escapement within Nason Creek and the Upper Wenatchee River.

Table 5.33. 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 1992-2014. 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
1995	0	0.0	0	0.0	0	0.0	2	66.7	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.	%
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	27.3
2001	211	35.3	0	0.0	0	0.0	271	77.7	46	39.0	52	31.3
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	29	78.4	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	59.1	49	13.0	7	36.8	98	82.4	45	32.1	15	21.4
2013	281	68.4	15	8.0	0	0.0	24	72.7	5	4.8	10	10.1
2014	204	86.1	19	4.5	0	0.0	41	87.2	0	0.0	1	1.9
Average	***159***	***37.1***	***13***	***7.3***	***2***	***8.4***	***59***	***49.8***	***16***	***13.6***	***18***	***20.0***
Median	***139***	***35.3***	***0***	***0.0***	***0***	***0.0***	***31***	***58.3***	***5***	***4.8***	***6***	***5.9***

Hatchery-origin Chiwawa spring Chinook have strayed into the Methow and Entiat basins (Table 5.34). Based on return year analyses, rates of hatchery-origin Chiwawa spring Chinook straying into these populations have been low in most years. However, during return years 2002, 2006, 2008-2009, and 2011-2013, Chiwawa spring Chinook made up more than 5% of the spawning escapement in the Entiat River basin. In three years, Chiwawa spring Chinook hatchery fish made up more than 20% of the spawning escapement in the Entiat River basin; however, in return year 2014, no strays were detected in the Entiat or Methow River basins.

Table 5.34. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Chiwawa spring Chinook, return years 1992-2014. 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
1996	NS	NS	0	0.0

Return year	Methow River basin		Entiat River basin	
	Number	%	Number	%
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	0.6
2001	0	0.0	1	0.2
2002	0	0.0	34	9.2
2003	0	0.0	6	2.3
2004	0	0.0	0	0.0
2005	10	0.7	15	4.2
2006	8	0.5	24	9.3
2007	9	0.8	4	1.6
2008	12	1.2	61	21.9
2009	9	0.3	15	5.4
2010	10	0.4	18	3.7
2011	51	1.7	190	31.9
2012	13	1.0	133	23.5
2013	9	0.8	24	10.1
2014	0	0.0	0	0.0
Average	***6***	***0.4***	***24***	***5.4***
Median	***0***	***0.0***	***1***	***0.6***

Based on brood year analyses, on average, about 31% of the hatchery returns have strayed into non-target spawning areas, exceeding the target of 5% (Table 5.35). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-81%. In most years, few (<1%) have strayed into non-target hatchery programs.

Table 5.35. 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 1989-2010. Percent strays should be less than 5%.

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
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

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
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	42.1	115	32.5	90	25.4	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	1104	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	47.1	62	2.5	1,144	46.4	99	4.0
2009	746	63.1	53	4.5	356	30.1	27	2.3
2010	790	51.7	365	23.9	348	22.8	25	1.6
Average	***500***	***48.7***	***109***	***19.5***	***341***	***30.9***	***12***	***1.0***
Median	***532***	***49.6***	***72***	***10.5***	***225***	***30.0***	***4***	***0.8***

* 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.

Recently, 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. 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 J). 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 five-year report (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.[9] The larger the 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

[9] 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.

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 5.36). Since brood year 1994, PNI has been less than 0.67.

Table 5.36. Proportionate Natural Influence (PNI) values for the Chiwawa spring Chinook supplementation program for brood years 1989-2015. 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
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	134	0.31	0.43
2015	337	630	0.65	72	0	1.00	0.61
Average	***316***	***420***	***0.47***	***56***	***75***	***0.56***	***0.56***
Median	***242***	***276***	***0.61***	***70***	***51***	***0.44***	***0.50***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; 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 5.37).[10] Over the nine 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 5.37. 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 2005-2013. 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)
2005	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	0.548 (0.038)	18.9 (7.3)	0.008 (0.001)
2011	9,987	0.458 (0.029)	14.2 (7.5)	NA
2012	5,061	0.478 (0.043)	30.9 (6.5)	NA
2013	10,021	0.438 (0.041)	29.5 (5.9)	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

[10] 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.

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 1989-2009, NRR for spring Chinook in the Chiwawa averaged 1.07 (range, 0.01-4.40) if harvested fish were not included in the estimate and 1.18 (range, 0.01-4.81) if harvested fish were included in the estimate (Table 5.38). 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. 2013). 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 5.38). HRRs exceeded the estimated target value of 6.7 in 8 of the 19 years.

Table 5.38. 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 1989-2009; 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	--	66	--	2.00	--	69	--	2.09
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	792	21.74	4.35
1998	48	91	991	349	20.65	3.84	1,186	373	24.71	4.10
1999	NP	94	--	10	--	0.11	--	11	--	0.12
2000	48	346	354	695	7.38	2.01	377	729	7.85	2.11
2001	382	1,725	1,808	309	4.73	0.18	1,864	317	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	851	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	2,616	1,215	6.57	2.30
2007	169	1,296	883	478	5.22	0.37	1,302	571	7.70	0.44
2008	329	1,158	2,465	740	7.49	0.64	3,859	830	11.73	0.72
2009	264	1,347	1,182	349	4.48	0.26	1,559	378	5.91	0.28
Average	***149***	***567***	***932***	***306***	***6.19***	***1.07***	***1,165***	***343***	***7.43***	***1.18***
Median	***100***	***529***	***709***	***255***	***4.90***	***0.37***	***791***	***282***	***6.57***	***0.43***

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 5.39).

Table 5.39. Smolt-to-adult ratios (SARs) for Chiwawa hatchery spring Chinook, brood years 1989-2010.

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
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	2,604	0.00475
2007	292,682	1,300	0.00444
2008	609,286	3,859	0.00633
2009	433,608	1,545	0.00356
2010	342,778	2,092	0.00610
Average	***241,168***	***1,199***	***0.00475***
Median	***219,009***	***947***	***0.00477***

[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 2013 Brood Chiwawa River spring Chinook broodstock was consistent with the 2013 Upper Columbia River salmon and steelhead broodstock objectives and site-based broodstock collection protocols. Specifically, broodstock collection targeted natural-origin fish at Tumwater Dam using genetic assignments. 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 15 May 2013 and concluded on 16 July 2013. Broodstock collection targeted natural-origin spring Chinook and hatchery-origin spring Chinook as needed to attain a minimum 33% natural-origin broodstock and a maximum 33% extraction of the estimated natural-origin return to the Chiwawa River.

The 2013 brood collection retained a total of 75 natural-origin spring Chinook. The brood successfully met the minimum targeted 33% natural-origin composition. 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.

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 1196 (expired).

No additional spring Chinook were handled and released as a function of maintaining, at minimum, 33% natural-origin spring Chinook in the broodstock.

Hatchery Rearing and Release

The rearing and release of 2013 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 2013 brood Chiwawa spring Chinook smolts totaled 147,480 fish, representing 102.4% of the program objective of 144,023 smolts and complied with the ESA Section 10 Permit 18121 program not to exceed level of 158,425 smolts.

Hatchery Effluent Monitoring

Per ESA Permits 1196 (expired), 1347, 1395, 18118, 18119, and 18121, 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 Chelan PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2015 are provided in Appendix F.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1196 (expired) 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 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 2015 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 5.40. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 1196, Section B.

Table 5.40. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2015.

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	39,396	147,480	77,510	6,350	7,148	31,152	44,650	
Encounter rate	NA	NA	NA	0.1612	0.0485	0.4019	0.1667	0.20
Mortality[e]	NA	NA	NA	42	0	414	456	
Mortality rate	NA	NA	NA	0.0066	0.0000	0.0133	0.0102	0.02
Lower Wenatchee Trap								
Population	58,595	235,184	14,157,778	1,559	9,920	252,293	263,772	
Encounter rate	NA	NA	NA	0.0266	0.0422	0.0178	0.0183	0.20
Mortality[d]	NA	NA	NA	17	2	282	301	
Mortality rate	NA	NA	NA	0.0109	0.0002	0.0011	0.0011	0.02
Wenatchee River Basin Total								
Population	97,991	235,184	14,235,288	7,909	17,068	283,445	308,422	
Encounter rate	NA	NA	NA	0.0807	0.0726	0.0199	0.0211	0.20
Mortality[d]	NA	NA	NA	59	2	696	757	
Mortality rate	NA	NA	NA	0.0075	0.0001	0.0025	0.0025	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.

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2015, as authorized by ESA Section 10 Permits 18118, 18119, 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 1196 (expired) and new Section 10 Permits 18118, 18119, 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 2015, all spring Chinook passing Tumwater Dam were enumerated, anesthetize, 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, and 2015) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2015.

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 1997, a spring Chinook captive-broodstock program was initiated for the Nason Creek population to reduce the risk of extinction. Improvements in adult escapement in Nason Creek have reduced the near-term risk of extinction and therefore the captive-broodstock program was discontinued. 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 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 cannot exceed 33% of the natural-origin spring Chinook estimates to Tumwater Dam.

The PRCC Hatchery Subcommittee decided to composite the Nason and Chiwawa natural-origin broodstock beginning with brood year 2015. The decision was also made to collect all the brood at 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 have been released volitionally during April and May the following year up until 2015. Beginning in 2016, all fish will be 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 will be 100% marked with CWTs and a minimum of 5,000 fish will be 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.

6.1 Broodstock Sampling

This section focuses on results from sampling 2013-2015 Nason Creek spring Chinook broodstock, which were collected in Nason Creek and at Tumwater Dam. Some information for the 2015 return is not available at this time (e.g., age structure and final origin determination). This information will be provided in the 2016 annual report.

Origin of Broodstock

Natural-origin adults made up between 18% and 84% of the Nason Creek spring Chinook broodstock for return years 2013-2015 (Table 6.1). For 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 Wenatchee population and they were not White River fish. 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, 2013-2015. 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
Average[c]	***43***	***1***	***4***	***34***	***4***	***22***	***0***	***0***	***22***	***0***	***56***
Median[c]	***28***	***1***	***5***	***21***	***0***	***4***	***0***	***0***	***4***	***0***	***25***

[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 2013 and 2014 returns, most adults, regardless of origin, were age-4 Chinook (Table 6.2). A larger percentage of the age-5 Chinook were natural-origin fish, whereas a larger percentage of the age-3 fish were hatchery-origin fish.

Table 6.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 2013-2014.

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
	Hatchery[a]	0.0	0.0	98.5	1.5
Average	***Wild***	***0.0***	***16.3***	***77.0***	***6.8***
	Hatchery	***0.0***	***0.0***	***99.3***	***0.8***
Median	***Wild***	***0.0***	***16.3***	***77.0***	***6.8***
	Hatchery	***0.0***	***0.0***	***99.3***	***0.8***

[a] Data from Table 5.2.

Length at age for Nason Creek wild spring Chinook are shown in Table 6.3.

Table 6.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 2013-2014; 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
Average	***Wild***	***-***	***0***	***-***	***57***	***4***	***4***	***79***	***16***	***7***	***86***	***2***	***8***
	Hatchery	***-***	***0***	***-***	***-***	***0***	***-***	***80***	***98.5***	***6***	***85***	***1.5***	***2***

[a] Data from Table 5.3.

Sex Ratios

Male spring Chinook in the 2013-2015 return years made up 50%, 60%, and 50%, respectively, of the adults collected. This resulted in overall male to female ratios of 1.00:1.00, 1.50:1.00, and 1.01:1.00, respectively (Table 6.4).

Table 6.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 2013-2015. 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
Total	***70***	***60***	***1.17:1.00***	***32***	***35***	***0.91:1.00***	***1.07:1.00***

[a] Data for HOR brood are in Table 5.4.

Fecundity

The mean fecundities for the 2013-2015 returns of Nason Creek spring Chinook ranged from 3,787-4,494 eggs per female (Table 6.5). Fecundities in the 2013 and 2015 natural-origin brood, and in the 2013 and 2014 hatchery-origin brood were less than the expected fecundity of 4,400 eggs per female assumed in the broodstock protocol.

Table 6.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 2013-2015.

Return year	Mean fecundity		
	Wild	Hatchery	Total
2013	4,047	4,069	4,052
2014[a]	4,484	3,834	3,787
2015	4,380	4,535	4,463
Average	***4,304***	***4,302***	***4,333***

[a] Average fecundities are from Table 5.5.

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 6.6). The green egg take for the 2013-2015 brood years was 30%, 102%, and 102% of program goal, respectively.

Table 6.6. Numbers of eggs taken from spring Chinook broodstock, 2013-2015.

Return year	Number of eggs taken
2013[a]	49,720
2014[b]	267,783
2015	268,247
Average	***195,250***
Median	***267,783***

[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 2013 brood were acclimated for 182 to 200 days on Nason Creek water (Table 6.7).

Table 6.7. Number of days spring Chinook broods were acclimated and water source, brood year 2013.

Brood year	Release year	Transfer date	Release date	Number of days and water source	
				Total	Nason Creek
2013	2015	13 Oct	13 Apr – 1 May	182-200	182-200

Release Information

Numbers released

The 2013 brood Nason Creek spring Chinook program achieved 34.5% of the 125,000 target goal with about 43,082 smolts being released volitionally into Nason Creek in 2015 (Table 6.8).

Table 6.8. Numbers of spring Chinook smolts tagged and released from the hatchery, brood year 2013. The release target for Nason Creek spring Chinook is 125,000 smolts.

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

Numbers tagged

The 2013 brood Chiwawa spring Chinook were 93% CWT and adipose fin clipped (Table 6.8).

In 2016, a total of 5,010 Nason Creek spring Chinook from the 2014 brood were PIT tagged at the Nason Creek Acclimation Facility on 29 February to 3 March. Fish were tagged in circular pond #8 where all of the fish were rearing and then subsequently distributed into multiple ponds. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 111 mm in length and 17.0 g at time of tagging.

Table 6.9 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into Nason Creek.

Table 6.9. Summary of PIT-tagging activities for Nason Creek hatchery spring Chinook, brood year 2013.

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

Fish size and condition at release

Spring Chinook from the 2013 brood were released as yearling smolts between 13 April and 1 May 2015. Size at release (16 fpp) was larger than the approximate target of 24 fpp established for the program. The CV for fork length was just short of the target (Table 6.10).

Table 6.10. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood year 2013. 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
2013	2015	129	8.3	27.6	16
Average		***129***	***8.3***	***27.6***	***16***
Median		***129***	***8.3***	***27.6***	***16***
Targets		***155***	***9.0***	***37.8***	***24***

Survival Estimates

Overall survival of Nason Creek spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 6.11). 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 6.11. Hatchery life-stage survival rates (%) for spring Chinook, brood year 2013. 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
Average	***100.0***	***100.0***	***93.5***	***98.8***	***99.4***	***98.2***	***93.8***	***99.1***	***86.6***
Median	***100.0***	***100.0***	***93.5***	***98.8***	***99.4***	***98.2***	***93.8***	***99.1***	***86.6***

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							
Standard	*90.0*	*85.0*	*92.0*	*98.0*	*97.0*	*93.0*	*90.0*	*95.0*	*81.0*

6.3 Disease Monitoring

Results of 2015 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females (100%) had ELISA values less than 0.199. None of the females had ELISA values less than 0.120, resulting in no limitations to rearing densities (Table 6.12).

For the 2013 brood, a formalin drip treatment was used shortly after transfer to the Nason Creek Acclimation Facility to prevent infection associated with stress caused by the transfer. No significant health issues were encountered for the remainder of juvenile rearing.

Table 6.12. Proportion of bacterial kidney disease (BKD) titer groups for the Nason Creek spring Chinook broodstock by origin, brood years 2013-2015. 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
Average	0.7333	0.6667	0.2000	0.3333	0.0000	0.0000	0.0667	0.0000	0.9077	0.5500	0.0923	0.0000
Median	0.7000	0.6667	0.3000	0.3333	0.0000	0.0000	0.0000	0.0000	0.9231	0.5500	0.0769	0.0000

[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 2015, 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 2015. A complete description of trapping operations on Nason Creek can be found in Appendix K.

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2015. During that time period the trap was inoperable for 105 days because of low stream discharge or ice accumulation. 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 daily total emigration. In the event that a viable flow-efficiency regression 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 (2013 brood year) were primarily captured from March through May 2015 (Figure 6.1). Because a viable yearling emigrant flow-efficiency regression model could not be established at the new downstream trap location, a pooled estimate was employed as a temporary method of expansion. Based on this pooled efficiency, the total number of wild yearling Chinook from the Nason Creek basin was 6,992 (±32,823). Combining the number of subyearling spring Chinook (43,711) that emigrated during the fall of 2014 with the total number of yearling Chinook (6,992) that emigrated during 2015 resulted in an emigrant estimate of 50,703 (±38,852) spring Chinook (Table 6.13). Based on PIT-tag analysis, an additional 6,822 (±9,035) spring Chinook immigrated during the winter (1 Dec – 28 Feb) when the trap was inoperable. Thus, the total number of emigrants was 57,525 (±39,889) spring Chinook for the 2013 brood year.

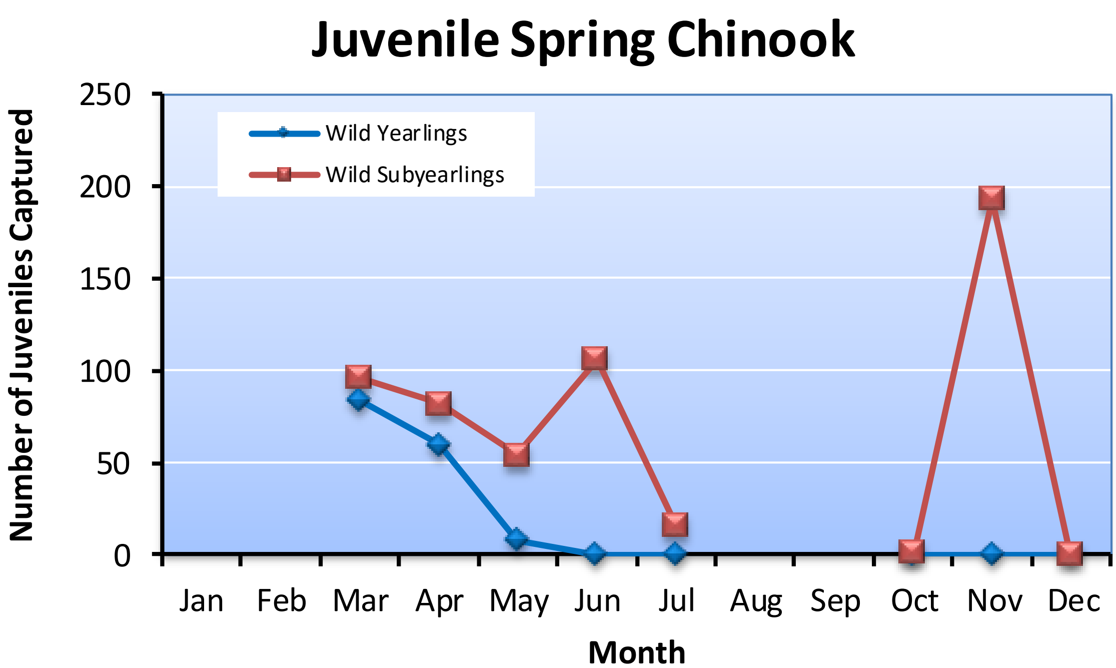


Figure 6.1. Monthly captures of wild subyearling and yearling spring Chinook at the Nason Creek Trap, 2015.

Table 6.13. Numbers of redds and juvenile spring Chinook at different life stages in the Nason Creek basin for brood years 2002-2014; 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	8,829	6,358	15,187
2004	169	811,031	11,822	2,597	14,419
2005	193	835,111	11,814	8,696	20,510
2006	152	657,248	4,144	7,798	11,942
2007	101	448,541	15,556	5,679	21,235
2008	336	1,542,912	23,182	3,611	26,793
2009	167	763,691	27,720	1,705	29,425

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]
2010	188	811,032	8,491	3,535	12,026
2011	170	745,450	17,991	2,422	20,413
2012	413	1,744,099	28,110	4,561	32,671
2013	212	999,792	43,711	6,992	57,525
2014	115	513,705	13,903	--	--
Average	***199***	***961,578***	***17,939***	***4,886***	***23,211***
Median	***170***	***811,031***	***14,730***	***4,622***	***20,510***

[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.

Wild subyearling spring Chinook (2014 brood year) were captured between 1 March and 27 November 2015 (Figure 6.1). Based on capture efficiencies estimated from the flow model, the total number of wild subyearling Chinook emigrating from Nason Creek was 13,903 (±11,963).

Yearling spring Chinook sampled in 2015 averaged 93 mm in length, 8.4 g in weight, and had a mean condition of 1.03 (Table 6.14). Weight and condition estimates for these fish were less than the overall mean of yearling spring Chinook sampled in previous years (overall means, 8.5 g and 1.05), while the estimated length equaled the overall mean (overall mean, 93 mm). Subyearling spring Chinook sampled in 2015 at the Nason Creek Trap averaged 84 mm in length, averaged 6.5 g, and had a mean condition of 1.08 (Table 6.14). These size estimates were greater than the overall mean of subyearling spring Chinook sampled in previous years (overall means, 76 mm, 5.0 g, and condition of 1.07).

Table 6.14. Mean fork length (mm), weight (g), and condition factor of subyearling and yearling spring Chinook collected in the Nason Creek Trap, 2004-2015. 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)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
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)
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)
Average	***Subyearling***	***1,592***	***76 (5)***	***5.0 (1.0)***	***1.07 (0.06)***
	Yearling	***368***	***93 (3)***	***8.5 (1.0)***	***1.05 (0.04)***
Median	***Subyearling***	***1,243***	***76 (5)***	***4.9 (1.0)***	***1.07 (0.06)***
	Yearling	***343***	***93 (3)***	***8.3 (1.0)***	***1.05 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

Both productivity and survival estimates for different life stages of spring Chinook in the Nason Creek watershed are provided in Table 6.15. Estimates for brood year 2013 were generally higher than estimates for brood years 2002-2012, even if numbers of juvenile spring Chinook estimated during non-trapping periods were not included in the estimate. During the period 2002-2013, freshwater productivities ranged from 10-77 smolts/redd and 64-271 emigrants/redd. Survivals during the same period ranged from 0.2-1.3% for egg-smolt and 1.5-5.8% for egg-emigrants.

Table 6.15. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Nason Creek watershed for brood years 2002-2013; ND = no data. These estimates were derived from data in Table 6.13.

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2002	16	ND	0.3	ND
2003	77	183	1.3	3.1
2004	15	85	0.3	1.8
2005	45	106	1.0	2.5
2006	51	79	1.2	1.8
2007	56	210	1.3	4.7
2008	11	80	0.2	1.7
2009	10	176	0.2	3.9

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2010	19	64	0.4	1.5
2011	14	120	0.3	2.7
2012	11	79	0.3	1.9
2013	33	271	0.7	5.8
Average	***30***	***132***	***0.6***	***2.9***
Median	***18***	***106***	***0.4***	***2.5***

[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, survival and productivity decreased as seeding levels increased (Figure 6.2). This suggests that density dependence regulates juvenile productivity and survival within the Nason Creek watershed.

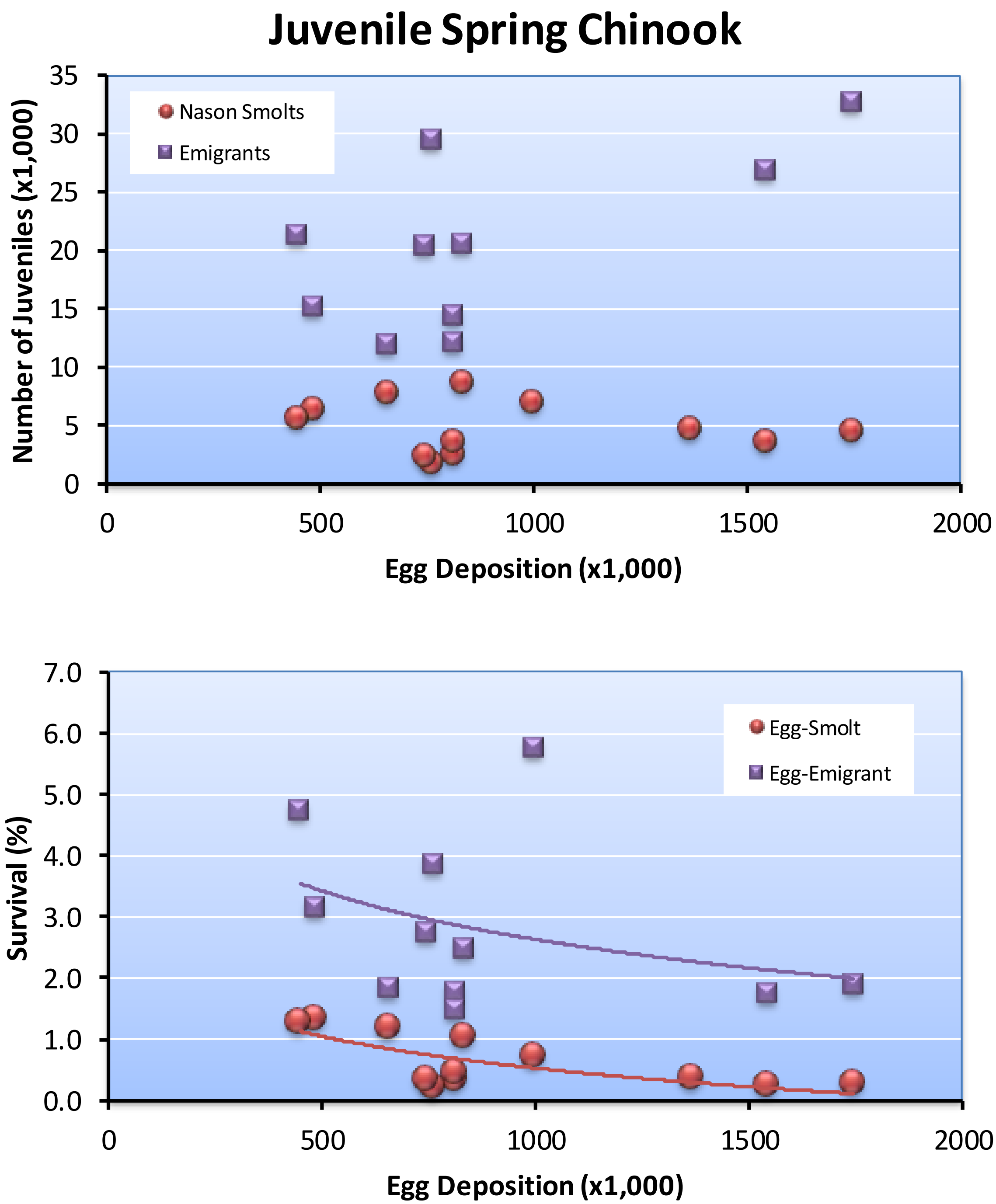


Figure 6.2. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Nason Creek spring Chinook, brood years 2002-2013. Nason Creek smolts are smolts produced only in the Nason Creek watershed.

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).[11] 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 C in Hillman et al. 2012 for a detailed description of methods). 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 6,522 smolts (95% CI: 0 – 9,970) (Figure 6.3). Here, smolts are defined as the number of yearling spring Chinook produced entirely within Nason Creek. These estimates reflect current environmental conditions (most recent 12 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.

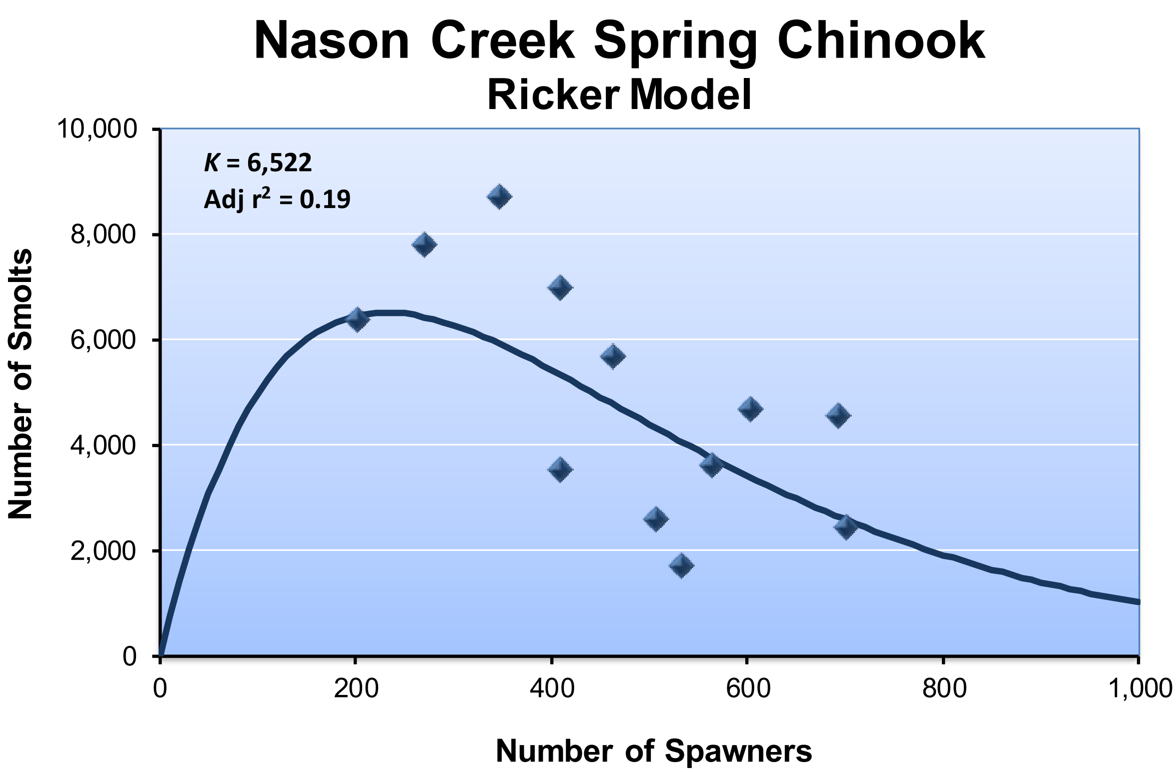


Figure 6.3. Relationship between spawners and number of yearling smolts produced in the Nason Creek watershed. Population carrying capacity (*K*) was estimated using the Ricker model.

11 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 appear to be stabilizing, but they still lack precision (Table 6.16; Figure 6.4). This was also apparent in the estimates of population carrying capacity (Figure 6.5).

Table 6.16. 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	SE	*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

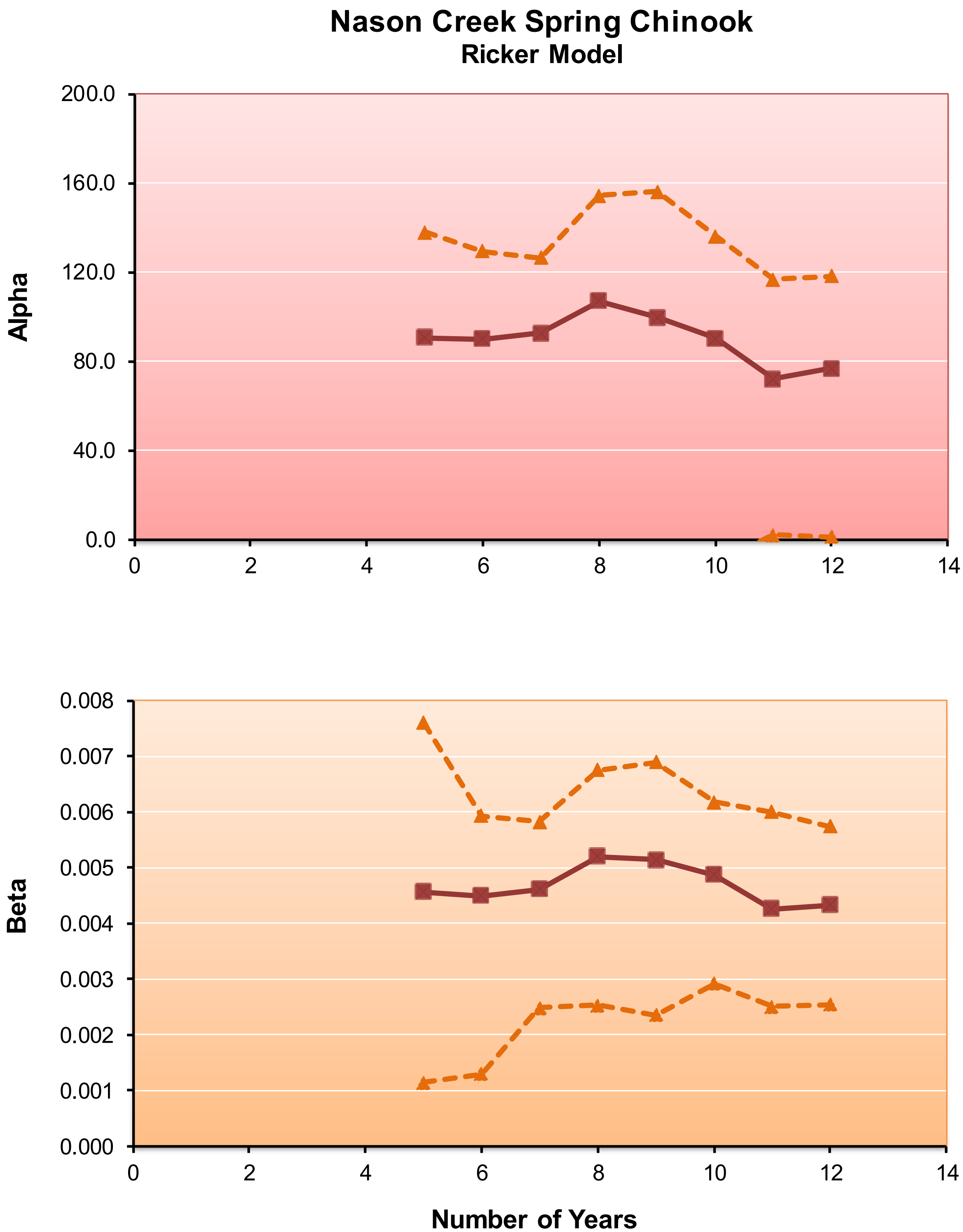


Figure 6.4. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to Nason Creek spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

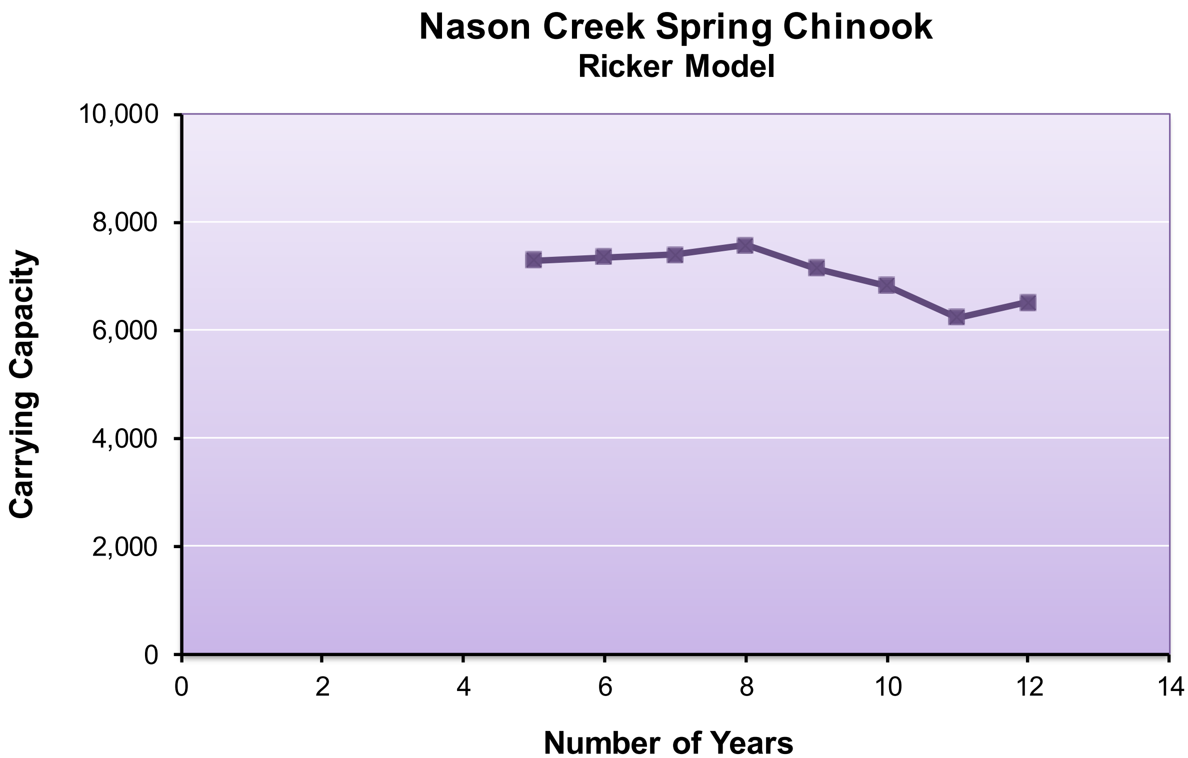


Figure 6.5. Time series of population carrying capacity estimates derived from fitting the Ricker model to Nason Creek spring Chinook smolt and spawning escapement data.

6.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during August through September, 2015, in the Chiwawa River (including Rock and Chikamin 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). See Section 5.5 for a complete coverage of spring Chinook redd surveys in the Wenatchee River basin. In the following section we describe the number and distribution of redds within the Nason Creek basin.

Redd Counts and Distribution

A total of 85 spring Chinook redds were counted in Nason Creek in 2015 (Table 6.17; see Table 5.20 for the complete time series of redd counts). This is lower than the average of 146 redds counted during the period 1989-2014 in Nason Creek. Redds were not distributed evenly among the four reaches in Nason Creek. Most were located in Reach 2 and Reach 3 (Table 6.17).

Table 6.17. Numbers and proportions of spring Chinook redds counted within different reaches within Nason Creek during August through September, 2015. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of redds	Proportion of redds within stream/watershed
Nason	Nason 1 (N1)	15	0.18
	Nason 2 (N2)	23	0.27
	Nason 3 (N3)	34	0.40
	Nason 4 (N4)	13	0.15
Total		***85***	***1.00***

Spawn Timing

Spring Chinook began spawning during the third week of August in Nason Creek and peaked the third week of September (Figure 6.6). Spawning in Nason Creek ended the fourth week of September.

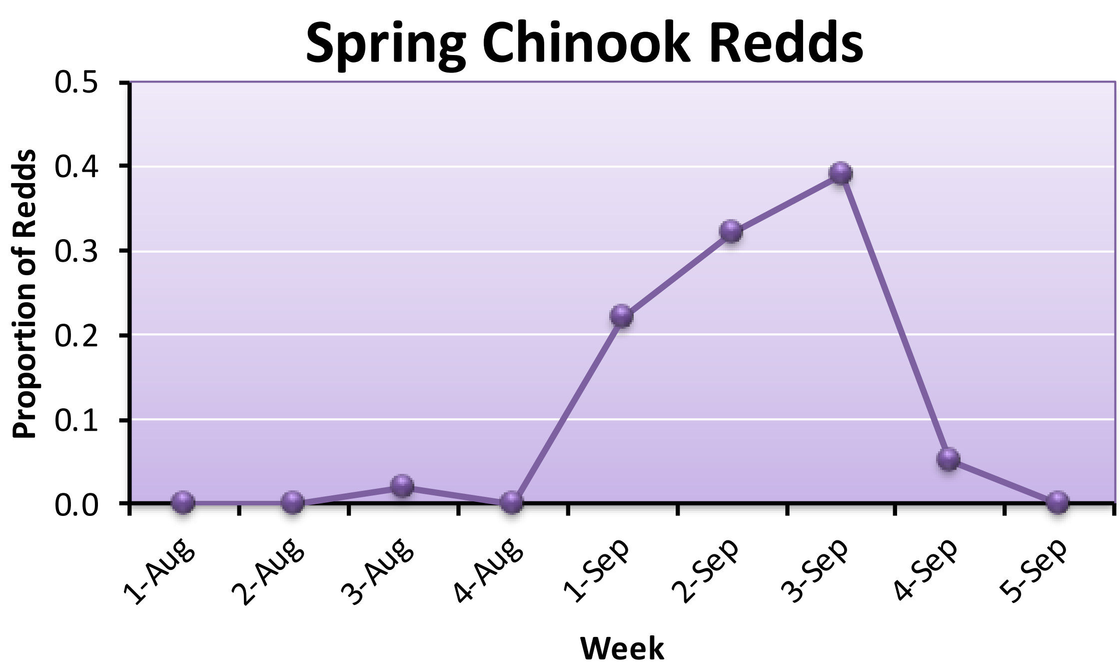


Figure 6.6. Proportion of spring Chinook redds counted during different weeks within Nason Creek, August through September 2015.

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. The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2015 was 1.78 (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

151 spring Chinook. The estimated total spawning escapement of spring Chinook in 2015 was less than the overall average of 319 spring Chinook in Nason Creek (see Table 5.23).

6.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September, 2015, in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin Creek, Upper Wenatchee River, Little Wenatchee River (including Chiwaukum Creek), and White River (including the Napeequa River and Panther Creek). In 2015, 43 spring Chinook carcasses were sampled in Nason Creek. Most of these were sampled in Reach 3. The number of carcasses sampled in 2015 was less than the overall average of 153 carcasses sampled during the period 1996-2014. See Section 5.6 for a complete coverage of spring Chinook carcass surveys in the Wenatchee River basin.

In the Nason Creek watershed, the spatial distribution of hatchery and wild fish was not equal among survey reaches (Table 6.18). In 2015, more wild fish were collected during surveys than hatchery fish and more wild fish were collected than hatchery fish in each of the reaches. This general trend was also apparent in the pooled data (Figure 6.7). It should be noted that the hatchery fish spawning in Nason Creek are strays from the Chiwawa spring Chinook Program. Nason Creek hatchery fish will return to Nason Creek beginning in 2016 as age-3 fish.

Table 6.18. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Nason Creek watershed, 1999-2015. 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**

Survey year	Origin	Survey Reach				Total
		N-1	N-2	N-3	N-4	
	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**
2015	Wild	8	4	20	2	**34**
	Hatchery	2	0	7	0	**9**
Average	***Wild***	***13***	***14***	***13***	***12***	***52***
	Hatchery	***46***	***24***	***17***	***12***	***99***
Median	***Wild***	***14***	***12***	***10***	***8***	***43***
	Hatchery	***42***	***21***	***17***	***13***	***97***

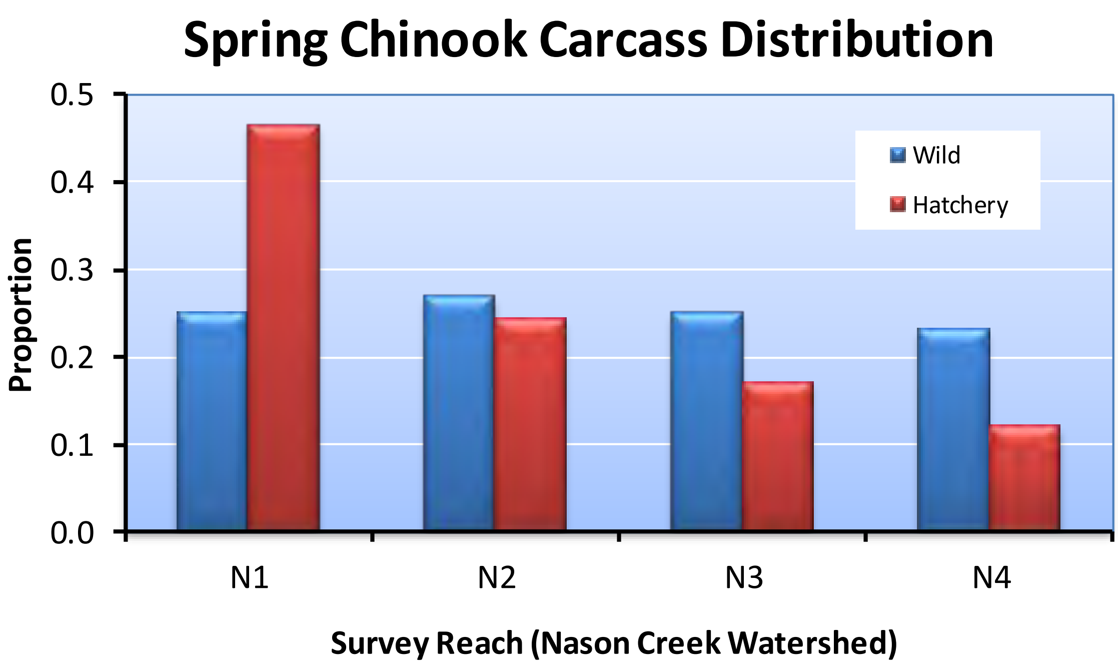


Figure 6.7. Distribution of wild and hatchery produced carcasses in different reaches in the Nason Creek watershed, 1999-2015. Reach codes are described in Table 2.8.

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

See Section 5.7 for a description of migration timing of spring Chinook at Tumwater Dam.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1999-2015 in the Nason Creek watershed were age-4 fish (total age) (Table 6.19; Figure 6.8). Until 2014, 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 6.19. Numbers of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Nason Creek watershed, 1999-2015.

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**
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**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
	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**
Average	***Wild***	***0***	***2***	***38***	***10***	***0***	***50***
	Hatchery	***0***	***21***	***73***	***5***	***0***	***99***
Median	***Wild***	***0***	***1***	***25***	***7***	***0***	***33***
	Hatchery	***0***	***12***	***65***	***3***	***0***	***96***

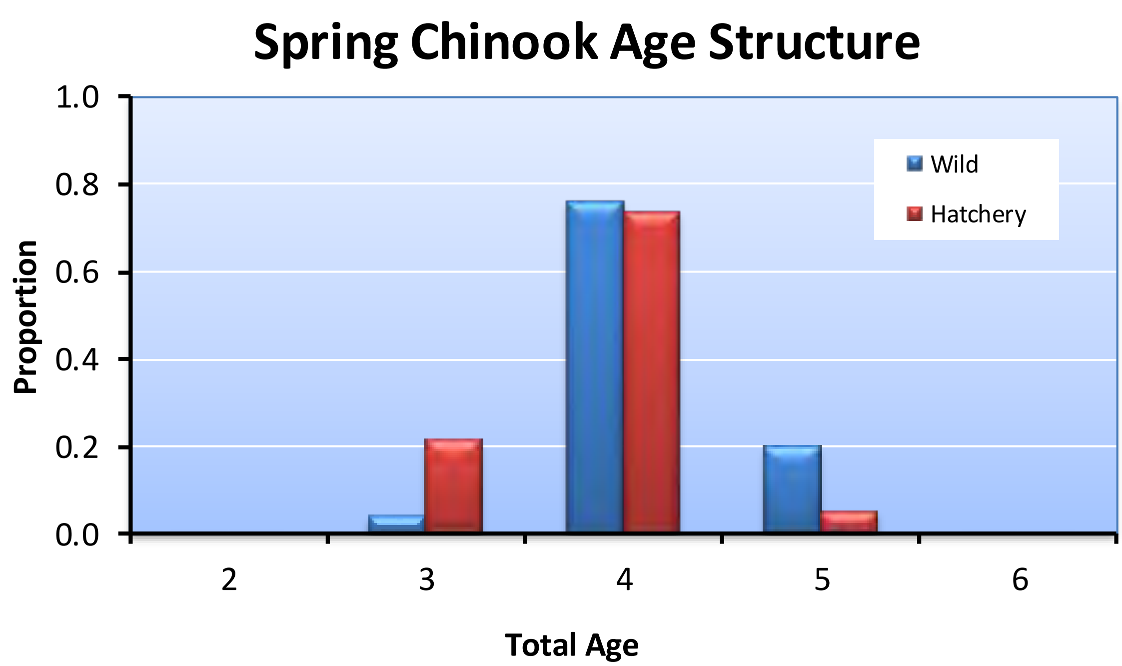


Figure 6.8. Proportions of wild and hatchery spring Chinook of different total ages sampled on spawning grounds in the Nason Creek watershed for the combined years 1999-2015.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed little in length (Table 6.20). Differences were usually no more than 3-5 cm between hatchery and wild fish of the same age.

Table 6.20. 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, 1999-2015.

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
1999	3	0	0	0	0
	4	71 ±2 (2)	0	64 ±2 (3)	0
	5	0	0	0	0
	6	0	0	0	0
2000	3	46 ±0 (1)	44 ±4 (14)	0	52 ±10 (4)
	4	62 ±4 (19)	0	63 ±3 (25)	60 ±1 (3)
	5	0	0	0	0
	6	0	0	0	0
2001	3	0	47 ±12 (5)	0	0
	4	65 ±4 (21)	66 ±5 (36)	63 ±4 (42)	63 ±4 (123)
	5	81 ±5 (3)	0	72 ±3 (10)	71 ±7 (3)
	6	0	0	0	0
2002	3	0	0	0	0
	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	0	0	0	0
2003	3	44 ±7 (3)	43 ±5 (3)	0	0
	4	58 ±7 (2)	79 ±0 (1)	67 ±0 (1)	0
	5	75 ±9 (11)	81 ±6 (2)	72 ±6 (25)	71 ±2 (3)
	6	0	0	0	0
2004	3	46 ±0 (1)	43 ±4 (56)	0	0
	4	61 ±4 (35)	60 ±3 (6)	61 ±3 (66)	62 ±4 (17)
	5	0	0	81 ±0 (1)	73 ±4 (2)
	6	0	0	0	0
2005	3	37 ±0 (1)	41 ±7 (3)	0	0
	4	59 ±6 (8)	63 ±4 (54)	61 ±3 (17)	61 ±3 (116)
	5	73 ±5 (4)	0	71 ±1 (13)	0
	6	0	0	0	0
2006	3	0	41 ±3 (12)	0	0
	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	0	0	0	0
2007	3	0	44 ±4 (122)	0	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	0	0	0	0
2008	3	51 ±21 (2)	45 ±5 (20)	0	45 ±0 (1)
	4	60 ±5 (15)	63 ±4 (42)	61 ±3 (31)	63 ±3 (121)

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	5	0	77 ±2 (3)	71 ±3 (4)	64 ±7 (3)
	6	0	0	0	0
2009	3	41 ±0 (1)	46 ±5 (18)	0	65 ±0 (1)
	4	60 ±5 (12)	63 ±4 (19)	60 ±3 (24)	61 ±4 (46)
	5	0	71 ±1 (2)	72 ±4 (2)	73 ±3 (2)
	6	0	0	0	0
2010	3	44 ±0 (1)	45 ±5 (5)	0	0
	4	62 ±5 (7)	63 ±4 (42)	61 ±3 (10)	62 ±4 (74)
	5	0	75 ±0 (1)	0	0
	6	0	0	0	0
2011	3	48 ±11 (3)	43 ±4 (31)	0	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	0	0	0	0
2012	3	41 ±0 (1)	42 ±3 (24)	0	0
	4	61 ±7 (35)	60 ±5 (45)	61 ±4 (54)	60 ±4 (151)
	5	77 ±4 (6)	0	66 ±5 (11)	70 ±3 (2)
	6	0	0	0	0
2013	3	0	42 ±4 (21)	0	0
	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	0	0	0	0
2014	3	44 ±5 (15)	49 ±4 (9)	60 ±0 (1)	0
	4	64 ±7 (8)	59 ±4 (8)	63 ±3 (11)	60 ±3 (12)
	5	0	0	69 ±8 (3)	0
	6	0	0	0	0
2015	3	44 ±0 (1)	45 ±1 (4)	0	0
	4	61 ±7 (15)	56±4 (3)	63 ±5 (10)	58 ±2 (6)
	5	72 ±7 (3)	0	65 ±0 (1)	0
	6	0	0	0	0

Contribution to Fisheries

Because the Nason Creek program began in 2013, there will be no harvest information on Nason Creek hatchery spring Chinook until about 2017.

Straying

Stray rates will be determined by examining CWTs and PIT tags 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 target for brood year stray rates should be less than 5%. Straying of Nason Creek spring Chinook will be estimated beginning in 2016 or 2017 when the 2013 brood fish return.

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 J). 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.[12] The larger the 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 1989-2012, when no brood stock were collected for the Nason Creek Program, the PNI values ranged from 0.28 to 1.00 (Table 6.21). During this period, PNI values varied over time because of Chiwawa spring Chinook straying into Nason Creek. For brood years 2013-2015, a period when brood stock was collected for the Nason Creek Program, PNI values for the Nason Creek Program were less than 0.67 and ranged from 0.46 to 0.55 (Table 6.21).

[12] 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.

Table 6.21. Proportionate Natural Influence (PNI) Index of hatchery spring Chinook spawning in Nason Creek, brood years 1989-2015. 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
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	0.55
2014	169	0	68	0.00	0.29	21	0	1.00	0.54
2015	28	0	123	0.00	0.81	59	63	0.48	0.46
Average**	***89***	***0***	***177***	***0.00***	***0.64***	***34***	***22***	***0.77***	***0.52***
Median**	***70***	***0***	***123***	***0.00***	***0.81***	***21***	***4***	***0.84***	***0.54***

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.

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 1989-2009, NRR for spring Chinook in Nason Creek averaged 0.87 (range, 0.05-5.48) if harvested fish were not included in the estimate and 0.95 (range, 0.05-5.86) if harvested fish were included in the estimate (Table 6.22). 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. 2013). The target value of 6.7 includes harvest and was based on HRRs for Chiwawa spring Chinook salmon. HRRs will be calculated beginning with the return of 2013 brood fish.

Table 6.22. 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 1989-2009.

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

Brood year	Spawning Escapement	Harvest not included		Harvest included	
		NOR	NRR	NOR	NRR
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
Average	***286***	***135***	***0.87***	***150***	***0.95***
Median	***231***	***123***	***0.43***	***137***	***0.46***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) will be calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. SARs will be calculated with the return of the 2013 brood fish.

6.8 ESA/HCP Compliance

Broodstock Collection

Collection of brood year 2013 broodstock for Nason Creek spring Chinook was to use genetic assignments to target 36 natural-origin broodstock for the Nason Conservation program. Because of poor assignments rates, only two adults were assigned to the Nason program. To increase the probability of meeting broodstock requirements for the current year, the parties initiated a tangle netting effort in Nason Creek, which resulted in an additional 24 adults for the program. Total broodstock achieved for the 2013 brood Nason Creek spring Chinook program was 26 adults.

Hatchery Rearing and Release

The 2013 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 43,082 smolts were released (57.4% of 2013 goal and 34.5% of the overall Nason conservation program goal). Survival from green-egg through release survival was 86.6%, well above the 81.0% target.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18119, and 18121, 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 PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for PUD Hatchery Programs during 2015 are provided in Appendix F.

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 2015 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 6.23. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 1196, 18118, 18120, and 18121, Section B. Table 6.23 does not include incidental or direct take associated with the Nason Creek smolt trap operated by the Yakama Nation.

Table 6.23. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2015.

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	39,396	147,480	77,510	6,350	7,148	31,152	44,650	
Encounter rate	NA	NA	NA	0.1612	0.0485	0.4019	0.1667	0.20
Mortality[e]	NA	NA	NA	42	0	414	456	
Mortality rate	NA	NA	NA	0.0066	0.0000	0.0133	0.0102	0.02
Lower Wenatchee Trap								
Population	58,595	235,184	14,157,778	1,559	9,920	252,293	263,772	
Encounter rate	NA	NA	NA	0.0266	0.0422	0.0178	0.0183	0.20
Mortality[d]	NA	NA	NA	17	2	282	301	
Mortality rate	NA	NA	NA	0.0109	0.0002	0.0011	0.0011	0.02
Wenatchee River Basin Total								
Population	97,991	235,184	14,235,288	7,909	17,068	283,445	308,422	
Encounter rate	NA	NA	NA	0.0807	0.0726	0.0199	0.0211	0.20
Mortality[d]	NA	NA	NA	59	2	696	757	
Mortality rate	NA	NA	NA	0.0075	0.0001	0.0025	0.0025	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.

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2015, as authorized by ESA Section 10 Permits 18118, 18119, 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 1196 (expired) and new Section 10 Permits 18118, 18119, 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 2015, 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, and 2015) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2015.

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 release 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.

The production goal for the White River captive brood program following the 2013 hatchery recalculation is 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 have been manipulated to evaluate different approaches to reduce precocious maturation. All of the fish are marked with CWTs. In addition, since 2008, juvenile spring Chinook have been PIT tagged annually.

Since its inception, the captive brood program has undergone 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 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). Information on spring Chinook collected throughout the Wenatchee River basin is presented in Section 5.

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 in close proximity of 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 for release into the White River.

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 ripening of ova has been an issue in the program, implementation of hormone treatments began in 2011 to facilitate ripening. 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. 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
2009	Female	0	0	119	0	119
	Male	65	54	0	0	119
2010	Female	0	0	42	0	42

Spawning year	Sex	Total age				Total
		2	3	4	5	
	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 have been 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. 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 2002-2014.

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
	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

Brood year	Acclimation site	Acclimation vessel	Number of smolts released	Release scenario	Release date	Number of acclimation days
	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 2007-2014 spring Chinook were tagged with a CWT in their peduncle. None of these fish were adipose fin clipped.[13] 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), 303,207 juvenile spring Chinook have been 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 2002-2014.

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
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

13 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
	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	34,905	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 2002-2014. 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
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

Brood year	Acclimation site	Release scenario	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
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.[14] 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 23 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.

[14] 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 (d)	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)	48.1 (20.4)	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)	NA	NA
	White and Wenatchee rivers	51,697	0.434 (0.010)	NA	NA
2012	Wenatchee River	52,440	0.351 (0.013)	NA	NA
2013	Wenatchee River	49,703	0.365 (0.020)	43.8 (10.3)	NA

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. 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 2015, the White River Trap operated between 1 March and 30 November 2015. During that time period the trap was inoperable for 42 days because of ice or debris accumulation, unsafe working conditions, or administrative reasons. 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. In the event that 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 L.

Wild yearling spring Chinook (2013 brood year) were primarily captured from March through April 2015 (Figure 7.1). Based on a composite regression model, the total number of wild yearling Chinook emigrating from the White River was 3,023 (±2,728). Combining the total number of subyearling spring Chinook (2,461 ±779) that emigrated during the fall of 2014 with the total number of yearling Chinook (3,023) that emigrated during 2015 resulted in a total emigrant estimate of 5,484 (±2,836) spring Chinook for the 2013 brood year (Table 7.7).

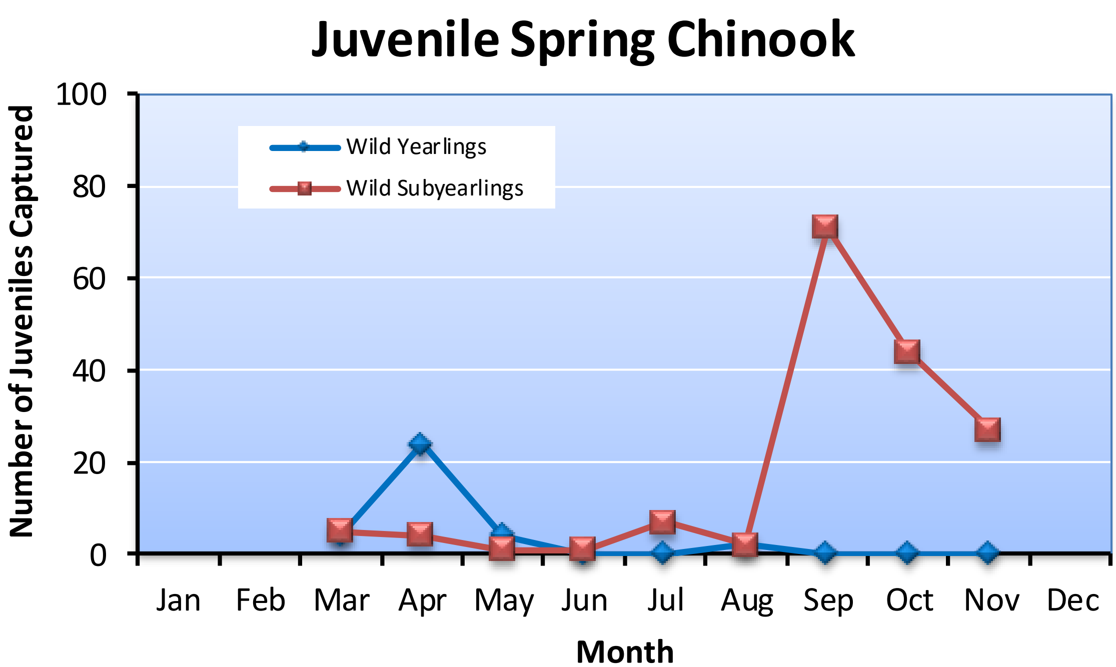


Figure 7.1. Monthly captures of wild subyearling (parr) and yearling spring Chinook at the White River Trap, 2015.

Table 7.7. Numbers of redds and juvenile spring Chinook at different life stages in the White River basin for brood years 2005-2014; 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	642	2,004	2,646
2007	20	88,820	2,293	3,399	5,692
2008	31	142,352	5,552	5,193	10,745
2009	54	246,942	2,485	2,939	5,424
2010	33	142,362	1,859	4,121	5,980
2011	20	87,700	3,128	1,659	4,787
2012	86	363,178	3,905	3,995	7,900
2013	54	254,664	2,461	3,023	5,484
2014	26	105,170	1,449	--	--
Average[c]	***42***	***193,735***	***2,642***	***3,465***	***6,082***
Median[c]	***32***	***142,357***	***2,461***	***3,399***	***5,588***

[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 (2014 brood year) were captured between 26 July and 30 November 2015, with peak catch during September (Figure 7.1). Based on a composite regression model, the total number of wild subyearling Chinook emigrating from the White River was 1,449 (±421).

Yearling spring Chinook sampled in 2015 averaged 104 mm in length, 13.0 g in weight, and had a mean condition of 1.14 (Table 7.8). These estimates were greater than the overall mean of yearling spring Chinook sampled in previous years (overall means, 99 mm, 11.2 g, and 1.11). Subyearling spring Chinook parr sampled in 2015 at the White River Trap averaged 96 mm in length, averaged 9.9 g, and had a mean condition of 1.11 (Table 7.8). These estimates were greater than the overall mean of subyearling spring Chinook sampled in previous years (overall means, 90 mm, 8.5 g, and 1.09).

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, 2007-2015. 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)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
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)
Average	***Subyearling***	***234***	***90 (5)***	***8.5 (1.2)***	***1.09 (0.03)***
	Yearling	***137***	***99 (4)***	***11.2 (1.4)***	***1.11 (0.04)***
Median	***Subyearling***	***185***	***91 (5)***	***8.9 (1.2)***	***1.10 (0.03)***
	Yearling	***105***	***100 (4)***	***11.3 (1.4)***	***1.12 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

Both productivity and survival estimates for different life stages of spring Chinook in the White River basin are provided in Table 7.9. Estimates for brood year 2013 fall within the range of productivity and survival estimates for brood years 2005-2013. During that period, freshwater productivities ranged from 46-170 smolts/redd and 85-347 emigrants/redd. Survivals during the same period ranged from 1.1-3.8% for egg-smolt and 2.0-7.5% for egg-emigrants.

Table 7.9. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the White River basin for brood years 2005-2013. These estimates were derived from data in Table 7.7.

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	7.5
2009	54	100	1.2	2.2
2010	125	181	2.9	4.2
2011	83	239	1.9	5.5
2012	46	92	1.1	2.2
2013	56	102	1.2	2.2

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
Average	***91***	***179***	***2.1***	***4.0***
Median	***65***	***141***	***1.5***	***3.2***

[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.

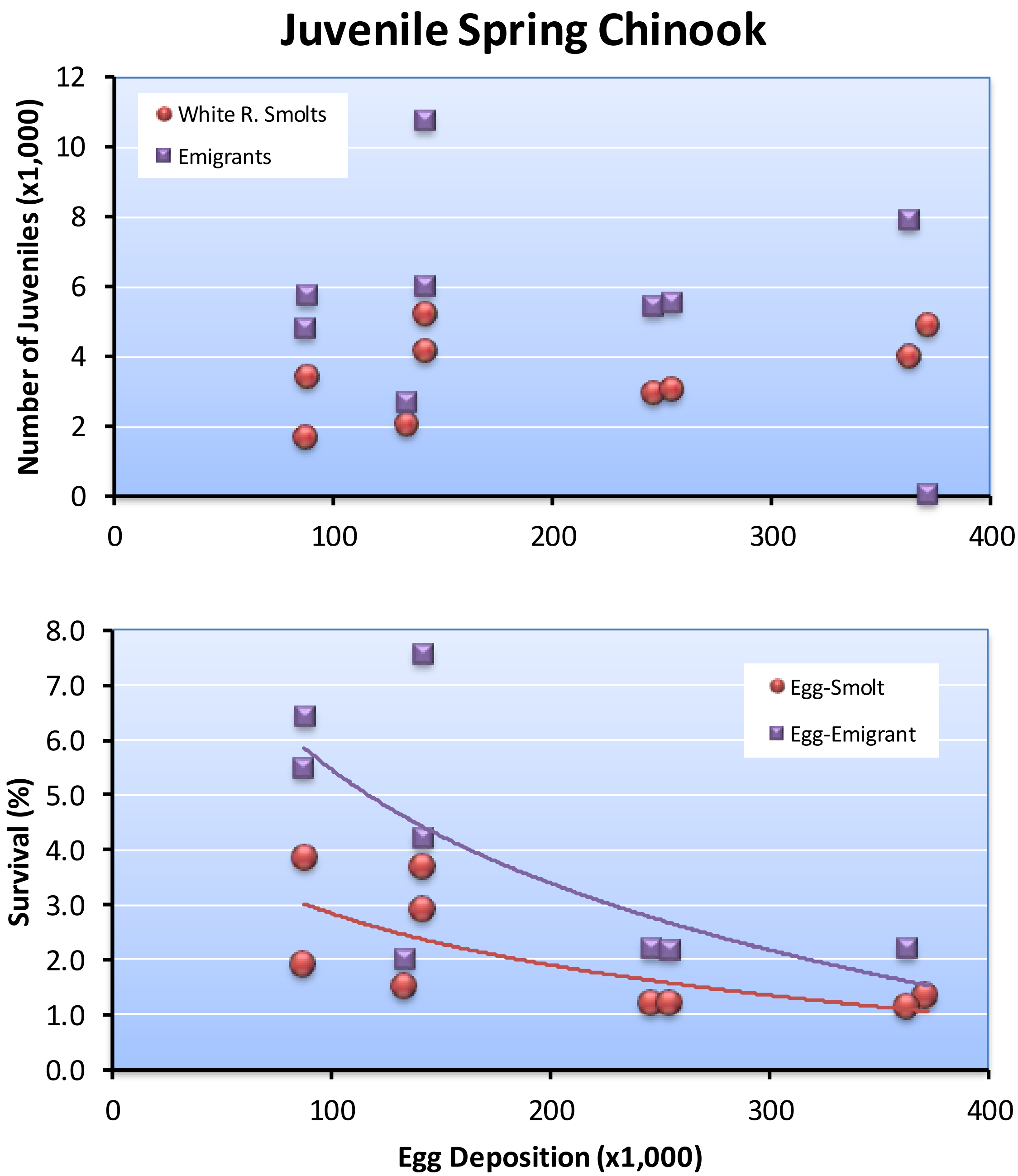


Figure 7.2. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for White River spring Chinook, brood years 2005-2013. White River smolts are smolts produced only within the White River basin.

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).[15] 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 C in Hillman et al. 2012 for a detailed description of methods). 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 White River basin is 3,605 smolts (95% CI: 0 – 5,762) (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.

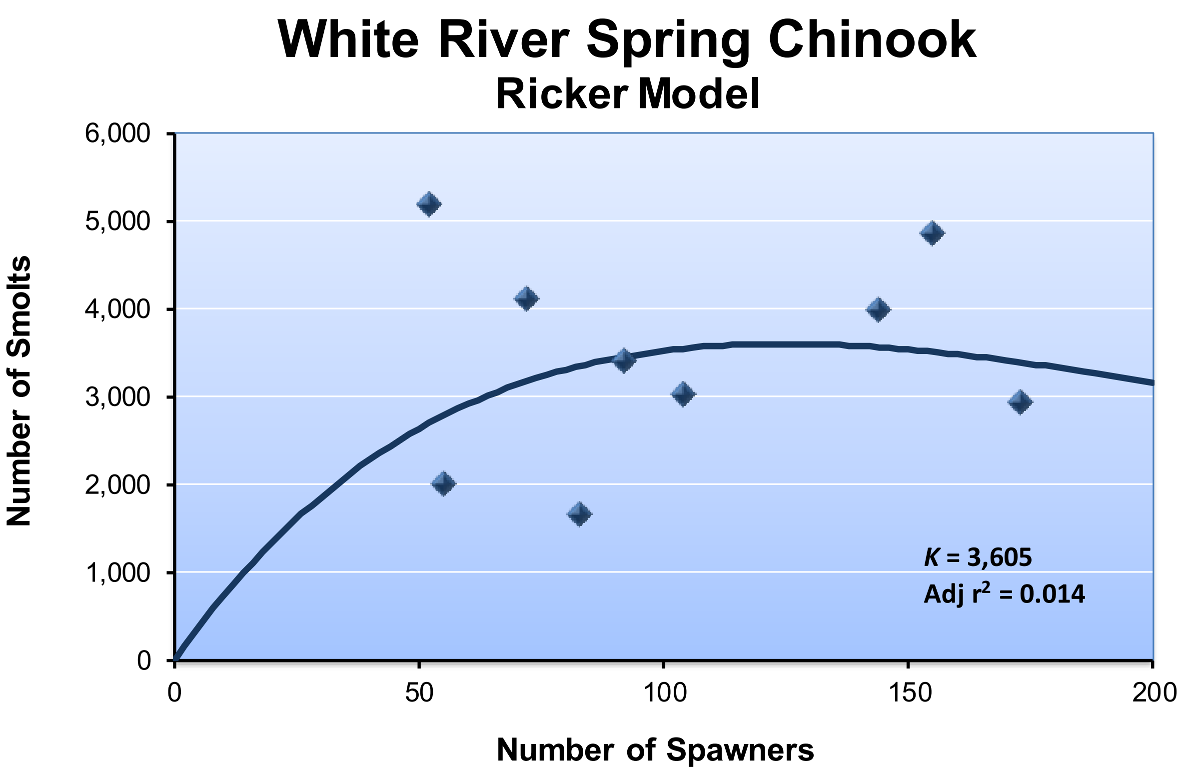


Figure 7.3. Relationship between spawners and number of smolts produced in the White River basin. Population carrying capacity (*K*) was estimated using the Ricker model.

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15 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 appear to be stabilizing, but they still lack precision (Table 7.10; Figure 7.4). This was also apparent in the estimates of population carrying capacity (Figure 7.5).

Table 7.10. 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	SE	*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	0.001
8	80.32	32.78	0.0080	0.0036	3,675	80	124	0.009
9	78.79	42.85	0.0080	0.0037	3,605	79	124	0.014

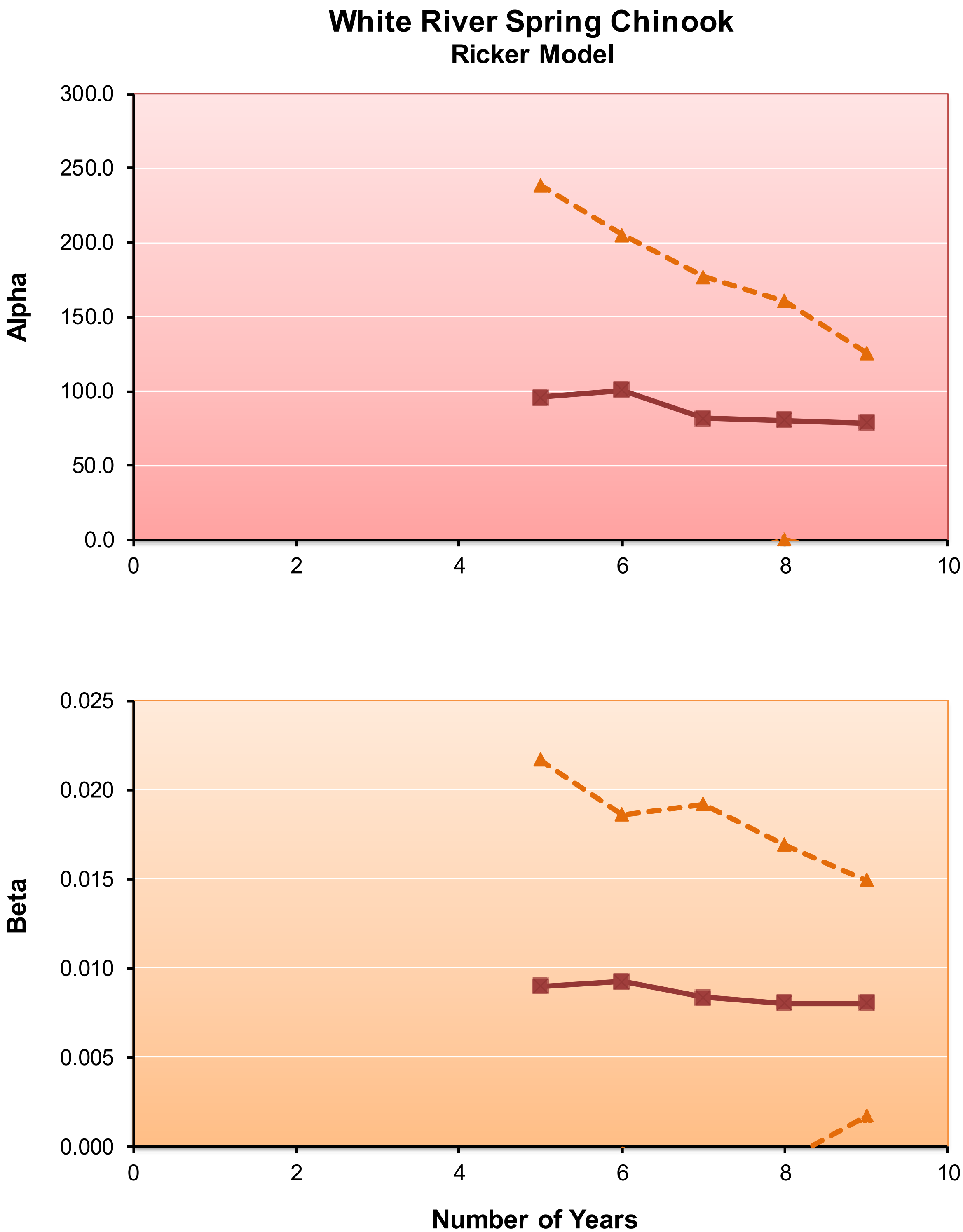

Figure 7.4. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to White River spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

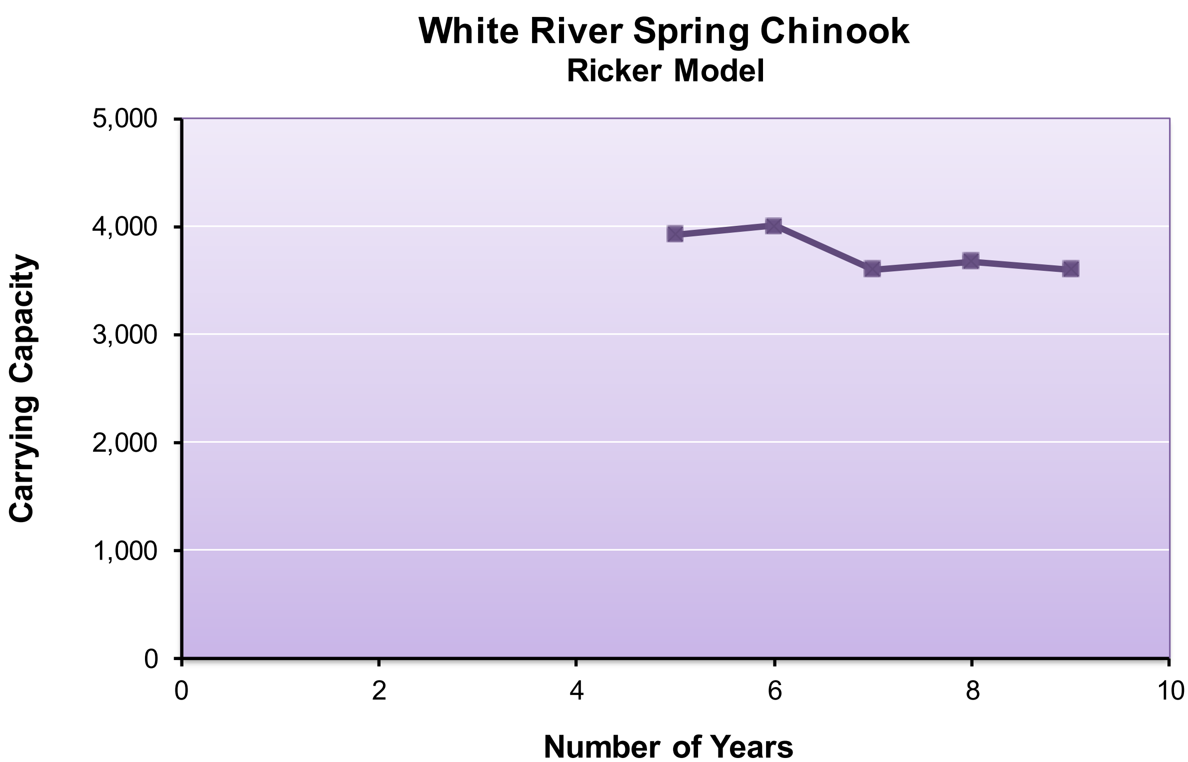

Figure 7.5. Time series of population carrying capacity estimates derived from fitting the Ricker model to White River spring Chinook smolt and spawning escapement data.

7.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during August through September, 2015, in the Chiwawa River (including Rock and Chikamin 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). See Section 5.5 for a complete coverage of spring Chinook redd surveys in the Wenatchee River basin. In the following section we describe the number and distribution of redds within the White River basin.

Redd Counts and Distribution

A total of 70 spring Chinook redds were counted in the White River basin in 2015 (Table 7.11; see Table 5.20 for the complete time series of redd counts). This is higher than the average of 34 redds counted during the period 1989-2014 in the White River. Redds were not distributed evenly among the six survey areas in the White River basin. Most were located in Reach 3 (Napeequa River to Grasshopper Meadows) in the White River (Table 7.11).

Table 7.11. Numbers and proportions of spring Chinook redds counted within different survey areas within the White River basin during August through September, 2015. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of redds	Proportion of redds within stream/watershed
White River	White 2 (H2)	4	0.06
	White 3 (H3)	63	0.90
	White 4 (H4)	2	0.03
	Napeequa 1 (Q1)	1	0.01
	Panther 1 (T1)	0	0.00
Total		***70***	***1.00***

Spawn Timing

Spring Chinook began spawning during the first week of August in the White River and peaked the second week of September (Figure 7.6). Spawning in the White River ended the third week of September.

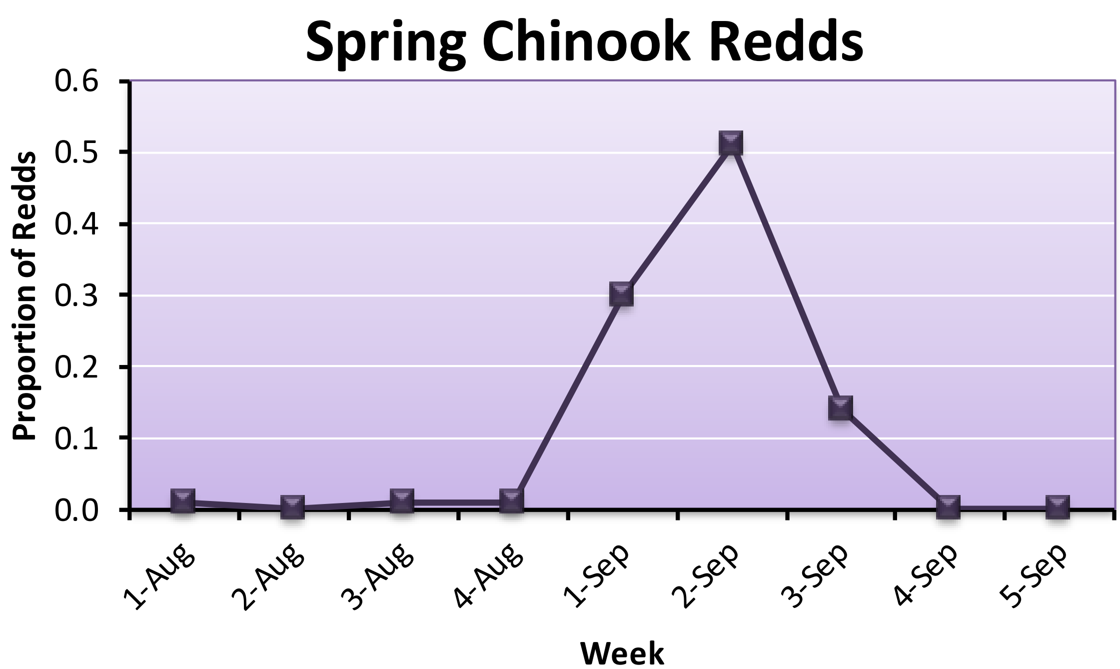

Figure 7.6. Proportion of spring Chinook redds counted during different weeks within the White River basin, August through September 2015.

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. The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2015 was 1.78 (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 125 spring Chinook. The estimated total spawning escapement of spring Chinook in 2015 was greater than the overall average of 76 spring Chinook in the White River basin (see Table 5.23).

7.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September, 2015, in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin Creek, Upper Wenatchee River (including Chiwaukum Creek), Little Wenatchee River, and White River (including the Napeequa River and Panther Creek). In 2015, 25 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 2015 was more than the overall average of 17 carcasses sampled during the period 1996-2014. See Section 5.6 for a complete coverage of spring Chinook carcass surveys in the Wenatchee River basin.

In the White River basin, the spatial distribution of hatchery strays (primarily from the Chiwawa Spring Chinook program) and wild spring Chinook was not equal (Table 7.12). Reach 2 had a higher proportion of hatchery fish (80%), while Reach 3 had primarily wild fish (70%). In 2015, most carcasses (80%) were observed in the reach between the Napeequa River and Grasshopper Meadows (Reach 3) (Table 7.12). Over the years, spring Chinook have spawned more often in this reach than in other reaches (Figure 7.7). A total of nine captive brood carcasses have been identified on the spawning grounds. They were found in Reaches 2 and 3. The low recoveries of captive brood fish may be because captive brood returns were not adipose-fin clipped and therefore any returns from the captive brood program may have been included inadvertently with wild fish.

Table 7.12. Numbers of wild, hatchery strays, and captive brood spring Chinook carcasses sampled within different reaches in the White River basin, 2000-2015. 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	6	0	0	2	**9**

Survey year	Origin	Survey Reach					Total
		H-2	H-3	H-4	Napeequa	Panther	
	Hatchery Strays	0	4	0	0	0	**4**
	Captive Brood	0	0	0	0	0	**0**
2008	Wild	1	3	0	0	1	**5**
	Hatchery Strays	2	5	0	0	1	**8**
	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	4	0	0	0	**4**
	Hatchery Strays	0	7	0	0	0	**7**
	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	8	0	0	0	**8**
	Hatchery Strays	0	10	0	0	3	**13**
	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	0	14	0	0	0	**14**
	Hatchery Strays	1	3	0	0	0	**4**
	Captive Brood	3	4	0	0	0	**7**
Average	***Wild***	***1***	***10***	***0***	***0***	***0***	***11***
	Hatchery Stray	***0***	***7***	***0***	***0***	***1***	***8***
	Captive Brood	***0***	***1***	***0***	***0***	***0***	***1***
Median	***Wild***	***1***	***9***	***0***	***0***	***0***	***10***
	Hatchery Stray	***0***	***6***	***0***	***0***	***0***	***6***
	Captive Brood	***0***	***0***	***0***	***0***	***0***	***1***

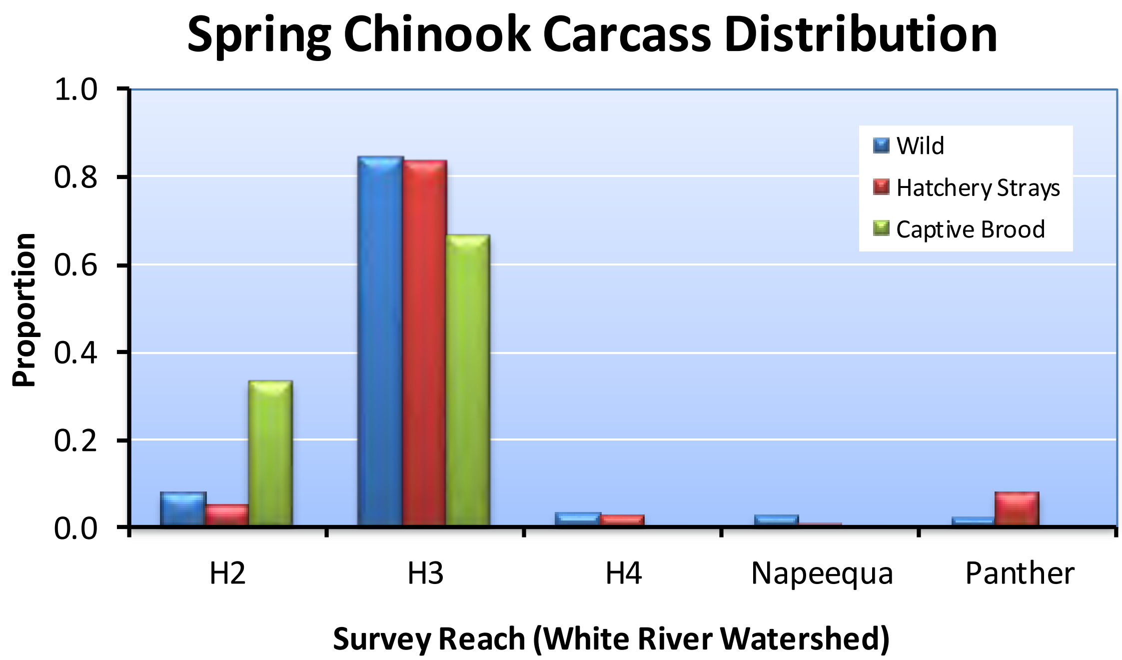

Figure 7.7. Distribution of wild, hatchery strays, and captive brood produced carcasses in different reaches in the White River basin, 2000-2015. Reach codes are described in Table 2.8.

7.7 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

See Section 5.7 for a description of migration timing of spring Chinook at Tumwater Dam.

Age at Maturity

Most of the wild and hatchery stray spring Chinook sampled during the period 2001-2015 in the White River basin were age-4 fish (total age) (Table 7.13; Figure 7.8). 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. At this time, 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 7.13. Numbers of wild, hatchery strays, and captive brood spring Chinook of different ages (total age) sampled on spawning grounds in the White River basin, 2001-2015.

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**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
	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	1	8	0	**9**
	Hatchery Strays	0	2	2	0	0	**4**
	Captive Brood	0	0	0	0	0	**0**
2008	Wild	0	0	4	1	0	**5**
	Hatchery Strays	0	0	8	0	0	**8**
	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	4	0	0	**4**
	Hatchery Strays	0	0	6	0	0	**6**
	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**
2013	Wild	0	0	6	2	0	**8**
	Hatchery Strays	0	0	11	1	0	**12**
	Captive Brood	0	0	1	1	0	**2**
2014	Wild	0	0	54	10	0	**64**
	Hatchery Strays	0	0	21	0	0	**21**
	Captive Brood	0	0	0	0	0	**0**
2015	Wild	0	0	13	1	0	**14**
	Hatchery Strays	0	0	4	0	0	**4**
	Captive Brood	0	0	7	0	0	**7**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
Average	*Wild*	*0*	*0*	*9*	*3*	*0*	*12*
	Hatchery Strays	*0*	*0*	*9*	*0*	*0*	*9*
	Captive Brood	*0*	*0*	*1*	*0*	*0*	*1*
Median	*Wild*	*0*	*0*	*7*	*1*	*0*	*8*
	Hatchery Strays	*0*	*0*	*6*	*0*	*0*	*6*
	Captive Brood	*0*	*0*	*0*	*0*	*0*	*0*

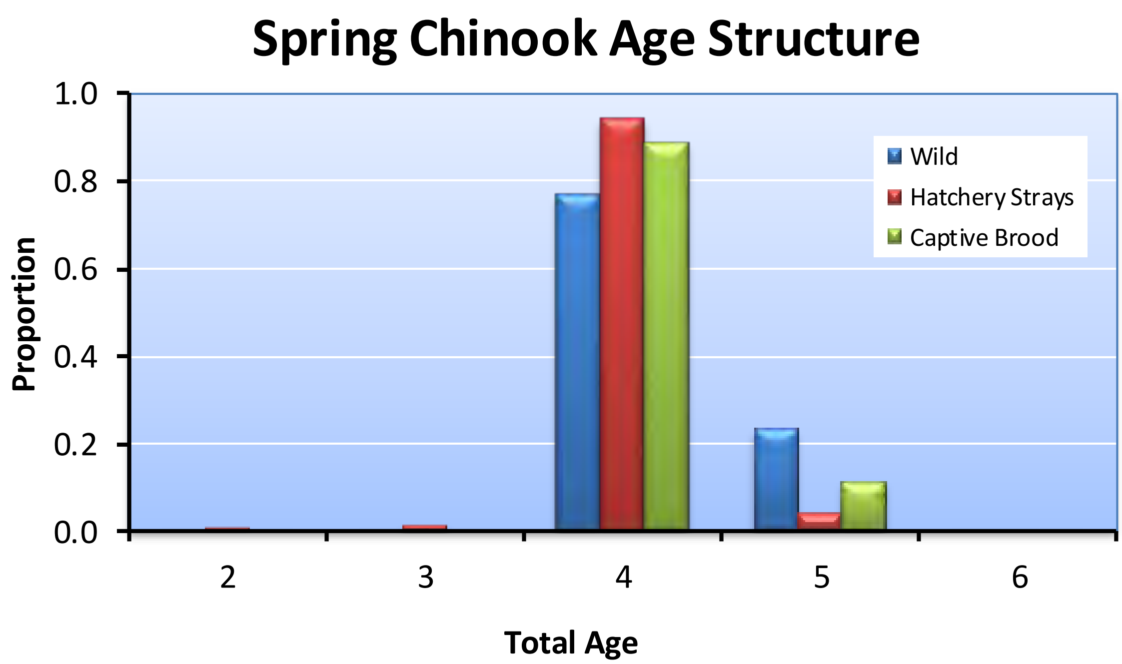

Figure 7.8. Proportions of wild, hatchery strays, and captive brood spring Chinook of different total ages sampled on spawning grounds in the White River basin for the combined years 2000-2015.

For comparison, Table 7.14 and Figure 7.9 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 2001-2015 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, very few age-3 fish have been recovered in the Little Wenatchee River.

Table 7.14. Numbers of wild and hatchery stray spring Chinook of different ages (total age) sampled on spawning grounds in the Little Wenatchee River basin, 2001-2015.

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	16	0	0	**16**
	Hatchery Strays	0	0	32	0	0	**32**
2006	Wild	0	0	4	4	0	**8**
	Hatchery Stray	0	1	0	3	0	**4**
2007	Wild	0	0	2	10	0	**12**
	Hatchery Strays	0	1	2	0	0	**3**
2008	Wild	0	0	3	0	0	**3**
	Hatchery Stray	0	0	12	0	0	**12**
2009	Wild	0	0	6	0	0	**6**
	Hatchery Strays	0	1	12	0	0	**13**
2010	Wild	0	0	2	0	0	**2**
	Hatchery Stray	0	0	5	0	0	**5**
2011	Wild	0	0	3	1	0	**4**
	Hatchery Strays	0	2	1	0	0	**3**
2012	Wild	0	0	12	2	0	**14**
	Hatchery Stray	0	0	9	1	0	**10**
2013	Wild	0	0	9	7	0	**16**
	Hatchery Strays	0	0	4	0	0	**4**
2014	Wild	0	1	8	2	0	**11**
	Hatchery Stray	0	0	1	0	0	**1**
2015	Wild	0	0	8	3	0	**11**
	Hatchery Strays	0	0	1	0	0	**1**
Average	***Wild***	***0***	***0***	***7***	***3***	***0***	***10***
	Hatchery Strays	***0***	***0***	***8***	***1***	***0***	***9***
Median	***Wild***	***0***	***0***	***6***	***2***	***0***	***11***
	Hatchery Strays	***0***	***0***	***8***	***1***	***0***	***9***

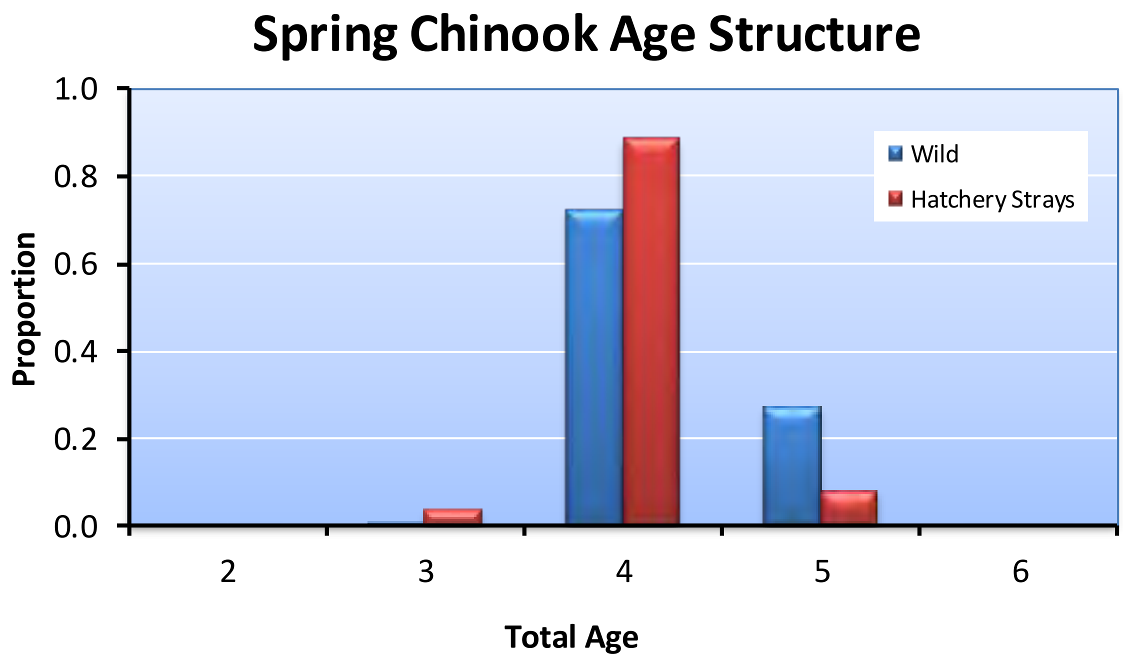

Figure 7.9. Proportions of wild and hatchery stray spring Chinook of different total ages sampled on spawning grounds in the Little Wenatchee River basin for the combined years 2000-2015.

Size at Maturity

On average, hatchery strays and wild spring Chinook of a given age differed little in length (Table 7.15). Differences were usually no more than 8 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 the same size as wild and hatchery strays of the same age.

Table 7.15. 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, 2001-2015.

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
2001	3	0	0	0	0	0	0
	4	65 ±3 (17)	66 ±4 (5)	0	63 ±3 (30)	63 ±4 (21)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2002	3	0	0	0	0	0	0
	4	66 ±0 (1)	69 ±0 (1)	0	63 ±4 (6)	59 ±6 (5)	0
	5	75 ±11 (2)	0	0	72 ±3 (9)	72 ±0 (1)	0
	6	0	0	0	0	0	0
2003	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	75 ±5 (6)	73 ±0 (1)	0

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	6	0	0	0	0	0	0
2004	3	0	0	0	0	0	0
	4	68 ±3 (3)	0	0	63 ±3 (6)	59 ±2 (2)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2005	3	0	0	0	0	0	0
	4	64 ±5 (3)	62 ±7 (5)	0	63 ±5 (8)	62 ±4 (33)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2006	3	0	0	0	0	0	0
	4	65 ±2 (3)	0	0	61 ±4 (4)	60 ±2 (3)	0
	5	69 ±4 (4)	0	0	67 ±5 (8)	70 ±5 (3)	0
	6	0	0	0	0	0	0
2007	3	0	49 ±5 (2)	0	0	0	0
	4	0	0	0	58 ±0 (1)	66 ±2 (2)	0
	5	75 ±5 (3)	0	0	75 ±1 (5)	0	0
	6	0	0	0	0	0	0
2008	3	0	0	0	0	0	0
	4	56 ±0 (1)	61 ±0 (1)	0	63 ±8 (2)	61 ±2 (7)	0
	5	0	0	0	75 ±0 (1)	0	0
	6	0	0	0	0	0	0
2009	3	0	0	0	0	0	0
	4	61 ±5 (3)	68 ±4 (2)	0	63 ±2 (5)	62 ±2 (8)	0
	5	0	0	0	78 ±0 (1)	0	0
	6	0	0	0	0	0	0
2010	3	0	0	0	0	0	0
	4	0	67 ±0 (1)	0	60 ±3 (3)	61 ±6 (5)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2011	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	73 ±5 (4)	0	0
	6	0	0	0	0	0	0
2012	3	0	0	0	0	0	0
	4	47 ±0 (1)	0	0	62 ±4 (12)	60 ±4 (8)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2013	3	0	0	0	0	0	0
	4	64 ±4 (3)	60 ±4 (2)	0	61 ±2 (3)	61 ±4 (7)	63 ±0 (1)
	5	0	0	0	67 ±1 (2)	71 ±0 (1)	71 ±0 (1)

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	6	0	0	0	0	0	0
2014	3	0	0	0	0	0	0
	4	0	54 ±0 (1)	0	60 ±2 (4)	58 ±0 (1)	0
	5	0	0	0	74 ±0 (1)	0	0
	6	0	0	0	0	0	0
2015	3	0	0	0	0	0	0
	4	60 ±6 (5)	74 ±0 (1)	61 ±0 (1)	64 ±5 (8)	64 ±4 (3)	64 ±5 (6)
	5	0	0	0	75 ±0 (1)	0	0
	6	0	0	0	0	0	0

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%. The target for brood year stray rates should be less than 5%.

Based on PIT-tag analyses, on average, about 57% of the White River spring Chinook returns were last detected in streams outside the White River (Table 7.16). The numbers in Table 7.16 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 7.16 are at least age-3 fish (total age) and some of them may not have migrated to the ocean but rather resided completely in freshwater.

Table 7.16. 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 2006-2010. Only PIT-tagged fish demonstrating anadromy were included in the analysis. Estimates were based on last detections of PIT-tagged spring Chinook. Percent strays should be less than 5%.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2006	1	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	15	100.0	0	0.0
2009	4	14.3	0	0.0	25	85.7	0	0.0
2010	0	0.0	0	0.0	6	100.0	0	0.0
Average	***1***	***22.9***	***0***	***0.0***	***9.2***	***57.1***	***0***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***6***	***85.7***	***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 7.17. 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. One was 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 7.17. 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 2010-2015. 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	1 (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	2 (16.7)	1 (8.3)	0 (0.0)	0 (0.0)	8 (66.7)	1 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)
2013	2 (6.7)	8 (26.7)	1 (3.3)	2 (6.7)	7 (23.3)	8 (26.7)	0 (0.0)	2 (6.7)	0 (0.0)
2014	4 (8.3)	17 (35.4)	0 (0.0)	1 (2.1)	3 (6.3)	17 (35.4)	0 (0.0)	5 (10.4)	1 (2.1)
2015	10 (23.3)	24 (55.8)	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (.0.0)	8 (18.6)	0 (0.0)
Average	***3 (25.8)***	***8 (21.0)***	***0 (0.9)***	***1(1.5)***	***3 (24.4)***	***5 (20.1)***	***0 (.0.0)***	***3 (5.9)***	***0 (0.3)***
Median	***2 (12.5)***	***5 (17.5)***	***0 (0.0)***	***0 (0.0)***	***2 (14.8)***	***1 (17.5)***	***0 (.0.0)***	***1(3.3)***	***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 J). 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.[16] The larger the 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 7.18). For brood years 2001-2013, PNI for the White River Program averaged 0.60 (range, 0.33-1.00) (Table 7.18).

Table 7.18. 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

[16] 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_W	HOS_S	$pHOS_W$	$pHOS_S$	NOB_N	HOB_N	pNOB	
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
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 1989-2009, NRR for spring Chinook in the White River basin averaged 1.05 (range, 0.00-4.91) if harvested fish were not included in the estimate and 1.27 (range, 0.00-5.91) if harvested fish were included in the estimate (Table 7.19). 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) to the parent broodstock collected. For brood years 2006-2009, hatchery replacement rates averaged 0.17 (range, 0.00-0.41) (Table 7.19). Only for brood year 2009 was HRR greater than the NRR. The HRR values would be much higher if they were calculated using the number of adult equivalents taken from the natural environment to initiate the captive brood program.

Table 7.19. 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 1989-2009.

Brood year	Brood stock spawned	Spawning Escapement	Harvest not included				Harvest included			
			HOR[1]	NOR[2]	HRR[1]	NRR[2]	NOR[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
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	--	77	--	0.90
2003	7	36	--	11	--	0.31	--	12	--	0.33
2004	6	66	--	25	--	0.38	--	30	--	0.45
2005	176	155	--	72	--	0.46	--	79	--	0.51
2006	326	55	5	110	0.02	2.00	5	157	0.02	2.85
2007	260	92	0	0	0.00	0.00	0	0	0.00	0.00
2008	116	52	30	100	0.26	1.92	30	156	0.26	3.00
2009	238	173	98	39	0.41	0.23	98	52	0.41	0.30
Average	***128***	***69***	***33***	***44***	***0.17***	***1.05***	***33***	***55***	***0.17***	***1.27***
Median	***116***	***52***	***18***	***39***	***0.14***	***0.39***	***18***	***45***	***0.14***	***0.45***

[1] HOR and HRR values represented here are detections of PIT-tag hatchery fish detected at Tumwater Dam. These values have not been expanded based on the untagged proportion of fish released from the White River spring Chinook Program or the sampling rate at Tumwater Dam.
[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 rates on hatchery-origin White River spring Chinook have not yet been estimated but will be expanded based on harvest rates observed for Chiwawa spring Chinook.
[4] Expanded NORs for harvest were based on harvest rates from Chiwawa River spring Chinook.

For comparison, we calculated NRR for spring Chinook within the Little Wenatchee River basin. Fish 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 1989-2009, NRR for spring Chinook in the Little Wenatchee River basin averaged 0.85 (range, 0.00-4.50) if harvested fish were not included in the estimate and 1.02 (range, 0.00-5.28) if harvested fish were included in the estimate (Table 7.20). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Table 7.20. 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 1989-2009.

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	95	5.28
1998	18	31	1.72	37	2.06
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	87	1.01
2003	29	13	0.45	15	0.52
2004	39	13	0.33	15	0.38
2005	115	43	0.37	47	0.41
2006	37	49	1.32	70	1.89
2007	101	59	0.58	87	0.86
2008	64	73	1.14	114	1.78
2009	125	52	0.42	69	0.55
Average	***59***	***35***	***0.85***	***44***	***1.02***
Median	***42***	***31***	***0.50***	***37***	***0.55***

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 0.00086 (Table 7.21).

Table 7.21. Smolt-to-adult ratios (SARs) for White River spring Chinook from the captive brood program, brood years 2006-2010. 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	36	0.00086
2010	18,850	12,283	6	0.00049
Average	***90,776***	***32,475***	***13***	***0.00040***
Median	***112,596***	***38,650***	***6***	***0.00049***

7.8 ESA/HCP Compliance

Brood Collection

The last collection of eggs or fry for this program occurred in 2010 (brood year 2009). From 2011 to 2013, the White River Captive Brood Program operated without ESA permit coverage. The hatchery program ended with the last release of juveniles in 2015 (brood year 2013).

Hatchery Rearing, Spawning, and Release

From 2011 to 2013, the White River Captive Brood Program has operated without ESA permit coverage. The hatchery program ended with the last release of juveniles in 2015 (brood year 2013). Release of juveniles in 2015 was consistent with the terms and conditions of Section 10(a)(1)(A) Permit 18120.

Hatchery Effluent Monitoring

Per ESA Permits 1196 (expired), 1347, 1395, 18118, 18119, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There was one NPDES violation reported at PUD Hatchery facilities during the period 1 January through 31 December 2014. NPDES monitoring and reporting for Grant PUD Hatchery Programs during 2014 are provided in Appendix F.

This report does not cover hatchery rearing of the White River Captive Brood Program (adults and juveniles) at the Little White Salmon National Fish Hatchery, operated by the U.S. Fish and Wildlife Service.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1196 (expired), 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 2015 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 7.22. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 1196 (expired), 18118, 18120, and 18121, Section B. Table 7.22 does not include incidental or direct take associated with the White River smolt trap operated by the Yakama Nation.

Table 7.22. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2015.

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	39,396	147,480	77,510	6,350	7,148	31,152	44,650	
Encounter rate	NA	NA	NA	0.1612	0.0485	0.4019	0.1667	0.20
Mortality[c]	NA	NA	NA	42	0	414	456	
Mortality rate	NA	NA	NA	0.0066	0.0000	0.0133	0.0102	0.02
Lower Wenatchee Trap								
Population	58,595	235,184	14,157,778	1,559	9,920	252,293	263,772	
Encounter rate	NA	NA	NA	0.0266	0.0422	0.0178	0.0183	0.20
Mortality[d]	NA	NA	NA	17	2	282	301	
Mortality rate	NA	NA	NA	0.0109	0.0002	0.0011	0.0011	0.02
Wenatchee River Basin Total								
Population	97,991	235,184	14,235,288	7,909	17,068	283,445	308,422	
Encounter rate	NA	NA	NA	0.0807	0.0726	0.0199	0.0211	0.20
Mortality[d]	NA	NA	NA	59	2	696	757	
Mortality rate	NA	NA	NA	0.0075	0.0001	0.0025	0.0025	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.

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2015, as authorized by ESA Section 10 Permits 18118, 18119, 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 1196 (expired) and new Section 10 Permits 18118, 18119, 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 2015, 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, and 2015) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2014.

SECTION 8: WENATCHEE SUMMER CHINOOK

The goal of summer Chinook salmon supplementation in the Wenatchee Basin is to use artificial production to replace adult production lost because of mortality at Rock Island, Wanapum, and Priest Rapids 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 the weekly quotas cannot be achieved at Dryden Dam. Prior to 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 revised. 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 make up the difference.

Adult summer Chinook are spawned and reared at Eastbank Fish Hatchery. 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 10 and 15 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 2013-2015 Wenatchee summer Chinook broodstock, which were collected at Dryden and Tumwater dams.

Origin of Broodstock

Consistent with the broodstock collection protocol, the 2013-2015 broodstock consisted primarily of natural-origin (adipose fin present and no CWT) summer Chinook (Table 8.1). Less than 1% of the 2013-2015 broodstock was comprised of hatchery-origin fish (hatchery-origin was determined by examination of scales and/or CWTs).

Table 8.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, 1989-2015. 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	0	0	245	0	0	0	0	0	0	245
Average[c]	***266***	***9***	***5***	***252***	***0***	***1***	***0***	***0***	***1***	***0***	***253***
Median[c]	***265***	***9***	***5***	***253***	***0***	***2***	***0***	***0***	***2***	***0***	***254***

[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 2013 return consisted primarily of age-4 and age-5 natural-origin Chinook (86%). Age-3 and age-6 natural-origin fish made up 12% and 2% of the broodstock, respectively (Table 8.2). The two hatchery Chinook included in the broodstock were age-4 and age-5 fish.

Broodstock collected from the 2014 return consisted primarily of age-4 and age-5 natural-origin Chinook (94.7%). Age-3 and age-6 natural-origin fish made up 4.5% and 0% of the broodstock, respectively (Table 8.2). The two hatchery Chinook included in the broodstock were age-4 and age-5 fish.

Broodstock collected from the 2015 return consisted primarily of age-4 and age-5 natural-origin Chinook (92.1%). Age-3 and age-6 natural-origin fish made up 7.8% and 0% of the broodstock, respectively (Table 8.2). No hatchery 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, 1991-2015.

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
	Hatchery	0.0	12.5	25.0	62.5	0.0
2004	Wild	0.2	3.6	10.1	83.9	2.1

Return Year	Origin	Total age				
		2	3	4	5	6
	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
Average	***Wild***	***0.5***	***5.6***	***41.2***	***50.5***	***2.1***
	Hatchery	***0.0***	***4.9***	***30.0***	***46.5***	***6.6***
Median	***Wild***	***0.0***	***4.6***	***40.1***	***53.2***	***1.2***
	Hatchery	***0.0***	***0.0***	***14.9***	***50.0***	***0.0***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years 2013-2015 (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, 1991-2015; 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	-

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
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	-
	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	-

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
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	***Wild***	***46***	***2***	***4***	***67***	***19***	***7***	***86***	***132***	***7***	***97***	***165***	***6***	***102***	***8***	***6***
	Hatchery	***0***	***0***	***0***	***47***	***4***	***5***	***74***	***16***	***6***	***89***	***18***	***7***	***86***	***5***	***6***

Sex Ratios

Male summer Chinook in the 2013 and 2014 broodstock made up about 50% of the adults collected, resulting in overall male to female ratios of 0.98:1.00 and 0.99:1.00, respectively (Table 8.4). In 2015, males made up just under 50% of the adults collected, resulting in an overall male to female ratio of 0.99:1.00 (Table 8.4). The ratios in 2013-2015 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, 1989-2015. 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
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

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	
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	0.00:0.00	0.99:1.00
Total	***4801***	***4612***	***1.01:1.00***	***574***	***425***	***1.35:1.00***	***1.07:1.00***

Fecundity

Fecundities for the 2013-2015 returns of summer Chinook averaged 4,990, 4,756, and 4,982 eggs per female, respectively (Table 8.5). These values are close to the overall average of 5,158 eggs per female. Mean observed fecundities for the 2013-2015 returns were near the expected fecundity of 5,031 eggs per female assumed in the broodstock protocol.

Table 8.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock in the Wenatchee River basin, 1989-2015; 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
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

Return year	Mean fecundity		
	Wild	Hatchery	Total
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
Average	***5,158***	***4,983***	***5,123***
Median	***5,137***	***4,963***	***5,119***

* Individual fecundities were not tracked with females until 1997.

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 8.6). The egg take in 2013 and 2014 were lower than the revised goal of 617,285 eggs.

Table 8.6. Numbers of eggs taken from Wenatchee summer Chinook broodstock, 1989-2014.

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
1995	949,531
1996	756,000
1997	554,617
1998	854,997
1999	1,182,130
2000	1,113,159
2001	733,882

Return year	Number of eggs taken
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
Average (2012-present)	***608,204***
Median (2012-present)	***612,422***

Number of acclimation days

The 2013 brood Wenatchee summer Chinook were transferred to Dryden Acclimation Pond between 9 and 13 March 2015, including a small group of less than 200 fish that were transferred on 17 April. These fish received 11-50 days of acclimation on Wenatchee River water before being released on 28 April 2015 (Table 8.7).

Table 8.7. Number of days Wenatchee summer Chinook were acclimated at Dryden Acclimation Pond, brood years 1989-2013. 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

Brood year	Release year	Transfer date	Release date	Number of days
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

Release Information

Numbers released

The 2013 Wenatchee summer Chinook program achieved 94.1% of the 500,001 target goal with about 470,570 fish being released in 2015 (Table 8.8).

Table 8.8. Numbers of Wenatchee summer Chinook smolts released from the hatchery, 1989-2013. Up to 2012, the release target for Wenatchee summer Chinook was 864,000 smolts. Beginning in 2012, the release target is 500,001 smolts.

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

Brood year	Release year	CWT mark rate	Number released with PIT tags	Number of smolts released
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
Average (2012-present)		***0.9786***	***20,199***	***510,724***
Median (2012-present)		***0.9786***	***20,199***	***510,724***

[a] Represents high ELISA group planted directly in the Wenatchee River at Leavenworth Boat Launch.

Numbers tagged

The 2013 brood Wenatchee summer Chinook were 98.7% CWT and adipose fin-clipped (Table 8.8).

In 2015, a total of 10,500 Wenatchee summer Chinook (brood year 2014) were tagged at Eastbank Hatchery in September. These fish were tagged in water-reuse circular ponds #1 and #2. This is part of the size-target study. Fish were not fed during tagging or for two days before and after tagging. Fish in the small-fish group averaged 74 mm in length and 5.5 g at time of tagging, while those in the big-fish group averaged 78 mm in length and 5.6 g.

An additional 5,500 Wenatchee summer Chinook (2,250 small-size fish and 2,250 big-size fish) were PIT tagged in March 2016. These fish were tagged in raceways #11 and #12. This is also part of the size-target study. Fish were not fed during tagging or for two days before and after tagging. Fish in the small-fish group averaged 129 mm in length and 23.0 g at time of tagging, while those in the big-fish group averaged 136 mm in length and 27.0 g.

Table 8.9 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Wenatchee River.

Table 8.9. Summary of PIT-tagging activities for Wenatchee hatchery summer Chinook, brood years 2008-2013.

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
	2014 (Reuse Circular)	5,150 (small-size)	109	0	5,041
		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

Fish size and condition at release

About 470,570 summer Chinook from the 2013 brood were force-released from Dryden Acclimation Pond on 28 April 2015. 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. The target weight (fish/pound or FPP) of juvenile fish has been met occasionally.

Table 8.10. 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 1989-2013; NA = not available. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (cm)		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

Brood year	Release year	Fork length (cm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1994	1996	138	NA	21.7	21
1995	1997	149	12.2	42.5	11
1996	1998	151	16.6	43.2	10
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
Average (2012-present)		***157***	***11.4***	***40.7***	***11***
Targets (2012-present)[a]		***163***	***9.0***	***45.4***	***10, 15***

[a] For brood year 2012, the fish per pound (fpp) targets were 10 fpp and 15 fpp.

Survival Estimates

Overall survival of the 2013 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 all stages with the exception of unfertilized egg to eyed stage. (Table 8.11).

Table 8.11. Hatchery life-stage survival rates (%) for Wenatchee summer Chinook, brood years 1989-2013. 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
Average	***90.8***	***95.5***	***86.2***	***97.8***	***98.9***	***98.4***	***93.1***	***96.7***	***78.7***
Median	***92.4***	***96.1***	***85.7***	***98.0***	***99.4***	***98.7***	***94.9***	***98.1***	***79.4***
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 2013 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 2015. Fish were transferred to Dryden Acclimation Pond from 9-13 March and on 17 April. Increased mortality caused by external fungus and bacterial cold water disease began to occur during the acclimation period at Dryden Acclimation Pond at which time a formalin treatment was initiated to prevent the fungus from proliferating.

Results of the 2015 adult broodstock bacterial kidney disease (BKD) monitoring indicated that most females (99.2%) had ELISA values less than 0.199. The one female that had an ELISA value greater than 0.120 was not included in the program and the eggs were culled. All remaining 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 8.12).

Table 8.12. Proportion of bacterial kidney disease (BKD) titer groups for the Wenatchee summer Chinook broodstock, brood years 1997-2015. 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
Average	***0.8708***	***0.0455***	***0.0307***	***0.0528***	***0.8993***	***0.1007***
Median	***0.9585***	***0.0154***	***0.0044***	***0.0163***	***0.9675***	***0.0325***

[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 2015, juvenile summer Chinook were sampled at the Lower Wenatchee Trap located near the town of Cashmere. Because the Lower Wenatchee Trap began operation in a new location in 2013, the historic flow-discharge relationships are invalid and new models to estimate trap efficiency must be developed for all species. Relationships and models between discharge and trap efficiencies are continuing to be developed and improved.

Emigrant Estimates

Lower Wenatchee Trap

The Lower Wenatchee Trap operated between 30 January and 28 June 2015. During that time period, the trap was inoperable for five days because of high and low river discharge, debris, elevated river temperatures, and major hatchery releases. During the five-month sampling period, a total of 252,204 wild subyearling Chinook were captured at the Lower Wenatchee Trap. Based on 23 capture efficiencies, a significant relationship between trap efficiency and river discharge was created ($R^2 = 0.61$, $P < 0.005$) and an estimate (95% C.I.) of 13,679,013 (±2,089,329) wild subyearling Chinook passed the trap within the sampling period. However, because of abnormal environmental conditions (low discharge and elevated river temperatures) the trap was pulled early.

Based on historical averages, about 3.5% of subyearling Chinook emigrate after 28 June. Therefore, to account for the trap being pulled early, we expanded our point estimate by 3.5%. This resulted in a new estimate of 14,157,778 (±2,125,578) subyearling Chinook. Because 142 summer Chinook redds were observed downstream from the trap in 2015, the total number of summer Chinook emigrating from the Wenatchee River in 2015 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 14,763,064 fish. Most of the fish emigrated during April (Figure 8.1). Monthly captures and mortalities of all fish collected at the Lower Wenatchee Trap are reported in Appendix B.

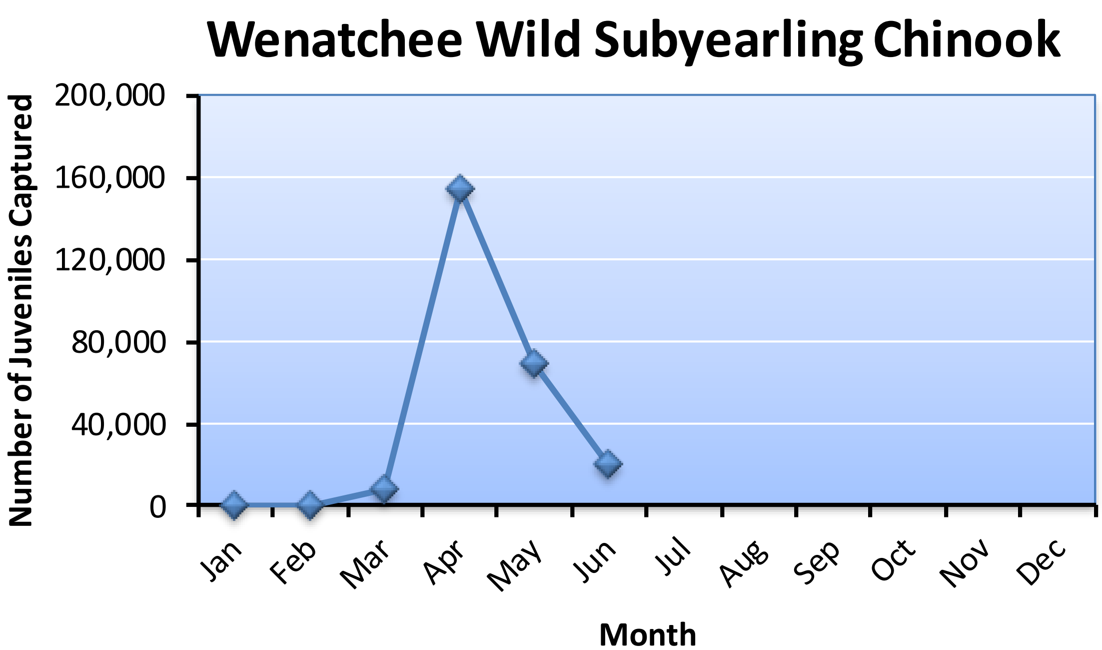

Figure 8.1. Numbers of wild subyearling Chinook captured at the Lower Wenatchee Trap during late January through June, 2015.

8.5 Spawning Surveys

Surveys for Wenatchee summer Chinook redds were conducted from 15 September to 5 November 2015 in the Wenatchee River and Icicle Creek.

Redd Counts

A total count of summer Chinook redds was estimated in 2015 based on weekly census surveys conducted in the Wenatchee River. Redds were counted in Icicle Creek when feasible. A total of 1,804 summer Chinook redds were counted in the Wenatchee River basin in 2015 (Table 8.13). This is one of the lowest counts on record.

In the future, spawning escapement estimates will be derived using the area-under-the-curve (AUC) method (described in Millar et al. 2012). WDFW now has two years of data (2014 and 2015) to inform model parameters (e.g., observer efficiency of redd counts and habitat characteristics). After the conclusion of 2016 surveys, WDFW will begin calibrating the model to generate preliminary spawning escapements and associated variance.

Table 8.13. Numbers of redds counted in the Wenatchee River basin, 1989-2015; 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

Survey year	Redd counts		Total count
	Wenatchee River	Icicle Creek	
2011	2,583	9	3,078
2012	2,301	2	2,504
2013	2,875	42	3,241
2014	3,383	75	3,458
2015	1,781	23	1,804
Average			***3,368***
Median			***3,077***

Redd Distribution

Summer Chinook redds were not evenly distributed among reaches within the Wenatchee River basin in 2015 (Table 8.14; Figure 8.2). Most of the spawning occurred upstream from the Leavenworth Bridge in Reaches 6, 9, and 10. The highest density of redds occurred in Reach 6 near the confluence of the Icicle River.

Table 8.14. Total numbers of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through mid-November, 2015. Reach codes are described in Table 2.10.

Survey reach	Total redd count
Wenatchee 1 (W1)	3
Wenatchee 2 (W2)	54
Wenatchee 3 (W3)	85
Wenatchee 4 (W4)	25
Wenatchee 5 (W5)	16
Wenatchee 6 (W6)	535
Wenatchee 7 (W7)	118
Wenatchee 8 (W8)	226
Wenatchee 9 (W9)	464
Wenatchee 10 (W10)	255
Icicle Creek (I1)	23
Totals	***1,804***

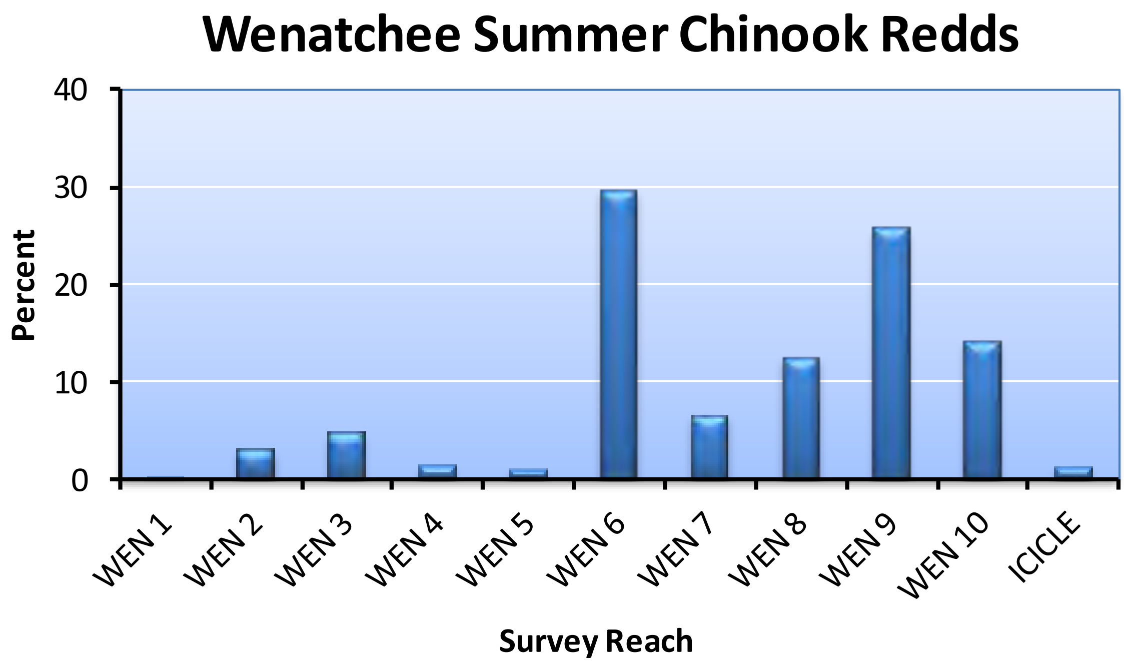

Figure 8.2. Percent of the total number of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through early-November, 2015. Reach codes are described in Table 2.10.

Spawn Timing

In 2015, spawning in the Wenatchee River began during the fourth week of September, peaked the first week of October, and ended the first week of November (Figure 8.3).

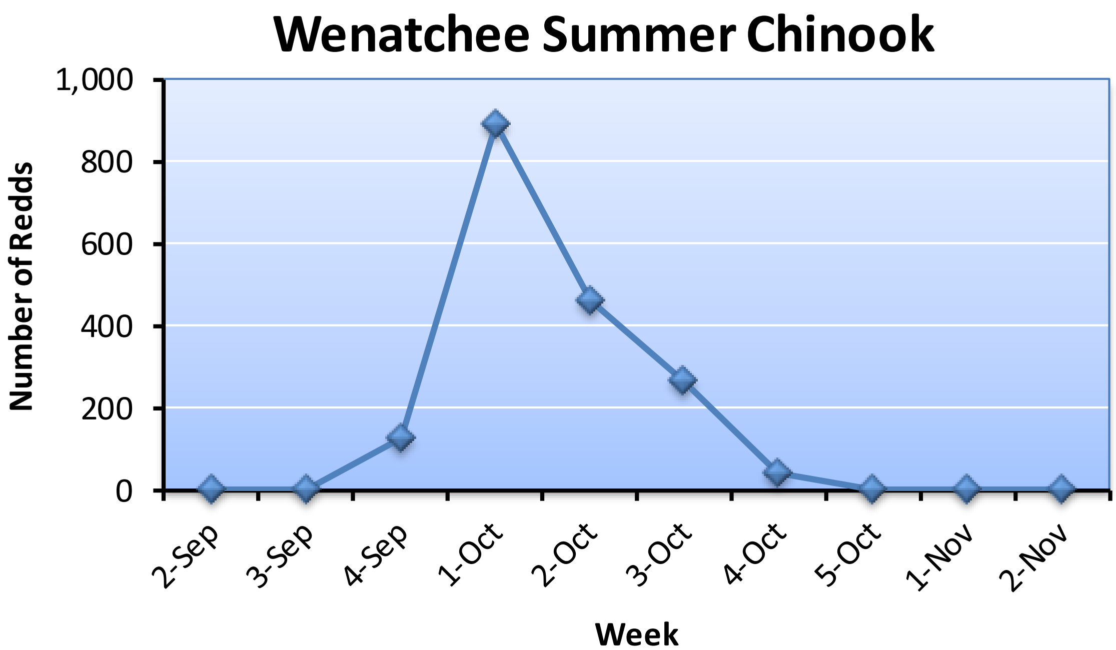

Figure 8.3. Number of new summer Chinook redds counted during different weeks in the Wenatchee River, September through mid-November 2015.

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. The estimated fish per redd ratio for summer Chinook in 2015 was 2.40. Multiplying this ratio by the number of redds counted in the Wenatchee River basin resulted in a total spawning escapement of 4,330 summer Chinook (Table 8.15). This is the lowest escapement on record.

Table 8.15. Spawning escapements for summer Chinook in the Wenatchee River basin, return years 1989-2015. 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
1997	3.40	1,739	5,913
1998	2.40	2,230	5,352
1999	2.00	2,738	5,476

Return year	Fish/Redd	Redds	Total spawning escapement
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
Average	***2.84***	***3,368***	***9,219***
Median	***3.02***	***3,077***	***9,450***

8.6 Carcass Surveys

Surveys for Wenatchee summer Chinook carcasses were conducted during late September to early November 2015 in the Wenatchee River and Icicle Creek.

Number sampled

A total of 988 summer Chinook carcasses were sampled during October through early November in the Wenatchee River basin in 2015 (Table 8.16).

Table 8.16. Numbers of summer Chinook carcasses sampled within each survey reach in the Wenatchee River basin, 1993-2015. 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**
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**

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**
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**
Average	***8***	***90***	***135***	***31***	***62***	***579***	***74***	***134***	***247***	***164***	***8***	***1,531***
Median	***5***	***81***	***112***	***19***	***38***	***659***	***50***	***80***	***185***	***150***	***6***	***1,416***

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among reaches within the Wenatchee River basin in 2015 (Table 8.16; Figure 8.4). Most of the carcasses in the Wenatchee River basin were found upstream from the Leavenworth Bridge. The highest percentage of carcasses (31%) was sampled in Reach 9 upstream of Tumwater Canyon.

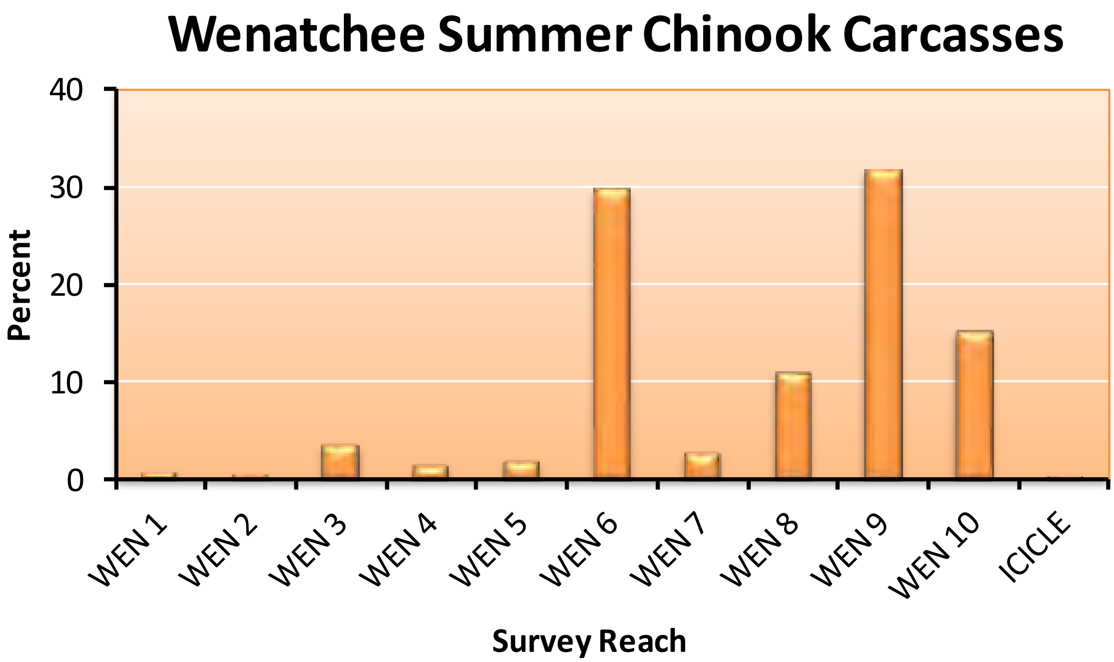

Figure 8.4. Percent of summer Chinook carcasses sampled within different reaches in the Wenatchee River basin during September through mid-November, 2015. Reach codes are described in Table 2.10.

Numbers of wild and hatchery-origin summer Chinook carcasses sampled in 2015 will be available after analysis of CWTs and scales. Based on the available data (1993-2014), most fish, regardless of origin, were found in Reach 6 (Leavenworth Bridge to Icicle Road Bridge) (Table 8.17). In general, a larger percentage of wild fish were found in the upper reaches than were hatchery fish (Figure 8.5). In contrast, a larger percentage of hatchery fish were found in reaches downstream from the Icicle Road Bridge.

Table 8.17. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Wenatchee River basin, 1993-2014.

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**

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	
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**
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	**1,600**
	Hatchery	0	7	7	2	11	87	0	2	0	1	22	**139**
Average	***Wild***	***6***	***63***	***108***	***21***	***42***	***398***	***70***	***127***	***234***	***158***	***3***	***1,231***
	Hatchery	***2***	***31***	***31***	***11***	***22***	***193***	***6***	***8***	***10***	***7***	***5***	***325***
Median	***Wild***	***4***	***48***	***80***	***13***	***25***	***387***	***49***	***71***	***171***	***147***	***0***	***1,201***
	Hatchery	***1***	***19***	***33***	***8***	***16***	***206***	***4***	***3***	***4***	***3***	***1***	***360***

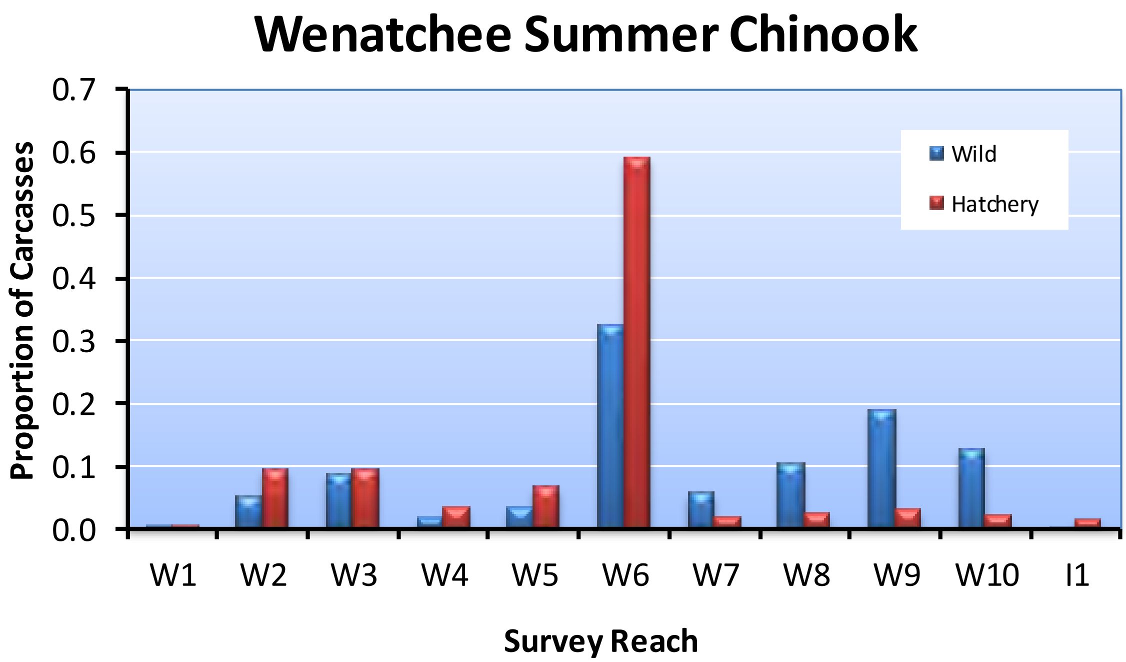

Figure 8.5. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, 1993-2014. Reach codes are described in Table 2.10.

Sampling Rate

If 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 2015 (Table 8.18). Sampling rates among survey reaches varied from 5 to 125%.

Table 8.18. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Wenatchee River basin, 2015.

Sampling reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Wenatchee 1 (W1)	3	9	7	1.25
Wenatchee 2 (W2)	54	7	130	0.05
Wenatchee 3 (W3)	85	36	204	0.18
Wenatchee 4 (W4)	25	15	60	0.25
Wenatchee 5 (W5)	16	19	38	0.49
Wenatchee 6 (W6)	535	296	1,284	0.23
Wenatchee 7 (W7)	118	27	283	0.10
Wenatchee 8 (W8)	226	110	542	0.20
Wenatchee 9 (W9)	464	314	1,114	0.28
Wenatchee 10 (W10)	255	150	612	0.25
Icicle Creek (I1)	23	5	55	0.09
Total	***1,804***	***988***	***4,330***	***0.23***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys in the Wenatchee River basin in 2015 are provided in Table 8.19. The average size of males and females sampled in the Wenatchee River basin were 65 cm and 70 cm, respectively.

Table 8.19. 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, 2015.

Stream/watershed	Mean length (cm)	
	Male	Female
Wenatchee 1 (W1)	64.0 (9.9)	64.8 (5.1)
Wenatchee 2 (W2)	78.7 (7.8)	75.0 (2.4)
Wenatchee 3 (W3)	65.7 (11.1)	75.6 (2.9)
Wenatchee 4 (W4)	73.3 (7.1)	72.8 (7.5)
Wenatchee 5 (W5)	62.9 (11.7)	73.5 (6.0)
Wenatchee 6 (W6)	65.8 (11.3)	70.3 (5.8)
Wenatchee 7 (W7)	75.0 (16.6)	69.7 (4.6)
Wenatchee 8 (W8)	64.4 (8.8)	70.3 (6.0)
Wenatchee 9 (W9)	64.7 (9.1)	70.3 (5.9)
Wenatchee 10 (W10)	61.5 (8.9)	69.2 (5.0)
Icicle Creek (I1)	60.0 (12.7)	68.0 (1.7)
Total	***64.5 (10.0)***	***70.4 (5.7)***

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 early July through mid-October. On average, during the early part of the migration, hatchery summer Chinook arrived about two weeks later than wild Chinook (Table 8.20). This pattern carried through the migration distribution of summer Chinook at Dryden Dam. By the end of the migration, hatchery fish passed Dryden Dam about three weeks after 90% of the wild fish passed the dam.

Table 8.20. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Dryden Dam, 2007-2015. 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
Average	***Wild***	***28***	***31***	***37***	***32***	***380***
	Hatchery	***30***	***34***	***40***	***34***	***355***
Median	***Wild***	***29***	***31***	***37***	***32***	***403***
	Hatchery	***29***	***34***	***40***	***35***	***338***

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 1993-2014 in the Wenatchee River basin were salt age-3 fish (Table 8.21; Figure 8.6). 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 8.21. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Wenatchee River basin, 1993-2014.

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
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

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
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	0.04	0.66	0.30	0.00	1,599
	Hatchery	0.00	0.05	0.22	0.70	0.03	139
Average	***Wild***	***0.01***	***0.12***	***0.54***	***0.32***	***0.00***	***1,139***
	Hatchery	***0.03***	***0.20***	***0.58***	***0.18***	***0.00***	***287***
Median	***Wild***	***0.01***	***0.12***	***0.70***	***0.18***	***0.00***	***1,078***
	Hatchery	***0.03***	***0.24***	***0.63***	***0.10***	***0.00***	***285***

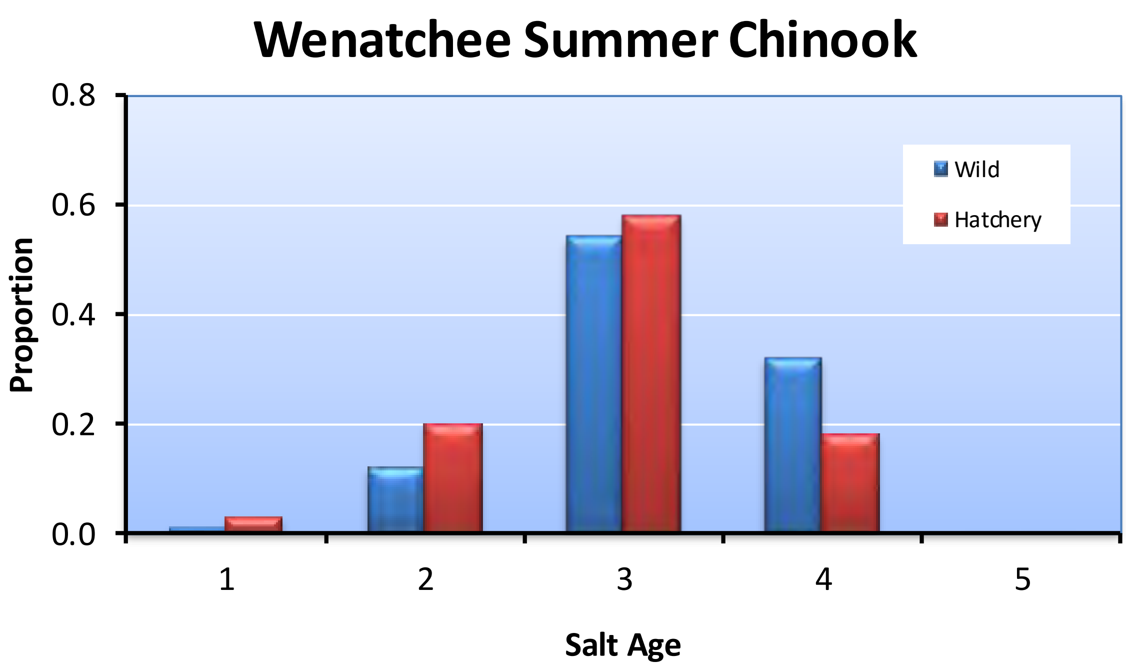

Figure 8.6. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Wenatchee River basin for the combined years 1993-2014.

Size at Maturity

On average, hatchery summer Chinook were about 4 cm smaller than wild summer Chinook sampled in the Wenatchee River basin (Table 8.22). 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 five-year reports will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 8.22. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Wenatchee River basin, 1993-2014; 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
	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

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
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	1,599	68	7	29	98
	Hatchery	139	66	10	26	85
Pooled	***Wild***	***1,238***	***71***	***8***	***32***	***95***
	Hatchery	***303***	***67***	***9***	***35***	***88***

[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 8.23). Ocean harvest has made up 47% to 100% of all hatchery Wenatchee summer Chinook harvested. Total harvest on early brood years (1990-1996 and 2007) was lower than for brood years 1997-2008.

Table 8.23. Estimated number and percent (in parentheses) of hatchery-origin Wenatchee summer Chinook captured in different fisheries, brood years 1989-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1989	1,510 (51)	1,432 (48)	0 (0)	20 (1)	2,962
1990	30 (100)	0 (0)	0 (0)	0 (0)	30
1991	30 (63)	0 (0)	0 (0)	18 (38)	48
1992	147 (79)	39 (21)	0 (0)	0 (0)	186
1993	35 (58)	25 (42)	0 (0)	0 (0)	60
1994	642 (91)	62 (9)	2 (0)	0 (0)	706
1995	561 (98)	9 (2)	5 (1)	0 (0)	575
1996	196 (96)	3 (1)	0 (0)	6 (3)	205
1997	2,991 (95)	49 (2)	12 (0)	106 (3)	3,158
1998	4,984 (92)	128 (2)	15 (0)	287 (5)	5,414
1999	1,550 (84)	168 (9)	21 (1)	104 (6)	1,843
2000	7,955 (73)	1,248 (11)	447 (4)	1,224 (11)	10,874
2001	1,062 (60)	238 (13)	106 (6)	364 (21)	1,770
2002	1,489 (56)	557 (21)	189 (7)	430 (16)	2,665
2003	816 (50)	484 (29)	89 (5)	257 (16)	1,646

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
2004	409 (47)	218 (25)	70 (8)	167 (19)	864
2005	1,333 (58)	481 (21)	186 (8)	287 (13)	2,287
2006	3,808 (52)	1,969 (27)	406 (6)	1,142 (16)	7,325
2007	212 (60)	81 (23)	8 (2)	53 (15)	354
2008	3,870 (60)	1,042 (16)	227 (4)	1,345 (21)	6,484
2009	1,710 (64)	454 (17)	97 (4)	430 (16)	2,691
Average	***1,683 (71)***	***414 (16)***	***90 (3)***	***297 (10)***	***2,483***
Median	***1,062 (63)***	***168 (16)***	***15 (1)***	***106 (11)***	***1,770***

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) and brood year should be less than 5%.

Hatchery-origin Wenatchee summer Chinook have strayed into the Entiat, Chelan, Methow, and Okanogan River basins and into the Hanford Reach (Table 8.24). In five different years, Wenatchee summer Chinook strays have made up more than 5% of the spawning escapement in the Chelan Tailrace. They have made up more than 5% of the spawning escapement in the Entiat River basin in nine different years and in the Methow River basins in eight different years. With the exception of the Entiat River basin (6.7% average stray rate), the average stray rate for Wenatchee summer Chinook during return years 1994-2012 has been less than 5%. Few have strayed into the Okanogan River basin or into the Hanford Reach.

Table 8.24. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Wenatchee summer Chinook, return years 1994-2014. 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 5%.

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
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	7.1	0	0.0	0	0.0

Return year	Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
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	11.2	0	0.0
2007	127	9.3	5	0.1	9	4.8	49	20.2	20	0.1
2008	87	4.5	24	0.3	10	2.0	31	9.7	0	0.0
2009	101	5.7	13	0.2	2	0.3	12	4.8	0	0.0
2010	208	8.3	35	0.6	55	4.9	34	7.8	0	0.0
2011	258	8.8	5	0.1	78	6.1	15	3.2	0	0.0
2012	109	3.7	24	0.3	53	4.1	54	6.0	0	0.0
2013	252	7.0	57	0.7	2	0.1	8	1.1	0	0.0
2014	15	0.9	0	0.0	4	0.4	12	2.2	0	0.0
Average	***103***	***4.3***	***24***	***0.4***	***25***	***3.7***	***31***	***6.7***	***3***	***0.0***
Median	***101***	***3.7***	***13***	***0.3***	***12***	***3.0***	***15***	***4.8***	***0***	***0.0***

Based on brood year analyses, on average, about 11% of the hatchery-origin Wenatchee summer Chinook returns have strayed into non-target spawning areas, exceeding the target of 5% (Table 8.25). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-20%. In addition, on average, about 8% have strayed into non-target hatchery programs, but straying into non-target programs has declined over time.

Table 8.25. Number and percent of hatchery-origin Wenatchee summer 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 1989-2009. Percent stays should be less than 5%.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	1,352	62.9	60	2.8	75	3.5	662	30.8
1990	74	84.1	1	1.1	0	0.0	13	14.8
1991	15	65.2	0	0.0	0	0.0	8	34.8
1992	375	84.8	7	1.6	0	0.0	60	13.6
1993	67	72.8	9	9.8	4	4.3	12	13.0
1994	890	71.8	207	16.7	61	4.9	81	6.5
1995	748	74.8	139	13.9	48	4.8	65	6.5
1996	261	70.4	42	11.3	53	14.3	15	4.0
1997	3,609	83.0	171	3.9	397	9.1	170	3.9
1998	1,790	78.2	11	0.5	416	18.2	72	3.1
1999	507	79.7	0	0.0	121	19.0	8	1.3
2000	2,745	82.3	0	0.0	545	16.3	44	1.3
2001	521	80.4	0	0.0	118	18.2	9	1.4

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2002	1,521	83.4	10	0.5	284	15.6	8	0.4
2003	1,268	88.5	42	2.9	114	8.0	9	0.6
2004	497	84.2	3	0.5	72	12.2	18	3.1
2005	1,126	83.7	1	0.1	193	14.3	25	1.9
2006	2,693	79.3	0	0.0	623	18.4	78	2.3
2007	99	78.0	0	0.0	25	19.7	3	2.4
2008	3,264	84.0	0	0.0	458	11.8	165	4.2
2009	758	78.1	0	0.0	103	10.6	110	11.3
Average	***1,151***	***78.6***	***33***	***3.1***	***177***	***10.6***	***78***	***7.7***
Median	***758***	***79.7***	***3***	***0.5***	***103***	***11.8***	***25***	***3.9***

* Homing to the target hatchery includes Wenatchee hatchery summer Chinook 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 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 M). 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 five-year report (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. 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 all brood years the PNI value has been greater than or equal to 0.67 (Table 8.26). This suggests that the natural environment has a greater influence on adaptation of Wenatchee summer Chinook than does the hatchery environment.

Table 8.26. Proportionate Natural Influence (PNI) values for the Wenatchee summer Chinook supplementation program for brood years 1989-2014. 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	8,849	600	0.06	406	44	0.90	0.94
1994	8,476	1,678	0.17	333	54	0.86	0.84
1995	6,862	894	0.12	363	16	0.96	0.89
1996	6,004	165	0.03	263	3	0.99	0.97

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
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	1,051	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	4,794	1,702	0.26	378	69	0.85	0.77
2009	7,113	1,214	0.15	452	8	0.98	0.87
2010	5,879	1,589	0.21	388	5	0.99	0.83
2011	8,155	1,695	0.17	376	7	0.98	0.86
2012	7,327	1,212	0.14	267	1	1.00	0.88
2013	7,449	2,760	0.27	234	2	0.99	0.79
2014	9,676	767	0.07	261	2	0.99	0.94
Average	***8,186***	***1,221***	***0.14***	***305***	***34***	***0.92***	***0.87***
Median	***7,802***	***1,237***	***0.15***	***295***	***6***	***0.99***	***0.87***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; 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 8.27).[17] Over the five 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 0.004 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 8.27). 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.

[17] 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.

Another experiment 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.

Table 8.27. 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 2008-2013. 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)
	9,994 (R2)	0.648 (0.031)	16.0 (8.4)	0.004 (0.001)
2010	0	--	--	--
2011	5,018	0.753 (0.070)	20.9 (8.9)	0.006 (0.001)
2012 (Raceway)	5,047 (small size)	0.724 (0.066)	18.9 (9.2)	NA
	4,740 (large size)	0.619 (0.061)	16.9 (8.6)	NA
2012 (RAS)	5,041 (small size)	0.784 (0.060)	11.8 (5.0)	NA
	5,082 (large size)	0.910 (0.077)	11.1 (4.6)	NA
2013 (Raceway)	5,116 (small size)	0.770 (0.101)	17.5 (6.0)	NA
	5,127 (large size)	0.704 (0.085)	16.7 (6.2)	NA
2013 (RAS)	5,120 (small size)	0.834 (0.124)	15.6 (5.3)	NA
	5,121 (large size)	0.768 (0.112)	14.7 (4.4)	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 1989-2008, NRR for summer Chinook in the Wenatchee averaged 0.98 (range, 0.16-2.95) if harvested fish were not included in the estimate and 2.85 (range, 0.34-10.00) if harvested fish were included in the estimate (Table 8.28). 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. 2013). The target value of 5.7 includes harvest. HRRs exceeded NRRs in 15 of the 20 years of data, regardless if harvest was or was not included in the estimate (Table 8.28). Hatchery replacement rates for Wenatchee summer Chinook have exceeded the estimated target value of 5.7 in eight of the 20 years of data.

Table 8.28. 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 1989-2008.

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	1,945	6,644	4.65	0.65
1995	398	7,755	1,000	5,329	2.51	0.69	1,575	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	7,505	16,888	31.27	2.86
1998	472	5,352	2,289	15,795	4.85	2.95	7,703	53,542	16.32	10.00
1999	488	5,476	636	12,081	1.30	2.21	2,479	47,376	5.08	8.65
2000	492	5,512	3,334	3,885	6.78	0.70	14,208	16,603	28.88	3.01
2001	493	11,360	648	19,209	1.31	1.69	2,418	72,214	4.90	6.36
2002	482	15,723	1,823	4,956	3.78	0.32	4,488	12,267	9.31	0.78
2003	496	11,800	1,433	1,845	2.89	0.16	3,079	3,985	6.21	0.34
2004	496	10,479	590	7,429	1.19	0.71	1,454	18,434	2.93	1.76
2005	494	8,703	1,345	5,177	2.72	0.59	3,632	14,106	7.35	1.62
2006	488	17,792	3,394	6,796	6.95	0.38	10,719	21,506	21.97	1.21
2007	419	4,590	127	10,761	0.30	2.34	481	40,761	1.15	8.88
2008	472	6,496	3,887	6,288	8.24	0.97	10,371	16,949	21.97	2.61
Average	***405***	***9,487***	***1,463***	***7,678***	***3.69***	***0.98***	***3,936***	***21,297***	***9.32***	***2.85***
Median	***472***	***9,802***	***1,120***	***6,073***	***2.62***	***0.70***	***2,449***	***16,746***	***4.99***	***1.57***

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 0.00037 to 0.01554 for hatchery summer Chinook in the Wenatchee River basin (Table 8.29).

Table 8.29. Smolt-to-adult ratios (SARs) for Wenatchee hatchery summer Chinook, brood years 1989-2009.

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	1,920	0.00424
1995	668,409	1,541	0.00231
1996	585,590	568	0.00097
1997	480,418	7,465	0.01554
1998	641,109	7,630	0.01190
1999	988,328	2,457	0.00249
2000	903,368	13,856	0.01534
2001	596,618	2,404	0.00403
2002	805,919	4,358	0.00541
2003	639,381	3,031	0.00474
2004	875,758	1,439	0.00164
2005	631,492	3,585	0.00568
2006	931,880	10,539	0.01131
2007	453,719	481	0.00106
2008	859,401	10,061	0.01171
2009	830,419	3,631	0.00437
Average	***600,682***	***3,664***	***0.00538***
Median	***631,492***	***2,404***	***0.00424***

[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 2013 broodstock collection protocol, 256 natural-origin (adipose fin present) summer Chinook adults were targeted for collection at Dryden and Tumwater dams. The actual 2013 collection totaled 258 summer Chinook (256 natural-origin and two hatchery-origin; the hatchery-origin fish were not direct collections but rather adipose-present non-wired fish with a hatchery scale pattern) in combination from Dryden and Tumwater dams. Trapping began 1 July and ended 13 September 2013.

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 1395 take authorizations. No steelhead or spring Chinook takes were associated with the Wenatchee summer Chinook collection.

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 2013 Wenatchee summer Chinook program released an estimated 470,570 smolts, representing 94.1% of the 500,001 programmed production, and was within the 110% overage allowance identified in ESA permit 1347.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18119, and 18121, 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 PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2015 are provided in Appendix F.

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 2015 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 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[18], 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 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 overwintered 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. Prior to 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 released from the new facility in late 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 15 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 2013-2015 Methow summer Chinook broodstock that were collected in the West Ladder of Wells Dam during 2013-2015.

[18] The majority of the production at Carlton Acclimation Pond is initial production, which terminated in 2013, and is not necessarily tied to hydro facility mortality. The balance of the production is the result of a swap between spring and summer Chinook. That is, Chelan PUD is currently producing summer Chinook at Carlton for Douglas PUD in exchange for Douglas PUD producing spring Chinook at the Methow Fish Hatchery for Chelan PUD.

Origin of Broodstock

Broodstock collected in 2013, 2014, and 2015 consisted almost entirely of natural-origin (adipose fin present) summer Chinook (Table 9.1). In 2013, to meet production goals, hatchery-origin adults were collected in concert with natural-origin fish.

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 1989-2012. Numbers of broodstock collected from 2013 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
Average[d]	***105***	***3***	***0***	***97***	***6***	***2***	***0***	***0***	***2***	***1***	***99***
Median[d]	***99***	***3***	***0***	***97***	***0***	***2***	***0***	***0***	***1***	***0***	***99***

[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 2013 return consisted primarily of age-4 and 5 natural-origin Chinook (84.8%) and age-5 hatchery-origin Chinook (100%). Age-3 natural-origin fish made up 15.2% of the broodstock (Table 9.2).

Broodstock collected from the 2014 return consisted primarily of age-4 and 5 natural-origin Chinook (95.8%). Age-3 natural-origin Chinook made up 4.1% of the broodstock (Table 9.2).

Broodstock collected from the 2015 return consisted primarily of age-4 and 5 natural-origin Chinook (87.8%). Age-3 natural-origin Chinook made up 12.2% 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, 1991-2015.

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

Return Year	Origin	Total age				
		2	3	4	5	6
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
	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
Average	***Wild***	***0.7***	***10.8***	***50.1***	***37.1***	***1.3***
	Hatchery	***0.2***	***8.3***	***34.0***	***43.3***	***6.7***
Median	***Wild***	***0.3***	***10.1***	***53.7***	***32.6***	***0.5***
	Hatchery	***0.0***	***5.1***	***29.3***	***49.0***	***2.4***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years 2013-2015 (Table 9.3). For 2013, average fork lengths for age-5 natural-origin adults were 5 cm longer than that of age-5 hatchery fish (Table 9.3). There were no hatchery-origin adults collected for the 2014 brood. 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, 1991-2015; 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	-	-	-	71	11	4	83	38	5	94	41	6	-	-	-
	Hatchery	-	-	-	-	-	-	75	1	0	-	-	-	-	-	-
Average	***Wild***	***42***	***3***	***4***	***63***	***30***	***6***	***81***	***133***	***7***	***91***	***102***	***6***	***94***	***3***	***7***
	Hatchery	***42***	***1***	***5***	***52***	***18***	***7***	***72***	***48***	***6***	***87***	***61***	***6***	***94***	***13***	***6***

Sex Ratios

Male summer Chinook in the 2013 broodstock made up about 51.0% of the adults collected, resulting in an overall male to female ratio of 1.04:1.00 (Table 9.4.). In 2014, males made up about 50.0% of the adults collected, resulting in an overall male to female ratio of 1.00:1.00 (Table 9.4). In 2015, males made up about 51.0% of the adults collected, resulting in an overall male to female ratio of 1.02:1.00 (Table 9.4). The ratios for 2013, 2014, and 2015 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, 1991-2015. 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
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

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	
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
Total[b]	***6,182***	***5820***	***1.06:1.00***	***2661***	***1935***	***1.36:1.00***	***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 2013, 2014, and 2015 summer Chinook broodstock averaged 4,700, 4,685, and 4,410 eggs per female, respectively (Table 9.5). These values are close to the overall average of 4,914 eggs per female. Mean observed fecundities for the 2013, 2014, and 2015 returns were slightly below the expected fecundity of 4,982 eggs per female assumed in the broodstock protocol.

Table 9.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock at Wells Dam for the Methow/Okanogan programs, 1989-2014; 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

Return year	Mean fecundity		
	Wild	Hatchery	Total
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
Average	***4,914***	***4,897***	***4,914***
Median	***5,040***	***4,923***	***4,849***

* Individual fecundities were not assigned to females until 1997 brood.

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 9.6). From 2012 to present, the egg take goal was not achieved (Table 9.6).

Table 9.6. Numbers of eggs taken from summer Chinook broodstock collected at Wells Dam for the Methow/Okanogan programs, 1989-2015.

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
Average (2012-present)	***229,080***
Median (2012-present)	***227,488***

Number of acclimation days

Rearing of the 2013 brood Methow summer Chinook was different than previous years with fish being held on well water before being transferred to Carlton Acclimation Pond for final acclimation on Methow River water in October of 2014 (Table 9.7). Groups of the 1994 and 1995 broods were reared for longer durations at the Methow Fish Hatchery on Methow River water.

Table 9.7. Number of days Methow summer Chinook were acclimated at Carlton Acclimation Pond, brood years 1989-2013.

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

Brood year	Release year	Transfer date	Release date	Number of days
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

Release Information

Numbers released

The 2013 brood Methow summer Chinook program achieved 94.4% of the 200,000 target goal with about 188,834 fish being volitionally released from the circular ponds. Most of the fish were force released on 13 May 2015 (Table 9.8).

Table 9.8. Numbers of Methow summer Chinook smolts released from the hatchery, brood years 1989-2013. Beginning with the 2014 release, the release target for Methow summer Chinook is 200,000 smolts.

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
Average (2012-present)		***0.9945***	***193,113***
Median (2012-present)		***0.9945***	***193,113***

Numbers tagged

The 2013 brood Methow summer Chinook were 99% CWT and adipose fin-clipped (Table 9.8).

A total of 5,000 Methow summer Chinook (brood 2014) were PIT tagged at the Carlton Acclimation Facility on 14-16 March 2016. These fish were tagged in circular ponds #1 through #8. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 116 mm in length and 17.0 g at time of tagging.

Table 9.9 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Methow River.

Table 9.9. Summary of PIT-tagging activities for Methow hatchery summer Chinook, brood years 2008-2013.

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	0	0
2011	2013	0	0	0	0
2012	2014	10,099	41	7	10,051
2013	2015	10,159	35	1	10,123

Fish size and condition at release

A volitional release of yearling smolts took place beginning on 13 April and ending on 13 May 2015 (remaining fish were forced out of the facility on 13 May). Size at release from the acclimated population was 79.8% and 59.9% of the respective target fork length and weight goals (Table 9.10). This brood year exceeded the target CV for length by 40%.

Table 9.10. 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 1991-2013. 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

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
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
Average		***144***	***12.4***	***34.4***	***14***
Targets		***163***	***9.0***	***45.4***	***15***

Survival Estimates

Overall survival of the Methow summer Chinook from green (unfertilized) egg-to-release was above the standard set for the program (Table 9.11). High hatchery survival can be attributed to exceeding the survival standards set for the program at almost every life stage.

Table 9.11. Hatchery life-stage survival rates (%) for Methow summer Chinook, brood years 1989-2013. 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

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	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
Average	***93.9***	***96.4***	***87.2***	***97.6***	***98.2***	***97.7***	***94.0***	***98.2***	***82.2***
Median	***94.3***	***97.5***	***88.2***	***98.0***	***99.4***	***98.9***	***96.7***	***99.5***	***84.4***
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 2015 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females had ELISA values less than 0.120 (Table 9.12).

Table 9.12. Proportion of bacterial kidney disease (BKD) titer groups for the Methow/Okanogan summer Chinook broodstock, brood years 1997-2015. 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

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)
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
Average	***0.9334***	***0.0300***	***0.0111***	***0.0256***	***0.9530***	***0.0471***
Median	***0.9620***	***0.0151***	***0.0075***	***0.0093***	***0.9780***	***0.0220***

[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 2015, 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 three mark-recapture release groups in 2015. The flow-efficiency estimate was based on 12 mark-recapture release groups that were conducted over the period 2008-2011.

The Methow Trap operated at night between 18 February and 25 November 2015. During that time period the trap was inoperable for three days because of fire activity. During the ten-month sampling period, a total of 12,914 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 2015 was 706,071

(±578,674). Because 29 summer Chinook redds were observed downstream from the trap in 2014, the total number of summer Chinook emigrating from the Methow River in 2015 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 742,505 fish. Most of these fish emigrated during May and June (Figure 9.1).

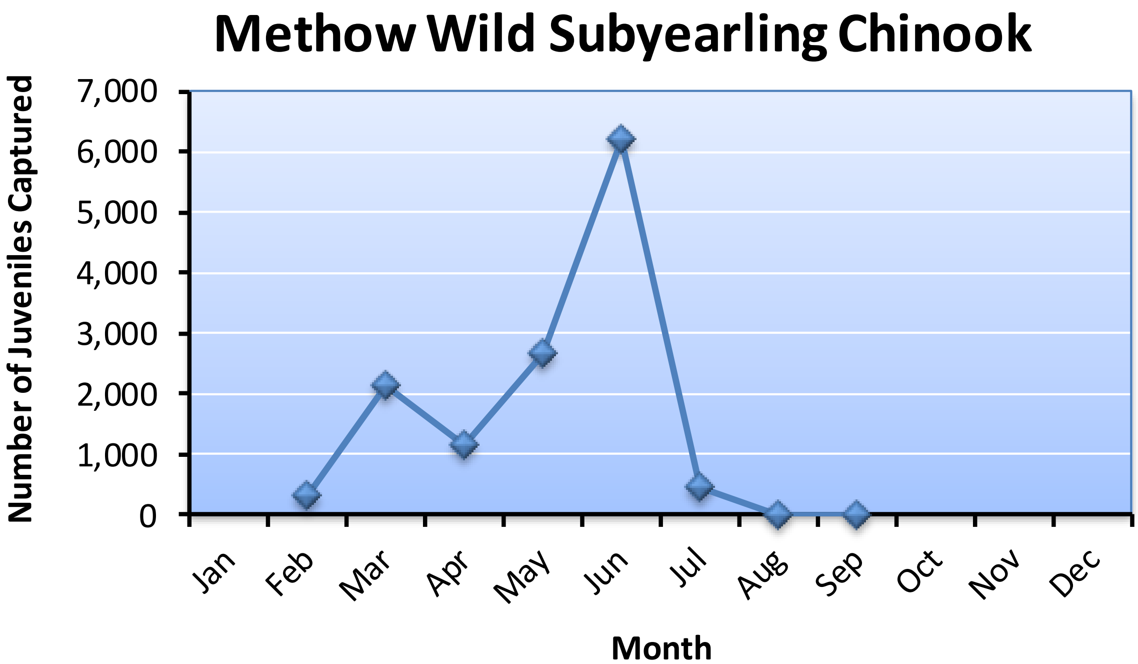

Figure 9.1. Numbers of wild subyearling Chinook captured at the Methow Trap during February through September, 2015.

9.5 Spawning Surveys

Surveys for Methow summer Chinook redds were conducted from late September to mid-November 2015 in the Methow River. Total redd counts (not peak counts) were conducted in the river (see Appendix N for more details).

Redd Counts

A total of 1,231 summer Chinook redds were counted in the Methow River in 2015 (Table 9.13). This is greater than the overall average of 696 redds.

Table 9.13. Total number of redds counted in the Methow River, 1989-2015.

Survey year	Total redd count
1989	149*
1990	418*
1991	153
1992	107

Survey year	Total redd count
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
Average	***696***
Median	***599***

* 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 (78%) were located within the lower three reaches (downstream from Twisp) (Table 9.14; Figure 9.2). Few Chinook spawned upstream from Winthrop (Reaches 6 and 7).

Table 9.14. Total number of summer Chinook redds counted in different reaches on the Methow River during September through early November, 2015. Reach codes are described in Table 2.11.

Survey reach	Total redd count	Percent
Methow 1 (M1)	350	28.4
Methow 2 (M2)	309	25.1
Methow 3 (M3)	307	24.9
Methow 4 (M4)	72	5.8
Methow 5 (M5)	146	11.9
Methow 6 (M6)	13	1.1

Survey reach	Total redd count	Percent
Methow 7 (M7)	34	2.8
Totals	***1,231***	***100***

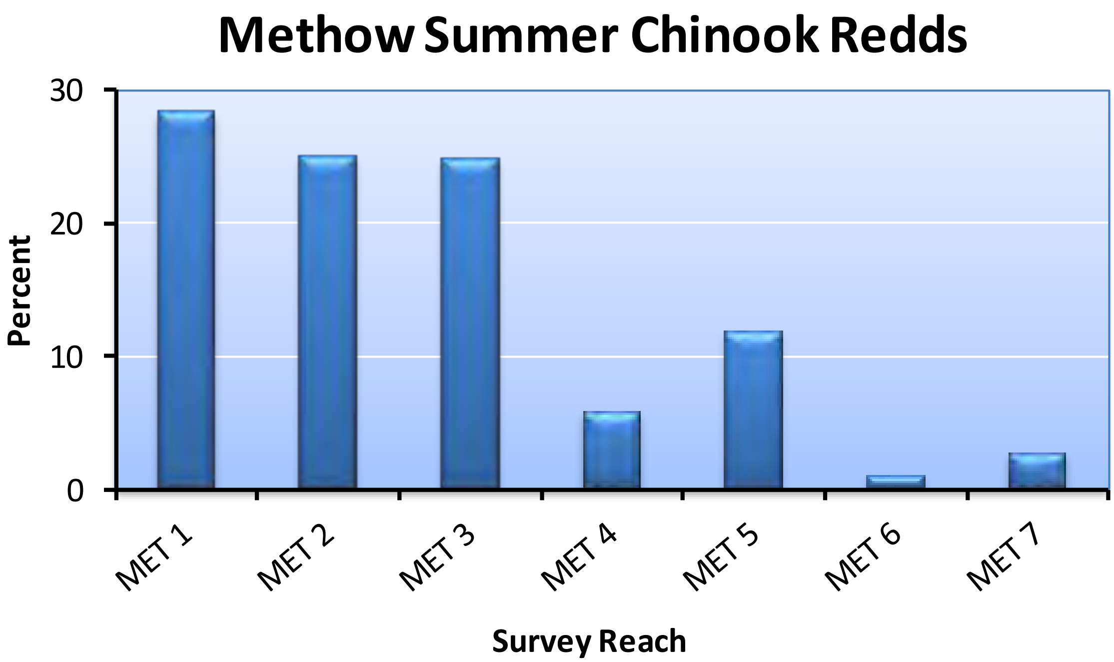

Figure 9.2. Percent of the total number of summer Chinook redds counted in different reaches on the Methow River during September through mid-November, 2015. Reach codes are described in Table 2.11.

Spawn Timing

Spawning in 2015 began the last week of September, peaked in early October, and ended the third week of November (Figure 9.3). Stream temperatures in the Methow River, when spawning began, varied from 9.0-10.0°C. Peak spawning occurred during the first week of October in the upper reaches of the Methow River and one week later in the lower reaches.

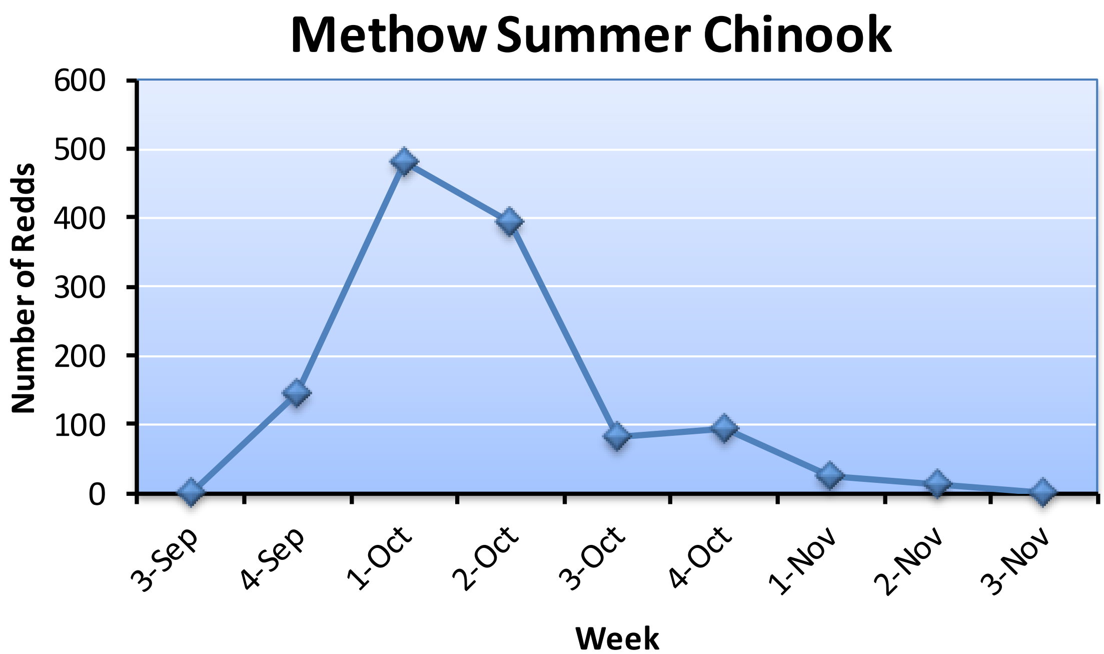

Figure 9.3. Number of new summer Chinook redds counted during different weeks in the Methow River, September through mid-November 2015.

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. The estimated fish per redd ratio for Methow summer Chinook in 2015 was 3.21. Multiplying this ratio by the number of redds counted in the Methow River resulted in a total spawning escapement of 3,952 summer Chinook (Table 9.15).

Table 9.15. Spawning escapements for summer Chinook in the Methow River for return years 1989-2015.

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
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

Return year	Fish/Redd	Redds	Total spawning escapement
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
Average	***2.98***	***696***	***1,901***
Median	***3.07***	***599***	***1,625***

* 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 2015 in the Methow River (see Appendix N for more details).

Number sampled

A total of 839 summer Chinook carcasses were sampled during September through mid-November in the Methow River (Table 9.16). This was greater than the overall average of 520 carcasses sampled since 1991.

Table 9.16. Numbers of summer Chinook carcasses sampled within each survey reach on the Methow River, 1991-2015. 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**

Survey year	Number of summer Chinook carcasses							
	M-1	M-2	M-3	M-4	M-5	M-6	M-7	Total
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**
Average	***113***	***129***	***154***	***42***	***71***	***8***	***3***	***520***
Median	***64***	***134***	***159***	***33***	***76***	***3***	***0***	***506***

[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 2015 (Table 9.15; Figure 9.4). 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).

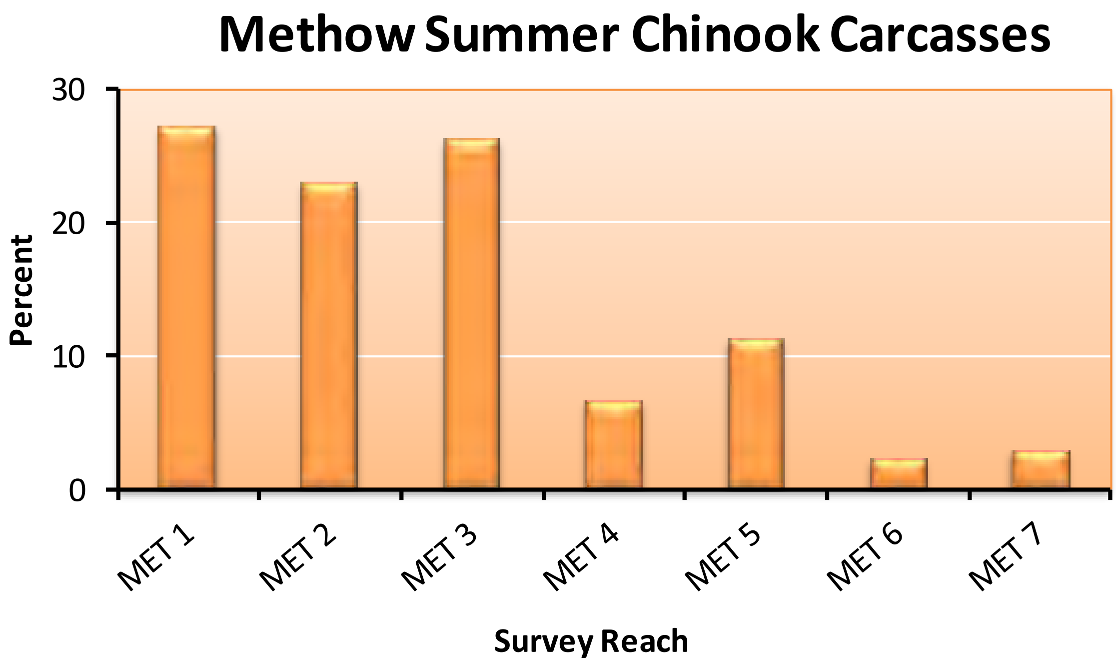

Figure 9.4. Percent of summer Chinook carcasses sampled within different reaches on the Methow River during September through mid-November, 2015. Reach codes are described in Table 2.11.

Numbers of wild and hatchery-origin summer Chinook carcasses sampled in 2015 will be available after analysis of CWTs and scales. Based on the available data (1991-2014), hatchery and wild summer Chinook carcasses were not distributed equally among the reaches in the Methow River (Table 9.17). 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 9.5).

Table 9.17. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches on the Methow River, 1991-2014.

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**

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
1997	Wild	5	8	31	1	17	0	0	**62**
	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	**355**
	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**
Average	***Wild***	***35***	***66***	***97***	***31***	***59***	***7***	***2***	***296***
	Hatchery	***74***	***60***	***54***	***10***	***12***	***1***	***0***	***211***
Median	***Wild***	***29***	***60***	***86***	***20***	***55***	***2***	***0***	***295***
	Hatchery	***43***	***62***	***38***	***8***	***8***	***0***	***0***	***196***

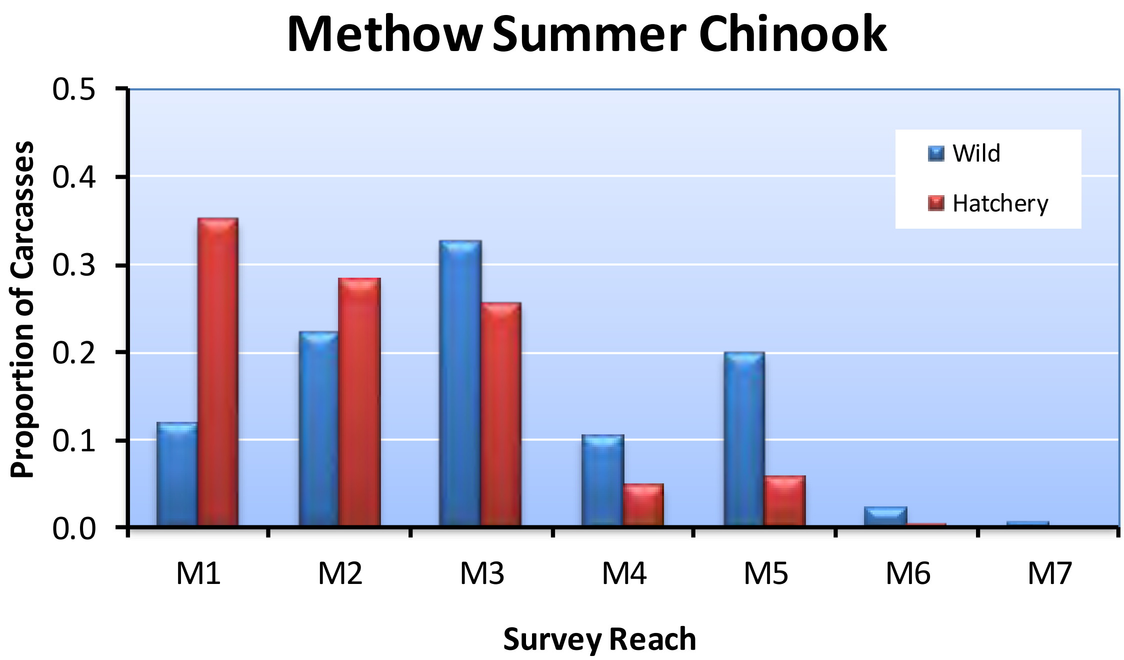

Figure 9.5. Distribution of wild and hatchery produced carcasses in different reaches on the Methow River, 1993-2014. Reach codes are described in Table 2.11.

Sampling Rate

Overall, 21% of the total spawning escapement of summer Chinook in the Methow River basin was sampled in 2015 (Table 9.18). Sampling rates among survey reaches varied from 20 to 46%.

Table 9.18. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Methow River basin, 2015. 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)	350	229	1,124	0.20
Methow 2 (M2)	309	194	992	0.20
Methow 3 (M3)	307	221	985	0.22
Methow 4 (M4)	72	56	231	0.24
Methow 5 (M5)	146	95	469	0.20
Methow 6 (M6)	13	19	42	0.46
Methow 7 (M7)	34	25	109	0.23
Total	***1,231***	***839***	***3,952***	***0.21***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Methow River in 2015 are provided in Table 9.19. The average size of males and females sampled in the Methow River were 61 cm and 68 cm, respectively.

Table 9.19. 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, 2015. Reach codes are described in Table 2.11.

Stream/watershed	Mean length (cm)	
	Male	Female
Methow 1 (M1)	59.7 (9.3)	67.0 (6.0)
Methow 2 (M2)	60.0 (8.6)	66.8 (5.7)
Methow 3 (M3)	61.7 (9.7)	67.8 (5.6)
Methow 4 (M4)	59.0 (9.0)	68.2 (6.1)
Methow 5 (M5)	64.3 (10.0)	69.3 (4.3)
Methow 6 (M6)	65.9 (8.8)	67.1 (7.9)
Methow 7 (M7)	61.9 (9.3)	69.0 (5.9)
Total	***60.9 (9.3)***	***67.6 (5.7)***

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) (Table 2.1). Based on broodstock sampling in 2015, hatchery summer Chinook generally arrived at Wells Dam later than wild summer Chinook (Table 9.20). 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 2007-2015 survey period.

Table 9.20. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Wells Dam, 2007-2015. 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

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
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
Average	***Wild***	***27***	***30***	***34***	***30***	***384***
	Hatchery	***28***	***30***	***34***	***30***	***588***
Median	***Wild***	***27***	***30***	***34***	***30***	***377***
	Hatchery	***27***	***30***	***33***	***30***	***591***

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 1993-2014 in the Methow River were salt age-3 fish (Table 9.21; Figure 9.6). 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 9.21. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Methow River, 1993-2014.

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

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
	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
	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

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
	Hatchery	0.06	0.43	0.47	0.04	0.00	0.00	47
Average	***Wild***	***0.02***	***0.20***	***0.52***	***0.25***	***0.00***	***0.00***	***298***
	Hatchery	***0.05***	***0.32***	***0.57***	***0.06***	***0.00***	***0.00***	***218***
Median	***Wild***	***0.01***	***0.17***	***0.59***	***0.22***	***0.00***	***0.00***	***281***
	Hatchery	***0.06***	***0.24***	***0.63***	***0.07***	***0.00***	***0.00***	***187***

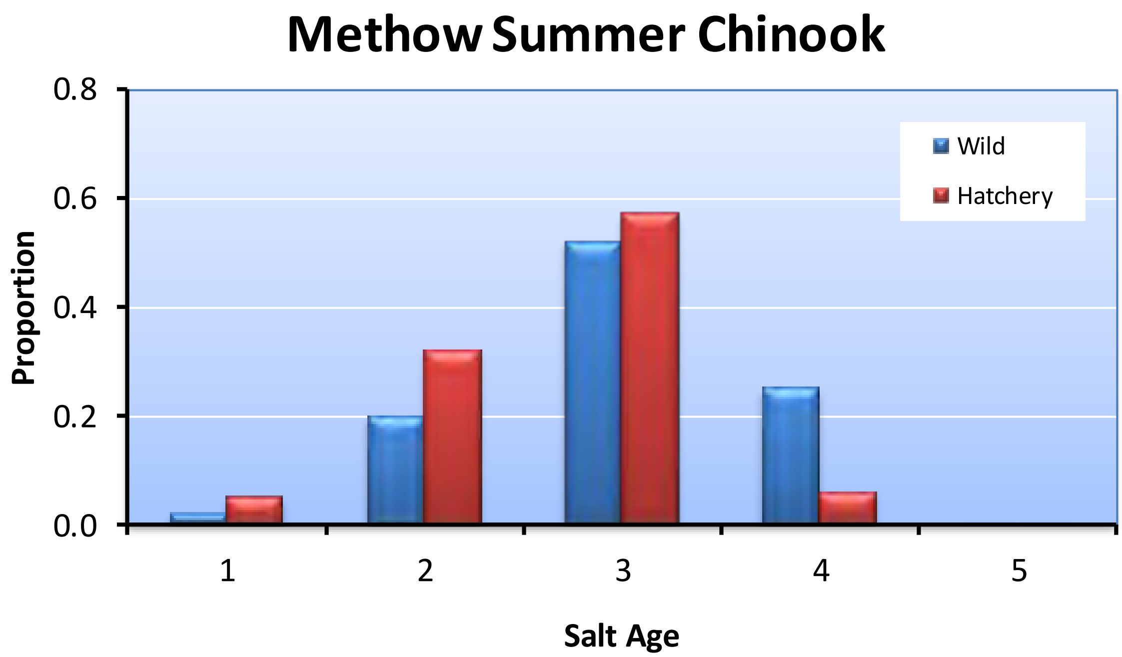

Figure 9.6. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Methow River for the combined years 1993-2014.

Size at Maturity

On average, hatchery summer Chinook were about 4 cm smaller than wild summer Chinook sampled in the Methow River basin (Table 9.22). 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 9.22. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Methow River basin, 1993-2013; 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

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	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
	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

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	613	66	8	27	83
2014	Wild	438	67	7	31	88
	Hatchery	49	60	10	35	76
Pooled	***Wild***	***7,292***	***70***	***8***	***29***	***99***
	Hatchery	***5,025***	***66***	***10***	***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 9.23). Ocean harvest has made up 13% to 99% of all hatchery-origin Methow summer Chinook harvested. Brood years 1989, 1998, 2006, 2008, and 2009 provided the largest harvests, while brood years 1996 and 1999 provided the lowest.

Table 9.23. Estimated number and percent (in parentheses) of hatchery-origin Methow summer Chinook captured in different fisheries, brood years 1989-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1989	1,043 (52)	884 (44)	0 (0)	66 (3)	1,993
1990	55 (57)	41 (43)	0 (0)	0 (0)	96
1991	12 (20)	49 (80)	0 (0)	0 (0)	61
1992	17 (55)	14 (45)	0 (0)	0 (0)	31
1993	29 (58)	17 (34)	4 (8)	0 (0)	50
1994	153 (81)	34 (18)	1 (1)	1 (1)	189
1995	77 (99)	0 (0)	1 (1)	0 (0)	78
1996	12 (92)	1 (8)	0 (0)	0 (0)	13
1997	216 (89)	7 (3)	0 (0)	21 (9)	244
1998	1,755 (83)	101 (5)	14 (1)	234 (11)	2,104
1999	2 (13)	13 (87)	0 (0)	0 (0)	15
2000	364 (71)	88 (17)	27 (5)	33 (6)	512
2001	321 (52)	97 (16)	43 (7)	160 (26)	621
2002	272 (48)	96 (17)	61 (11)	137 (24)	566
2003	58 (58)	17 (17)	7 (7)	18 (18)	100
2004	133 (49)	55 (20)	16 (6)	68 (25)	272
2005	298 (54)	137 (25)	50 (9)	66 (12)	551
2006	1,128 (48)	811 (34)	100 (4)	314 (13)	2,353
2007	205 (60)	69 (20)	16 (5)	54 (16)	344
2008	1,656 (59)	366 (13)	65 (2)	705 (25)	2,792
2009	805 (67)	203 (17)	27 (2)	175 (14)	1,210
Average	***410 (60)***	***148 (27)***	***21 (3)***	***98 (10)***	***676***

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
Median	***205 (58)***	***55 (18)***	***7 (2)***	***33 (9)***	***272***

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) and brood year should be less than 5%.

Few hatchery-origin Methow summer Chinook have strayed into basins outside the Methow (Table 9.24). 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 escapement within those areas.

Table 9.24. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Methow summer Chinook, return years 1994-2014. 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 5%.

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
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	1.2	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	17	0.1	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***

Return year	Wenatchee		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
Median	***0***	***0.0***	***12***	***0.2***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 3% of the returns have strayed into non-target spawning areas, falling within the acceptable level of less than 5% (Table 9.25). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-11.9%. Few (<1% on average) have strayed into non-target hatchery programs.

Table 9.25. Number and percent of hatchery-origin Methow summer 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 1989-2009. Percent stays should be less than 5%.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	773	55.7	459	33.0	81	5.8	76	5.5
1990	199	70.6	81	28.7	0	0.0	2	0.7
1991	82	65.6	43	34.4	0	0.0	0	0.0
1992	68	63.0	40	37.0	0	0.0	0	0.0
1993	25	65.8	10	26.3	3	7.9	0	0.0
1994	419	79.7	94	17.9	13	2.5	0	0.0
1995	126	81.8	28	18.2	0	0.0	0	0.0
1996	57	93.4	4	6.6	0	0.0	0	0.0
1997	379	93.8	7	1.7	18	4.5	0	0.0
1998	1,653	94.7	32	1.8	60	3.4	0	0.0
1999	18	100.0	0	0.0	0	0.0	0	0.0
2000	239	93.0	4	1.6	14	5.4	0	0.0
2001	272	88.3	6	1.9	29	9.4	1	0.3
2002	315	94.6	4	1.2	14	4.2	0	0.0
2003	131	99.2	1	0.8	0	0.0	0	0.0
2004	194	85.5	6	2.6	27	11.9	0	0.0
2005	373	90.5	13	3.2	23	5.6	3	0.7
2006	1,317	91.4	15	1.0	109	7.6	0	0.0
2007	134	98.5	2	1.5	0	0.0	0	0.0
2008	1,871	97.9	13	0.7	25	1.3	3	0.2
2009	170	92.4	14	7.6	0	0.0	0	0.0
Average	***420***	***85.5***	***42***	***10.8***	***20***	***3.3***	***4***	***0.4***
Median	***199***	***91.4***	***13***	***2.6***	***13***	***2.5***	***0***	***0.0***

* Homing to the target hatchery includes Methow hatchery summer Chinook that are captured and included as broodstock in the Methow Hatchery program. These hatchery fish are typically collected at Wells Dam.

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 M). 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.

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. 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 1993-2003, the PNI values were generally less than 0.67 (Table 9.26). However, since brood year 2003, PNI has generally been greater than 0.67; brood year 2014 had a PNI value of 0.90.

Table 9.26. Proportionate Natural Influence (PNI) values for the Methow summer Chinook supplementation program for brood years 1989-2014. 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	437	238	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	2,039	694	0.25	500	10	0.98	0.80
2007	764	600	0.44	456	17	0.96	0.69
2008	1,293	654	0.34	359	86	0.81	0.71
2009	1,093	665	0.38	503	4	0.99	0.73
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	1,807	1,776	0.50	97	4	0.96	0.66

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
2014	1,451	174	0.11	96	0	1.00	0.90
Average	***1,132***	***689***	***0.32***	***391***	***163***	***0.72***	***0.70***
Median	***1,108***	***584***	***0.37***	***350***	***181***	***0.80***	***0.69***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; 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 9.27).[19] Over the four brood years for which PIT-tagged hatchery fish were released, survival rates from the Methow River to McNary Dam ranged from 0.485 to 0.747; SARs from release to detection at Bonneville Dam ranged from 0.002 to 0.016. Average travel time from the Methow River to McNary Dam ranged from 17 to 55 days.

Table 9.27. 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 2008-2013. 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)	NA
2013	9,825	0.560 (0.101)	54.5 (8.3)	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 1989-2008, NRR for summer Chinook in the Methow averaged 1.13

[19] 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.

(range, 0.10-4.90) if harvested fish were not included in the estimate and 2.34 (range, 0.18-10.84) if harvested fish were included in the estimate (Table 9.28). 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 3.0 (the calculated target value in Hillman et al. 2013). The target value of 3.0 includes harvest. HRRs exceeded NRRs in 12 out of the 20 years of data, regardless if harvest was or was not included in the estimate (Table 9.28). Hatchery replacement rates for Methow summer Chinook have exceeded the estimated target value of 3.0 in nine of the 20 years of data.

Table 9.28. 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 1989-2008.

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	545	2.02	0.50	715	743	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	648	2,404	3.10	3.45
1998	235	675	1,745	3,307	7.43	4.90	3,849	7,316	16.38	10.84
1999	222	986	18	2,862	0.08	2.90	33	5,251	0.15	5.33
2000	222	1,200	257	808	1.16	0.67	769	2,426	3.46	2.02
2001	223	2,768	308	2,877	1.38	1.04	929	8,718	4.17	3.15
2002	222	4,630	333	1,072	1.50	0.23	899	2,913	4.05	0.63
2003	224	3,930	132	397	0.59	0.10	232	698	1.04	0.18
2004	223	2,189	227	1,646	1.02	0.75	499	3,626	2.24	1.66
2005	225	2,561	412	1,159	1.83	0.45	963	2,714	4.28	1.06
2006	236	2,733	1,441	1,714	6.11	0.63	3,794	4,522	16.08	1.65
2007	209	1,364	136	1,510	0.65	1.11	480	5,355	2.30	3.93
2008	184	1,947	1,929	1,498	10.48	0.77	4,721	3,699	25.66	1.90
Average	***224***	***1,602***	***503***	***1,274***	***2.33***	***1.13***	***1,153***	***2,875***	***5.37***	***2.34***
Median	***223***	***1,207***	***270***	***1,116***	***1.27***	***0.76***	***574***	***2,415***	***2.52***	***1.66***

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 0.01883 for hatchery summer Chinook in the Methow River basin (Table 9.29).

Table 9.29. Smolt-to-adult ratios (SARs) for Methow summer Chinook, brood years 1989-2009.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	358,237	2,871	0.008010
1990	371,483	361	0.000970
1991	377,097	130	0.000340
1992	392,636	138	0.000350
1993	200,345	62	0.000310
1994	400,488	710	0.001770
1995	344,974	229	0.000660
1996	289,880	73	0.000250
1997	380,430	644	0.001690
1998	202,559	3,815	0.018830
1999	422,473	33	0.000080
2000	334,337	768	0.002300
2001	246,159	925	0.003760
2002	310,846	896	0.002880
2003	353,495	232	0.000660
2004	394,490	496	0.001260
2005	262,496	961	0.003660
2006	417,795	3,786	0.009060
2007	426,188	479	0.001120
2008	373,234	4,472	0.011980
2009	450,237	1,382	0.003070
Average	***348,089***	***1,117***	***0.00348***
Median	***371,483***	***644***	***0.00169***

[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 2013 broodstock collection protocol, 102 natural-origin (adipose fin present) adults were targeted for collection between 1 July and 15 September at the West Ladder of Wells Dam. Actual collections occurred between 2 July and 13 September and totaled 102 summer Chinook (including four unmarked hatchery adults identified through scale patter analysis). 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 2013, broodstock collection activities were accomplished within the allowable trapping days authorized under ESA Permit 1347.

Collection of Methow and Okanogan 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 and Okanogan 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.

Hatchery Rearing and Release

The 2013 brood Methow/Okanogan summer Chinook reared throughout their juvenile life-stages at Eastbank Fish Hatchery and the Carlton Acclimation Pond without incident (see Section 9.2). The 2013 brood smolt release totaled 188,834 summer Chinook, representing 94.4% of the 200,000 production objective and was compliant with the 10% overage allowable in ESA Section 10 Permit 1347. Lower than anticipated fecundity (94% of the biological assumption used in the 2013 broodstock collection protocols) was the largest factor in not meeting the full program.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18119, and 18121, 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 PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for PUD Hatchery Programs during 2015 are provided in Appendix F.

Spawning Surveys

Summer Chinook spawning ground surveys conducted in the Methow River basin during 2015 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 the east ladder trapping facility 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 will be 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 was typically collected at the East and West Ladders of Wells Dam. In 2012, broodstock was also collected at the mouth of the Okanogan River via purse seine. In 2012, a total of 81 summer Chinook (79 wild Chinook and two hatchery Chinook)[20] were spawned for the Okanogan program. Refer to Section

[20] 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

9.1 for information on the origin, age and length, sex ratios, and fecundity of summer Chinook broodstock collected at Wells Dam prior to 2013.

10.2 Hatchery Rearing

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
2011	683,419
Average (1989-2011)	***708,173***
Median (1989-2011)	***724,200***

Return year	Number of eggs taken
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
2006	2008	Similkameen	15-17-Oct	16-Apr – 7-May	182-205
2007	2009	Bonaparte	3-4-Nov	10-22-Apr	157-170

Brood year	Release year	Rearing facility	Transfer date	Release date	Number of days
		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
2002	2004	Similkameen	0.9204	388,589
2003	2005	Similkameen	0.9929	579,019
2004	2006	Similkameen	0.9425	703,359

Brood year	Release year	Rearing facility	CWT mark rate	Number of smolts released
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
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 Methow/Okanogan summer Chinook are shown in Table 9.12 in Section 9.3.

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 2015, the number of summer Chinook redds in the Okanogan River basin averaged 2,064 and ranged from 110 to 6,025 (Table 10.7).

Table 10.7. Total number of redds counted in the Okanogan River basin, 1989-2015. 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

Survey year	Number of summer Chinook redds		
	Okanogan River	Similkameen River	Total count
2014	2,231	2,022	4,253
2015	2,379	1,897	4,276
Average	***1,042***	***1,022***	***2,064***
Median	***1,035***	***1,000***	***2,008***

* 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. During the survey period 1989 through 2015, the summer Chinook spawning escapement within the Okanogan River basin averaged 5,695 and ranged from 473 to 13,857 (Table 10.8).

Table 10.8. Spawning escapements for summer Chinook in the Okanogan and Similkameen rivers for return years 1989-2015. 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

Return year	Fish/Redd	Spawning escapement		
		Okanogan	Similkameen	Total
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
Average	***2.99***	***2,841***	***2,854***	***5,695***
Median	***3.07***	***2,841***	***2,805***	***4,417***

* 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 2015, the number of summer Chinook carcasses sampled in the Okanogan River basin averaged 1,337 and ranged from 115 to 3,293 (Table 10.9). In all years, most were sampled in the upper Okanogan River and lower Similkameen River (Table 10.9).

Table 10.9. Numbers of summer Chinook carcasses sampled within each survey reach in the Okanogan River basin, 1993-2015. 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

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	
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
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	1702	232	3,293
Average	***1***	***5***	***36***	***15***	***160***	***317***	***674***	***129***	***1,337***
Median	***0***	***2***	***31***	***11***	***127***	***291***	***658***	***105***	***1,414***

[a] 25 additional carcasses were sampled on the Similkameen and 46 on the Okanogan without any reach designation.
[b] One additional carcasses 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 (1991-2014), most fish, regardless of origin, were found in Reach 1 on the Similkameen River (Driscoll Channel to Oroville Bridge) (Table 10.10). 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 10.10. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Okanogan River basin, 1993-2014.

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

Survey year	Origin	Survey reach								Total
		O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
2000	Wild	0	0	8	8	24	11	189	4	244
	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	23	7	37	360	216	4	647
	Hatchery	0	0	7	2	15	72	164	3	263
2014	Wild	0	1	62	47	233	717	648	426	2,134
	Hatchery	0	1	17	7	42	66	122	63	318
Average	***Wild***	***1***	***2***	***17***	***8***	***93***	***197***	***304***	***67***	***689***
	Hatchery	***1***	***3***	***18***	***7***	***61***	***90***	***323***	***57***	***560***
Median	***Wild***	***1***	***5***	***19***	***18***	***154***	***180***	***329***	***69***	***775***
	Hatchery	***2***	***5***	***11***	***24***	***87***	***172***	***296***	***79***	***676***

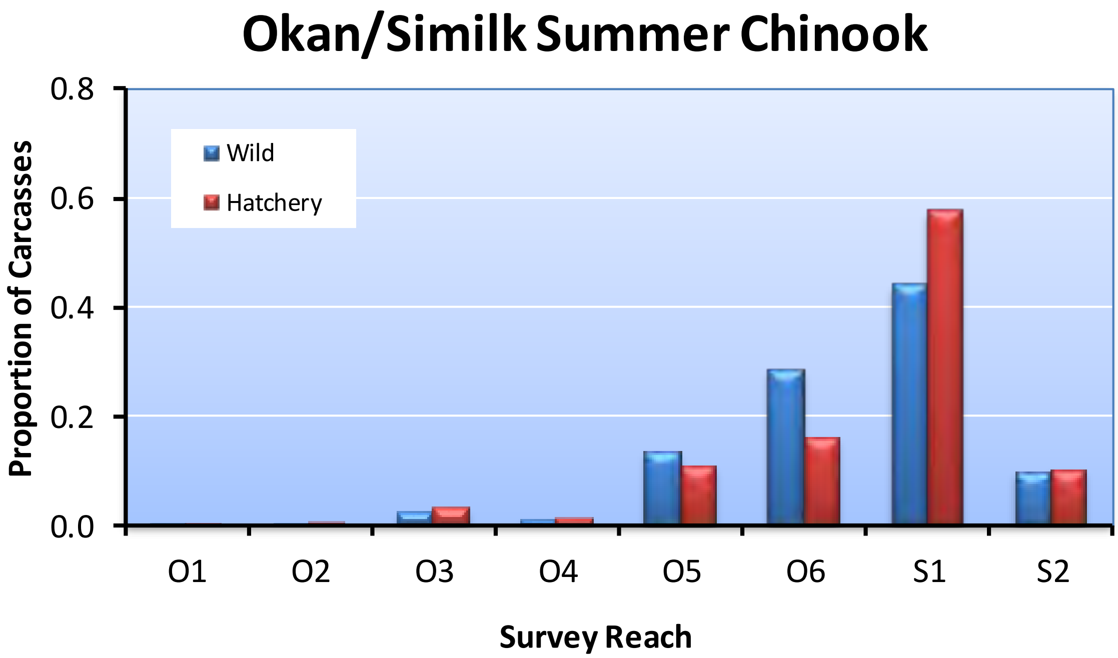

Figure 10.1. Distribution of wild and hatchery produced carcasses in different reaches in the Okanogan River basin, 1993-2014. Reach codes are described in Table 2.11.

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 for Okanogan/Similkameen summer Chinook is described in Section 9.6.

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 1993-2014 in the Okanogan River basin were salt age-3 fish (Table 10.11; 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 10.11. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Okanogan River basin, 1993-2014.

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
	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

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
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	1892
	Hatchery	0.18	0.26	0.55	0.02	0.00	300
Average	***Wild***	***0.01***	***0.14***	***0.58***	***0.26***	***0.00***	***629***
	Hatchery	***0.05***	***0.30***	***0.58***	***0.07***	***0.00***	***526***
Median	***Wild***	***0.01***	***0.15***	***0.70***	***0.14***	***0.00***	***612***
	Hatchery	***0.04***	***0.21***	***0.65***	***0.10***	***0.00***	***531***

[a] There was one salt age-6 hatchery fish that was not included in this table.

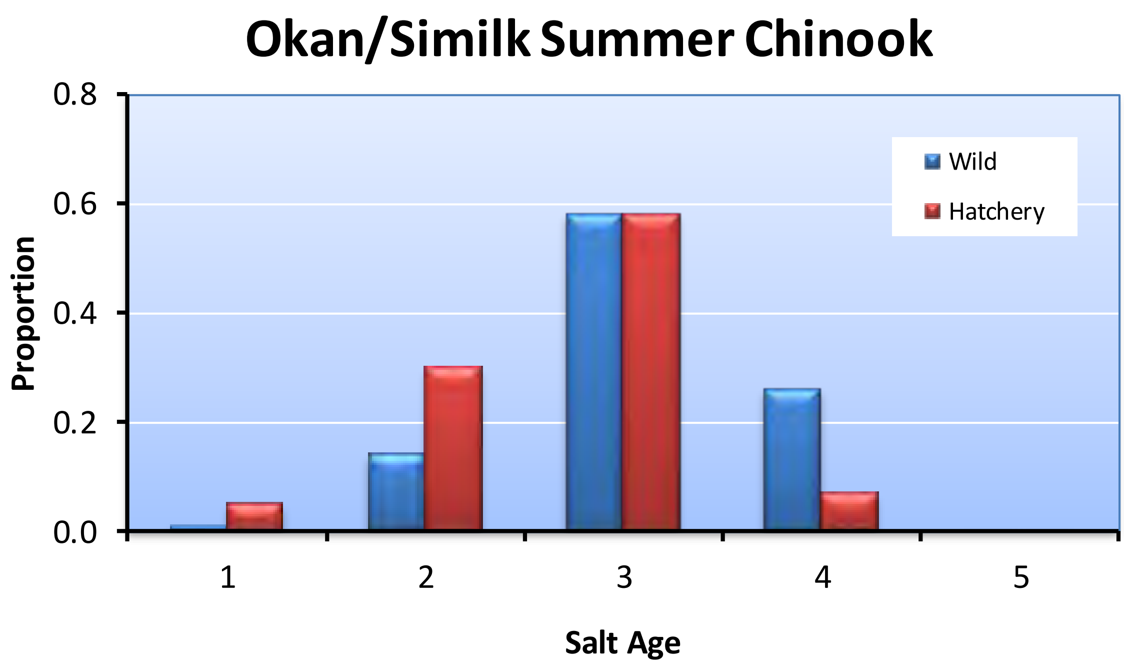

Figure 10.2. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Okanogan River basin for the combined years 1993-2014.

Size at Maturity

For the period 1993 through 2014, on average, hatchery summer Chinook were about 2 cm smaller than wild summer Chinook sampled in the Okanogan River basin (Table 10.12). This is likely because a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish.

Table 10.12. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Okanogan River basin, 1993-2014; 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
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

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
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
Pooled	***Wild***	***15,079***	***70***	***8***	***22***	***99***
	Hatchery	***12,152***	***68***	***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 10.13). Ocean harvest has made up 37-100% of all hatchery-origin Okanogan/Similkameen summer Chinook harvested. Brood years 1997, 1998, 2000, 2004, 2006, 2008, and 2009 provided the largest harvests, while brood years 1993 and 1996 provided the lowest.

Table 10.13. Estimated number and percent (in parentheses) of hatchery-origin Okanogan/Similkameen summer Chinook captured in different fisheries, brood years 1989-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1989	2,371 (80)	553 (19)	0 (0)	42 (1)	2,966
1990	355 (89)	34 (8)	0 (0)	12 (3)	401
1991	220 (86)	37 (14)	0 (0)	0 (0)	257
1992	422 (91)	28 (6)	2 (0)	10 (2)	462
1993	24 (80)	6 (20)	0 (0)	0 (0)	30
1994	374 (92)	23 (6)	2 (0)	7 (2)	406
1995	652 (93)	9 (1)	12 (2)	25 (4)	698
1996	6 (100)	0 (0)	0 (0)	0 (0)	6
1997	6,493 (92)	136 (2)	36 (1)	416 (6)	7,081
1998	4,374 (89)	251 (5)	45 (1)	219 (4)	4,889
1999	1,353 (68)	224 (11)	31 (2)	384 (19)	1,992
2000	3,142 (69)	533 (12)	222 (5)	665 (15)	4,562
2001	184 (58)	81 (25)	31 (10)	23 (7)	319
2002	696 (56)	200 (16)	90 (7)	258 (21)	1,244
2003	692 (37)	568 (31)	130 (7)	466 (25)	1,856
2004	3,087 (38)	2,162 (27)	694 (9)	2,165 (27)	8,108

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
2005	468 (46)	306 (30)	79 (8)	167 (16)	1,022
2006	3,153 (38)	3,352 (40)	469 (6)	1,419 (17)	8,393
2007	1,549 (45)	951 (27)	67 (2)	910 (26)	3,477
2008	4,529 (43)	1,963 (18)	217 (2)	3,948 (37)	10,637
2009	2,009 (47)	976 (23)	205 (5)	1,085 (25	4,275
Average	***1,722 (68)***	***590 (16)***	***111 (3)***	***581 (12)***	***3,004***
Median	***696 (69)***	***224 (16)***	***36 (2)***	***219 (7)***	***1,856***

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) and brood year should be less than 5%.

Few hatchery-origin Okanogan summer Chinook have strayed into basins outside the Okanogan (Table 10.14). Although hatchery-origin Okanogan summer Chinook have strayed into other spawning areas, they usually made up less than 5% of the spawning escapement within those areas. The Chelan tailrace has received the largest number of Okanogan strays.

Table 10.14. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Okanogan summer Chinook, return years 1994-2014. 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 5%.

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
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	1.2	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	1.3	0	0.0
2009	15	0.2	3	0.2	11	1.8	18	7.2	0	0.0

Return year	Wenatchee		Methow		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
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	4	0.2	8	0.7	0	0.0	0	0.0
Average	**2**	**0.0**	**3**	**0.2**	**16**	**2.5**	**3**	**0.9**	**1**	**0.0**
Median	**0**	**0.0**	**0**	**0.0**	**10**	**1.5**	**0**	**0.0**	**0**	**0.0**

On average, about 1% of the returns have strayed into non-target spawning areas, falling within the acceptable level of less than 5% (Table 10.15). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-4.4%. Few (<1% on average) have strayed into non-target hatchery programs.

Table 10.15. Number and percent of hatchery-origin Okanogan summer Chinook that homed to target spawning areas and the target hatchery, and number and percent that strayed to non-target spawning areas and non-target hatchery programs, by brood years 1989-2009. Percent stays should be less than 5%.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	3,132	69.7	1,328	29.6	2	0.0	31	0.7
1990	729	71.4	291	28.5	0	0.0	1	0.1
1991	1,125	71.3	453	28.7	0	0.0	0	0.0
1992	1,264	68.5	572	31.0	8	0.4	1	0.1
1993	54	62.1	32	36.8	0	0.0	1	1.1
1994	924	80.8	203	17.7	16	1.4	1	0.1
1995	1,883	85.4	271	12.3	50	2.3	0	0.0
1996	27	100.0	0	0.0	0	0.0	0	0.0
1997	11,629	97.1	309	2.6	34	0.3	3	0.0
1998	2,727	95.3	102	3.6	31	1.1	2	0.1
1999	828	96.7	18	2.1	10	1.2	0	0.0
2000	2,088	93.6	29	1.3	99	4.4	15	0.7
2001	105	98.1	2	1.9	0	0.0	0	0.0
2002	702	96.2	17	2.3	11	1.5	0	0.0
2003	1,580	96.2	47	2.9	16	1.0	0	0.0
2004	4,947	94.4	206	3.9	85	1.6	2	0.0
2005	606	93.2	22	3.4	22	3.4	0	0.0
2006	5,220	97.6	60	1.1	68	1.3	0	0.0
2007	1,396	97.8	21	1.5	10	0.7	0	0.0

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2008	3,600	98.3	36	1.0	23	0.6	4	0.1
2009	993	91.9	75	6.9	12	1.1	1	0.1
Average	**2,169**	**88.4**	**195**	**10.4**	**24**	**1.1**	**3**	**0.1**
Median	**1,264**	**94.4**	**60**	**3.4**	**12**	**1.0**	**1**	**0.0**

* Homing to the target hatchery includes Okanogan/Similkameen hatchery summer Chinook that are captured and included as broodstock in the Okanogan/Similkameen Hatchery program. These hatchery fish were typically collected at Wells Dam.

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 M). 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.

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. 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 1993-2003, the PNI values were less than 0.67 (Table 10.16). 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 10.16. 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

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
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; 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 10.17).[21] 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 0.030. 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 10.17).

Table 10.17. 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	0.682 (0.064)	41.9 (12.3)	NA

[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.

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 1989-2008, NRR for summer Chinook in the Okanogan averaged 1.01 (range, 0.17-3.82) if harvested fish were not included in the estimate and 2.31 (range, 0.32-10.26) if harvested fish were included in the estimate (Table 10.18). 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. 2013). The target value of 8.6 includes harvest. HRRs exceeded NRRs in 17 of the 20 years of data, regardless if harvest was or was not included in the estimate (Table 10.18). Hatchery replacement rates for Okanogan summer Chinook have exceeded the estimated target value of 8.6 in 9 of the 20 years of data.

Table 10.18. 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 1989-2009.

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	1,550	2,946	5.13	0.73
1995	385	3,002	2,204	959	5.72	0.32	2,902	1,267	7.54	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	19,113	6,959	61.06	3.18
1998	352	1,092	2,919	4,166	8.29	3.82	7,817	11,199	22.21	10.26
1999	333	3,617	856	6,641	2.57	1.84	2,848	22,211	8.55	6.14
2000	334	3,701	2,234	1,716	6.69	0.46	6,795	5,232	20.34	1.41
2001	335	10,857	107	8,959	0.32	0.83	426	35,784	1.27	3.3
2002	333	13,857	730	6,077	2.19	0.44	1,980	16,470	5.95	1.19
2003	337	3,420	1,643	566	4.88	0.17	3,504	1,201	10.40	0.35
2004	335	6,721	5,240	3,119	15.64	0.46	13,352	7,959	39.86	1.18

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
2005	338	8,889	650	6,177	1.92	0.69	1,670	15,951	4.94	1.79
2006	355	8,601	5,348	2,421	15.06	0.28	13,752	6,242	38.74	0.73
2007	314	4,417	1,426	6,233	4.54	1.41	4,908	21,841	15.63	4.94
2008	276	6,975	3,663	2,674	13.27	0.38	14,300	10,445	51.81	1.50
Average	***328***	***4,414***	***2,461***	***3,136***	***7.62***	***1.01***	***5,405***	***8,747***	***16.80***	***2.31***
Median	***333***	***3,519***	***1,611***	***2,295***	***4.71***	***0.69***	***2,875***	***5,737***	***8.07***	***1.46***

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 0.03239 for hatchery summer Chinook in the Okanogan River basin (Table 10.19).

Table 10.19. Smolt-to-adult ratios (SARs) for Okanogan/Similkameen summer Chinook, brood years 1989-2009.

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	1,528	0.00702
1995	574,197	2,851	0.00497
1996	487,776	32	0.00007
1997	572,531	18,543	0.03239
1998	287,948	7,641	0.02654
1999	610,868	2,776	0.00454
2000	528,639	6,765	0.01280
2001	26,315	424	0.01611
2002	245,997	1,969	0.00800
2003	574,908	3,484	0.00606
2004	676,222	12,892	0.01906
2005	273,512	1,662	0.00608
2006	597,276	13,622	0.02281
2007	610,379	4,886	0.00800
2008	516,533	14,242	0.02757
2009	522,295	5,348	0.01024

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
Average	***436,631***	***5,110***	***0.01159***
Median	***516,533***	***2,851***	***0.00800***

[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

Because summer Chinook adults collected at Wells Dam are used for both the Methow and Okanogan supplementation programs, please refer to Section 9.7 for information on ESA compliance during 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 1196, 1347, 1395, 18118, 18120, and 18121, 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 PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for PUD Hatchery Programs during 2015 are provided in Appendix F. 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

Although the Chelan Falls summer Chinook program (formerly the Turtle Rock program) is an augmentation program, the production of 200,000 fish is No Net Impact (NNI) compensation for passage mortalities associated with Rocky Reach Dam. In addition, the conversion of the subyearling program to a 400,000 yearling program is 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, 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 Fish Hatchery. 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 has been piloted at the Eastbank Hatchery Outfall.

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 these programs. Beginning in 2013, broodstock collection for the Chelan Falls program is being piloted at the Eastbank Hatchery Outfall.

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 2012-2015, the egg take goal was only reached in 2013.

Disease

There were no significant health concerns encountered during rearing of Chelan Falls summer Chinook in 2015 (BY 2013) at Eastbank Fish Hatchery or at Chelan Falls Acclimation Facility.

Number of acclimation days

Rearing of the 2013-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 third year that the whole program was transferred to the Chelan Falls Acclimation Facility for final overwinter acclimation on Chelan River water. Transfer occurred on 3-6 November 2014. Fish were force released on 15 April 2015 after 160-163 days of acclimation.

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 11.1 and 11.2. Production from the subyearling programs was converted to the yearling program.

The 2013 yearling summer Chinook program achieved 99.9% of the 600,000 target goal with about 599,584 fish being released from the Chelan River Acclimation Ponds (Table 11.3). Releases of 2014 yearling Chinook will be reported in the 2016 report.

Table 11.1. 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

Brood year	Release year	CWT mark rate	Number of subyearlings released
2005	2006	0.4337	490,074
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 11.2. 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***

Table 11.3. Numbers of Turtle Rock summer Chinook yearling smolts released from the hatchery, brood years 1995-2013. 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.

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
1997	1999	Turtle Rock	0.9800	202,989
1998	2000	Turtle Rock	0.9337	217,797

Brood year	Release year	Acclimation facility	CWT mark rate	Number of smolts released
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
Average (2010-present)		***Chelan Falls***	***0.9839***	***578,014***
Median (2010-present)		***Chelan Falls***	***0.9869***	***574,324***

[a] No CWT mark rate was provided because of the early release of this group.

Numbers tagged

Brood year 2013 yearling Chinook were 98.4% CWT and adipose fin-clipped.

In 2015, a total of 10,000 summer Chinook from the 2014 brood were PIT tagged at the Chelan Hatchery during 16-19 March 2016. These fish are part of a size target at release evaluation. The fish were tagged in four different circular ponds representing different size targets at release groups (based on fish per pound; fpp). Pond #1 consisted of fish at 22 fpp, pond #2 consisted of fish at 18 fpp, pond #3 consisted of fish at 13 fpp, and pond #4 consisted of fish at 10 fpp. Fish were not fed during tagging or for two days before and after tagging. Within the respective ponds, fish averaged 118, 116, 136, and 139 mm in length and 19, 18, 26, and 31 g at time of tagging.

Table 11.4 summarizes the number of yearling summer Chinook that have been PIT-tagged and released from the Turtle Rock/Chelan Falls Program.

Table 11.4. Summary of PIT-tagging activities for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2007-2013; 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	15	0	11,087
		Standard	11,100	18	2	11,080
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	4,190
2011	2013	Chelan Falls	4,101	26	0	4,075
2012	2014	Chelan Falls (18 fpp)	2,500	17	0	2,483
		Chelan Falls (22 fpp)	2,500	23	0	2,477
		Chelan Falls (10 fpp)	2,500	6	0	2,494
		Chelan Falls (13 fpp)	2,500	11	0	2,489
2013	2015	Chelan Falls (18 fpp)	2,500	14	0	2,486
		Chelan Falls (22 fpp)	2,500	27	0	2,473
		Chelan Falls (10 fpp)	2,500	15	0	2,485
		Chelan Falls (13 fpp)	2,500	22	0	2,478

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 11.5 and 11.6.

Table 11.5. 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

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
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 11.6. 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
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 2013 yearling summer Chinook was 85.1% and 59.0% of the fork length and weight targets, respectively, for the Chelan Falls group. This group exceeded the target CV for length (Table 11.7).

Table 11.7. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock/Chelan summer Chinook yearling releases, brood years 1995-2013. 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
Average			***160***	***16.7***	***50.0***	***10***
Targets[a]			***161***	***9.0***	***45.4***	***10***

[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 11.8). Lower than expected survival at ponding and post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.8. 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 11.9). Lower than expected survival in post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.9. 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 yearling Chelan Falls summer Chinook program from green egg to release was above the standard set for the program (Table 11.10). Higher than expected survivals in most life stages contributed to the increased program performance.

Table 11.10. Hatchery life-stage survival rates (%) for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2004-2013. 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
Average (Chelan)	***NA***	***NA***	***89.7***	***96.2***	***98.2***	***97.9***	***94.9***	***97.4***	***82.0***
Median (Chelan)	***NA***	***NA***	***90.8***	***97.6***	***98.8***	***98.2***	***95.9***	***98.7***	***85.5***
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 2015. Total redd counts were conducted in the river (see Appendix N for more details).

Redd Counts

A total of 448 summer Chinook redds were counted in the Chelan River in 2015 (Table 11.11). This was higher than the overall average of 296 redds.

Table 11.11. Total number of redds counted in the Chelan River, 2000-2015.

Survey year	Total redd count
2000	196
2001	240
2002	253
2003	173
2004	185
2005	179
2006	208
2007	86
2008	153

Survey year	Total redd count
2009	246
2010	398
2011	413
2012	426
2013	729
2014	400
2015	448
Average	***296***
Median	***243***

Redd Distribution

Summer Chinook redds were not evenly distributed among the four sampling areas within the Chelan River. Most redds (48%) were located in the Chelan Tailrace (Table 11.12). Few summer Chinook spawned in the Habitat Pool.

Table 11.12. Total number of summer Chinook redds counted in different survey areas within the Chelan River during September through early November, 2015.

Survey area	Total redd count	Percent
Chelan Tailrace	217	48
Columbia Tailrace	106	24
Habitat Channel	91	20
Habitat Pool	34	8
Totals	***448***	***100***

Spawn Timing

Spawning in 2015 began the first week of October, peaked in late October, and ended late November. Peak spawning occurred in the Chelan Tailrace, Habitat Channel, and Habitat Pool during late October and in the Columbia Tailrace in early November (Figure 11.1).

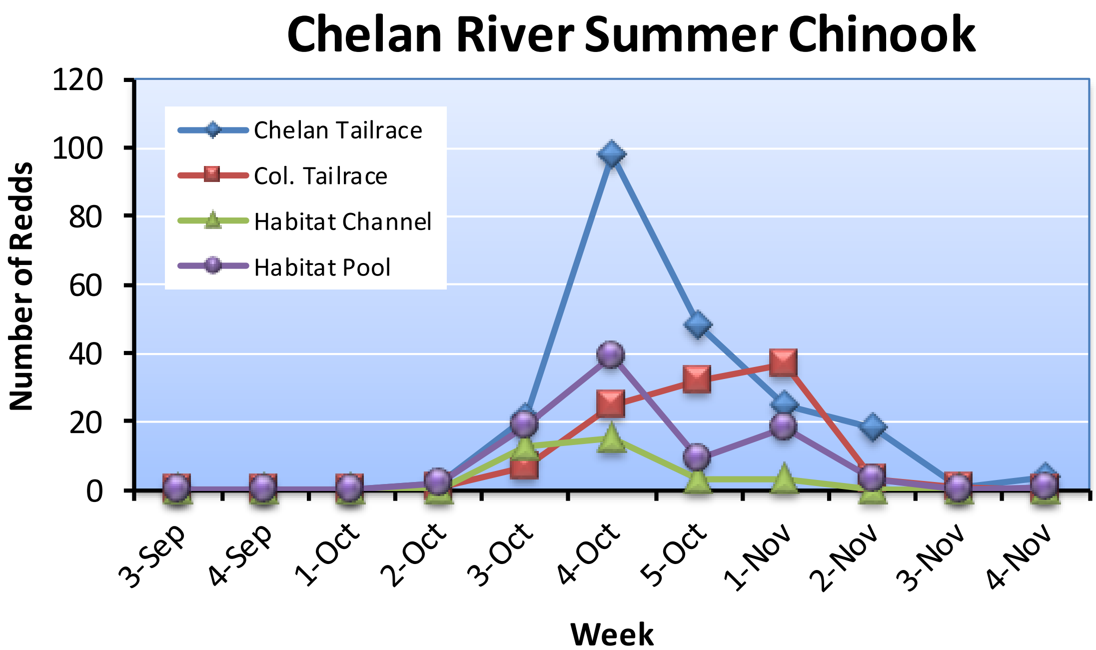

Figure 11.1. Number of new summer Chinook redds counted during different weeks within different sections of the Chelan River, September through November 2015.

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. The estimated fish per redd ratio for Methow summer Chinook in 2015 was 3.21. Multiplying this ratio by the number of redds counted in the Chelan River resulted in a total spawning escapement of 1,438 summer Chinook (Table 11.13).

Table 11.13. Spawning escapements for summer Chinook in the Chelan River for return years 2000-2015.

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

Return year	Fish/Redd	Redds	Total spawning escapement
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
Average	***2.73***	***296***	***816***
Median	***2.65***	***243***	***604***

11.4 Carcass Surveys

Surveys for summer Chinook carcasses within the Chelan River were conducted during late September to mid-November 2015 (see Appendix N for more details).

Number sampled

A total of 363 summer Chinook carcasses were sampled during September through late-November in the Chelan River (Table 11.14). This was higher than the overall average of 173 carcasses sampled since 2000.

Table 11.14. Numbers of summer Chinook carcasses sampled within each survey area within the Chelan River, 2000-2015; 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**
Average	***90***	***152***	***83***	***17***	***173***
Median	***50***	***120***	***50***	***18***	***139***

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among survey areas within the Chelan River in 2015 (Table 11.14). Most of the carcasses in the Chelan River were found in the Columbia Tailrace.

Numbers of wild and hatchery-origin summer Chinook carcasses sampled in 2015 will be available after analysis of CWTs and scales. Based on the available data, hatchery and wild summer Chinook carcasses were not distributed equally among the survey areas within the Chelan River (Table 11.15; Figure 11.2). 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 and Columbia River tailraces.

Table 11.15. Numbers of wild and hatchery summer Chinook carcasses sampled within different survey areas on the Chelan River, 2000-2014; 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**

Survey year	Origin	Survey reach				Total
		Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	
	Hatchery	23	65	106	22	**225**
2014	Wild	32	142	18	1	**193**
	Hatchery	17	113	23	17	**170**
Average	***Wild***	***25***	***99***	***35***	***4***	***63***
	Hatchery	***20***	***89***	***65***	***20***	***101***
Median	***Wild***	***25***	***99***	***35***	***4***	***46***
	Hatchery	***20***	***89***	***65***	***20***	***71***

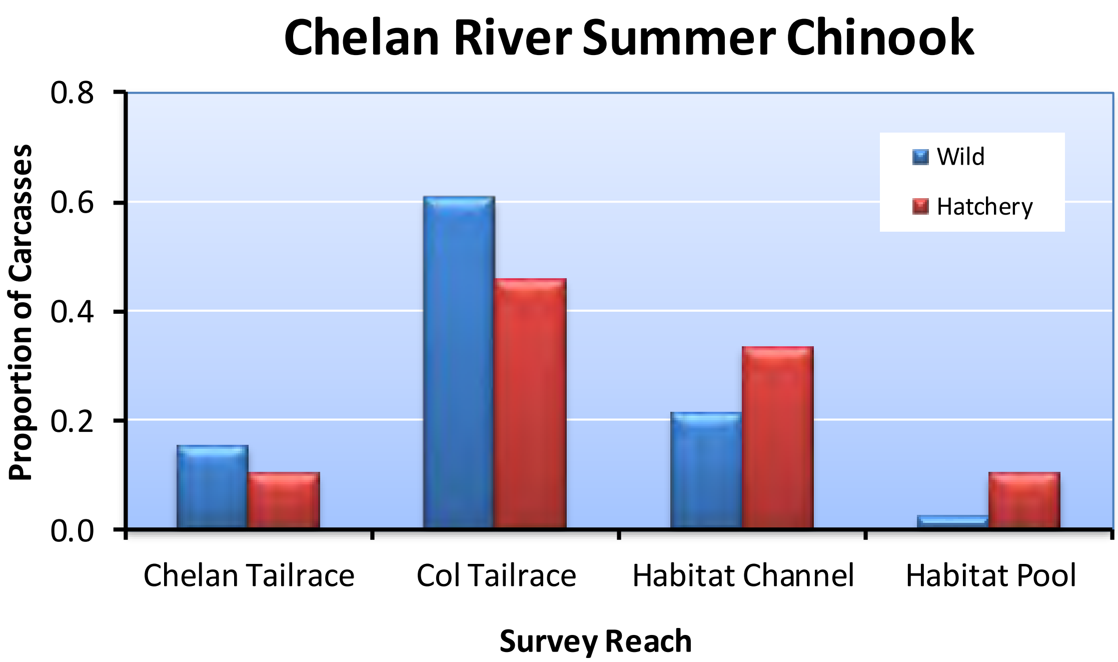

Figure 11.2. Distribution of wild and hatchery produced carcasses in different survey areas within the Chelan River, 2015.

Sampling Rate

Overall, 25% of the total spawning escapement of summer Chinook in the Chelan River was sampled in 2015 (Table 11.16). Sampling rates among survey reaches varied from 7 to 75%.

Table 11.16. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Chelan River, 2015.

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chelan Tailrace	217	49	697	0.07
Columbia Tailrace	106	255	340	0.75
Habitat Channel	91	41	292	0.14

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Habitat Pool	34	18	109	0.16
Total	***448***	***363***	***1,438***	***0.25***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Chelan River in 2015 are provided in Table 11.17. The average size of males and females sampled in the Chelan River were 60 cm and 66 cm, respectively.

Table 11.17. 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, 2015.

Stream/watershed	Mean length (cm)	
	Male	Female
Chelan Tailrace	67.0 (5.4)	66.9 (4.9)
Columbia Tailrace	59.6 (7.8)	66.0 (5.0)
Habitat Channel	62.4 (5.0)	65.4 (4.7)
Habitat Pool	61.7 (10.6)	66.6 (4.3)
Total	***60.4 (7.9)***	***66.1 (4.9)***

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 11.18). 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 11.18. 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
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1995	688 (84)	106 (13)	11 (1)	16 (2)	821
1996	72 (80)	0 (0)	5 (6)	13 (14)	90
1997	10 (100)	0 (0)	0 (0)	0 (0)	10
1998	21 (100)	0 (0)	0 (0)	0 (0)	21
1999	184 (64)	26 (9)	4 (1)	75 (26)	289

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
2000	36 (55)	8 (12)	8 (12)	14 (21)	66
2001	164 (64)	30 (12)	20 (8)	44 (17)	258
2002	23 (20)	33 (29)	3 (3)	56 (49)	115
2003	9 (10)	55 (61)	2 (2)	24 (27)	90
2004	42 (37)	29 (25)	2 (2)	42 (37)	115
2005	100 (38)	95 (36)	24 (9)	44 (17)	263
2006	305 (41)	288 (38)	53 (7)	104 (14)	750
2007	110 (34)	91 (28)	21 (6)	104 (32)	326
2008	42 (31)	32 (24)	4 (3)	56 (42)	134
2009	82 (39)	68 (33)	6 (3)	52 (25)	208
Average	***126 (53)***	***57 (21)***	***11 (4)***	***43 (21)***	***237***
Median	***72 (41)***	***32 (24)***	***5 (3)***	***44 (21)***	***134***

Accelerated subyearling releases

Most of the harvest on Turtle Rock summer Chinook (accelerated subyearling releases) occurred in ocean fisheries (Table 11.19). 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 11.19. 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
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1995	3 (100)	0 (0)	0 (0)	0 (0)	3
1996	77 (89)	5 (6)	5 (6)	0 (0)	87
1997	3 (100)	0 (0)	0 (0)	0 (0)	3
1998	97 (95)	2 (2)	3 (3)	0 (0)	102
1999	1,025 (76)	142 (10)	12 (1)	178 (13)	1,357
2000	117 (100)	0 (0)	0 (0)	0 (0)	117
2001	205 (59)	49 (14)	13 (4)	80 (23)	347
2002	9 (100)	0 (0)	0 (0)	0 (0)	9
2003	0 (0)	0 (0)	0 (0)	0 (0)	0
2004	45 (27)	79 (48)	6 (4)	34 (21)	164
2005	65 (59)	12 (11)	26 (24)	7 (6)	110
2006	130 (43)	113 (37)	16 (5)	43 (14)	302
2007	169 (41)	168 (41)	12 (3)	59 (14)	408
2008	20 (54)	2 (5)	4 (11)	11 (30)	37

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
Average	***140 (67)***	***41 (13)***	***7 (4)***	***29 (9)***	***218***
Median	***71 (67)***	***4 (6)***	***5 (3)***	***4 (3)***	***106***

Yearling releases

Most of the harvest on Turtle Rock/Chelan Falls summer Chinook (yearling releases) occurred in ocean fisheries (Table 11.20). Ocean harvest has made up 39% to 95% of all Turtle Rock summer Chinook harvested. Brood years 1998 and 2008 provided the largest harvest, while brood years 1995 and 2005 provided the lowest.

Table 11.20. Estimated number and percent (in parentheses) of Turtle Rock/Chelan Falls summer Chinook (yearling releases) captured in different fisheries, brood years 1995-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational (sport)	
1995	457 (75)	51 (8)	31 (5)	70 (11)	609
1996	766 (95)	14 (2)	2 (0)	21 (3)	803
1997	2,797 (91)	61 (2)	27 (1)	176 (6)	3,061
1998	4,292 (90)	224 (5)	16 (0)	230 (5)	4,762
1999	1,655 (73)	233 (10)	7 (0)	383 (17)	2,278
2000	1,205 (72)	147 (9)	54 (3)	273 (16)	1,679
2001	1,937 (59)	453 (14)	178 (5)	729 (22)	3,298
2002	1,004 (50)	384 (19)	102 (5)	536 (26)	2,026
2003	738 (45)	449 (27)	70 (4)	378 (23)	1,635
2004	838 (39)	560 (26)	127 (6)	605 (28)	2,130
2005	501 (44)	303 (27)	123 (11)	206 (18)	1,133
2006	1,168 (39)	880 (30)	231 (8)	688 (23)	2,967
2007	753 (49)	367 (24)	66 (4)	349 (23)	1,535
2008	4,096 (54)	1,144 (15)	245 (3)	2,036 (27)	7,521
2009	1,702 (52)	771 (23)	122 (4)	686 (21)	3,281
Average	***1,594 (62)***	***403 (16)***	***93 (4)***	***491 (18)***	***2,581***
Median	***1,168 (54)***	***367 (15)***	***70 (4)***	***378 (21)***	***2,130***

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.[22] All tag codes, except brood year 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 5% of the spawning escapement within those areas (Table 11.21). The Chelan tailrace has received the largest number of Turtle Rock strays. This hatchery program was discontinued after brood year 2009.

Table 11.21. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock summer Chinook (normal subyearling releases), return years 1998-2014. 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 5%.

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	9.5	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
Average	***1***	***0.0***	***4***	***0.2***	***4***	***0.1***	***7***	***0.9***	***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***

On average, about 29% of the brood year returns have strayed into spawning areas in the upper basin (Table 11.22). Depending on brood year, percent strays into spawning areas have ranged from 0-100%. Few (2.3% on average) have strayed into non-target hatchery programs.

22 Non-associated releases are release groups not containing any coded-wire tagged fish.

Table 11.22. Number and percent of Turtle Rock summer Chinook (normal subyearling releases) that homed to the target hatchery and strayed to non-target spawning areas and non-target hatchery programs, by brood years 1995-2009.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	197	74.1	64	24.1	5	1.9
1996	-	-	54	54.5	44	44.4	1	1.0
1997	-	-	2	28.6	5	71.4	0	0.0
1998	-	-	0	0.0	24	100.0	0	0.0
1999	-	-	40	43.5	52	56.5	0	0.0
2000	-	-	5	50.0	5	50.0	0	0.0
2001	-	-	56	77.8	16	22.2	0	0.0
2002	-	-	10	100.0	0	0.0	0	0.0
2003	-	-	27	100.0	0	0.0	0	0.0
2004	-	-	71	97.3	2	2.7	0	0.0
2005	-	-	80	92.0	7	8.0	0	0.0
2006	-	-	194	72.1	72	26.8	3	1.1
2007	-	-	113	68.5	34	20.6	18	10.9
2008	-	-	16	80.0	0	0.0	4	20.0
2009	27	42.2	29	45.3	8	12.5	0	0.0
Average	***27***	***42.2***	***60***	***65.6***	***22***	***29.3***	***2***	***2.3***
Median	***27***	***42.2***	***40***	***72.1***	***8***	***22.2***	***0***	***0.0***

* Homing to the target hatchery includes Turtle Rock hatchery fish that were captured and included as broodstock in the Turtle Rock Hatchery program. These hatchery fish were typically collected at Wells Dam and Wells Hatchery.

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 5% of the spawning escapement within those areas (Table 11.23). 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 11.23. 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 5%.

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***

On average, about 29% of the brood year returns have strayed into spawning areas in the upper basin (Table 11.24). Depending on brood year, percent strays into spawning areas have ranged from 0-83%. Few (1.3% on average) have strayed into non-target hatchery programs.

Table 11.24. Number and percent of Turtle Rock summer Chinook (accelerated subyearling releases) that homed to the target hatchery and strayed to non-target spawning areas and non-target hatchery programs, by brood years 1995-2008.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	7	70.0	3	30.0	0	0.0
1996	-	-	33	32.4	69	67.6	0	0.0
1997	-	-	6	100.0	0	0.0	0	0.0
1998	-	-	2	16.7	10	83.3	0	0.0
1999	-	-	138	54.1	117	45.9	0	0.0

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2000	-	-	12	40.0	18	60.0	0	0.0
2001	-	-	57	89.1	7	10.9	0	0.0
2002	-	-	0	0.0	0	0.0	0	0.0
2003	-	-	3	100.0	0	0.0	0	0.0
2004	-	-	90	75.6	29	24.4	0	0.0
2005	-	-	64	75.3	19	22.4	2	2.4
2006	-	-	88	88.9	7	7.1	4	4.0
2007	-	-	133	61.9	81	35.8	12	5.3
2008	-	-	21	84.0	8	25.8	2	6.5
Average	**-**	**-**	***47***	***63.4***	***26***	***29.5***	***1***	***1.3***
Median	**-**	**-**	***27***	***72.7***	***9***	***25.1***	***0***	***0.0***

* Homing to the target hatchery includes Turtle Rock hatchery fish that were captured and included as broodstock in the Turtle Rock Hatchery program. These hatchery fish were typically collected at Wells Dam and Wells Hatchery.

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[23] used to differentiate Chelan River yearling releases by brood year, release type, and location (there were four non-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 in the upper basin have varied widely depending on spawning area. Most of these fish strayed to spawning areas within the Chelan tailrace (Turtle Rock released fish), Entiat Basin, and Methow River basin. On average, Turtle Rock summer Chinook have made up 4-13% of the spawning escapement within those basins (Table 11.25). Relatively few, on average, have strayed to spawning areas in the Okanogan River basin, Wenatchee River basin, and the Hanford Reach (i.e., they made up less than 5% of the spawning escapement in these areas).

[23] 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.

Table 11.25. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock/Chelan Falls summer Chinook (yearling releases), return years 1998-2014. 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 5%.

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	11.0	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	17.9	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	5.5	0	0.0
2007	0	0.0	65	4.8	31	0.7	40	21.2	58	24.0	19	0.1
2008	18	0.3	72	3.7	60	0.9	110	22.1	46	14.4	0	0.0
2009	8	0.1	95	5.4	32	0.4	5	0.8	18	7.1	0	0.0
2010	12	0.2	105	4.2	111	1.9	0	0.0	30	6.9	0	0.0
2011	8	0.1	88	3.0	35	0.4	15	1.2	12	2.6	0	0.0
2012	21	0.2	33	1.1	43	0.5	110	8.4	29	3.2	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	22	1.4	24	0.2	16	1.5	18	3.2	0	0.0
Average	***22***	***0.2***	***119***	***4.4***	***76***	***1.0***	***75***	***13.0***	***35***	***7.8***	***3***	***0.0***
Median	***8***	***0.1***	***73***	***3.7***	***35***	***0.5***	***64***	***11.0***	***18***	***3.2***	***0***	***0.0***

On average, about 46% of the brood year returns have strayed into spawning areas in the upper basin (Table 11.26). Depending on brood year, percent strays into spawning areas have ranged from 8-86%. Few (1.4% on average) have strayed into non-target hatchery programs.

Table 11.26. Number and percent of Turtle Rock/Chelan Falls summer Chinook (yearling releases) that homed to the target hatchery and strayed to non-target spawning areas and non-target hatchery programs, by brood years 1995-2009.

Brood year	Homing				Straying			
	Target stream		Target hatchery[a]		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	180	39.3	278	60.7	0	0.0
1996	-	-	218	27.2	583	72.8	0	0.0
1997	-	-	254	14.2	1,531	85.6	3	0.2
1998	-	-	166	16.1	864	83.8	1	0.1
1999	-	-	181	42.7	243	57.3	0	0.0

Brood year	Homing				Straying			
	Target stream		Target hatchery[a]		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2000	-	-	102	29.1	249	70.9	0	0.0
2001	-	-	389	58.2	279	41.8	0	0.0
2002	-	-	303	54.2	255	45.6	1	0.2
2003	-	-	373	62.3	225	37.6	1	0.2
2004	-	-	287	56.6	219	43.2	1	0.2
Average[b]	**-**	**-**	***245***	***40.0***	***473***	***59.9***	***1***	***0.1***
Median[b]	**-**	**-**	***236***	***41.0***	***267***	***59.0***	***1***	***0.1***
2005	149	29.4	202	39.9	144	28.5	11	2.2
2006	429	40.3	376	35.3	223	21.0	36	3.4
2007	123	27.8	218	49.3	69	15.6	32	7.2
2008	889	43.9	736	36.3	315	15.6	85	4.2
2009	115	10.3	870	78.0	92	8.2	39	3.5
Average[c]	***341***	***30.3***	***480***	***47.8***	***171***	***17.8***	***39***	***4.1***
Median[c]	***149***	***29.4***	***376***	***39.9***	***144***	***15.6***	***36***	***3.5***

[a] Homing to the target hatchery includes Turtle Rock/Chelan Hatchery fish that were captured and included as broodstock in the Turtle Rock/Chelan Hatchery program. These hatchery fish are typically collected at Wells Dam, Wells Hatchery, and the Eastbank Hatchery Outfall.
[b] Summary statistics for yearling Turtle Rock summer Chinook released into the Columbia River (brood years 1995-2004).
[c] Summary statistics for yearling Turtle Rock/Chelan River summer Chinook released into the Chelan River (brood years 2005 to present).

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 10.27).[24] Over the seven brood years for which PIT-tagged hatchery fish were released, survival rates from the release sites to McNary Dam ranged from 0.423 to 0.760; SARs from release to detection at Bonneville Dam ranged from 0.009 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 10.27). 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 appeared to be greater for the Circular Reuse fish than for the Standard Raceway fish. However, the differences between groups were small for brood year 2008. 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.

24 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.

Another experiment was conducted with brood years 2012 and 2013 (Table 10.27). Those brood years were split into two different treatment groups (small-size fish and large-size fish). The big-size fish appeared to have a higher survival rate to McNary Dam and faster travel time than did the small-size fish. SARs for these fish will be calculated after all fish have returned to the Columbia River.

Table 10.27. 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 2007-2013. 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	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	9,546	0.564 (0.037)	28.4 (11.7)	0.009 (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	3,141	0.641 (0.055)	22.6 (12.2)	0.022 (0.003)
2011*	Chelan Falls	4,075	0.552 (0.054)	27.2 (11.5)	NA
2012	Chelan Falls (Small Fish)	4,983	0.590 (0.049)	25.0 (11.2)	NA
	Chelan Falls (Big Fish)	4,960	0.578 (0.043)	24.4 (10.1)	NA
2013	Chelan Falls (Small Fish)	4,958	0.423 (0.068)	33.0 (13.6)	NA
	Chelan Falls (Big Fish)	4,963	0.760 (0.175)	28.6 (12.4)	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 0.000034 to 0.001886 (Table 11.28). This hatchery program was discontinued after brood year 2009.

Table 11.28. 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	188	0.000506
1997	496,904	17	0.000034
1998	194,723	28	0.000144
1999	197,793	203	0.001026
2000	222,460	28	0.000126
2001	211,306	330	0.001562
2002	200,163	38	0.000190
2003	203,410	49	0.000241
2004	198,019	91	0.000460
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***	***0.000661***
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 0.004609 (Table 11.29). This hatchery program was discontinued after brood year 2008.

Table 11.29. 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	69	0.000372
1999	192,665	888	0.004609
2000	194,603	63	0.000324
2001	196,355	169	0.000861

Brood year	Number released[a]	Estimated adult captures[b]	SAR
2002	200,165	5	0.000025
2003	185,834	2	0.000011
2004	203,255	156	0.000768
2005	192,045	82	0.000427
2006	186,324	217	0.001165
2007	188,328	308	0.001635
2008	197,136	35	0.000178
Average	***191,689***	***149***	***0.000776***
Median	***193,634***	***74***	***0.000385***

[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, SARs for yearling-released Chinook have ranged from 0.00721 to 0.02820 (Table 11.30).

Table 11.30. Smolt-to-adult ratios (SARs) for Turtle Rock/Chelan Falls yearling-released summer Chinook, brood years 1995-2009.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	145,318	1,048	0.00721
1996	194,251	1,553	0.00800
1997	198,924	4,775	0.02400
1998	215,646	5,772	0.02677
1999	280,683	2,670	0.00951
2000	278,308	2,029	0.00729
2001	199,694	3,922	0.01964
2002	192,234	2,556	0.01330
2003	199,386	2,083	0.01045
2004	202,682	2,605	0.01285
2005	202,329	1,631	0.00806
2006	142,699	4,024	0.02820
2007	161,071	1,872	0.01162
2008	447,155	9,473	0.02119
2009	423,565	4,312	0.01018
Average	***232,263***	***3,355***	***0.01455***
Median	***199,694***	***2,605***	***0.01162***

[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.

11.6 ESA/HCP Compliance

Broodstock Collection

The 2013 brood Chelan Falls (formerly Turtle Rock) summer Chinook program was supported through adult collections at the Eastbank outfall with the option of using the volunteer trap at Wells Fish Hatchery as backup. During 2013, broodstock collections at the Eastbank outfall were consistent with the 2013 Upper Columbia River Salmon and Steelhead Broodstock Objectives and site-based broodstock collection protocols as required in ESA permit 1347. The 2013 collection target totaled 318 summer Chinook.

Hatchery Rearing and Release

The brood year 2013 release totaled 599,584 yearling fish. These releases represented 104.1% 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 Permits 1196, 1347, 1395, 18118, 18119, and 18121, 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 PUD Hatchery facilities during the period 1 January through 31 December 2015. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2015 are provided in Appendix F.

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SECTION 13: APPENDICES

Appendix A

Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2015

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January 25, 2016

TO: HCP Hatchery Committee

FROM: Tracy Hillman

Subject: Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2015

The Chelan County Public Utility District (PUD) hatchery program is operated through a habitat conservation program (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 2013, the Hatchery Committees updated the hatchery monitoring and evaluation plan (Hillman et al. 2013). 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 and September 2015. This was the 23rd 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-

[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.

8.55), respectively (Hillman and Miller 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. However, as directed by the Hatchery Committee, we continue to sample sites in Nason Creek. Following methods described in Hillman and Miller (2004), we used underwater observations to estimate numbers of fish in 199 randomly selected sites.

During sampling in August 2015, discharge in the Chiwawa River averaged 108 cubic feet per second (cfs) and ranged from 89-137 cfs (Figure 2). Stream temperatures during the study period ranged from 8.0 to 20.0ºC. Fish species observed in the Chiwawa River basin and reference areas during the 1992-2015 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 2015 survey were produced from 485 redds counted in the fall of 2014 (Hillman et al. 2015). Assuming a mean fecundity of 4,045 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 1,961,825 eggs in 2014 (Appendix A).

In 2015, 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 (24%), glides (7%), and multiple channels (16%) 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 111,224 (±7% of the estimated total) in the Chiwawa River basin in August 2015 (Table 2). Extrapolating based on volume of habitat types, age-0 Chinook numbered 97,358 (±7%) in the Chiwawa River basin. About 7% of the juvenile Chinook were in tributaries to the Chiwawa River. During the 1992-2015 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 1992-2014 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 2014 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 least abundant in glides and riffles. We found the majority of the Chinook

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[2] The study period 1992-2015 includes only 23 years of sampling because there was no sampling in 2000.

associated with woody debris in multiple channels (multiple channel use index = 2.80)[3]. These sites (multiple channels) made up 16% of the total surface area of the Chiwawa River basin, but they provided habitat for 63% of all the age-0 Chinook in the basin in 2015 (Appendix C). In contrast, riffles made up 53% of the total surface area, but provided habitat for only 5% of all age-0 Chinook in the Chiwawa River basin (riffle use index = 0.25). Pools made up 24% of the total surface area and provided habitat for 31% of all age-0 Chinook in the basin (pool use index = 1.58). Few Chinook used glides that lacked woody debris (glide use index = 0.26).

As noted earlier, we assumed that the Chiwawa River was seeded with 1,961,825 Chinook eggs (485 redds times 4,045 eggs/female) in fall, 2014, and that at least 111,224 of those survived to August 2015. This means that the egg-to-parr survival was at least 5.7% (95% confidence bound 5.2-6.1%). During 1992-2015, egg-to-parr survival averaged 8.1% (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 two reaches of the Chiwawa River were generally less than those in corresponding reference areas (Figure 5). Within both the Chiwawa River and its reference areas, pools and multiple channels consistently had the highest densities of age-0 Chinook.

We estimated a total of 620 (±43% of the estimated total) age-1+ Chinook salmon in the Chiwawa River basin in August 2015 (Table 3). In August 1992-2015, 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; although, numbers in Rock Creek were higher in 2015 than in past years. Age-1+ Chinook were most abundant in multiple channels and pools.

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[3] The habitat use index was calculated as follows: Multiple channel use = ($parr_{mc}/parr_t$) / ($area_{mc}/area_t$), where parr $_{mc}$ = 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 of the use index 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:

$$\boldsymbol{J = \frac{(\alpha R)}{(\beta + R)}}$$

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:

$$\boldsymbol{J = J_{\infty}\left(1 - e^{-\left(\frac{\alpha}{J_{\infty}}\right)R}\right)}$$

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:

$$\boldsymbol{J = \alpha R e^{-\beta R}}$$

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:

$$\boldsymbol{J = \alpha R^{\gamma}}$$

where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the number of juveniles per redd at low spawning levels, and $\boldsymbol{\gamma}$ describes the level of density dependence at high spawning levels. The Gamma function is a three-parameter model that has the form:

$$\boldsymbol{J = \alpha R^{\gamma} e^{-\beta R}}.$$

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:

$$\boldsymbol{AIC_c = -2log\big(£(\theta|data)\big) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)}$$

where $\boldsymbol{log(£(\theta|data))}$ is the maximum likelihood estimate, $\boldsymbol{K}$ is the number of estimable parameters (structural parameters plus the residual variance parameter), and $\boldsymbol{n}$ is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate $\boldsymbol{log(£(\theta|data))}$, which was calculated as $\boldsymbol{log(\sigma^2)}$, where $\boldsymbol{\sigma^2}$ = residual sum of squares divided by the sample size ($\boldsymbol{\sigma^2 = RSS/n}$). 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 (**Δ**$\boldsymbol{AIC_c}$), Akaike weights ($\boldsymbol{w_i}$), and evidence ratios. Models with **Δ**$\boldsymbol{AIC_c}$ 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 $\boldsymbol{w_i}$ 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:

$$Juveniles = \frac{(148{,}410 \times Redds)}{(184 + Redds)}$$

where the bootstrap estimated standard errors for the two parameters were 17,021 and 55, respectively. The adjusted $R^2 = 0.84$. The second-best model was the smooth hockey stick model, which was 1.64 AIC_c units from the best model (Table 4; Figure 6). The estimated parameters for this model were:

$$LN(Juveniles) = 11.6 + LN\left(1 - e^{-\left(\frac{723.8}{113,413}\right)Redds}\right)$$

where the bootstrap estimated standard errors of the two parameters were 0.1 and 136, 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 10.

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. 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 would limit the capacity of juvenile Chinook to about 180,000 parr in the basin (bootstrap upper 95% CI of $\boldsymbol{\alpha}$ in the Beverton-Holt model). This equates to about 1,621 Chinook parr per hectare. In contrast, the smooth hockey stick model, which fit the data as well as the Beverton-Holt model, would limit the carrying capacity for juvenile Chinook to about 140,000 parr (bootstrap upper 95% CI of $\boldsymbol{J_\infty}$ in the smooth hockey stick model). This equates to about 1,261 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 10,208 (±11% of the estimated total) age-0 steelhead/rainbow (<4 in) in reaches of the Chiwawa River basin in August 2015 (Table 5). During the 1992-2015 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 1992-2015, 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 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 754 (±26% of the estimated total) age-1+ steelhead/rainbow (4-8 in) lived in reaches of the Chiwawa River basin in August 2015 (Table 6). This was the lowest number of age-1+ steelhead/rainbow that we recorded during the more than 20-year survey period. During the survey period 1992-2015, 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

[4] The γ parameter in the Gamma model was greater than 0, which means that this model is nearly identical to the Ricker model.

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 18 (±106% of the estimated total) in the Chiwawa River basin in August 2015 (Table 7). During the period 1992-2015, steelhead/rainbow numbers ranged from 8 to 1,869 (Appendix B). Steelhead/rainbow larger than 8 inches were 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 239 (±17% of the estimated total) juvenile (2-8 in) bull trout lived in reaches of the Chiwawa River basin in August 2015 (Table 8). We found most of these fish in the upper-most reaches of the Chiwawa River and in Rock Creek. During 1992-2015, 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.[5] 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. Of the reaches we surveyed, they were most numerous in Reaches 7-10 on the Chiwawa River. In 2015, they occurred in Reaches 9-10 on the Chiwawa River. We found the majority of 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. As a result, she found it difficult to accurately estimate their numbers. Although this implies that we underestimated numbers of juvenile bull trout in the Chiwawa River, the relative

[5] 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.

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 2,286 (±14% of the estimated total) adult (>8 in) bull trout in reaches of the Chiwawa River basin in August 2015 (Table 9). This was the greatest number of adult bull trout that we recorded during the more than 20-year survey period. In previous years, numbers ranged from 76 to 900 (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 2015, we estimated that at least 28 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. Brook trout occurred in the lower seven reaches on the Chiwawa River. In both the Chiwawa and Little Wenatchee rivers, brook trout usually used multiple channels. 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 294 westslope cutthroat trout occurred in the Chiwawa River, Phelps Creek, Nason Creek, and Little Wenatchee River survey areas in August 2015. These fish most often occurred in pools and multiple channel habitats. They ranged in size from 2-22 inches. Juvenile coho salmon were observed in Nason Creek and the Chiwawa River.

We observed both juvenile and adult mountain whitefish in the Chiwawa River, Phelps Creek, Rock Creek, Nason Creek, and the Little Wenatchee River survey areas. In sum, at least 6,861 adult and 2,145 juvenile whitefish lived in these streams in August 2015. We found few whitefish in most tributaries to the Chiwawa River.

Conclusion

This was the 23rd 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 23-year period. Numbers of juveniles in 2001, 2002, and 2009-2015 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 capacity of the Chiwawa River basin is between 140,000 to 180,000 spring Chinook parr. This equates to an overall density of about 1,300-1,600 parr per hectare. These densities can be achieved with about 470 redds. Assuming that a female Chinook produces only one redd (Murdoch et al. 2009), a spawning escapement of about 470 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 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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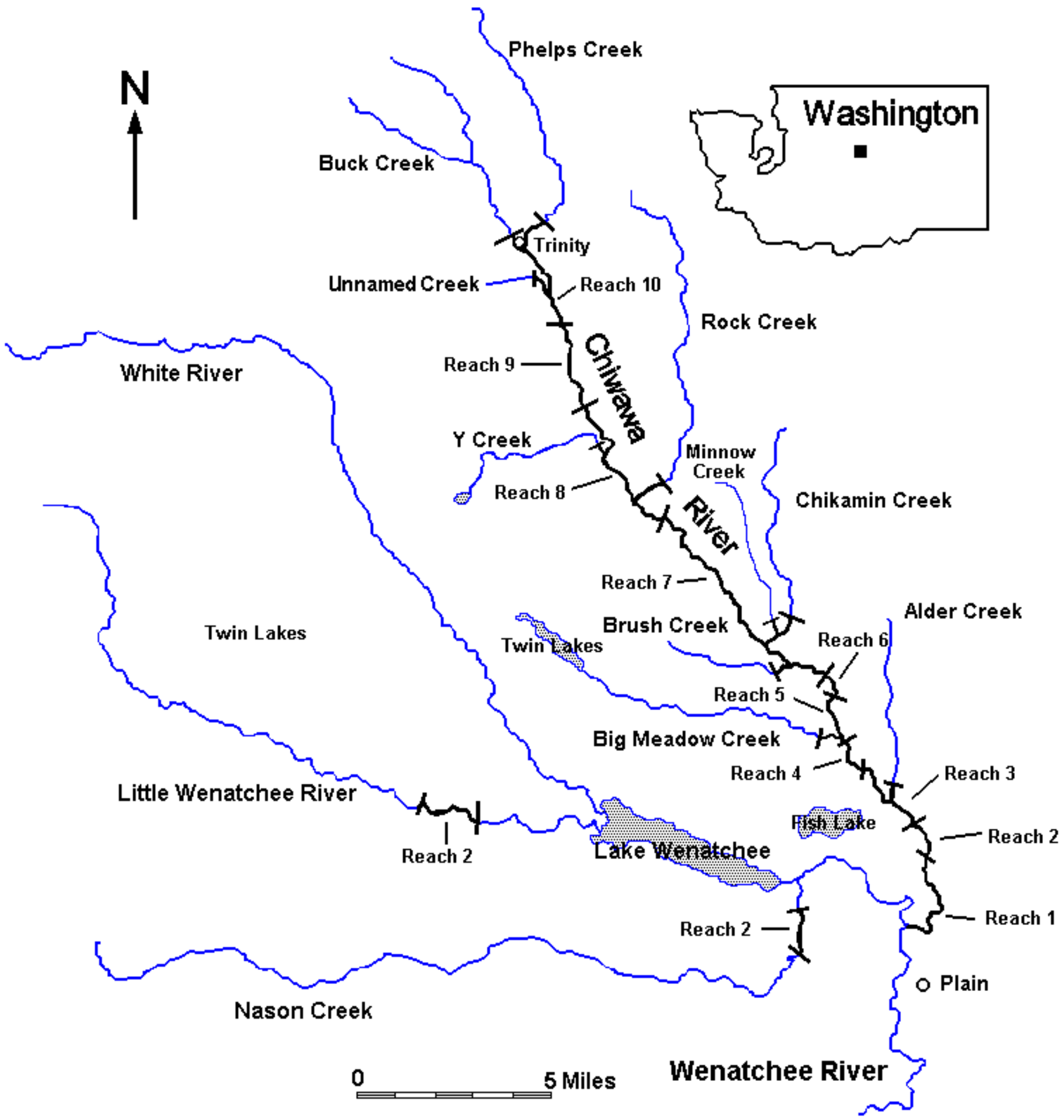

Figure 1. Location of study reaches on the Chiwawa River, and Chikamin, Rock, Big Meadow, Unnamed, Alder, Brush and Phelps creeks, Chelan County, Washington. Reach 2 on Nason Creek and Reach 2 on the Little Wenatchee River were matched with Reaches 3 and 8 on the Chiwawa River, respectively.

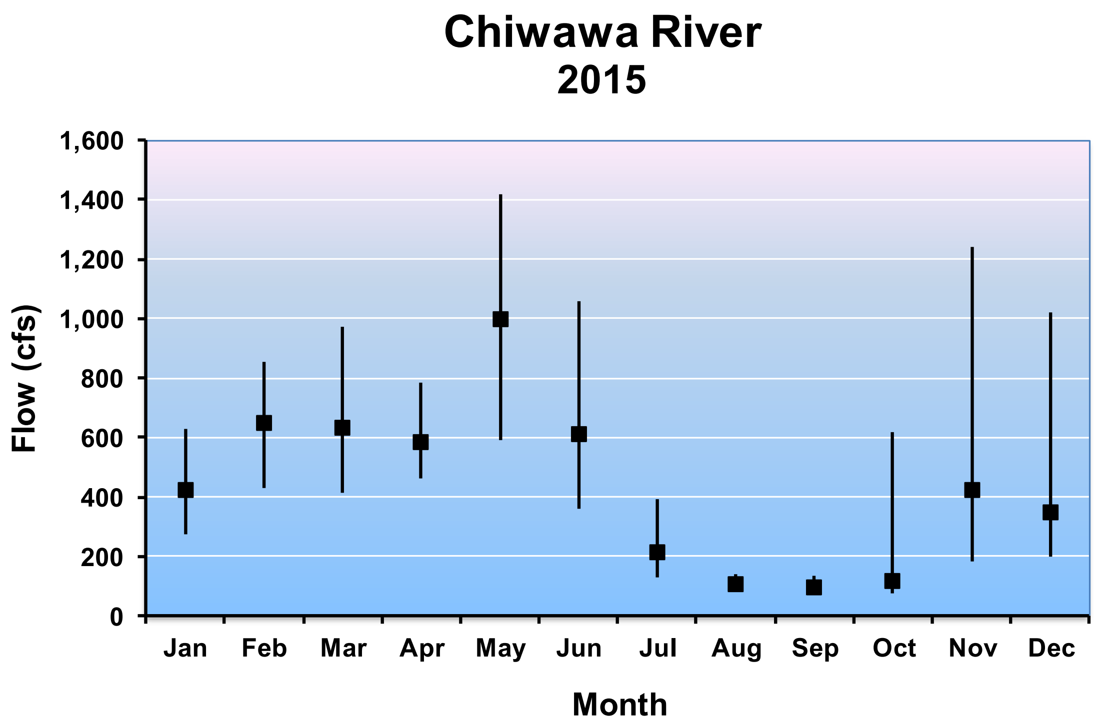

Figure 2. Mean, minimum, and maximum monthly flows in the Chiwawa River for 2015.

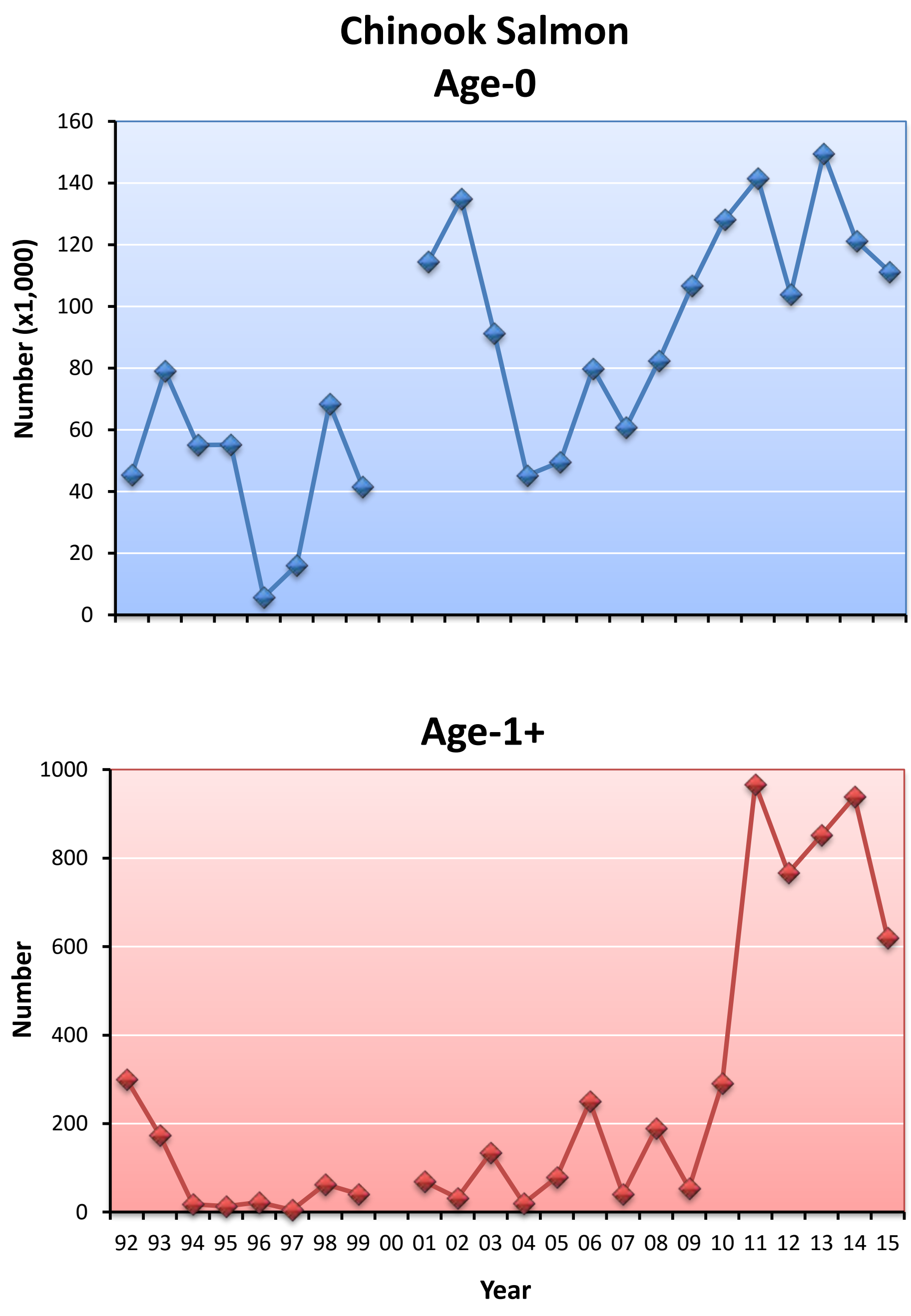

Figure 3. Numbers of age-0 and age-1+ Chinook salmon within the Chiwawa River basin in August 1992-2015; ND = no data.

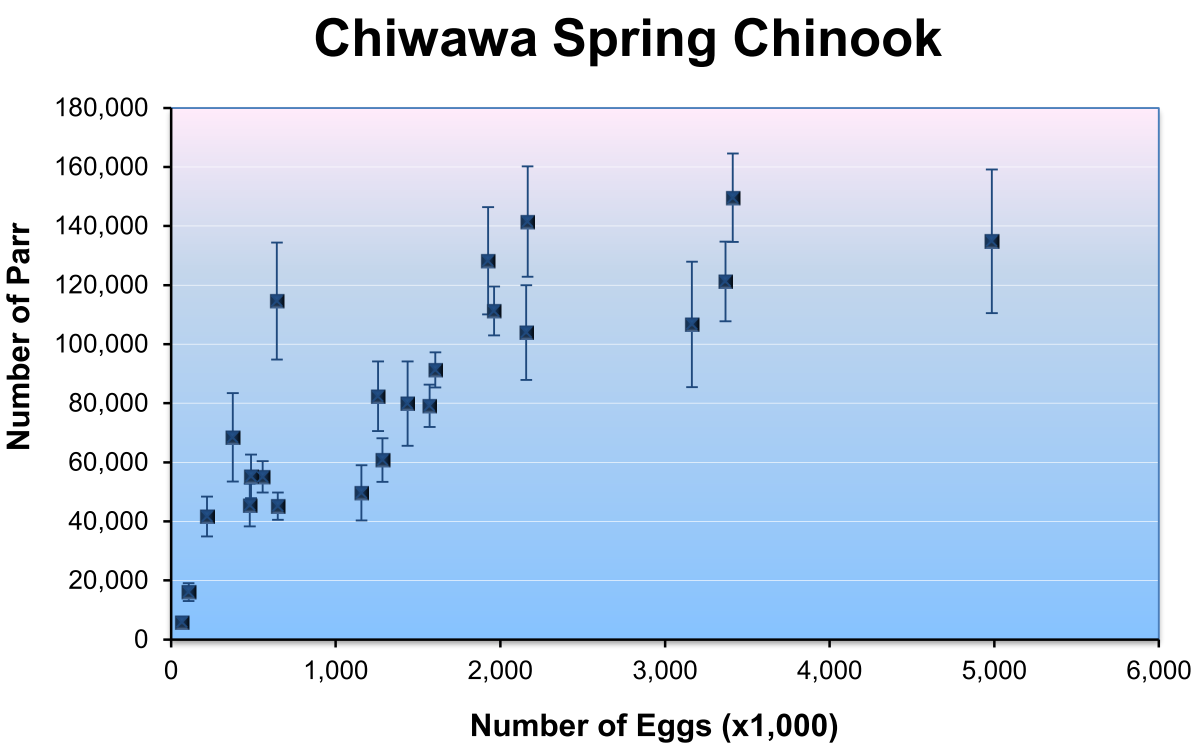

Figure 4. Relationship between total numbers of age-0 Chinook salmon (based on fish/ha) and numbers of eggs in the Chiwawa River basin. Vertical bars indicate 95% confidence bounds.

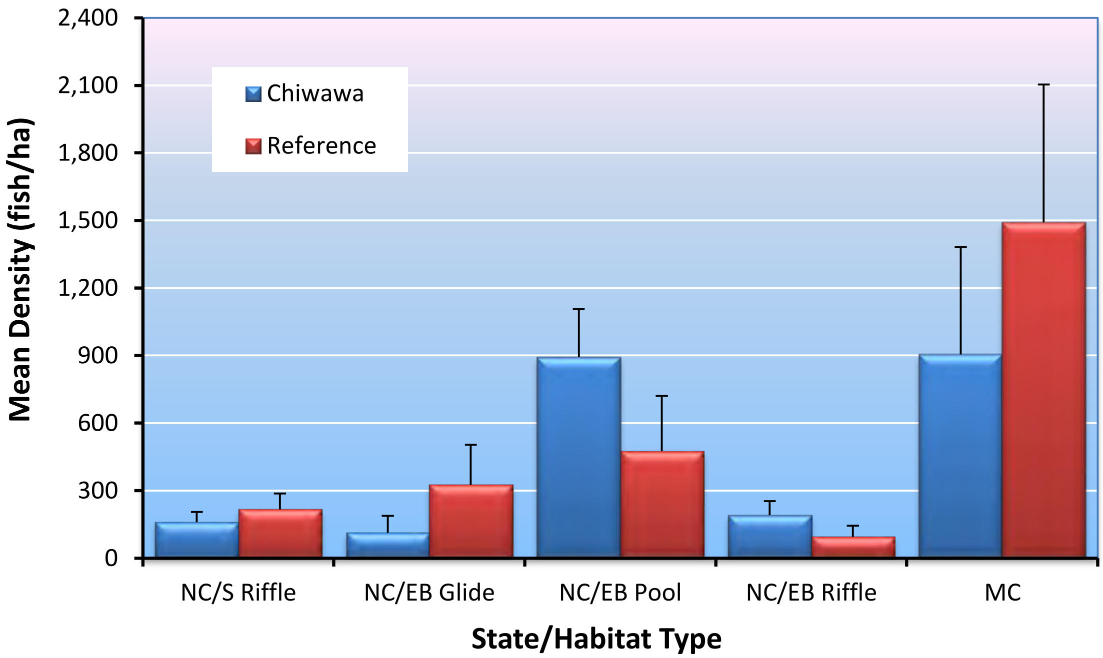

Figure 5. Comparison of the means (95% CI) of age-0 Chinook salmon densities (fish/ha) within state/habitat types in Reaches 3 and 8 of the Chiwawa River and their matched reference areas on Nason Creek and the Little Wenatchee River. There was no sampling in 2000 and no sampling in reference areas in 1992.

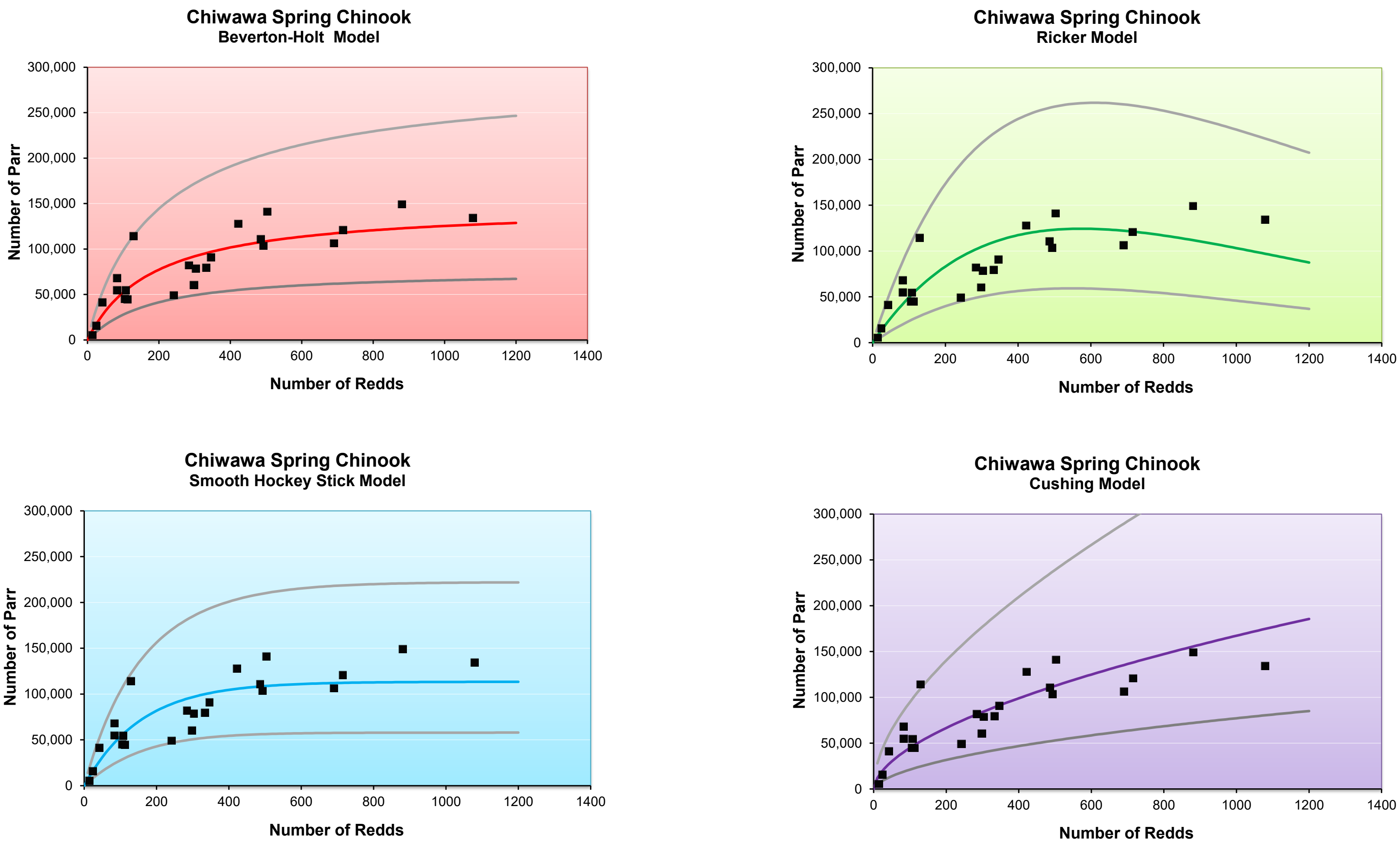

Figure 6. Relationship between numbers of juvenile (age-0) Chinook and redds in the Chiwawa River basin, 1992-2015 (no sampling occurred in 2000). Figures show the fit of the Beverton-Holt model, smooth hockey stick, Ricker model, and the Cushing model to the data. Gray lines indicate the upper and lower 95% C.B.

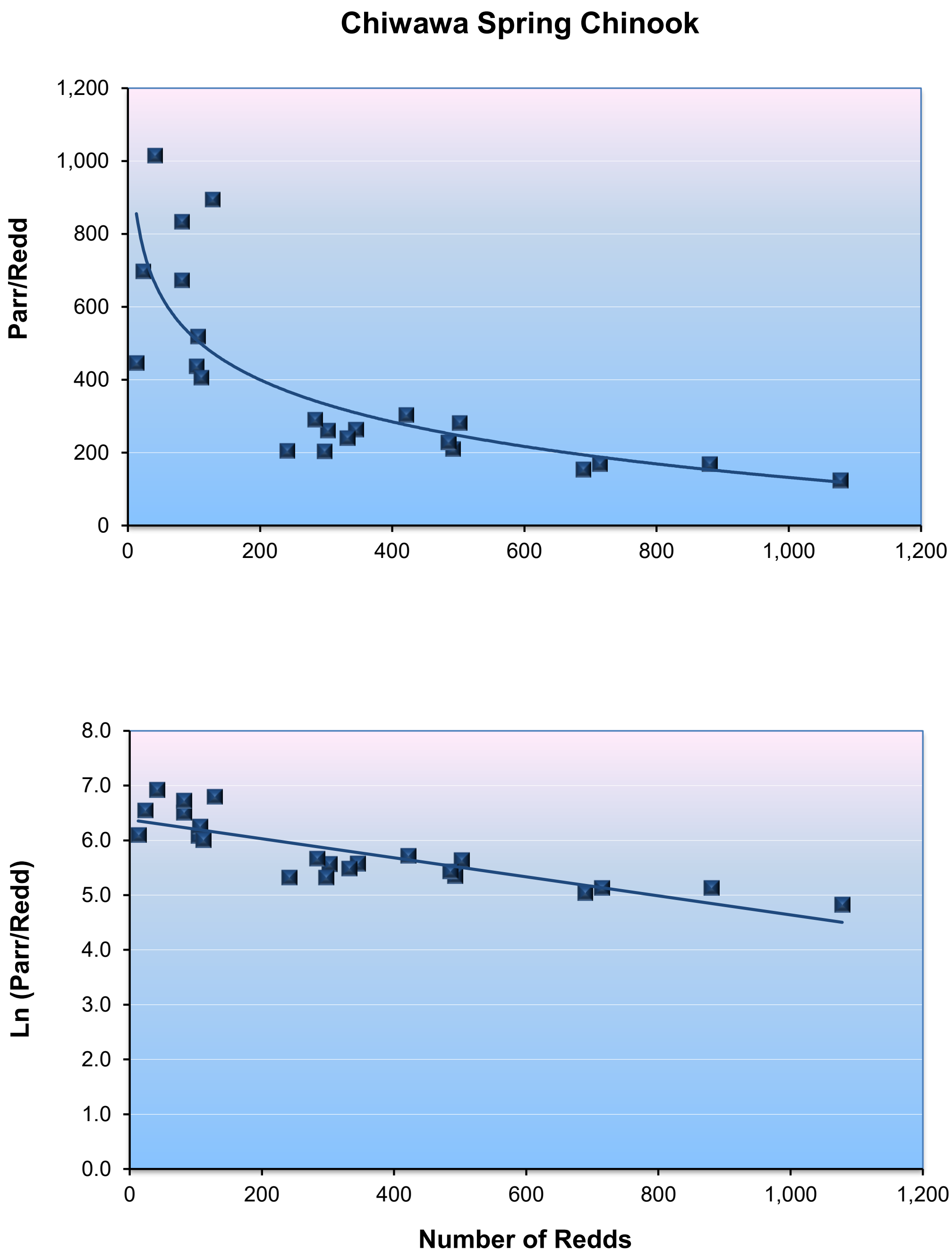

Figure 7. Relationship between parr/redd and numbers of redds (top figure) and natural log parr/redd and numbers of redds (bottom figure) in the Chiwawa River basin, 1992-2015. No sampling was conducted in 2000. Estimates for 1993-2015 included the Chiwawa River and its tributaries; the 1992 estimate included only the Chiwawa River. The linear relationship LN(P/R) = 6.38 – 0.002(Redds) was significant with P = 0.0000; R^2 = 0.690.

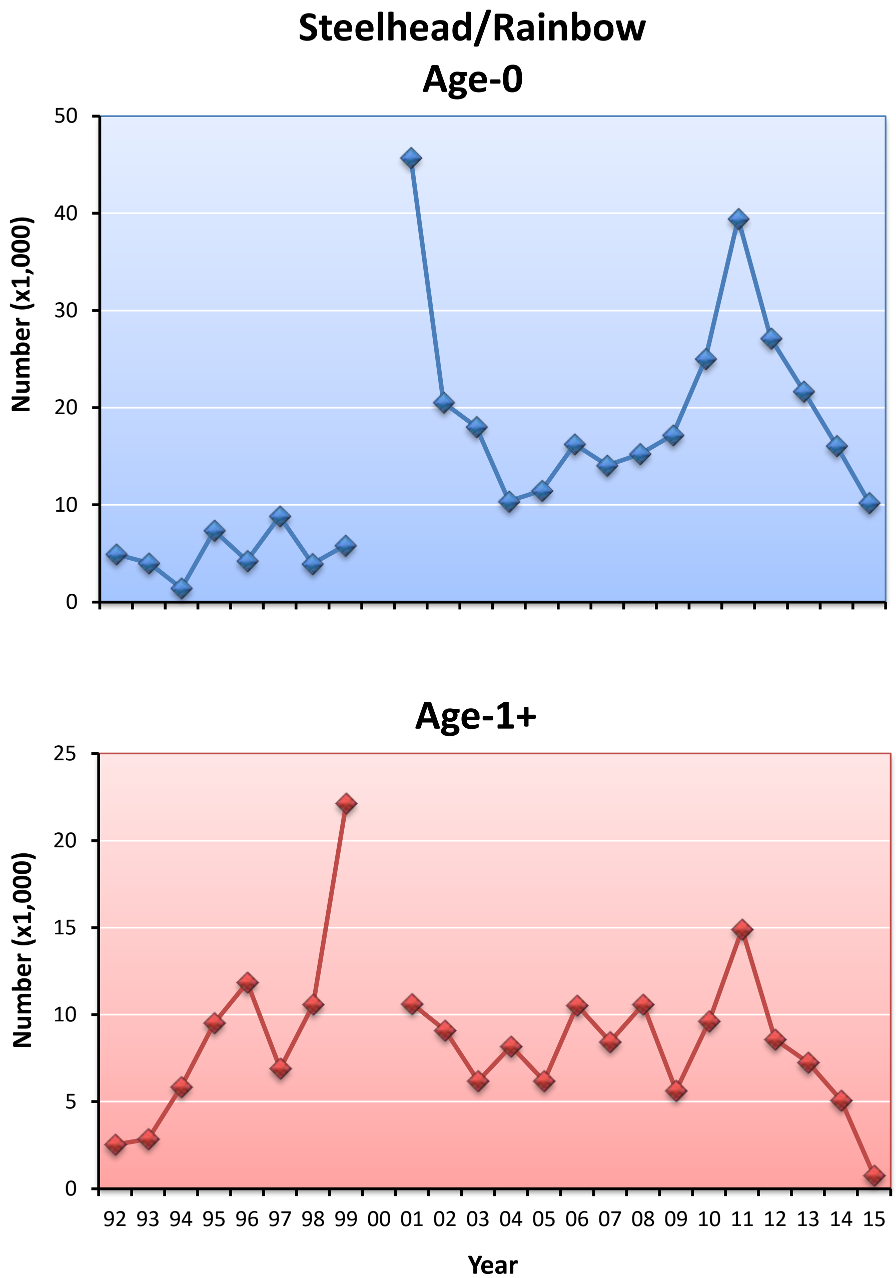

Figure 8. Numbers of age-0 (<4 in) and age-1+ (4-8 in) steelhead/rainbow within the Chiwawa River basin in August 1992-2015; ND = no data.

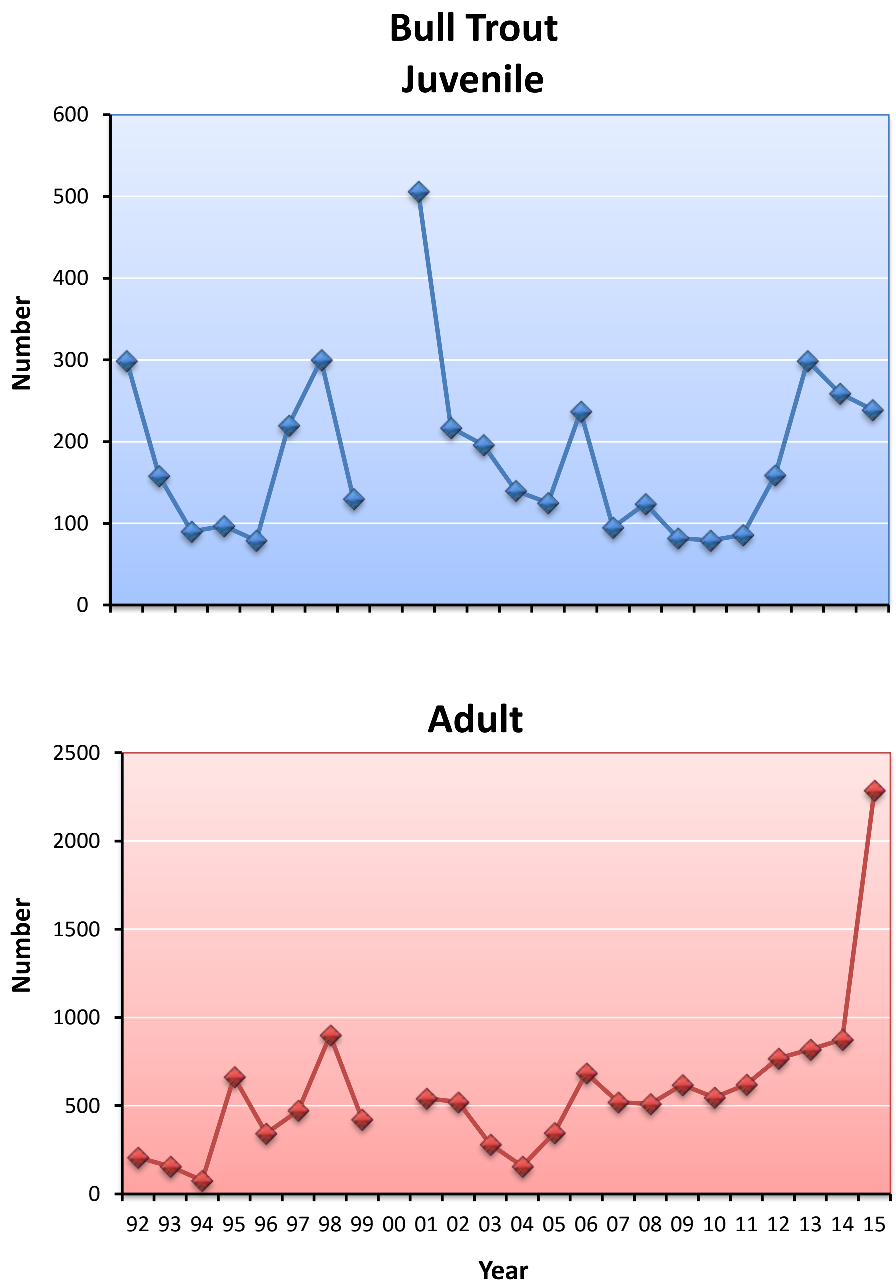

Figure 9. Numbers of juvenile (2-8 inches) and adult (>8 inches) bull trout within the Chiwawa River basin in August 1992-2015; ND = no data.

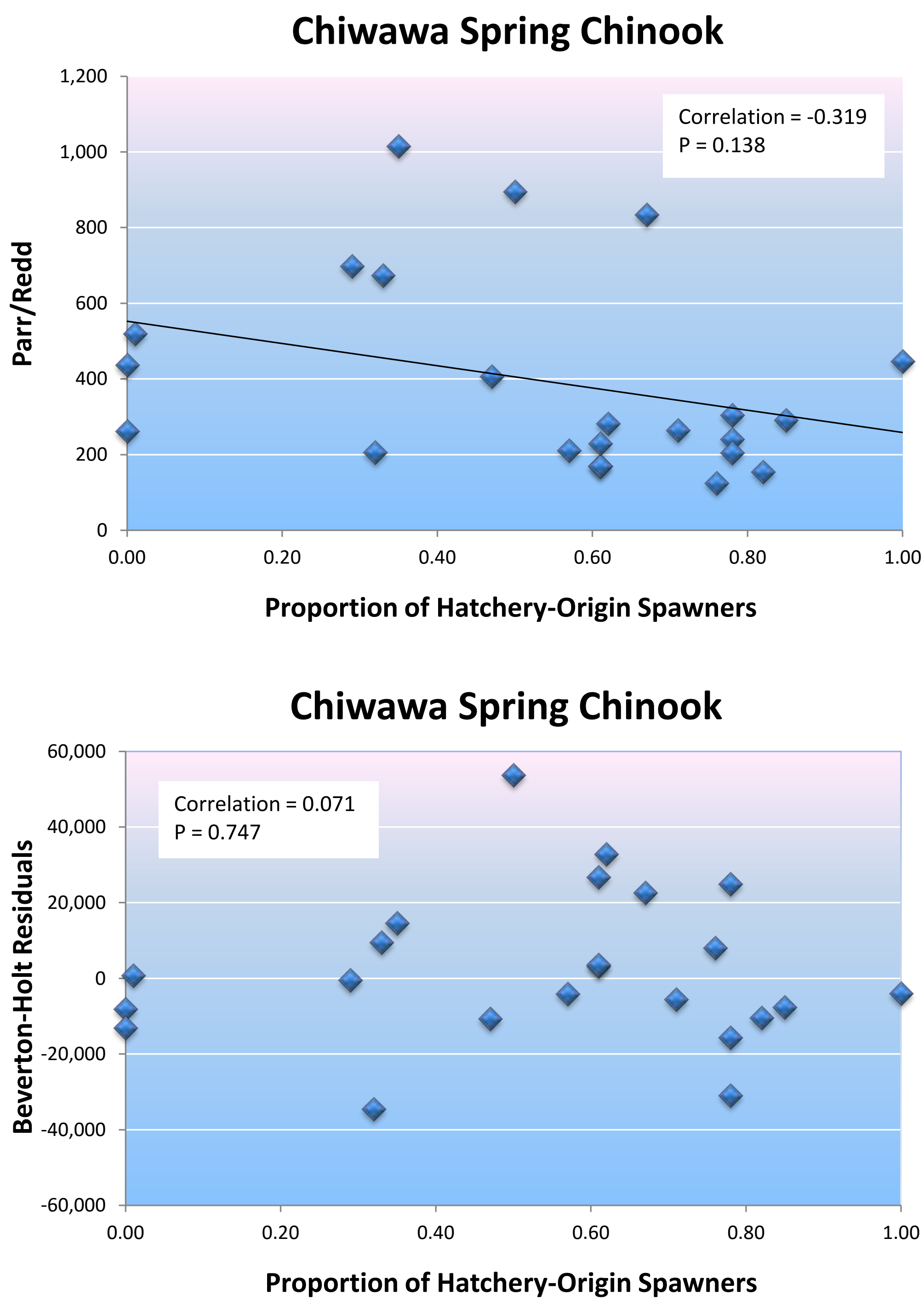

Figure 10. Relationship between juvenile productivity (parr/redd) and the proportion of hatchery-origin spawners (pHOS) (top figure) and the relationship between the residuals from the Beverton-Holt stock/recruitment relationship and pHOS (bottom figure).

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, 2015. Reaches were classified according to geologic district, landtype 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	0.49	0.49
						NC/EB	P	1.17	0.88
						NC/EB	R	16.60	1.57
2	3.77-5.51	0.010	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	G	0.29	0.25
						NC/EB	P	0.70	0.24
						NC/EB	R	6.08	0.58
3	5.51-7.88	0.009	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/S	R	4.45	0.70
						NC/EB	G	0.11	0.11
						NC/EB	R	4.13	0.48
						MC	MC	0.38	0.38
4	7.88-8.90	0.007	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.34	0.26
						NC/EB	R	2.34	0.33
						MC	MC	0.39	0.39
5	8.90-10.83	0.011	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/EB	P	0.13	0.13
						NC/EB	R	7.63	0.92
6	10.83-11.80	0.008	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.35	0.35
						NC/EB	R	3.72	0.93
						MC	MC	0.36	0.36
7	11.80-20.03	0.001	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	1.89	0.44
						NC	P	5.11	0.49
						NC	R	0.71	0.17
						NC/EB	G	2.30	1.20
						NC/EB	P	5.83	1.50
						NC/EB	R	4.20	0.47
						MC	MC	4.05	1.77
8	20.03-25.42	0.003	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC/EB	G	2.09	0.85
						NC/EB	P	7.01	2.02
						NC/EB	R	4.46	0.81
						EB	P	0.22	0.22
						EB	R	0.34	0.34
						MC	MC	5.90	2.34
9	25.42-28.81	0.007	Glacial Drift over Swakane Gneiss	Glacial Valley	MCV Alluvial	NC	P	3.92	0.43
						NC	R	2.20	0.47
						MC	MC	2.58	1.10
10	28.81-31.11	0.011	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.47	0.24
						NC	R	1.87	0.27
						MC	MC	3.92	0.28

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	0.40	0.08
						NC	R	0.14	0.06
						NC	MC	0.07	0.07
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	0.14	0.14
Chikamin Creek[1]									
1	0.00-0.94	0.013	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	0.05	0.05
						NC	P	0.19	0.06
						NC	R	0.32	0.10
						MC	MC	0.14	0.14
Rock Creek									
1	0.00-0.73	0.020	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC	P	0.20	0.05
						NC	R	0.37	0.08
						MC	MC	0.10	0.10
Unnamed Creek									
1	0.00-0.05		Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.00	0.00
						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	0.02	0.02
						NC	P	0.10	0.05
						NC	R	0.07	0.02
						NC	MC	0.00	0.00
Alder Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC	P	0.001	0.001
						NC	R	0.006	0.006
Brush Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.002	0.002
						NC	R	0.003	0.003
Clear Creek									
1	0.00-0.05		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.003	0.003
						NC	R	0.002	0.002
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/m^3), 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 2015.

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	70.3	0.025	1,285	±437	0.34	1,250	±384	0.31
2	111.7	0.027	790	±135	0.17	690	±75	0.11
3	47.5	0.014	431	±22	0.05	471	±21	0.05
4	368.7	0.082	1,132	±66	0.06	1,137	±89	0.08
5	44.2	0.012	343	±27	0.08	377	±21	0.06
6	58.7	0.020	260	±45	0.17	252	±37	0.15
7	728.6	0.113	17,553	±3,979	0.23	15,333	±2,998	0.20
8	743.2	0.135	14,878	±5,167	0.35	13,792	±4,405	0.32
9	1,953.8	0.343	16,998	±4,623	0.27	14,448	±1,710	0.12
10	7,283.8	1.992	50,040	±1,852	0.04	41,690	±2,185	0.05
Phelps Creek								
1	2,035.7	2.074	285	±0	0.00	285	±0	0.00
Chikamin Creek[1]								
1	2,738.6	1.947	1,917	±626	0.33	2,467	±560	0.23
Rock Creek								
1	6,205.9	2.524	4,158	±564	0.14	4,110	±1,875	0.46
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	5,446.2	2.688	1,013	±545	0.54	915	±373	0.41
Alder Creek								
1	10,142.9	11.270	71	±0	0.00	71	±0	0.00
Brush Creek								
1	12,400.00	22.963	62	±0	0.00	62	±0	0.00
Clear Creek								
1	1,600.0	1.404	8	±0	0.00	8	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**1,001.6**	**0.206**	**111,224**	**±8,280**	**0.07**	**97,358**	**±6,342**	**0.07**

[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 2015.

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	0.9	0.000	16	±21	1.31	15	±10	0.67
2	4.5	0.001	32	±37	1.16	26	±24	0.92
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	7.5	0.002	23	±0	0.00	23	±0	0.00
5	0.5	0.000	4	±0	0.00	3	±0	0.00
6	0.0	0.000	0	±0	0.00	0	±0	0.00
7	11.9	0.002	286	±227	0.79	244	±140	0.57
8	3.3	0.001	67	±78	1.16	61	±53	0.87
9	6.0	0.001	52	±72	1.38	42	±53	1.26
10	1.2	0.001	8	±11	1.38	10	±6	0.60
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	31.4	0.025	22	±33	0.00	32	±33	0.00
Rock Creek								
1	164.2	0.066	110	±67	0.61	108	±144	1.33
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	**5.6**	**0.001**	**620**	**±265**	**0.43**	**564**	**±218**	**0.39**

[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 23. 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	-123.272	0.000	1.000	0.663	0.838
Smooth Hockey Stick	3	-121.632	1.640	0.440	0.292	0.826
Gamma[b]	4	-116.473	6.799	0.033	0.022	0.799
Ricker	3	-115.227	8.046	0.018	0.012	0.778
Cushing	3	-115.186	8.087	0.018	0.012	0.770

[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/m^3), 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 2015.

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	52.2	0.017	953	±90	0.09	852	±91	0.11
2	58.0	0.015	410	±114	0.28	388	±139	0.36
3	102.4	0.030	929	±17	0.02	988	±9	0.01
4	61.6	0.014	189	±42	0.22	190	±32	0.17
5	46.1	0.013	358	±38	0.11	433	±32	0.07
6	18.7	0.006	83	±15	0.18	78	±11	0.14
7	65.4	0.011	1,575	±689	0.44	1,448	±700	0.48
8	1.7	0.000	35	±42	1.20	31	±28	0.90
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	2,841.4	1.913	1,989	±585	0.29	2,424	±571	0.24
Rock Creek								
1	2,500.0	1.064	1,675	±391	0.23	1,732	±683	0.39
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	9,467.7	4.780	1,761	±446	0.25	1,627	±179	0.11
Alder Creek								
1	24,285.7	26.984	170	±0	0.00	170	±0	0.00
Brush Creek								
1	12,400.0	22.963	62	±0	0.00	62	±0	0.00
Clear Creek								
1	3,800.0	3.333	19	±0	0.00	19	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**91.9**	**0.022**	**10,208**	**±1,093**	**0.11**	**10,442**	**±1,160**	**0.11**

[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 2015.

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	7.4	0.003	135	±46	0.34	123	±38	0.31
2	2.5	0.001	18	±24	1.33	16	±19	1.19
3	19.3	0.006	175	±31	0.18	206	±22	0.11
4	12.7	0.003	39	±10	0.26	39	±7	0.18
5	14.4	0.004	112	±14	0.13	130	±9	0.07
6	8.1	0.003	36	±14	0.39	33	±11	0.33
7	4.1	0.001	99	±108	1.09	95	±118	1.24
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	57.1	0.032	40	±0	0.00	40	±0	0.00
Rock Creek								
1	149.3	0.060	100	±149	1.49	98	±178	1.82
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	**6.8**	**0.002**	**754**	**±195**	**0.26**	**780**	**±219**	**0.28**

[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 2015.

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	0.7	0.000	13	±19	1.46	15	±5	0.33
2	0.0	0.000	0	±0	0.00	0	±0	0.00
3	0.1	0.000	1	±0	0.00	1	±0	0.00
4	0.3	0.000	1	±0	0.00	1	±0	0.00
5	0.4	0.000	3	±0	0.00	3	±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	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**	**18**	**±19**	**1.06**	**20**	**±5**	**0.25**

[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 2015.

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	0.0	0.000	0	±0	0.00	0	±0	0.00
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	6.9	0.001	60	±34	0.57	55	±27	0.49
10	21.8	0.006	150	±21	0.14	120	±14	0.12
Phelps Creek								
1	35.7	0.036	5	±0	0.00	5	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	35.8	0.002	24	±6	0.25	24	±17	0.71
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	**2.2**	**0.000**	**239**	**±41**	**0.17**	**204**	**±35**	**0.17**

[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 2015.

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	1.3	0.000	24	±16	0.67	20	±6	0.30
2	7.1	0.002	50	±21	0.42	42	±1	0.02
3	0.1	0.000	1	±0	0.00	1	±0	0.00
4	3.9	0.001	12	±10	0.83	12	±7	0.58
5	1.4	0.000	11	±0	0.00	10	±0	0.00
6	1.1	0.000	5	±0	0.00	5	±0	0.00
7	16.3	0.003	392	±204	0.52	352	±128	0.36
8	9.2	0.002	185	±159	0.86	184	±55	0.30
9	37.4	0.007	325	±64	0.20	283	±47	0.17
10	185.4	0.051	1,274	±169	0.13	1,072	±177	0.17
Phelps Creek								
1	42.9	0.044	6	±0	0.00	6	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	1.5	0.001	1	±0	0.00	1	±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	**20.6**	**0.004**	**2,286**	**±316**	**0.14**	**1,988**	**±230**	**0.12**

[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 1991-2014; 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	3,412,184	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
Average	**324**	**1,466,346**	**82,078**	**244**	**8.1**

APPENDIX B. Estimated numbers of salmonids (based on fish/ha) in the Chiwawa River basin, Washington, 1992-2015; 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

[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 1992-2015; 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									**0.08**
Pool	0.22	0.24									**0.19**
Riffle	0.54	0.53									**0.53**
M. Chan	0.17	0.16									**0.20**
Fraction of all age-0 Chinook within habitat types											
Glide	0.01	0.01									**0.02**
Pool	0.37	0.31									**0.30**
Riffle	0.11	0.05									**0.13**
M. Chan	0.51	0.63									**0.55**
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	133	66									**171**
Pool	1,569	1,300									**1,048**
Riffle	190	98									**163**
M. Chan	2,957	3,768									**1,855**
Number of age-0 Chinook within habitat types											
Glide	1,120	518									**1,745**
Pool	44,321	34,993									**24,908**
Riffle	13,085	6,017									**10,899**
M. Chan	62,713	69,969									**45,515**

Appendix B

Fish Trapping at the Chiwawa and Wenatchee Smolt Traps during 2015

Monitoring Juvenile Salmonids in the Wenatchee River Subbasin:

Activities in the Chiwawa River and Lower Wenatchee River during 2015

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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 gathers 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 subbasin 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 screw 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 Basin in 2012.

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 (cms); 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 at river kilometer (rkm) 76, about 9 km downstream of Lake Wenatchee (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.

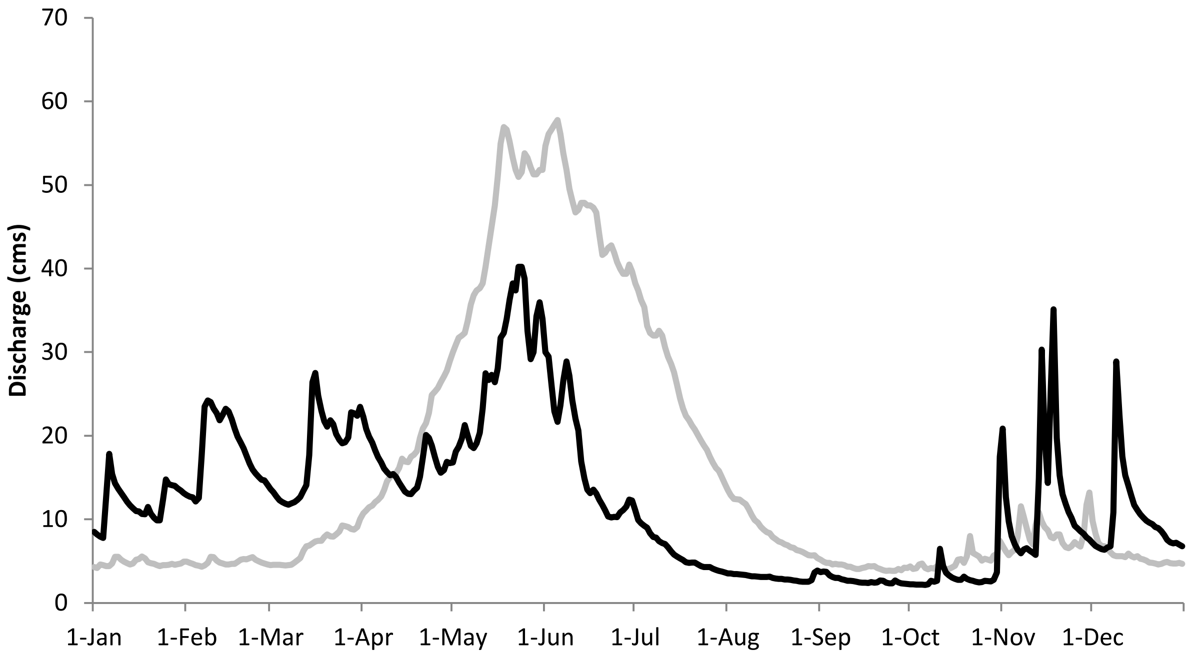

Figure 1. Discharge of the Chiwawa River at Plain, USGS gauge # 12456500. Black line represents 2015 discharge and grey line represents mean discharge from 1990-2014.

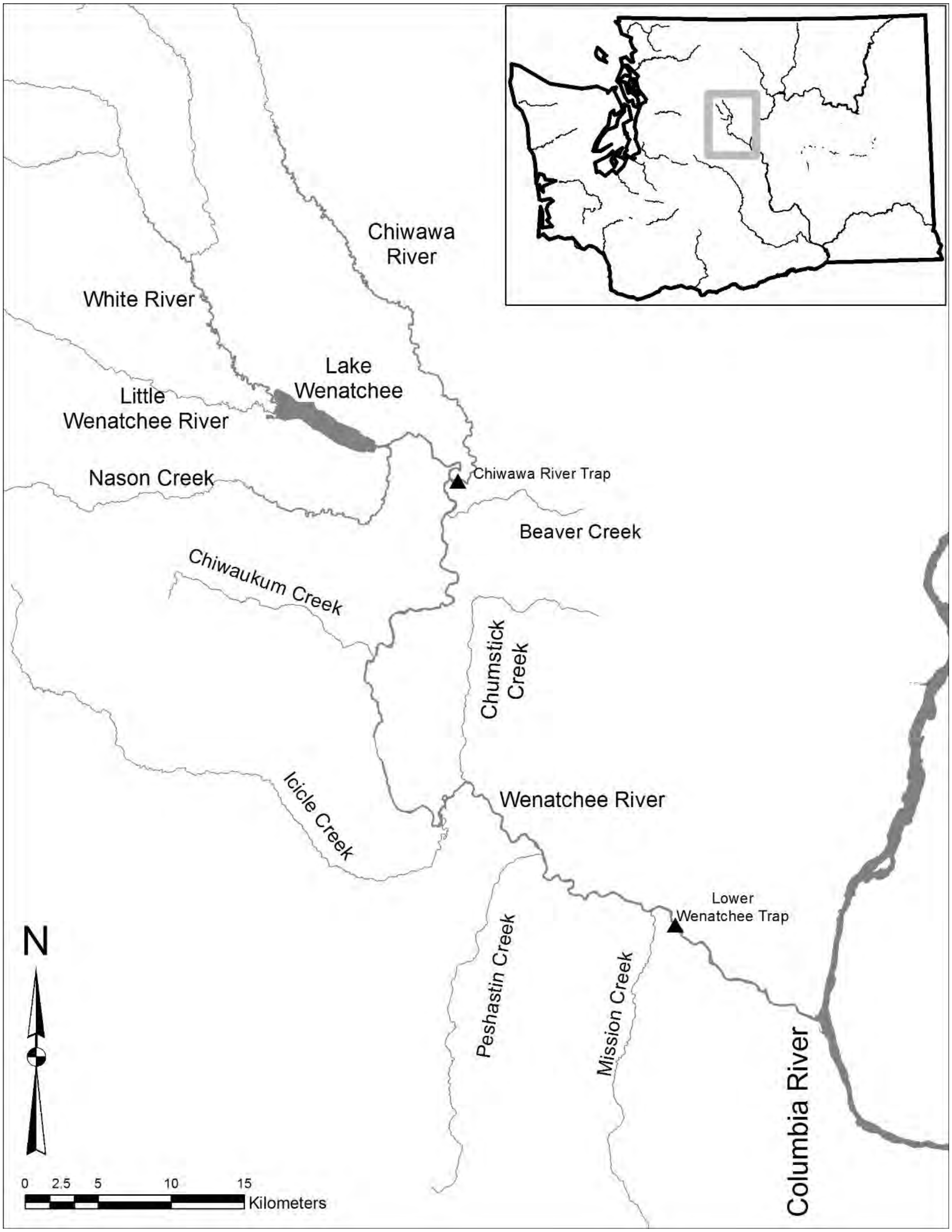

Figure 2. Wenatchee River subbasin (with rotary screw trap locations).

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 cms. 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.

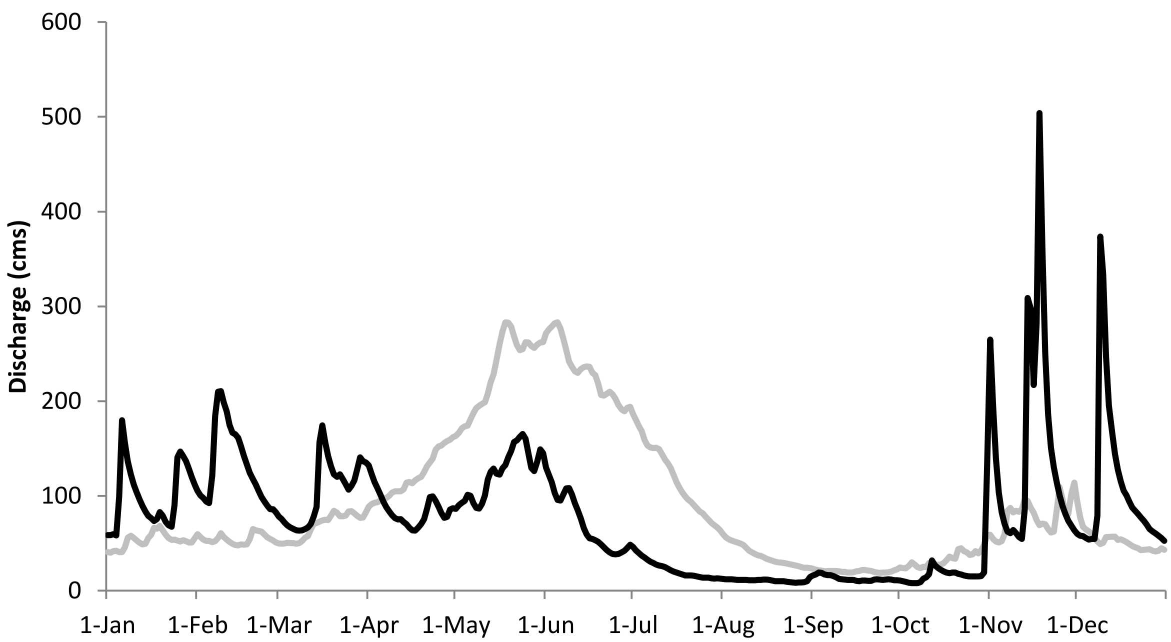

Figure 3. Discharge of the Wenatchee River at Monitor, USGS gauge # 12462500. Black line represents 2015 discharge and grey line represents mean discharge from 1990-2014.

METHODS

Rotary Screw 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 ice suspends 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) with the exception of coho. Based on length subsamples of known hatchery coho at Leavenworth Fish Hatchery, all coho collected at the Lower Wenatchee smolt trap were considered wild if < 80mm FL or unknown origin if ≥ 80mm FL. All coho collected in the Chiwawa River were considered wild. Target species (≥ 65 mm FL) were tagged using 12.5 mm FDX PIT tags and all PIT tagging information was uploaded to a reginal PIT tag database (PTAGIS) maintained by the Pacific States Marine Fisheries Commission.

A combination of age 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. 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.

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. All estimates of emigrating spring Chinook do not include fry 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. 2014). 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 Screw Traps – Chiwawa

Trap Operation

The Chiwawa trap operated between 25 February and 24 November 2015. During that time the trap was inoperable for 29 days as a result of low or high discharge, debris and hatchery fish releases. The trap was operated in two positions based on season (i.e., lower position through June 30 and upper position after July 1).

Fish Sampling

A total of 60,302 individual fish were collected, with wild spring Chinook Salmon and steelhead comprising 62% and 5% of the total catch, respectively. Additionally, 7,162 hatchery spring Chinook, 3,151 hatchery steelhead, and 38 wild coho were collected. Throughout the sampling period 18,470 PIT tag were deployed into wild spring Chinook and steelhead (16,675 and 1,795 respectively). Spring Chinook mortality for the season totaled 42 yearling, 390 subyearling parr, and 31 fry (0.7%, 2.1%, and 0.24%, respectively). Mortality of steelhead throughout the season totaled 45 (1.38%). The mean fork length (SD) of captured yearling and subyearling spring Chinook Salmon (fry excluded) was 93 (9.0) mm and 71 (10.7) mm, respectively (Table 1).

Table 1. Mean fork length (mm) and weight (g) of spring Chinook Salmon captured in the Chiwawa River smolt trap during 2015.

	Yearling transitional/smolts			Subyearling parr		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	92.5	9.0	6,304	71.1	10.7	15,241
Weight	8.8	2.9	6,244	4.2	1.7	14,660

Yearling Spring Chinook (Brood Year 2013)

Wild yearling spring Chinook Salmon were primarily captured between 25 February and 14 June (Figure. 4). A total of 6,350 yearling Chinook Salmon were captured and an estimated 6,891 would have been captured if the trap had operated without interruption. Nine mark/recapture efficiency trials using PIT tags were conducted when the trap was in the lower position producing a mean trap efficiency of 19%. In 2015, mark/recapture trials were conducted at all desired discharge levels but a statistically significant flow-efficiency regression model could not be obtained (R^2 = 0.22, P < 0.069). Thus, a pooled estimate combining the 2014 and 2015 mark/recapture trials was developed. The estimated number (95% C.I.) of yearling spring Chinook Salmon that emigrated from the Chiwawa River in 2015 was 39,396 (±8,399).

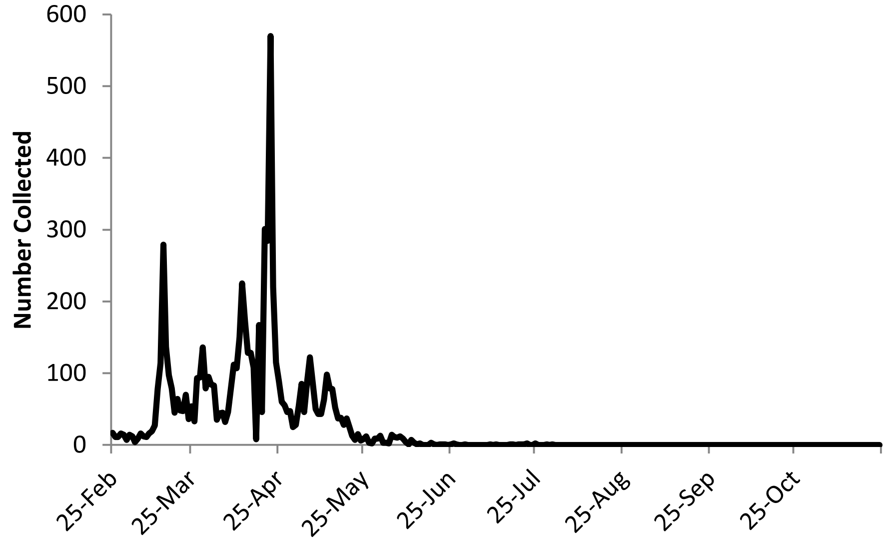

Figure 4. Daily catch of yearling spring Chinook Salmon at the Chiwawa River rotary screw trap.

Subyearling Spring Chinook (Brood Year 2014)

Wild subyearling spring Chinook Salmon were captured throughout the sampling period, with peak catches of parr in October and November and fry occurring in March and April (Figures 5 and 6, respectively). A total of 18,190 subyearling parr and 12,962 fry were captured with an estimated 19,435 subyearling parr and 13,936 fry had the trap operated without interruption. Four mark/recapture efficiency trials were conducted (three PIT and one Bismarck Brown) with a mean trap efficiency of 25.4%. A combination of mark/recapture efficiency trials from 2014 and 2015 were used to create a regression model for the upper trap position (R^2 = 0.58, P = 0.002). Data from 2002, 2003, 2013 and 2015 were combined to create a regression model (R^2 = 0.83, P < 0.001) for subyearling Chinook captured at the lower trap position. In 2015, the estimated number of subyearling spring Chinook Salmon (excluding fry < 50 mm FL) emigrating from the Chiwawa River during the sampling period was 77,510 (± 9,074).

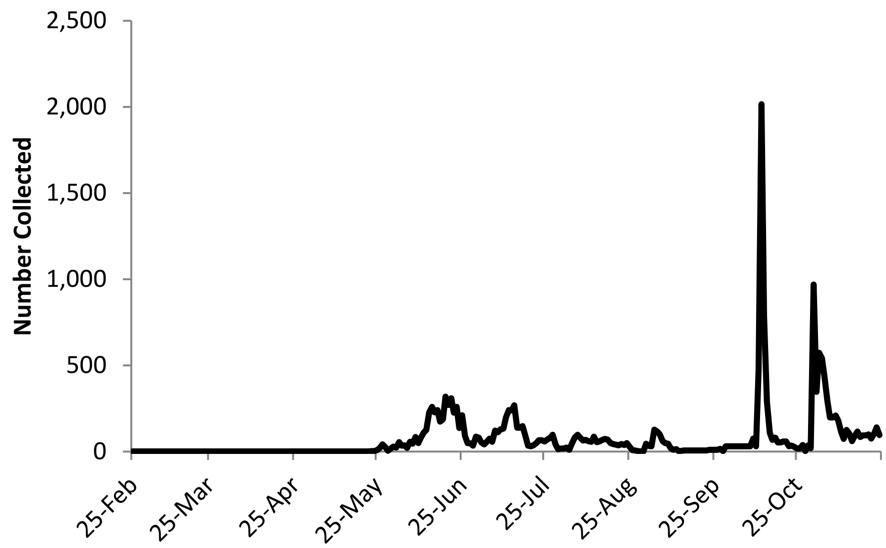

Figure 5. Daily catch of wild spring Chinook subyearling parr at the Chiwawa River rotary screw trap.

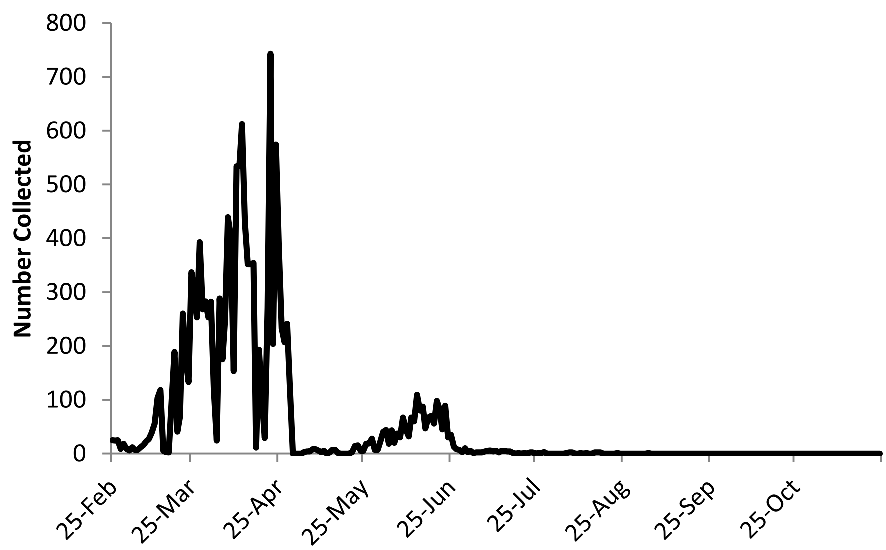

Figure 6. Daily catch of wild spring Chinook fry at the Chiwawa River rotary screw trap.

Summer Steelhead

During the trapping period, 259 steelhead transitional/smolts and 3,004 steelhead/rainbow parr and fry were captured. While collections occurred in moderate numbers throughout the year, peak collections occurred during October (Figure 7). The mean fork length (SD) of steelhead parr and transitional/smolts captured was 75.8 (23.1) and 167.1 (21.8) mm, respectively (Table. 2).

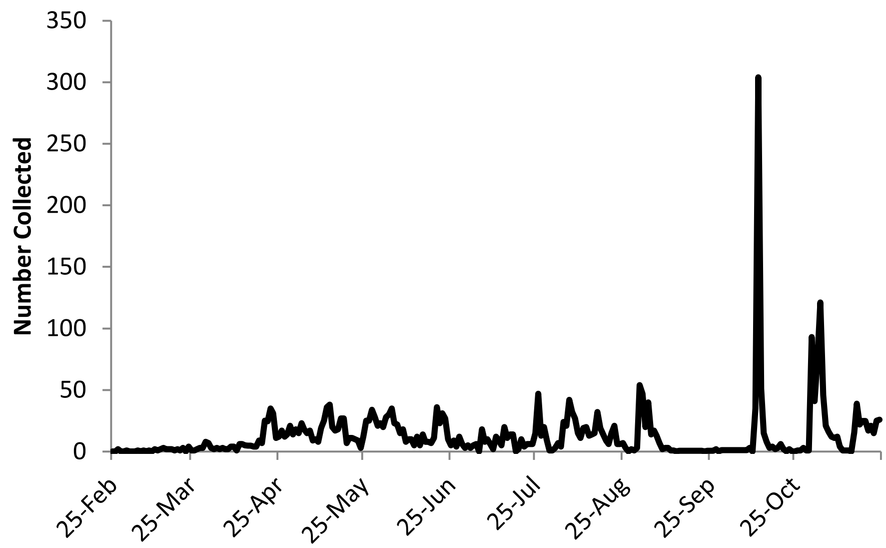

Figure 7. Daily catch of all wild steelhead at the Chiwawa River rotary screw trap.

Table 2. Mean fork length (mm) and weight (g) and of steelhead/rainbow captured in the Chiwawa River smolt trap during 2015.

	Transitional/smolts			Parr		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	167.1	21.8	256	75.8	23.1	2,570
Weight	50.1	19.2	252	6.0	7.88	2,557

Egg-to-emigrant Survival

For BY 2013, 714 redds were counted in the Chiwawa River with an estimated 3,367,224 eggs being deposited. A total of 113,091 emigrants were estimated resulting in an egg-to-emigrant survival of 3.4% (Table 3). This is down slightly from a five year moving average of 3.8%.

Table 3. 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				Egg-to-emigrant survival (%)
			Sub-yearling	Non trapping	Yearling	Total emigrants	
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
1997	82	374,740	16,228		28,334	44,562	11.9

Brood Year	Number of redds	Estimated egg deposition	Estimated number				Egg-to-emigrant survival (%)
			Sub-yearling	Non trapping	Yearling	Total emigrants	
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]	485	1,961,825	77,510	--	--	--	--

[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 298 bull trout (32 ≥ 300 mm FL and 266 <300 mm FL) were captured. Additionally, a total of 72 western cutthroat trout (*O. clarki lewisi*), 2 resident rainbow (*O. mykiss*) and 8 Eastern brook trout (*S. fontinalis*) were collected. In all, 260 bull trout, and 65 western cutthroat trout were released with PIT tags. Monthly and annual totals of all fish captured are presented in Appendix D and Appendix E, respectively.

Rotary Screw Traps – Lower Wenatchee

Trap Operation

The Lower Wenatchee trap operated from 30 January through 27 June 2015. During this time the trap was inoperable for a total of 5 days due to high/low flows, high temperatures, heavy debris and major hatchery releases. Extreme river temperatures and low flows resulted in trapping operations being suspended for the season on 28 June. Throughout the season, the trap cones were operated in the lower position.

Fish Sampling

A total of 282,976 individual fish were collected, with wild summer Chinook Salmon comprising 89% of the total catch. Additionally, 1,559 wild yearling spring Chinook Salmon, 9,920 hatchery yearling Chinook Salmon, 4,178 wild sockeye, 331 wild steelhead, and 2,288 hatchery steelhead were captured. Throughout the sampling period 5,513 PIT tag were deployed into wild yearling spring Chinook, sockeye and steelhead (1,301; 3,922; and 290 respectively). Mortality for the season totaled 17 yearling spring Chinook, 282 subyearling summer Chinook, 64 sockeye, and 2 steelhead (1.1%, 0.1%, 1.5%, and 0.6%, respectively).

Wild Yearling Spring Chinook (Brood Year 2013)

Wild yearling spring Chinook Salmon were primarily captured in March and April (Figure 8). Throughout the trapping period 1,559 spring Chinook were collected and an estimated 1,654 would have been collected had the trap operated without interruption. One mark/recapture efficiency trial was carried out using caudal fin clipped yearling hatchery spring Chinook Salmon. A combination of 2013, 2014, and 2015 trials were used to develop a significant relationship between discharge and trap efficiency (R^2 = 0.62, P = 0.02). This model was used to calculate an emigrant estimate of 58,595 (±6,731). The mean fork length (SD) of captured yearling Chinook was 96 (9.7) mm (Table 4).

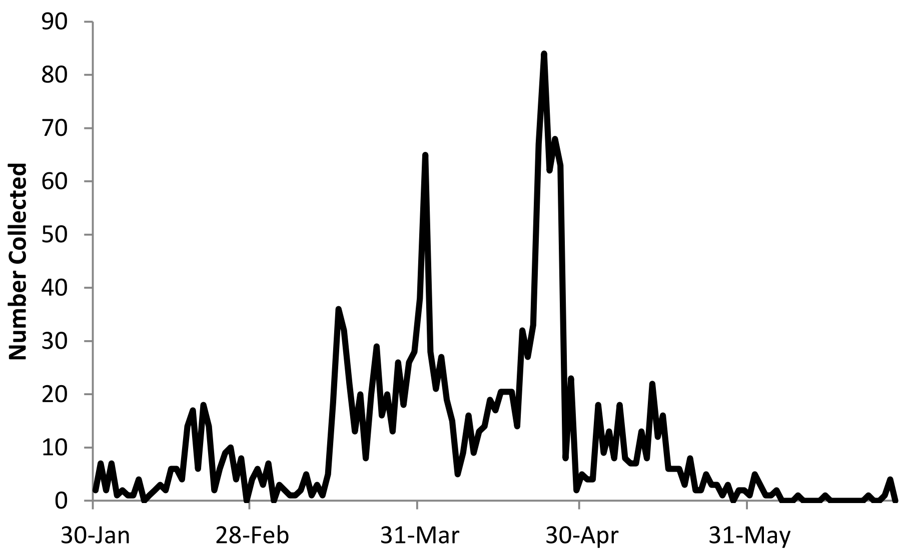

Figure 8. Daily capture of wild yearling Chinook Salmon at the Lower Wenatchee smolt trap.

Table 4. Average length and weight for wild yearling spring Chinook Salmon sampled at the Lower Wenatchee trap.

	Mean	SD	N
Fork length	96	9.8	1,491
Weight	9.4	3.7	1,473

Wild Subyearling Summer Chinook (Brood Year 2014)

Wild subyearling summer Chinook dominated the catch with 252,293 fish being processed, most being collected in April and May (Figure 9). An estimated 274,346 would have been captured had the trap operated without interruption. Over the season, eight mark/recapture efficiency trials were carried out using Bismarck Brown during the 2015 trapping season. When combined with trials from the previous trapping season a significant discharge efficiency relationship was developed (R^2 = 0.61, P < 0.001) and an emigrant estimate (95% C.I.) of 14,157,778 (±2,125,578) was calculated. The mean fork length (SD) for captured subyearling parr and fry summer Chinook was 63 (9.7) and 41 (3.3), respectively (Table 5). No PIT tags were deployed in summer Chinook.

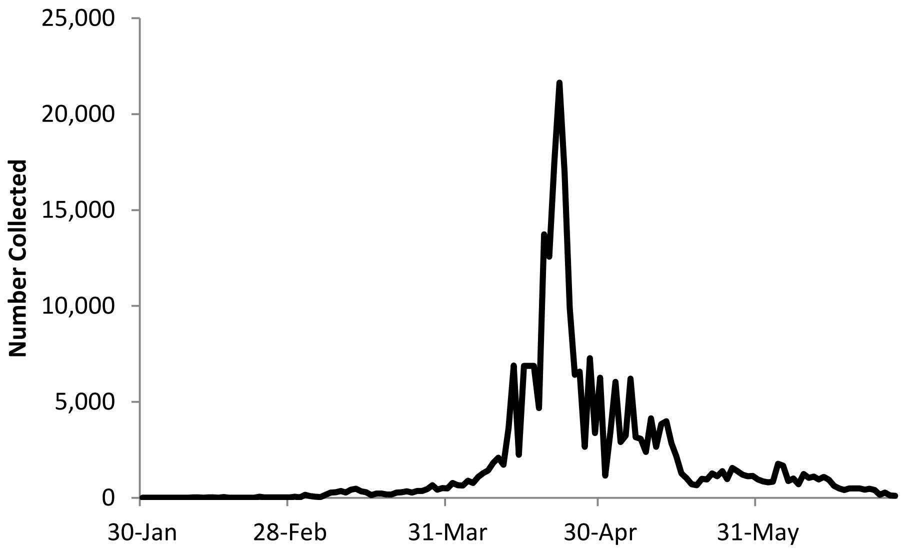

Figure 9. Daily capture of wild summer Chinook Salmon at the Lower Wenatchee River trap.

Table 5. Fork length and weight of subyearling Summer Chinook Salmon sampled at the lower Wenatchee smolt trap.

	Transition / Smolt			Parr			Fry		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Fork length	75.3	7.2	8	62.8	9.7	2,011	41.0	3.3	6,267
Weight	4.36	1.3	7	3.07	1.5	1,690	0.62	0.3	2,863

Wild Sockeye

A total of 4,178 juvenile sockeye were collected in the 2015 season and an estimated 5,239 had the trap operated without interruption. Almost all of these fish (96%) were collected in April (Figure 10). Three mark/recapture efficiency trials were carried out using PIT tagged juvenile sockeye Salmon. When combined with efficiency trials from the 2014 and 2013 season a significant discharge efficiency model (R^2 = 0.52, P < 0.043) was developed. This model produced an estimate (95% C.I.) of the 2015 emigrant population of juvenile sockeye at 1,065,614 (±238,901). Smolt survival (SE) to McNary of those tagged fish was 45% (5%) using a

Cormack Jolly Seber estimator. Over 90% of sockeye in run year 2013 and 2014 migrated as Age 1+ with the remaining being Age 2+ (Table 6). Mean fork length (SD) for captured sockeye was 86 (9.4) mm (Table 7).

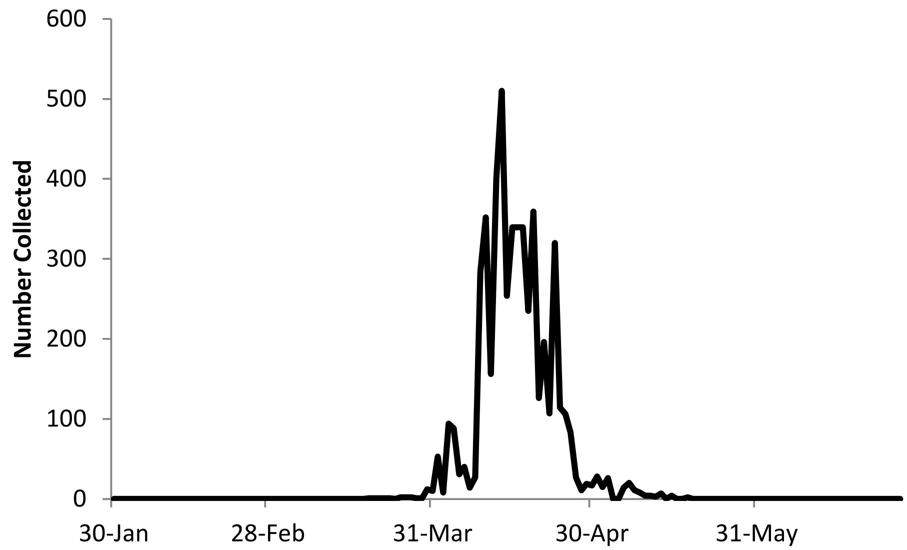

Figure 10. Daily capture of wild sockeye Salmon at the Lower Wenatchee River trap.

Table 6. Age structure and estimated number of wild sockeye smolts that emigrated from Lake Wenatchee in 2013-2015.

Run year	Proportion of Wild Smolts			Total Wild Smolts
	Age 1+	Age 2+	Age 3+	
2013	0.932	0.068	0.000	873,096
2014	0.924	0.076	0.000	1,275,027
2015	NA	NA	NA	1,065,614

Table 7. Fork length and weight of wild sockeye Salmon smolts sampled at the Lower Wenatchee smolt trap.

	Mean	SD	N
Fork length	86.0	9.4	4,067
Weight	5.37	3.0	4,049

Wild Summer Steelhead

Capture of wild steelhead at the Lower Wenatchee site for all life stages was low, totaling 331 smolts, parr, and fry combined and an estimated 339 collected had the trap operated without interruption. Peak catches of steelhead occurred in May (Figure 11). Due to the low captures no mark/recapture trials were conducted in 2015. In 2014 however, two trials using hatchery steelhead transitional/smolts were piloted. Based on these two trials a pooled efficiency of

0.036 was used to estimate (95% C.I.) the emigrant population at 8,632 (±45,053) parr and smolt emigrant steelhead. However, due to the small number of trials, small sample sizes, use of hatchery transitional/smolts surrogates and the relationship not being significant, caution should be used in the interpretation and use of the estimate. Mean length (SE) of transitional/smolts and parr was 179 (24.8) and 94 (22.7) mm, respectively (Table 8).

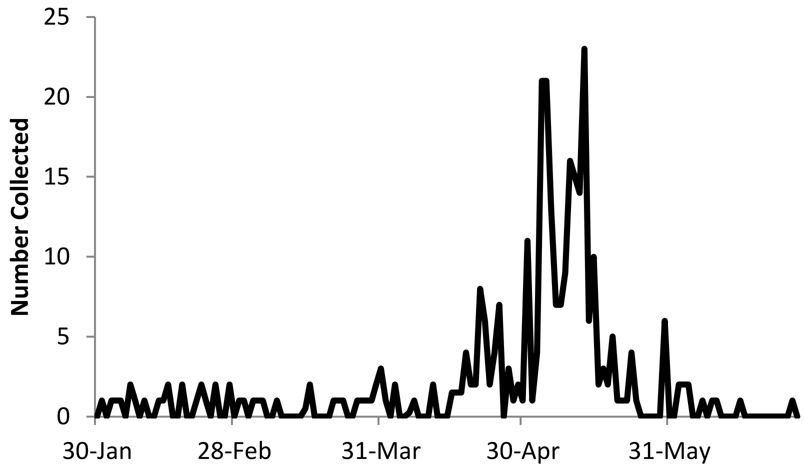

Figure 11. Daily capture of wild steelhead at the Lower Wenatchee River trap.

Table 8. Fork length and weight of wild steelhead sampled at the lower Wenatchee smolt trap.

	Transitional/Smolt			Parr		
	Mean	SD	N	Mean	SD	N
Fork length	179	24.8	227	94	22.7	74
Weight	60.24	25.6	226	10.39	9.4	71

Survival

For BY 2013, 1,159 spring Chinook Salmon redds were surveyed in the Wenatchee Basin producing an estimated 5,512,204 eggs. An estimate of 58,595 emigrants results in an estimated egg-to-emigrant survival of 1.06%. This is down from the last two year average of 1.65% (Table 9).

Table 9. 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

Brood Year	Number of redds	Estimated egg deposition	Estimated number	
			Total emigrants	Egg-to-emigrant survival (%)
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	--	--	--	--
2010	--	--	--	--
2011	872	3,823,720	89,917	2.35
2012	1,704	7,195,992	67,973	0.94
2013	1,159	5,512,204	58,595	1.06

For BY 2014, 3,458 summer Chinook Salmon redds were surveyed in the Wenatchee Basin, 95.9% being upstream of the Lower Wenatchee smolt trap. After extrapolating by the proportion of redds above the trap a total emigrant population of 14,763,064 was estimated resulting in an egg-to-emigrant survival of 89.17%. This is up from the last two year average of 80.73% (Table 10).

Table 10. 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	9,685,591	70.93
2000	2,540	13,820,140	0.983	1,299,476	1,322,383	9.57
2001	3,550	18,094,350	0.987	8,229,920	8,340,342	46.09
2002	6,836	37,488,624	0.977	13,167,855	13,475,368	35.95
2003	5,268	28,241,748	0.996	20,336,968	20,426,149	72.33
2004	4,874	26,207,498	0.989	14,764,141	14,935,745	56.99
2005	3,538	17,877,514	0.993	11,612,939	11,695,581	65.42
2006	8,896	45,663,168	0.979	9,397,044	9,595,512	21.01
2007	1,970	10,076,550	0.983	4,470,672	4,546,838	45.12
2008	2,800	14,302,400	0.978	4,309,496	4,405,473	30.8
2009	3,441	18,206,331	0.983	6,695,977	6,814,805	37.43
2010	3,261	16,184,343	0.957	--	--	--
2011	3,078	15,122,214	0.958	--	--	--
2012	2,504	12,021,704	0.93	9,333,214	10,034,508	83.47

Brood year	Peak total redd expansion	Estimated egg deposition	Redds above trap / total redds	Estimated number		
				Trap estimate	Total emigrants	Egg-to-emigrant survival (%)
2013	3,241	16,162,867	0.947	11,936,928	12,605,925	77.99
2014	3,458	16,556,904	0.959	14,157,778	14,763,064	89.17

Non-target Taxa

One westslope cutthroat trout was sampled at the Lower Wenatchee site and no bull trout where sampled. No PIT tags were applied to non-target taxa. Monthly and annual totals of all fish captured are presented in Appendix F and Appendix G, respectively.

Backpack Electrofishing

Fish Sampling

Between 1 October and 17 November 2014, WDFW personnel sampled the Chiwawa River over a 13-day span for a total of 55,895 seconds. During this sampling 1,019 subyearling spring Chinook received a PIT tag. The majority of the sampling (95%) occurred between rkm 35 and 55. The greatest concentration of juvenile Chinook occurred between rkm 50 and 53 which had a mean sample rate of one Chinook collected for every 53 seconds of sampling. Over the sample period 14 Chinook died resulting in a mortality rate of 1.3%. Additionally, 121 juvenile bull trout and 94 steelhead were collected, with 67 bull trout and 23 steelhead receiving PIT tags. Highest catch rates for bull trout were between rkm 42 and 47 while the lowest site sampled (rkm 11) had the highest catch rate of steelhead. There was no mortality associated with bull trout or steelhead.

Detections and Calculations

Between the non-trapping season of 18 November 2014 through 24 February 2015, a total of 16 detections of remotely tagged Chinook were recorded at the lower Chiwawa antenna array. During the trapping season of 17 October and 6 November 2014, and 13 March and 6 June 2015, the Chiwawa rotary smolt trap collected 17 and 47 remotely tagged Chinook, respectively. Due to uneven distribution of effort throughout the Chiwawa River and poor sample size, no emigrant estimate for the non-trapping period was calculated for the BY 2013.

DISCUSSION

Chiwawa River Smolt Trap

Over the last five years the Chiwawa River smolt trap has had an average installation date of 3 March. With the relatively mild spring in 2015, the smolt trap was installed almost a week earlier on 25 February. The 2015 trapping season provided relatively good trapping conditions with two minor stoppages in the spring (due to hatchery releases) and two minor stoppages in the fall (due to high discharge and debris). The Chiwawa River smolt trap is considered operable between discharges of 90 and 1,500 cfs, and the only significant stoppages occurred between mid-September and mid-October when flow periodically dropped below 90 cfs.

A significant discharge efficiency model was produced for subyearling Chinook and a pooled estimate was used for yearling Chinook. Historically, emigrant estimates were calculated using the Peterson estimator of abundance (Seber 1982), however more accurate estimates currently utilize a modified Bailey estimator (Murdoch et al. 2012).

The total production estimate for brood year 2013 was 119,615 and comprises estimates of subyearling emigrants in 2014 and yearling emigrants in 2015. Unfortunately, high flows and the inability to electrofish the Chiwawa River due to spawning bull trout concerns resulted in an abbreviated sampling window and prevented the completion of 2014 remote tagging efforts. This resulted in no estimate being calculated for the 2014 non-trapping season and a known underestimate of the total brood year production. Protocols and field sampling will be continually adapted to fit within environmental and permit constraints and estimates will be improved upon when possible.

Abnormally low discharge levels also limited the number of mark/recapture trials that could be done at the Chiwawa River smolt trap and reliance on historical data was necessary. Further complicating estimates, emigrating yearling and subyearling Chinook were collected when the trap was operating at both the upper and lower cone positions. However, insufficient numbers were present to produce a trap efficiency model for both life stages at each cone positions. In an effort to expand operational condition and reduce the dependence on historic data, 2016 trap operations will eliminate the lower cone position and a single upper cone positon will be used.

Lower Wenatchee River 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, 2015 proved to be a difficult trapping season for the Lower Wenatchee trap. Up until late June the Lower Wenatchee trap only had three minor stoppages due to hatchery fish releases and debris. However, the Lower Wenatchee trap is considered operable between discharges of 1,300 and 10,000 cfs and summer proved to be a substantial departure from normal discharge and river temperature. From late June through July water temperatures at our Lower Wenatchee trapping site fluctuated between 18 and 26 degrees Celsius and discharge was about 25% of normal. The culmination of these factors resulted in trapping operations terminating at its earliest known date of 28 June.

The early removal of the lower Wenatchee trap proved to be the most difficult part of the 2015 trapping season. To account for the early removal of the trap, historical run timing was used to extrapolate what the catch would have been had the trap been able to operate as normal. Historical emigration timing showed no sockeye, and only a small percentage of spring and summer Chinook emigrated after 28 June (0.4% and 3.5%, respectively). Emigration estimates used these percentages to extrapolate to a total estimate of emigrants had the trap been able to operate further into the season.

Discharge efficiency models were obtained for three of the four target species at the lower Wenatchee trap during the 2015 trapping season (wild spring and summer Chinook Salmon and sockeye Salmon). Collections of wild steelhead continue to be inadequate for conducting a mark/recapture trial. In 2016, hatchery steelhead from the Chiwawa acclimation site will be used in mark/recapture trials in an effort to improve emigrant estimates of this target species. This approach requires the assumption that hatchery fish behave in a similar manner to wild fish, an assumption we will test over time as possible. While the new trap location has allowed for greater operational flexibility, it does require the development of new flow-efficiency models. While this can be accomplished relatively quickly with species that are relatively abundant (e.g., summer Chinook and sockeye), it may take several years for those in low abundance (e.g., steelhead). Fortunately, given similar operation parameters across time, we will be able to reexamine past abundance estimates when those models are fully developed.

Backpack Electrofishing

Remote sampling in the Chiwawa Basin started in 2012. Some success occurred early on with PIT tag targets being met, however, there have been substantial obstacles since 2013. Permit restrictions limit field operations until bull trout spawning has concluded; which typically occurs early October. At this time, weather becomes increasingly unfavorable and elevated discharge and cold air and water temperatures hinder sampling efforts. In 2014, early high water events halted sampling efforts and limited not only the area that was sampled, but also the number of fish that were processed. Future investigations will look into alternative sampling techniques and the allocation of personnel to maximize sampling efforts in the basin.

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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 [illegible]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.

$$\text{Estimated daily emigration} = \left(\hat{N}_i = \frac{C_i + 1}{\hat{e}_i} \right) \Big/ t_i$$

$$\text{Where } t_i \text{ is equal to the tag rate} = t_i = \frac{t}{p}$$

Appendix D. Monthly collection information for the Chiwawa River smolt trap.

	2015											
Species/Origin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Chinook												
Wild yearling	--	55	1,839	3,072	1,277	94	13	0	0	0	0	6,350
Wild subyearling	--	83	3,516	7,639	352	5,509	3,058	1,423	641	5,340	3,591	31,152
Hatchery yearling	--	0	0	7,141	1	2	4	8	6	0	0	7,162
Steelhead												
Wild												
Smolt	--	0	9	59	163	8	6	12	2	0	0	259
Parr and fry	--	2	45	200	416	447	283	453	168	538	452	3,004
Hatchery	--	0	1	630	2,433	63	4	12	3	4	1	3,151
Coho												
Wild												
Smolt	--	0	0	0	0	0	0	0	0	0	0	0
Parr and fry	--	0	1	2	8	22	3	2	0	0	0	38
Hatchery	--	0	0	0	0	0	0	0	0	0	0	0
Bull trout												
Juvenile	--	0	9	1	4	7	18	13	14	147	53	266
Adult	--	0	0	0	0	0	2	5	10	14	1	32
Westslope cutthroat	--	0	3	0	6	8	22	24	8	0	1	72
Eastern brook trout	--	0	0	1	4	1	0	0	0	1	1	8
Rainbow trout	--	0	0	0	0	1	1	0	0	0	0	2
Mountain whitefish	--	0	3	17	6	44	2,407	2,619	355	42	51	5,544
Longnose dace	--	1	21	33	636	661	197	369	255	415	75	2,663
Northern pikeminnow	--	0	0	0	1	16	157	150	7	0	0	331
Sculpin spp.	--	0	8	0	13	40	48	23	13	58	22	225
Sucker spp.	--	0	0	0	0	0	11	16	1	2	0	30
Redside shiner	--	0	0	0	0	0	1	11	0	1	0	13

Appendix E. Annual collection information from the Chiwawa River smolt trap.

Species origin	2015	2014	2013	2012	2011	2010
Chinook						
Wild yearling	6,350	5,419	3,199	7,626	4,848	6,482
Wild subyearling	31,152	23,755	27,621	14,831	20,561	13,344
Hatchery yearling	7,162	5,293	15,909	30,751	25,620	22,481
Steelhead						
Wild	3,263	1,938	2,034	1,921	1,176	1,226
Smolt	259	49	85	183	195	210
Parr and Fry	3,004	1,889	1,949	1,738	981	1,016
Hatchery	3,151	290	1,539	1,664	8,250	9,921
Coho						
Wild yearling	0	0	1	1	3	4
Wild subyearling	38	12	0	0	4	5
Hatchery yearling	0	1	10	3	0	3
Bull trout						
Juvenile	266	260	310	488	351	499
Adult	32	75	51	31	7	45
Westslope cutthroat trout	72	59	86	60	38	54
Eastern brook trout	8	12	13	66	3	0
Mountain whitefish	5,544	2,970	2,108	3,291	990	778
Longnose dace	2,663	2,633	2,257	1,762	1,526	1,393
Northern pikeminnow	331	5	71	34	20	5
Sculpin spp.	225	131	91	157	129	51
Sucker spp.	30	4	6	0	0	0
Redside shiner	13	0	0	0	0	0
Yellow perch	0	0	0	0	0	0

Appendix F. Monthly collection information for the Lower Wenatchee River smolt trap.

	2015											
Species/Origin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Chinook												
Wild yearling	9	154	405	751	220	20	--	--	--	--	--	1,559
Wild subyearling	5	418	8,418	154,499	69,035	19,918	--	--	--	--	--	252,293
Hatchery yearling	0	15	0	8,973	931	1	--	--	--	--	--	9,920
Steelhead												
Wild												
Smolt	0	3	4	33	186	5	--	--	--	--	--	231
Parr and fry	1	18	16	15	19	31	--	--	--	--	--	100
Hatchery	0	0	7	247	1,991	43	--	--	--	--	--	2,288
Sockeye												
Wild	0	0	35	3,997	146	0	--	--	--	--	--	4,178
Coho												
Wild												
Smolt	1	6	10	5	0	0	--	--	--	--	--	22
Fry and parr	2	280	313	968	2,153	1,256	--	--	--	--	--	4,972
Hatchery	0	0	76	4,653	1,794	43	--	--	--	--	--	6,566
Unknown	0	0	0	16	121	6	--	--	--	--	--	143
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	1	0	--	--	--	--	--	1
Mountain whitefish	0	0	0	1	3	5	--	--	--	--	--	9
Lamprey spp.	1	77	64	12	13	116	--	--	--	--	--	283
Longnose dace	1	29	6	5	49	152	--	--	--	--	--	242
Sculpin spp.	0	16	7	5	8	16	--	--	--	--	--	52
Sucker spp.	1	11	2	2	24	11	--	--	--	--	--	51
Redside shiner	0	0	0	4	2	13	--	--	--	--	--	19
Stickleback (3-spined)	0	0	0	0	2	11	--	--	--	--	--	13
Northern pikeminnow	0	2	0	2	5	3	--	--	--	--	--	12
Chiselmouth	0	0	0	0	0	6	--	--	--	--	--	6
Peamouth	0	0	0	0	0	3	--	--	--	--	--	3

Appendix G. Annual collection information from the Lower Wenatchee River smolt trap.

Species/Origin	2015	2014	2013
Chinook			
Wild yearling	1,559	1,700	1,854
Wild subyearling	252,293	81,445	52,652
Hatchery yearling	9,920	31,290	13,979
Steelhead			
Wild	331	182	710
Smolt	231	80	173
Parr	100	102	537
Hatchery	2,288	494	819
Sockeye			
Wild	4,178	7,678	4,520
Hatchery	0	0	72
Coho			
Wild yearling	22	220	597
Wild subyearling	4,972	393	923
Hatchery yearling	6,566	16,908	12,960
Unknown yearling	143	NA	NA
Bull trout			
Juvenile	0	3	6
Adult	0	0	0
Westslope cutthroat trout	1	3	0
Mountain whitefish	9	27	110
Lamprey spp.	283	292	762
Longnose dace	242	541	1,382
Sculpin spp.	52	128	242
Sucker spp.	51	134	240
Redside shiner	19	94	423
Stickleback (3-spined)	13	66	196
Northern pikeminnow	12	37	39
Chiselmouth	6	69	10
Peamouth	3	9	10

Appendix C

Summary of PIT-Tagging Activities in the Wenatchee Basin, 2015

Appendix C. Numbers of fish captured, PIT tagged, lost, and released in the Wenatchee River basin during February through November, 2015.

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	31,152	169	10,471	414	0	10,471	1.33
	Wild Yearling Chinook	6,350	218	6,204	44	0	6,204	0.69
	Wild Steelhead/Rainbow	3,262	6	1,795	23	0	1,795	0.71
	Hatchery Steelhead/Rainbow	3,152	2	1	0	0	1	0
	Wild Coho	38	0	0	0	0	0	0
	Total	**43,954**	**395**	**18,471**	**481**	**0**	**18,471**	**1.09**
Chiwawa Remote (Electrofishing)	Wild Subyearling Chinook	1,103	0	1,054	20	0	1,054	1.81
	Wild Yearling Chinook	0	0	0	0	0	0	0
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0
	Wild Coho	0	0	0	0	0	0	0
	Total	**1,103**	**0**	**1,054**	**20**	**0**	**1,054**	**1.81**
Nason Creek Trap	Wild Subyearling Chinook	548	0	219	9	0	219	1.64
	Wild Yearling Chinook	152	0	142	5	0	142	3.29
	Wild Steelhead/Rainbow	444	1	383	2	1	383	0.45
	Hatchery Steelhead/Rainbow	448	0	0	1	0	0	0.22
	Wild Coho	0	0	0	0	0	0	0
	Total	**1,592**	**1**	**744**	**17**	**1**	**744**	**1.07**
Nason Creek Remote (Electrofishing)	Wild Subyearling Chinook	1,143	10	1,089	46	0	1,089	4.02
	Wild Yearling Chinook	0	0	0	0	0	0	0
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0
	Wild Coho	152	2	120	0	0	2	0
	Total	**1,295**	**12**	**1,209**	**46**	**0**	**1,091**	**3.55**
White River Trap	Wild Subyearling Chinook	162	1	150	0	1	149	0
	Wild Yearling Chinook	34	0	34	0	0	34	0
	Wild Steelhead/Rainbow	6	0	6	0	0	6	0
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0
	Wild Coho	0	0	0	0	0	0	0
	Total	**202**	**1**	**190**	**0**	**1**	**189**	**0.00**
Lower Wenatchee Trap	Wild Subyearling Chinook	252,293	83	0	282	0	0	0.11
	Wild Yearling Chinook	1,559	1	1,301	17	0	1,301	1.09
	Wild Steelhead/Rainbow	311	0	290	2	0	290	0.64
	Hatchery Steelhead/Rainbow	2,288	0	1	0	0	1	0
	Wild Coho	4,994	1	1	20	0	1	0.4
	Wild Sockeye	4,178	3	3,922	64	0	3	1.53
	Total	**265,623**	**88**	**5,515**	**385**	**0**	**1,596**	**0.14**

Sampling Location	Species and Life Stage	Number collected	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
Total:	Wild Subyearling Chinook	286,401	263	12,983	771	1	12,982	0.27
	Wild Yearling Chinook	8,095	219	7,681	66	0	7,681	0.82
	Wild Steelhead/Rainbow	4,023	7	2,474	27	1	2,474	0.67
	Hatchery Steelhead/Rainbow	5,888	2	2	1	0	2	0.02
	Wild Coho	5,184	3	121	20	0	3	0.39
	Wild Sockeye	4,178	3	3,922	64	0	3,922	1.53
Grand Total:		313,769	497	27,183	949	2	27,064	0.30

Appendix D

Wenatchee Steelhead Spawning Escapement Estimates, 2015

Wenatchee Steelhead Spawning Escapement Estimates in 2015

Kevin See

March 15, 2016

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 09, 2015 - May 28, 2015) and non-index reaches are surveyed once during the peak spawning period. The goal of this work is to:

- Predict observer net error, based on a model developed with data from steelhead redd surveys in the Methow, similar to that described in Murdoch et al. (2014).
- 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 a model averaging of the two best models that were fit to 43 data points in the Methow. Both models contained covariates of observed redd density (redds / m) and mean thalweg CV as a proxy for channel complexity. One model also contained discharge while the other also contained total redd survey experience as an additional covariate. Predictions were made using model averaged coefficients (based on AICc model weights) and the 2015 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 using the 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, two modifications 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 led to many redds not disappearing before the end of the survey season, the estimates of redd life are biased low for this year. 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 became the mean and standard deviation of the survey interval. 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 5, any violation of this assumption should not affect the overall estimates very much. Based on the peak spawning time for the associated index reaches, the surveys in the non-index reaches were conducted either at peak spawning, or within 10 days after peak spawning (Figure 2}).

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 1.78 above Tumwater dam, and 1.73 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 0.6 above Tumwater dam, and 0.34 below Tumwater (Table 2).

Tributary areas

Estimates of escapement to various tributaries in the Wenatchee were made using a branching patch-occupancy model 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 (W2, 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 reaches 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).

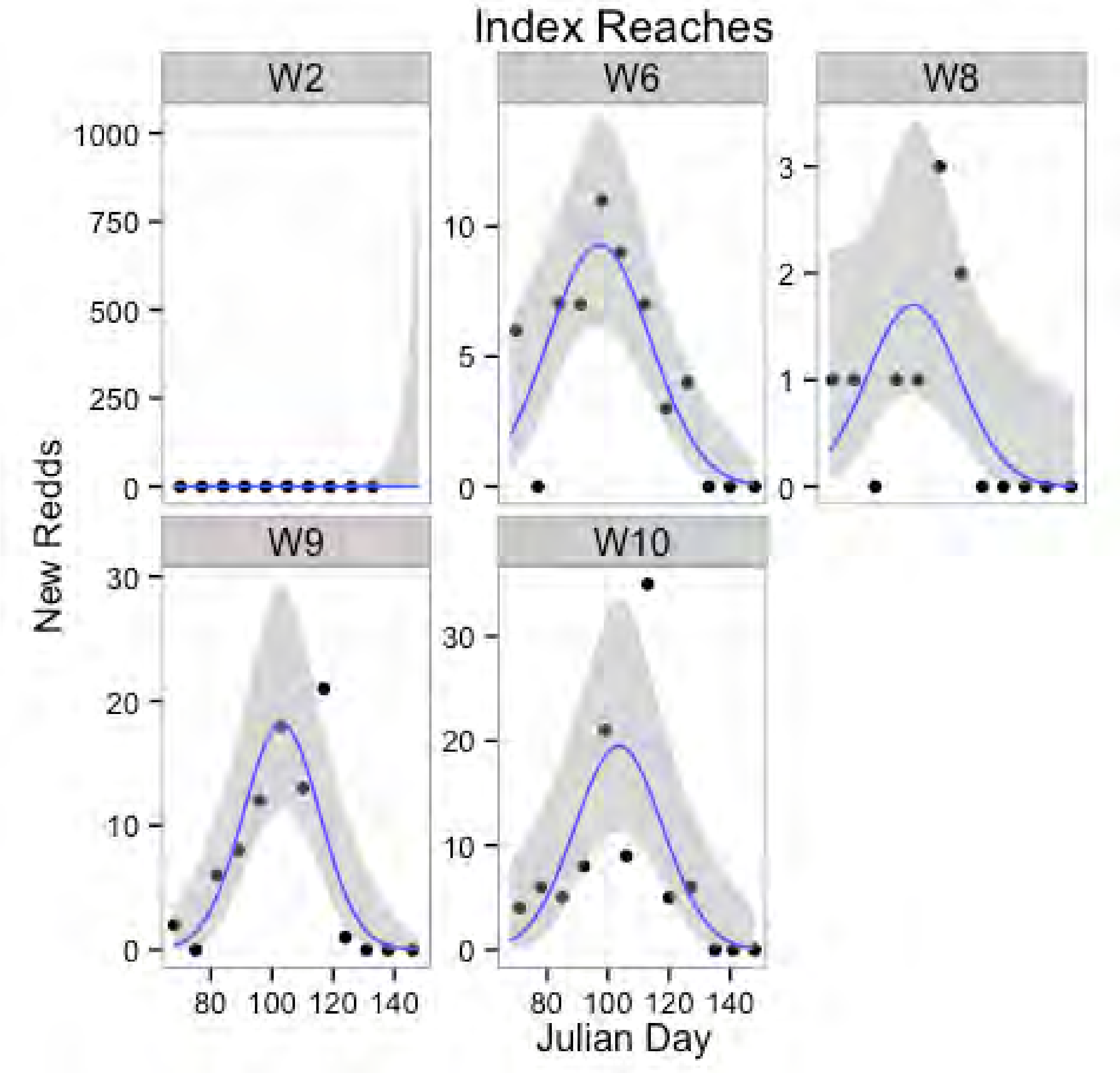
Results

Redd estimates

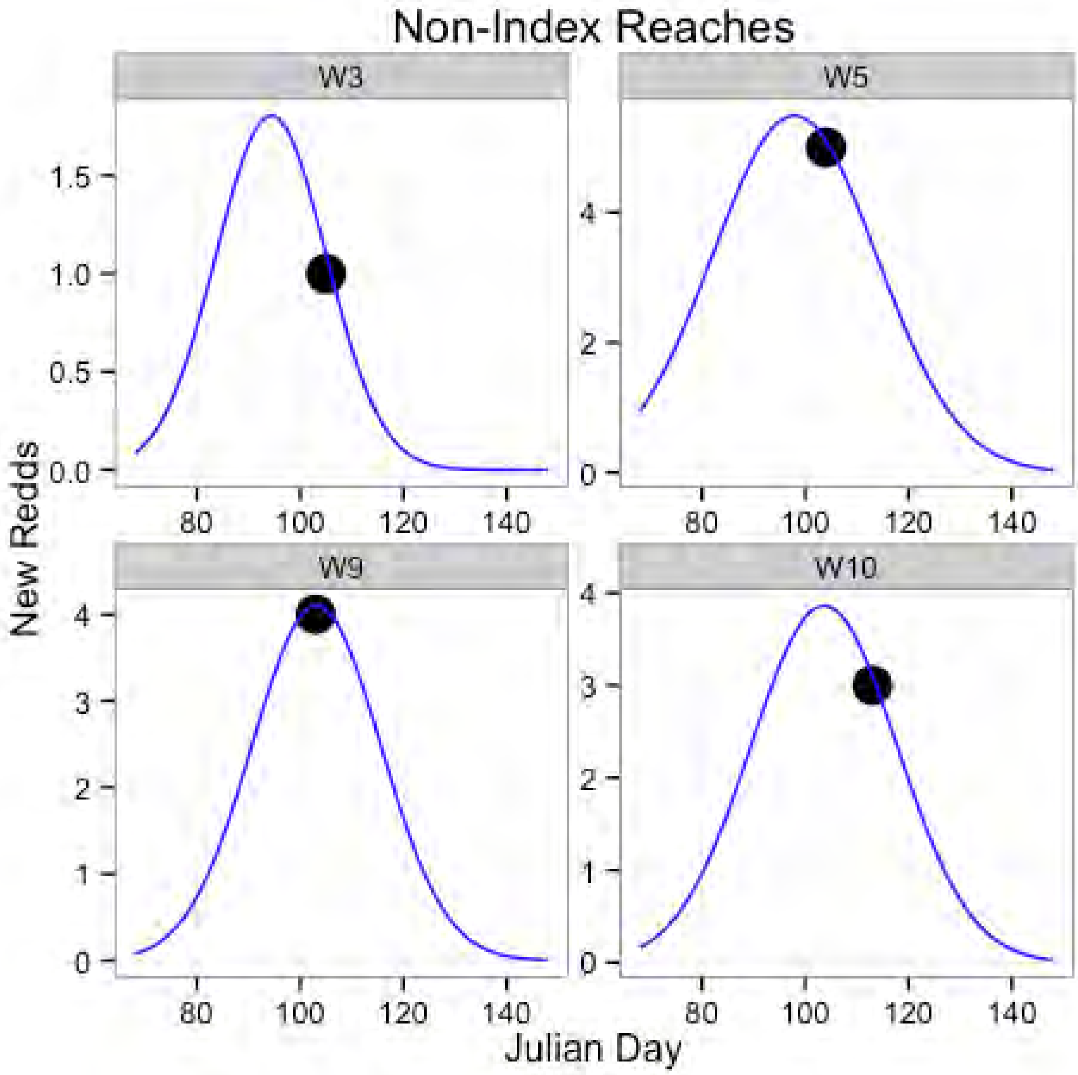
It should be noted that the GAUC parameters from index reaches were not used to estimate total redds in the associated non-index reaches. Figure 4 does illustrate that the non-index reach surveys were conducted close to the period of peak spawning (as determined by the associated index reaches), thus helping to validate the assumptions that go into estimating total redds in non-index reaches.

Table 1: Estimates of mean net error and total redds for each reach.

Reach	Type	Index.Reach	Net.Error	Net.Error.CV	Redds.Counted	Redds.Est	Redds.CV
W1	Non-Index	W2	0.55	0.24	0	0	NA
W2	Index	-	0.59	1.40	2	3	1.50
W3	Non-Index	W2	0.44	0.30	1	2	0.30
W4	Non-Index	W6	0.46	0.23	0	0	NA
W5	Non-Index	W6	0.50	0.22	5	10	0.22
W6	Index	-	0.99	0.85	54	53	0.88
W6	Non-Index	W6	0.46	0.15	0	0	NA
W8	Index	-	0.92	0.90	9	10	0.95
W9	Index	-	0.79	0.89	81	102	0.91
W9	Non-Index	W9	0.63	0.15	4	6	0.15
W10	Index	-	0.83	0.61	99	120	0.65
W10	Non-Index	W10	0.59	0.13	3	5	0.13
Total		NA	NA	NA	258	311	0.63



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).



Observed redd counts for non-index reaches with non-zero peak redd counts. The blue curve shows the GAUC estimated spawning curve, demonstrating how close to peak spawning the non-index surveys were conducted.

Spawner estimates

Table 2: Fish per redd and hatchery / natural origin proportion estimates.

Area	Fish / redd	FpR Std. Error	Prop. Hatchery	Prop Std. Error
Above TUF	1.777	0.059	0.599	0.026
Below TUF	1.728	0.089	0.343	0.040

Table 3: Estimates (CV) of spawners by area and origin.

Area	Type	Hatchery	Natural
W1	Non-Index	0 (--)	0 (--)
W2	Index	2 (1.51)	4 (1.51)
W3	Non-Index	1 (0.32)	3 (0.31)
W4	Non-Index	0 (--)	0 (--)
W5	Non-Index	6 (0.25)	11 (0.23)
W6	Index	32 (0.89)	60 (0.88)
W6	Non-Index	0 (--)	0 (--)
W8	Index	10 (0.95)	7 (0.95)
W9	Index	108 (0.92)	73 (0.92)
W9	Non-Index	7 (0.16)	5 (0.16)
W10	Index	127 (0.65)	85 (0.66)
W10	Non-Index	5 (0.14)	4 (0.15)
Icicle	Trib	52 (0.32)	83 (0.25)
Peshastin	Trib	40 (0.37)	206 (0.16)
Mission	Trib	23 (0.49)	71 (0.28)
Chumstick	Trib	0 (--)	38 (0.39)
Chiwaukum	Trib	12 (0.72)	48 (0.34)
Chiwawa	Trib	168 (0.23)	168 (0.21)
Nason	Trib	68 (0.29)	237 (0.15)
Little Wenatchee	Trib	0 (--)	0 (--)
White River	Trib	0 (--)	0 (--)
Total		661 (0.45)	1103 (0.3)

Discussion

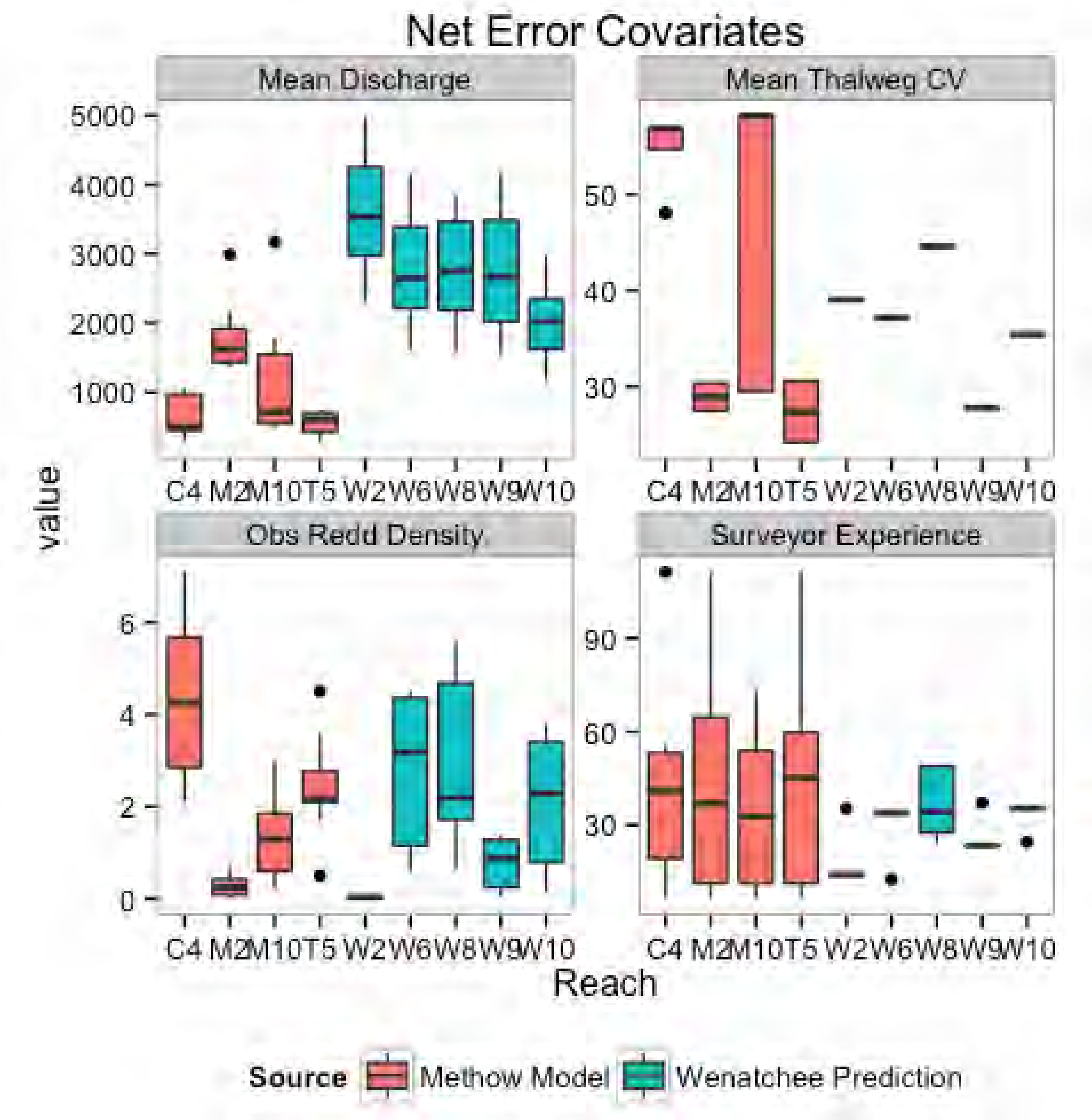
We have estimated the number of steelhead redds based on redd surveys, while incorporating potential observation error. After translating these to estimates of spawners by origin, we can then compare the spawner estimates to escapement estimates made using PIT tags, and estimate a pre-spawn mortality rate (Table 4). Taking the total PIT-tag based escapement estimate to the Wenatchee (after subtracting the number of hatchery fish removed at Tumwater), 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 did this for natural and hatchery origin fish, and found that hatchery fish had a higher pre-spawn mortality rate, although the difference is not statistically significant.

Table 4: Wenatchee pre-spawn mortality rates.

Origin	Pre-spawn_Mort	CV
Hatchery	0.25	0.0016
Natural	0.16	0.0013

Caveats

The predictions of surveyor net error were made using a model that had been fit to data in the Methow. Most covariates in the Wenatchee were within the range of values in the Methow study, but mean discharge was higher in all reaches in the Wenatchee than in the modeled reaches in the Methow (Figure 3). The mean discharge in the Methow study was 1069.2, while it was 2680 in the Wenatchee reaches in 2015. That difference alone would change net error predictions by 0.29, not an insignificant amount. However, the observed covariate values in the Wenatchee did not lead to unrealistic estimates of net error. The ranges of net error estimates for the Methow study and the Wenatchee in 2015 were very similar.



Net error covariate values from the study in the Methow and the predicted reaches in the Wenatchee.

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Appendix E

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

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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.

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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.

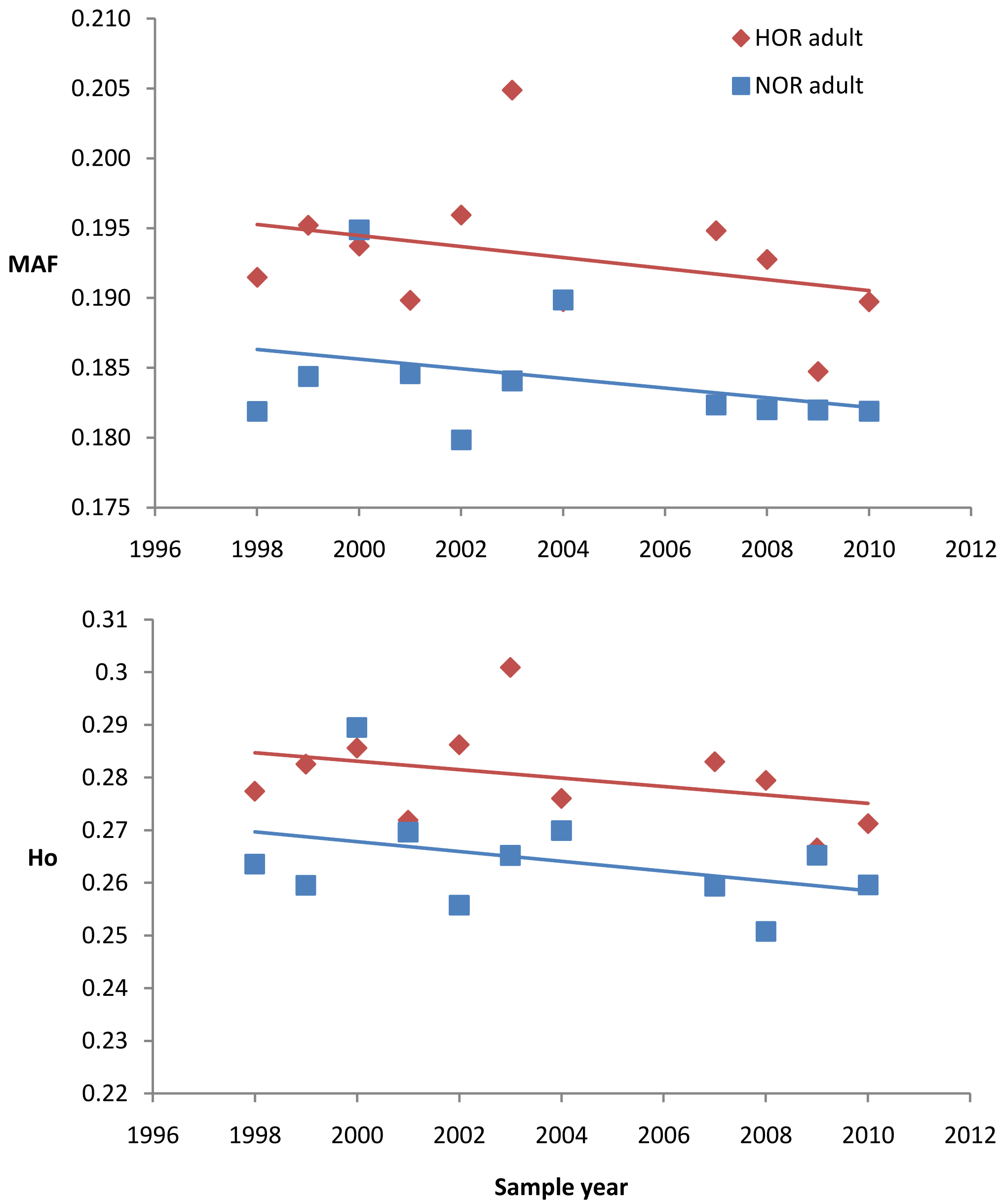


Figure 2. Observed average minor allele frequencies (MAF) and observed heterozygosities (Ho) of 119 SNP loci from 15 collections of natural origin juvenile steelhead from Wenatchee River tributaries, the lower Wenatchee River and the Entiat River. There were no consistent temporal trends in MAF or Ho in these collections.

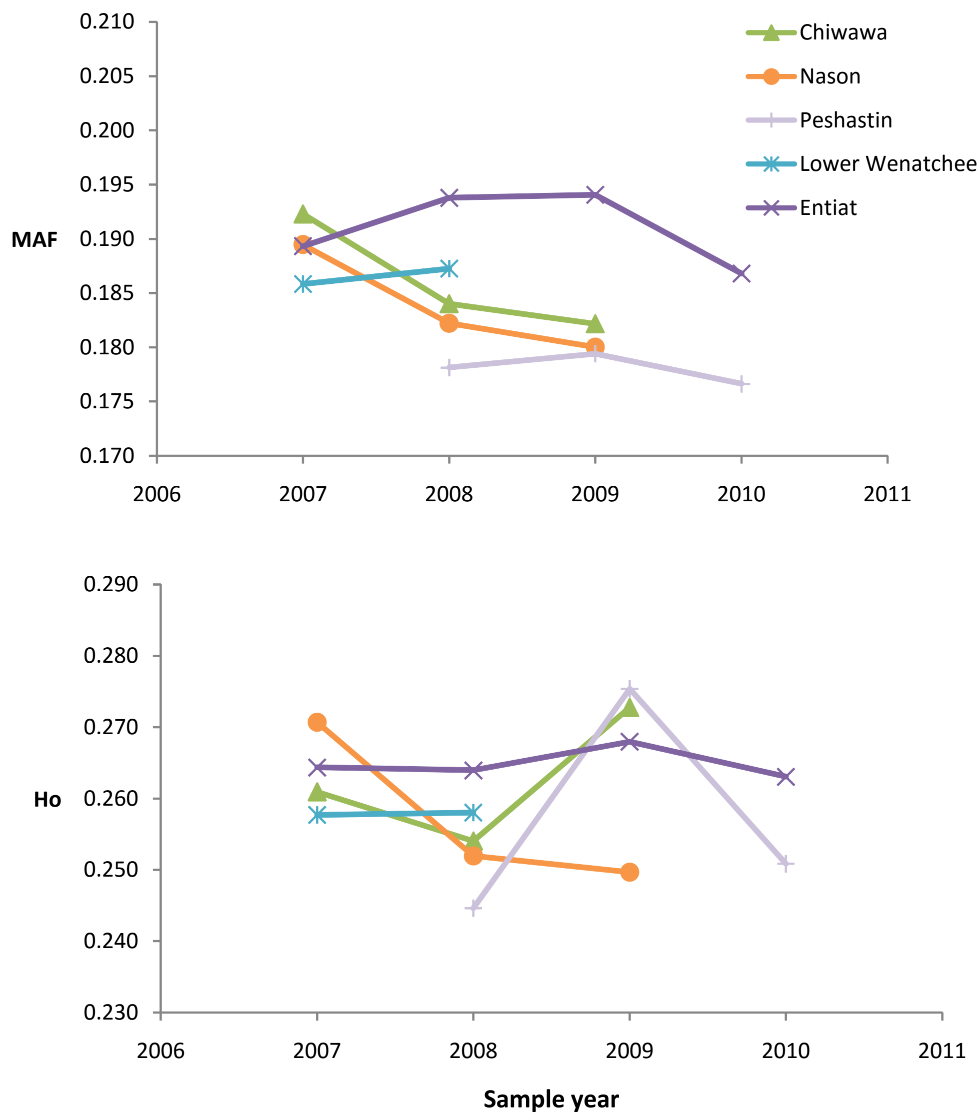


Figure 3. The relationship of time with pairwise F_{ST} estimates between hatchery-produced (adipose fin clipped) and natural origin (unclipped) adults of the same sample year. The line is the prediction based on beta regression.

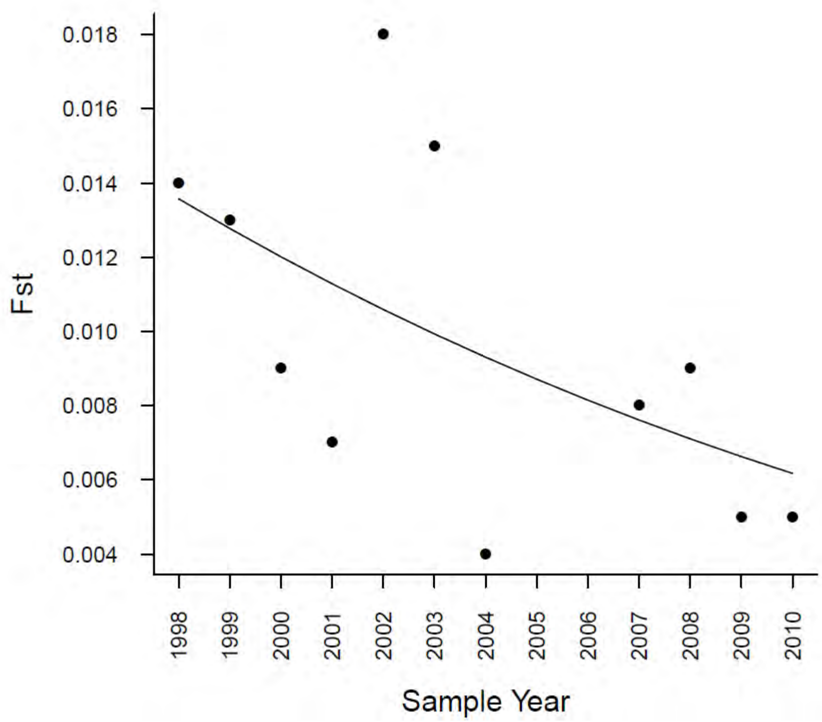


Figure 4. Principal component (PC) 1 versus 2 (top left), PC 1 versus 3 (bottom left), and PC 2 versus 3 (bottom right) based on an analysis using all adults aggregated into origin and spawn-year collections. Natural-origin spawn-years are shown in italicized typeface. The percentage within the label 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 $R^2 = 0.45$.

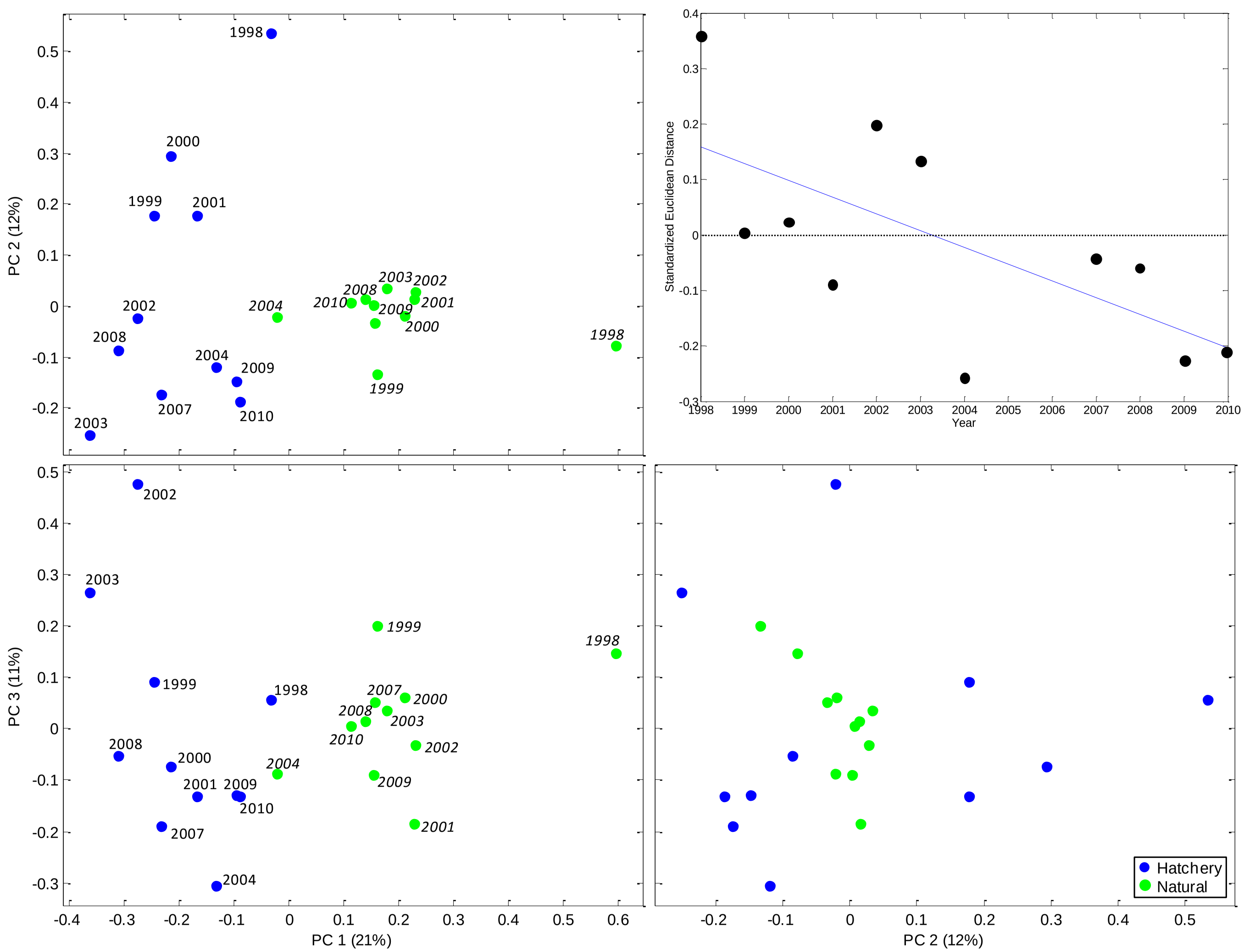


Figure 5. Principal components (PC) 1 versus 2 (top) and 3 (bottom) for adults aggregated into brood-year (BY; left) and spawn-year (SY; right). Spawn-year analysis is the same as in Figure x1, except fewer individuals per collection were included (see methods). Note that for the SY analysis here PC 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.

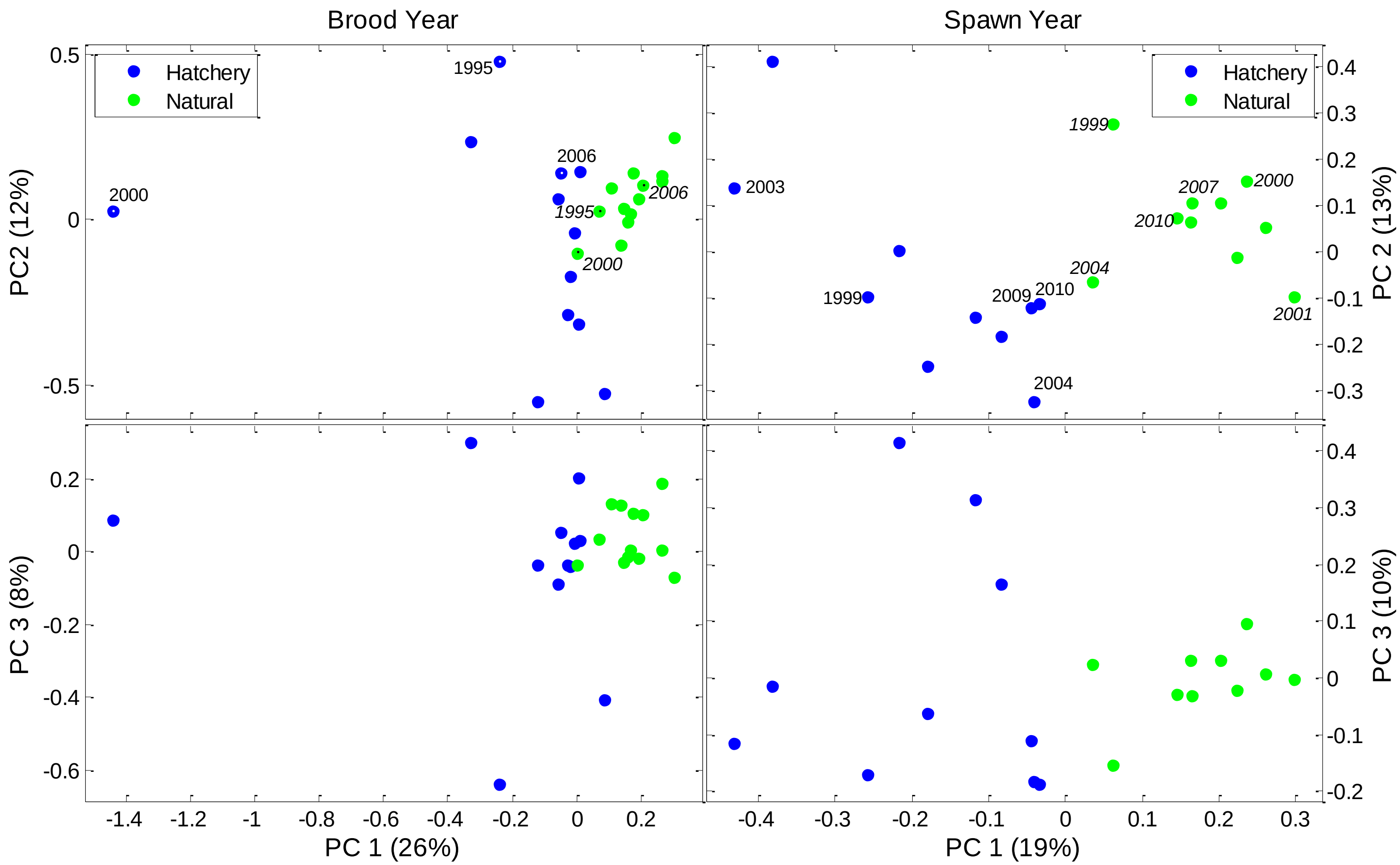


Figure 6. Principal component (PC) 1 versus 2 (top) and PC 1 versus 3 (bottom) based on an analysis using all adult and juvenile fish aggregated into age (juvenile versus adult), origin (hatchery versus adult) and spawn-year collections.

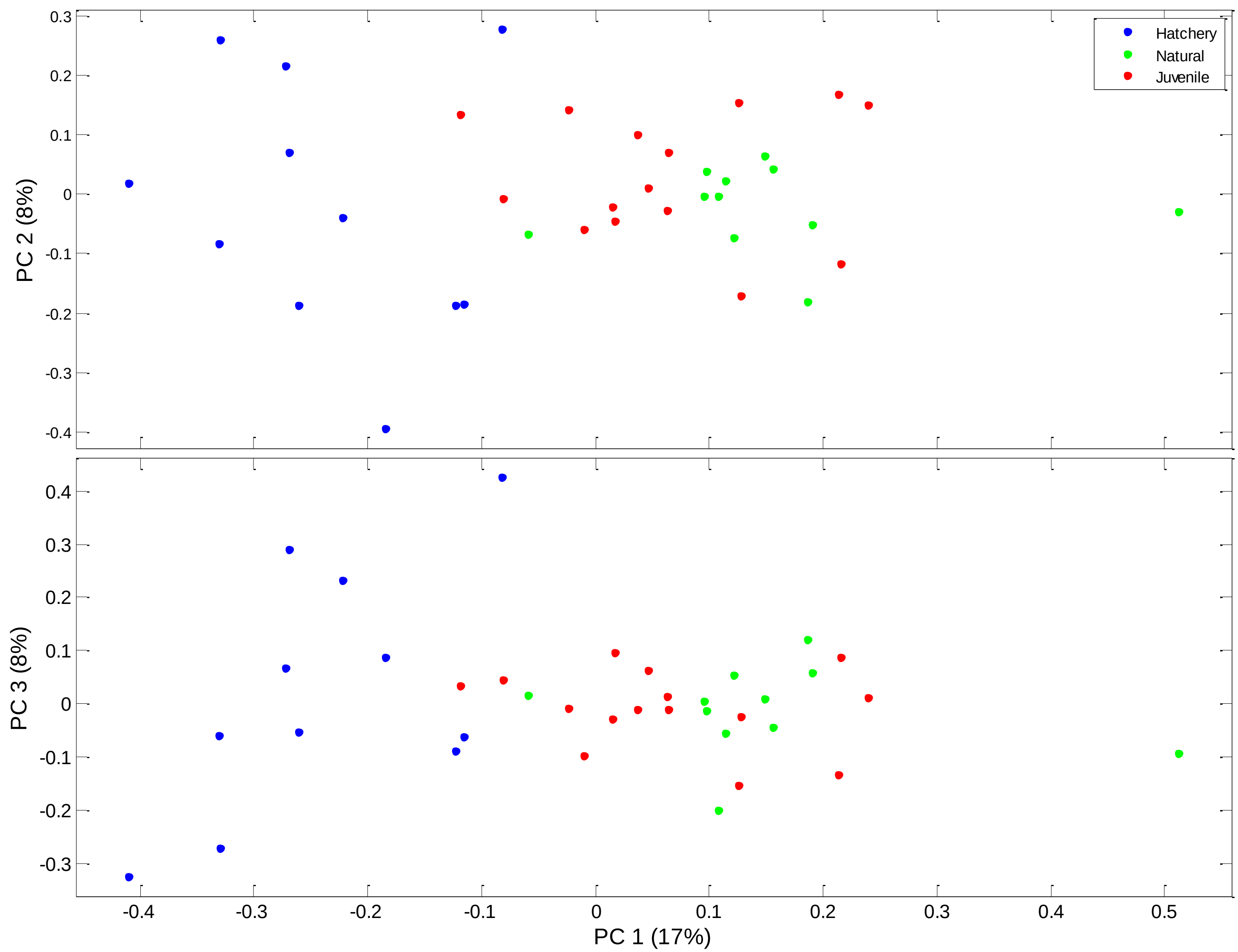


Figure 7. Pairwise Euclidian distances versus brood-year (top) and spawn-year (bottom), with zero distance equal to average distance across all pairwise distances. Blue lines are least-squares fits, which is not significant (slope = 0) for brood-year, but significant (slope > 0) for spawn-year.

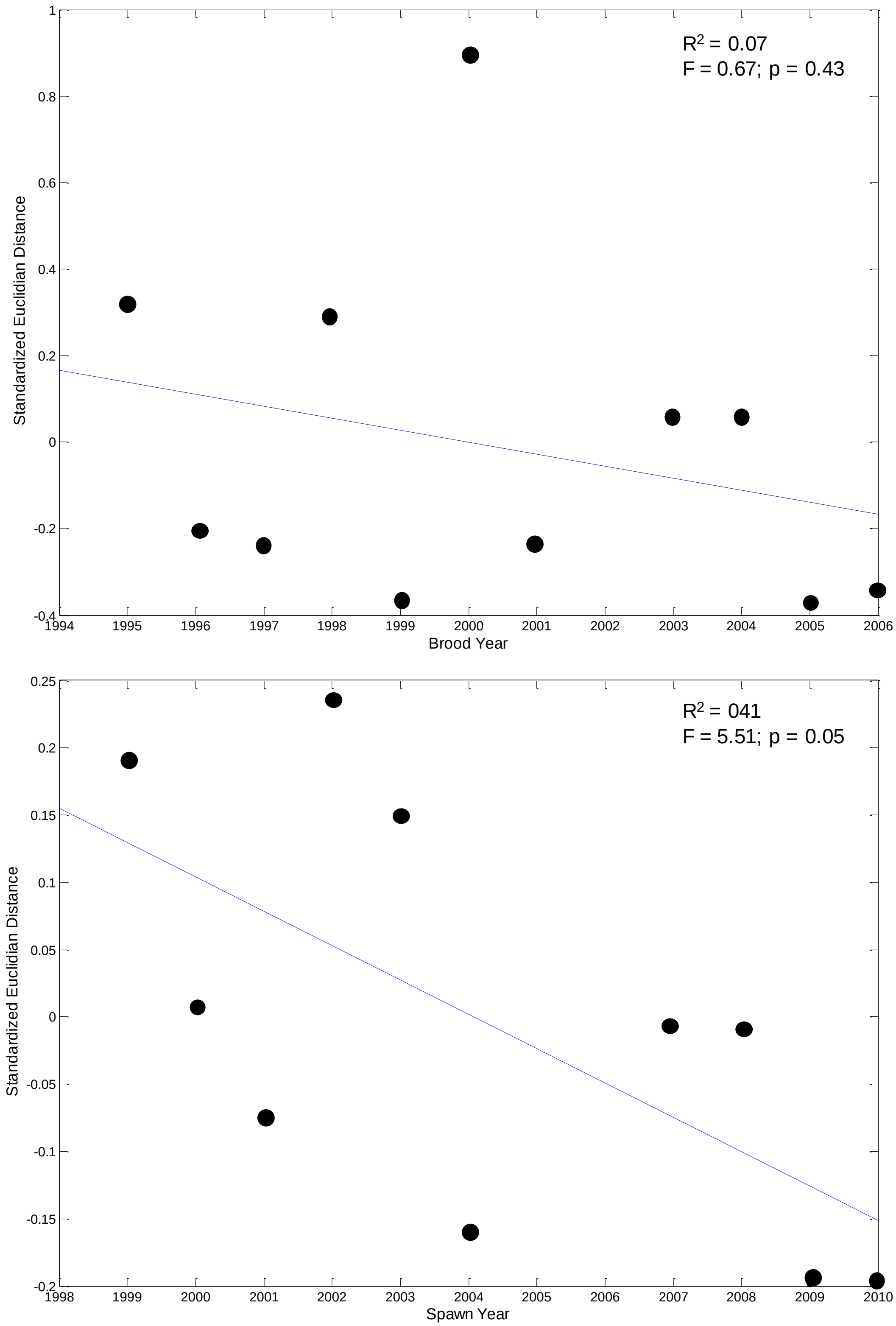


Figure 8. Effective population size estimates (N_b) from Wenatchee River adult hatchery-produced steelhead annual collections calculated using single sample methods implemented in the program LDNE (Waples and Do 2008). Each line connects annual estimates of N_b estimated with a different value of P_{crit}, 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.

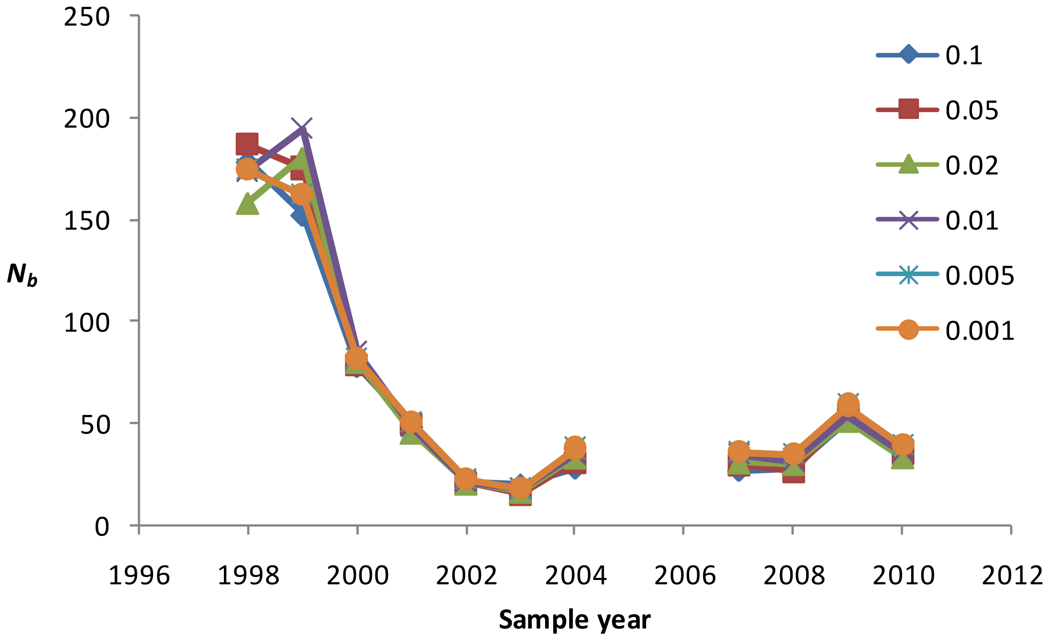


Figure 9. Estimates of Wenatchee River steelhead effective number of breeders (N_b) estimated using the single sample methods incorporated in the program LDNE (Waples and Do 2008). Estimates of N_b refer to parental (and even grantparental) generations. N_b data were plotted against their estimated parental 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).

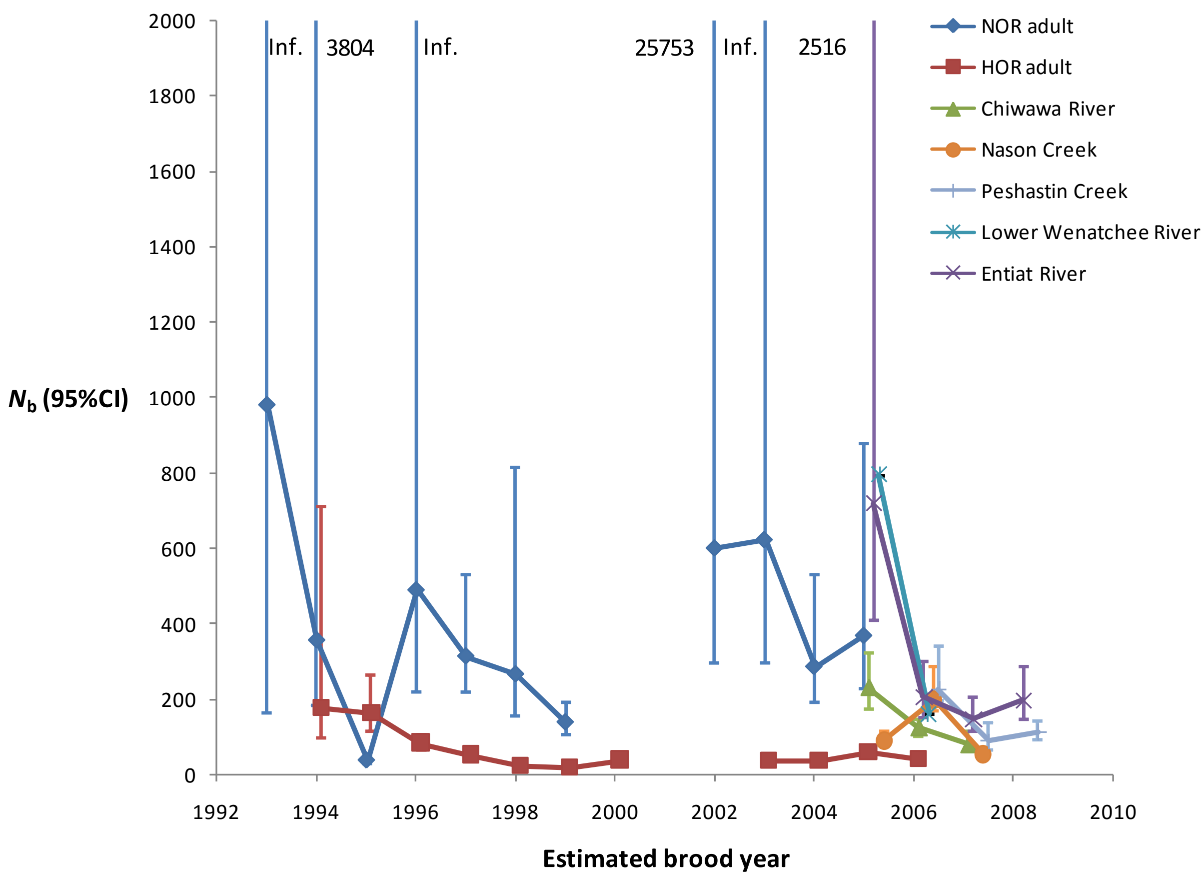


Figure 10. Estimates of N_b for collections of hatchery-produced (HOR) and natural origin (NOR) Wenatchee River summer steelhead grouped by brood year rather than spawn year. Brood year was estimated using scale-based age data. Error bars that extend past the top of the chart are all bounded by infinity.

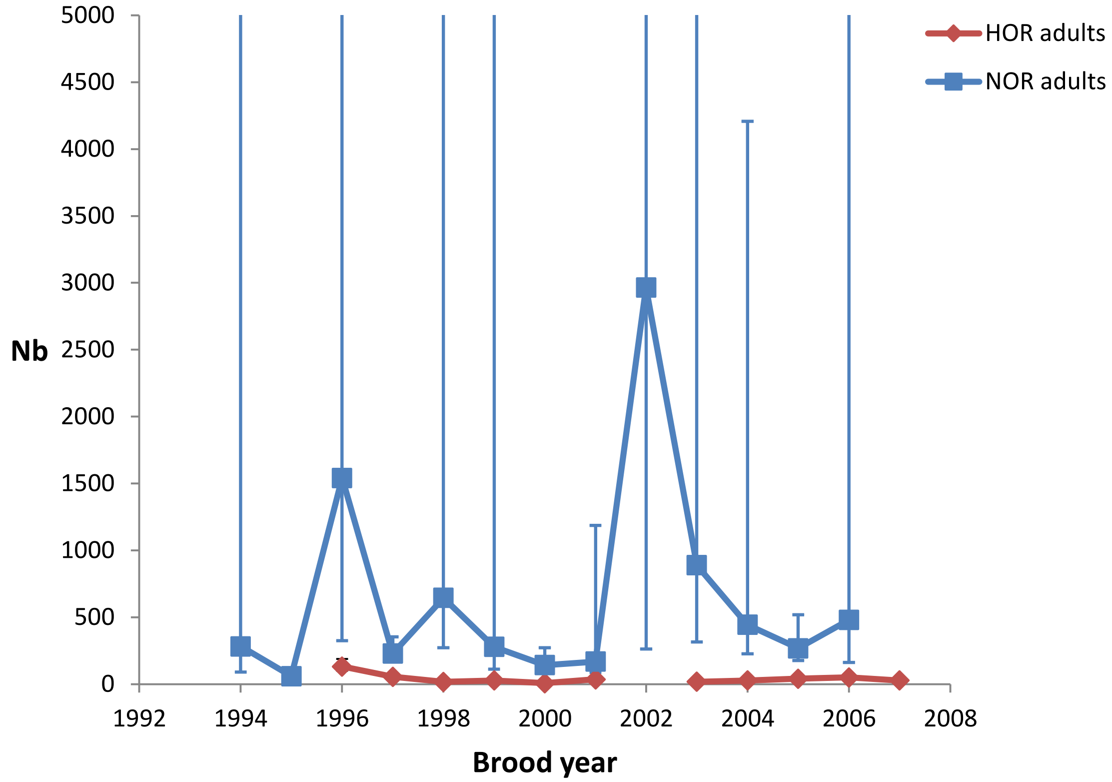


Figure 11. Estimates of N_b for combined annual adult hatchery-produced (HOR) and natural origin (NOR) steelhead and for HOR adults alone. The temporal patterns are similar, though estimates from combined collections are larger than those from HOR collections alone.

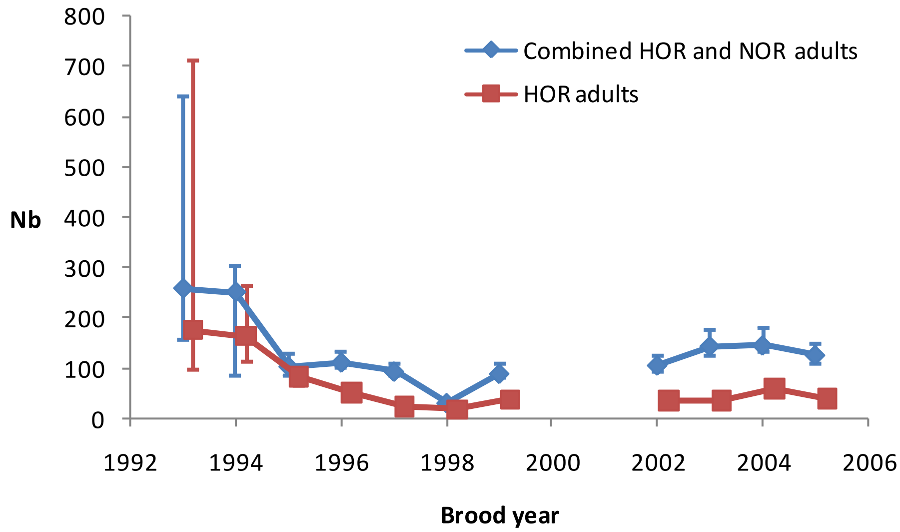


Figure 12. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead grouped by spawn year. The average N_b/N ratios are not different, though in later years NOR adults appear to have lower N_b/N ratios.

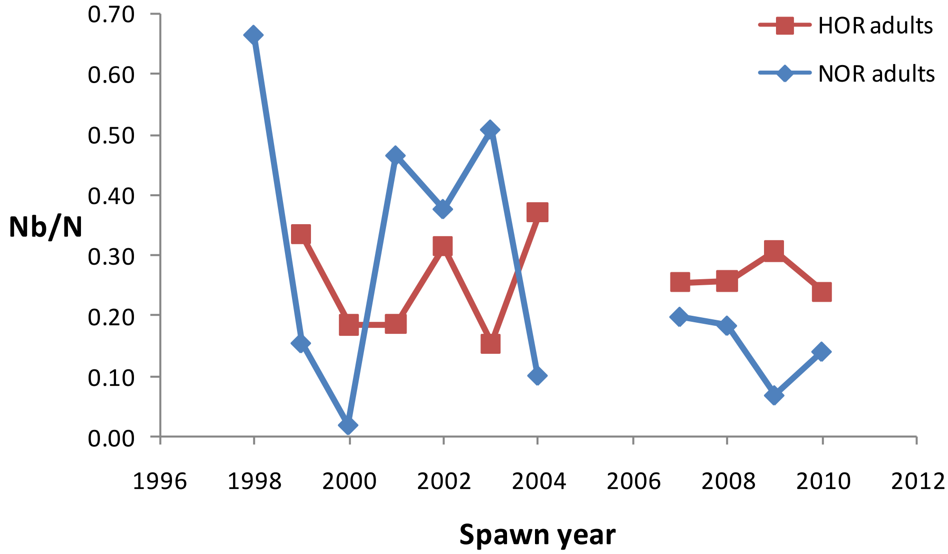
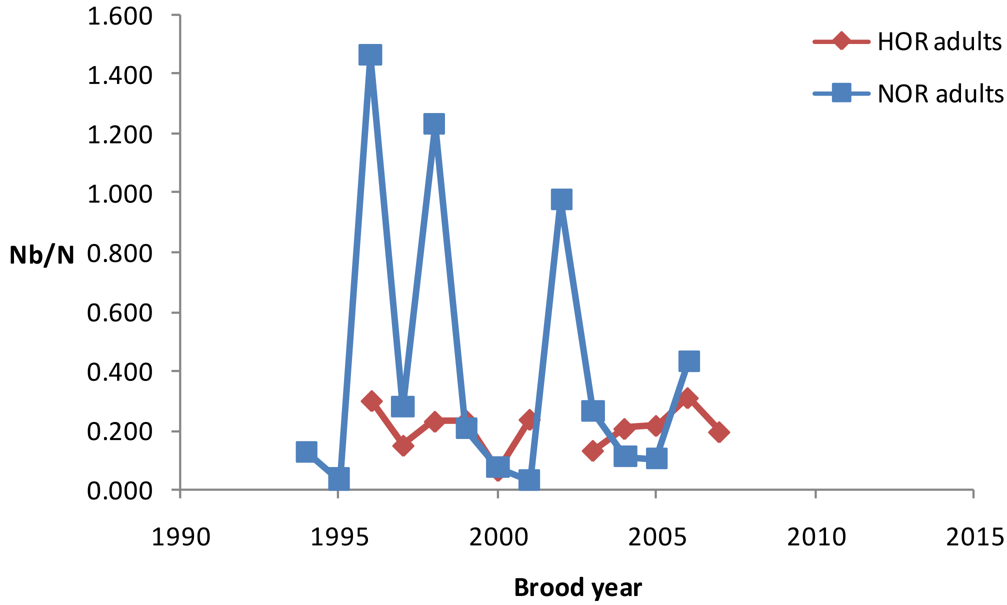


Figure 13. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead collections with individuals grouped in brood years rather than spawn years. Individual brood year was estimated using scale-based age data.



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 F

NPDES Hatchery Effluent Monitoring, 2015

NPDES MONITORING FOR WDFW FACILITIES

The WDFW facilities requiring discharge reports are: Chelan Hatchery, Chelan Falls Hatchery, Eastbank Hatchery, Wells Hatchery, Chiwawa Ponds, Methow Hatchery, Similkameen Hatchery, Dryden Acclimation Pond, and Priest Rapids Hatchery. Carlton Acclimation Pond permit became inactive January 2014. An inactive permit is exempt from sampling and submitting discharge reports because production is below the permit requirements for monitoring discharges. NPDES permits are not required for the Twisp and Chewuch acclimation facilities, because they are below the levels that require a discharge permit.

The Wells Hatchery Pollution Abatement (PA) pond has no effluent data January through December. Priest Rapids Hatchery Pollution Abatement (PA) pond has no effluent data January through March, and September through December. The PA ponds for these facilities had no discharge throughout these months.

There were no violations reported at these NPDES permitted facilities during the period 1 January 2015 through 31 December 2015.

All WDFW hatcheries monitor their discharge in accordance with the National Pollutant Discharge Elimination System (NPDES) permit. This permit is administered in Washington by the Washington Department of Ecology under agreement with the United States Environmental Protection Agency. The current permit was extended until 31 March 2016. The permit was renewed effective 1 April 2016 and will expire 31 March 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 to be 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 the pounds of fish and pounds of feed remain below monitoring guidelines set by the permit.

Sampling at permitted facilities includes 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.
<SS PA	Maximum settleable solids discharge from the pollution abatement pond, measured in ml/L.
<SS %	Removal of settleable solids within the pollution abatement pond from inlet to outlet, measured as a percent. No longer required under permit effective 1 June 2000.
<TSS PA	Maximum total suspended solids effluent grab from the pollution abatement pond discharge, measured in mg/L.

<TSS % Removal of suspended solids within the pollution abatement pond from inlet to outlet, measured as a percent. No longer required under permit effective June 1, 2000.

<SS DD Settleable solids discharged during drawdown for fish release. One sample per pond drawdown, measured in ml/L.

<TRC Total residual chlorine discharge after rearing vessel disinfection and after neutralization with sodium thiosulfate. One sample per disinfection, measured in ug/L.

In addition, at Similkameen Hatchery only, the following sampling was conducted at the request of WA Dept of Ecology, but is not required under NPDES permit:

<SS IW Settleable solids influent grab taken as wastes are pumped into the pollution abatement pond, measured in mg/L. No longer monitored as of January 2008.

<TSS IW Total suspended solids influent grab as wastes are pumped into the pollution abatement pond, measured in mg/L. No longer monitored as of January 2008.

Eastbank Hatchery
NPDES Permit Number WAG13-5011

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	lbs of Fish	lbs of Feed
2015	JAN	28.43	0	0.4	0.4	7000	0.01		26.6		25412	6743
	FEB	28.43	0	0.4	0.4	8500	0.01		24.8		33757	4618
	MAR	20.68	0	0	0	10000	0.01		10		26814	5033
	APR	22.29	0	0	0	3000	0.01		21.4		19553	5573
	MAY	22.96	0	0	0	5000	0.01		14.2		27705	8855
	JUN	29.73	0	0.2	0.2	7500	0.01		15		37051	9782
	JUL	25.85	0	0.4	0.4	5000	0.01		10.6		35599	5821
	AUG	27.14	0	1	1.4	7500	0.01		20.8		17833	6587
	SEP	27.78	0	0.4	0.4	15000	0.01		39.8		24733	10184
	OCT	31.03	0	0.2	0.2	10000	0.01		2.6		35072	9143
	NOV	23.59	0	0	0	7500	0.01		17.6		24480	3504
	DEC	23.59	0	0.6	0.6	5000	0.01		15.6		19478	4759

Wells Hatchery
NPDES Permit Number WAG13-5009

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	lbs of Fish	lbs of Feed	SS DD	TSS DD
2015	JAN	16.85	0	0.2	0.2	**	**		**		69543	14511		
	FEB	19.41	0	0.2	0.2	**	**		**		79660	17750		
	MAR	18.96	0	0.2	0.2	**	**		**		101677	15519		
	APR	16.13	0	0.2	0.4	**	**		**		85708	9827	0.1	1.4
	MAY	11.54	0	0.6	0.6	**	**		**		30900	5296	0.17	3
	JUN	5.54	0	0.8	0.8	**	**		**		9177	1887		
	JUL	5.38	0	0.4	0.4	**	**		**		7459	2459		
	AUG	5.69	0.01	0.2	0.2	**	**		**		11132	6628		
	SEP	7.06	0.01	1	1	**	**		**		21400	7904		
	OCT	8.49	0.01	0.9	1	**	**		**		30343	8420		
	NOV	9.95	0	1.2	1.2	**	**		**		39509	13790		
	DEC	10.53	0.01	1.4	1.4	**	**		**		53633	14376		

** PA pond - No discharge. PA pond system down during hatchery rebuild.

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
2015	JAN	4.25	0	0.8	0.8	10040	300		
	FEB	3.62	0	1.4	1.4	15765	390		
	MAR	4.52	0	-0.4	-0.4	9775	260		
	APR	3.85	0	-0.2	-0.2	8194	132	0.04	4
	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	4.22	0	1	1	6042	1012		
	NOV	3.65	0	-0.2	-0.2	11234	348		
	DEC	3.49	0	2	2	10026	341		

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
2015	JAN	6.18	0	2.2	2.2	16650	870		
	FEB	4.84	0	-0.8	-0.8	16280	1784		
	MAR	3.89	0	-1	-1	18300	3720		
	APR	No Monitoring				0	0		
	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	4.66	0	-0.8	-0.8	8800	1010		
	DEC	6.55	0	0.2	0.2	11817	1811		

Methow Hatchery
NPDES Permit Number WAG13-5000

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	lbs of Fish	lbs of Feed	SS DD	TSS DD
2015	JAN	11.52	0	0.1	0.2	14400	0.1		0		9700	1300		
	FEB	11.52	0	0	0	14400	0.1		5.4		10500	1420		
	MAR	10.08	0	1.3	1.8	14400	0.1		0.2		9600	828		
	APR	10.08	0	-0.4	-0.4	14400	0.1		6.4		9700	900	0	0
	MAY	2.6	0	1.4	1.4	14400	0.1		5.2		1223	455	0.1	3.8
	JUN	3.77	0	0	0	14400	0.1		0		2036	757		
	JUL	4.32	0	0.6	0.6	14400	0.1		17.2		2600	600		
	AUG	4.32	0	0.2	0.2	14400	0.1		1		4000	1100		
	SEP	5.33	0	0	0	14400	0.1		0.8		6200	852		
	OCT	5.33	0	0	0	14400	0.1		0.8		10000	800		
	NOV	5.62	0	0	0	14400	0.1		3.2		10600	875		
	DEC	7.98	0	0.2	0.2	14400	0.1		0.2		11200	930		

Similkameen Hatchery
NPDES Permit Number WAG13-5007

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS IW	TSS IW	lbs of Fish	lbs of Feed	SS DD	TSS DD
2015	JAN	6.62	0	0.4	0.4				8461	44		
	FEB	6.62	0	-9.2	-9.2				8398	902		
	MAR	6.62	0	-1.4	-1.4				11325	2684		
	APR	6.62	0	-1	0.6				11313	2596	0	15.2
	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	No Monitoring							0	0		
	NOV	6.34	0	0.6	0.6				11250	308		
	DEC	6.36	0	-0.4	-0.4				11116	132		

Chelan Hatchery
NPDES Permit Number WAG13-5006

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	lbs of Fish	lbs of Feed
2015	JAN	4.2	0.05	-1	-1	68000	0.05		0.8		10780	3914
	FEB	5.2	0.05	0.8	0.8	68000	0.05		0.8		15461	5226
	MAR	7.4	0.05	-0.4	-0.4	68000	0.05		1		25346	10141
	APR	10	0.04	0	0	68000	0.05		1.4		9800	2697
	MAY	7.2	0.05	-0.2	-0.2	68000	0.05		1.4		5445	564
	JUN	7.2	0.05	0	0	68000	0.05		0.2		7470	2566
	JUL	9.5	0.04	-0.6	-0.6	68000	0.05		3.2		4687	4996
	AUG	7.5	0.05	0.8	0.8	68000	0.05		1.6		7211	9113
	SEP	7.5	0.05	0	0	68000	0.05		1.8		12347	9714
	OCT	6.7	0.05	0.2	0.4	68000	0.05		4.4		8357	4751
	NOV	7.2	0.05	0.4	0.4	68000	0.05		4.2		6604	3436
	DEC	7.2	0.05	0.4	0.4	68000	0.05		3		8472	3548

Chelan Falls Hatchery
NPDES Permit Number WAG13-7019

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	lbs of Fish	lbs of Feed
2015	JAN	12.9	0.05	-8.8	-8.8	857	0.05		0.8		31994	4568
	FEB	12.9	0.05	-1.9	-1.8	857	0.05		1.2		33820	1650
	MAR	12.8	0.05	-2.2	-2.2	857	0.05		1.4		34262	3766
	APR	12.6	0.05	0.2	0.2	857	0.05		1.6		35344	17751
	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	7	0.04	-9.4	-9.4	3000	0.05		0.2		17614	2227
	DEC	7	0.04	-1	-1	3000	0.05		0.8		19753	2481

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
2015	JAN	No Monitoring				0	0		
	FEB	No Monitoring				0	0		
	MAR	14.21	0	-0.8	-0.8	33366	2948		
	APR	15.26	-0.1	0.3	0.4	46973	5236	0.01	3.8
	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
2015	JAN	23.93	0	0.4	0.4	**	**	**	9211	202		
	FEB	26.98	0	0	0	**	**	**	10229	1180		
	MAR	28.24	0	0.4	0.4	**	**	**	14796	4440		
	APR	30.55	0	-0.4	-0.4		0		26695	13102		
	MAY	46.88	0	0	0		0		78430	30166		
	JUN	44.43	0	0.6	0.6		0		135899	34962	0	1.32
	JUL	No Monitoring							0	0		
	AUG	No Monitoring							0	0		
	SEP	60.35				**	**	**	0	0		
	OCT	65.95	0			**	**	**	0	0		
	NOV	65.95	0			**	**	**	0	0		
	DEC	24.25	0	-0.4	-0.4	**	**	**	8632	0		

**PA pond - No discharge this month

Appendix G

Steelhead Stock Assessment at Priest Rapids Dam, 2013-2014

Priest Rapids Dam 2013-2014 Adult Upper Columbia River Steelhead Run-Cycle Stock Assessment Report

Introduction

Upper Columbia River (UCR) steelhead stock assessment sampling at Priest Rapids Dam (PRD) is authorized through 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 2013 steelhead sampling at Priest Rapids Dam began 8 July and concluded 14 November. Sampling consisted of operating the Priest Rapids Off Ladder Trap (OLAFT), located on the left bank Priest Rapids Dam, eight hours per day, up to three days per week, for a total of 57 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 2013 totaled 13.5%.

The Washington Department of Fish and Wildlife (WDFW) sampled 2,318 steelhead of the 2013/2014 run-cycle passing PRD, totaling 15,072 steelhead, for an overall sampling rate of 14.6%. Of the 2,196 steelhead sampled, 1,426 (64.9%) were hatchery origin and 770 (35.1%) were wild origin. The estimated 2013-2014 run- cycle total wild steelhead return was 4,657, representing 166.6% of the 1986-2012 average and about 88.6% of the most recent five-year average (Table 1).

Based on external marks and external and internal tags, 1,426 hatchery-origin steelhead were sampled at Priest Rapids Dam during the 2013 return cycle and included 19.5% Wenatchee hatchery-origin steelhead and 49.6% "above Wells Dam" hatchery-origin steelhead[1] (Table 2), while 12.0% of the hatchery-origin steelhead sampled could not be assigned to a specific hatchery program. Ringold FH origin steelhead represented about 12.5% of the hatchery sample (Table 2).

[1] Defined as "above Wells Dam" because hatchery origin, adipose-clipped steelhead release 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, 1974-2013.

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
1986-2012 average	**11,828**	**2,796**	**18.7**	**14,181**
2008-2012 average	**18,939**	**5,257**	**21.7**	**24,197**

[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, 8 July – 14 November 2013.

Steelhead origin																					
Wild			**Hatchery**																		
Wild			**Wenatchee**						**Above Wells**				**Ringold FH**			**Unk. Hat.**					
Criteria			**VIE**						**Criteria**				**Criteria**			**Criteria**			**Total**	**Total**	**Total**
NS	**NM**	**Total**	**LTGR**	**RTGR**	**RTOR**	**RTPK**	**AD**	**Total**	**AD**	**LTYL**	**LV**	**Total**	**AD**	**RV**	**Total**	**SD**	**NM**	**Total**	**Wild**	**Hatchery**	**Total**
x	x	770	x					9	x			692	x	x	178	x	x	263	770	1,426	2,196
				x				0		x		3									
					x			0			x	12									
						x		62													
							x	207													
Total		**770**						**278**				**707**			**178**			**263**	**770**	**1,426**	**2,196**
% Hatchery								**19.5**				**49.6**			**12.5**			**18.4**		**100.0**	
% Total		**35.1**						**12.7**				**32.2**			**8.0**			**12.0**	**35.1**	**64.9**	**100.0**

Reconciliation of salt water age of wild and hatchery steelhead sampled at Priest Rapids Dam during 2013 was accomplished through scale sample analysis. Salt-age analysis of the 2013 UCR steelhead run-cycle provides an estimated hatchery-origin return dominated by 1- salt and 2-salt age composition of 60.1% and 39.7%, respectively (Table 3). Natural-origin steelhead salt ages were 68.6% and 31.2% for salt ages 1 and 2, respectively. Three-salt age fish represented only 0.2% of the combined hatchery/wild sample (Table 3).

Table 3. Salt-water age composition of 2013 – 2014 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	845	60.1	521	68.6	1,366	63.1
2-salt	559	39.7	237	31.2	796	36.7
3-salt	3	0.2	1	0.1	4	0.2
4-salt	0	0.0	0	0.0	0	0.0
Total	**1,407**	**65.0**	**759**	**35.0**	**2,166**	

Freshwater residency of naturally produced Upper Columbia River steelhead present in the 2013-2014 run cycle were dominated by age-2 freshwater fish (70.8%), and was only slightly lower than the 1986-2012 average of 74.7% (Table 4).

Table 4. 2013 return year freshwater age of wild Upper Columbia River steelhead sampled at Priest Rapids Dam during steelhead stock assessment activities, compared to July – November 1986-2012 average.

Freshwater age	**2013-2014 run cycle**		**1986-2012 proportion**	
	N	**%**	***N***	**%**
1.x	31	4.4	458	8.4
2.x	495	70.8	4,086	74.7
3.x	161	23.0	885	16.2
4.x	12	1.7	39	0.7
5.x	0	0.0	3	>0.1
Total	**699**		**5,471**	

Wild and hatchery origin steelhead exhibited similar saltwater growth in the 2013 run-cycle. Wild 1- and 2-salt adults were slightly larger than their hatchery cohorts (Table 5). Age 1-salt hatchery and age 1- and 2-salt wild steelhead observed in the 2013-2014 adult run-cycle return past PRD were comparable in size to the 1986-2012 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 2013 and the period between 1986-2012.

	Average fork length (cm)			
	2013-2014 run cycle		1986-2012 run cycle	
Salt age	**Wild**	**Hatchery**	**Wild**	**Hatchery**
x.1	57.7	57.2	60.3	59.0
x.2	70.5	69.7	72.7	71.8

Appendix H

Wenatchee Sockeye Salmon Spawning Escapement, 2015

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 20, 2015

To: HCP Hatchery Committee

From: Catherine Willard

Subject: 2015 Wenatchee Sockeye Mark/Recapture-Based Sockeye Escapement Estimates to Tributaries

Introduction

In 2015, 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 2015. 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 2015). Resulting tag files were queried in PTAGIS (2015), providing detection histories for each study fish.

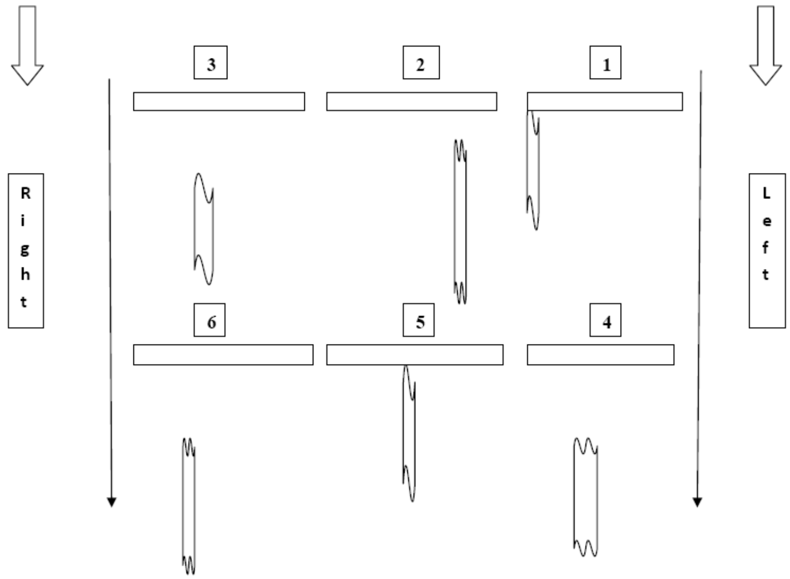


Figure 1. Schematic of a PIT array configuration.

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 51,410 adult sockeye salmon passed the facility during the 2015 migration, which was a sufficient return to open a recreational fishery in Lake Wenatchee for 2015. PIT tags were implanted in 943 of these fish at Tumwater and seven of these fish were PIT-tagged before passing Tumwater; 76 fish were subsequently detected at the Little Wenatchee PIT tag array and 371 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 4,113 adult sockeye and 20,087 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 2015, 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*	76	1.000	*76*	76	4

[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.

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, 2009-2015.

Year	Tumwater count	Recreational harvest	Little Wenatchee	White River	Combined	Escapement
2009	16,034	2,229	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	51,410	7,916	4,113	20,087	24,200	0.470
Average	**45,333**	**6,989**	**2,933**	**22,181**	**25,115**	**0.684**

[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 I

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

Developed by
Scott M. Blankenship, Cheryl A. Dean, Jennifer Von Bargen
WDFW Molecular Genetics Laboratory
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and

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March 2008

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

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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	0.572	0.018	0.041	0.012	0.093	0.040
01AAS	0.115	0.471	0.160	0.219	0.519	0.049	0.654	0.133
04AAV	0.136	0.219	0.210	0.423	0.208	0.328	0.037	0.153
06CN	0.029	0.004	0.053	0.007	0.022	0.004	0.019	0.001
07EE	0.099	0.229	0.053	0.015	0.093	0.178	0.090	0.037

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 J

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

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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.

Task 3: 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.

<u>Task 7:</u> 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).

<u>Task 8:</u> 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.

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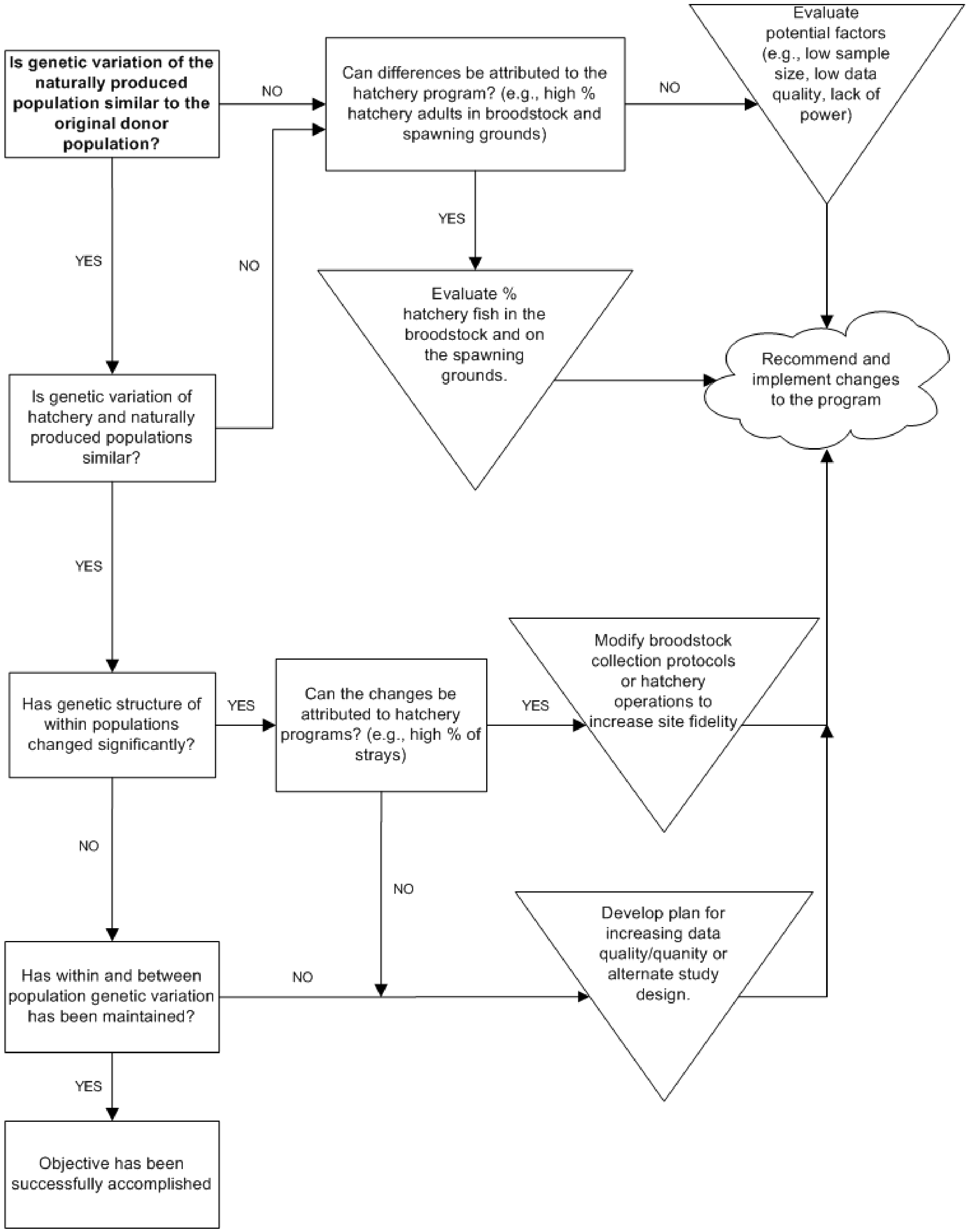

Figure 1. Conceptual process for evaluating potential changes in genetic variation in the Chiwawa naturally produced populations as a result of the supplementation hatchery programs (From Murdoch and Peven 2005).

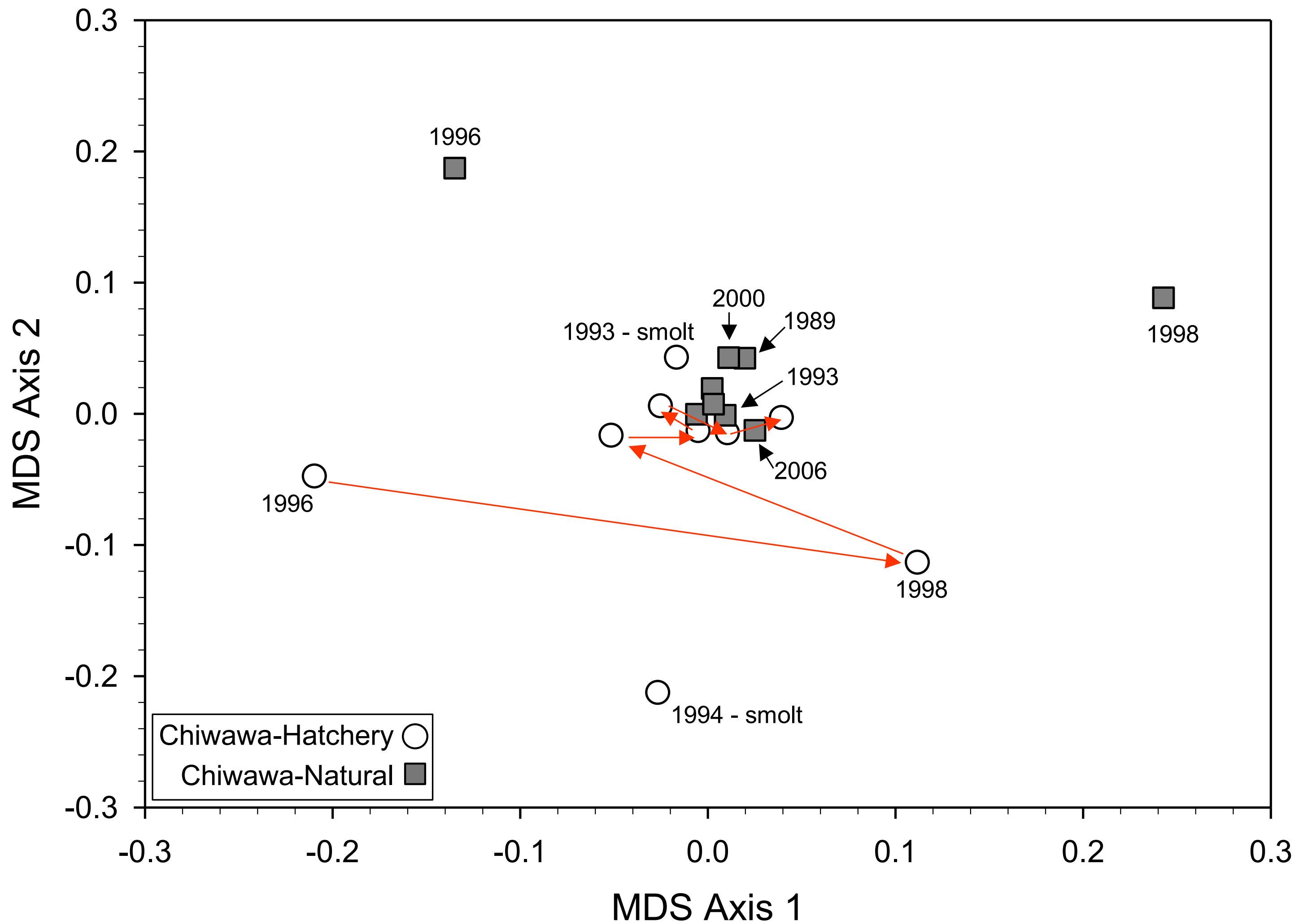

Figure 2. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by fish origin (i.e., hatchery versus natural). The red arrows connect consecutive hatchery-origin collections starting with the first adult collection (1996) and ending with the 2006 collection (see Table 1 for collection years).

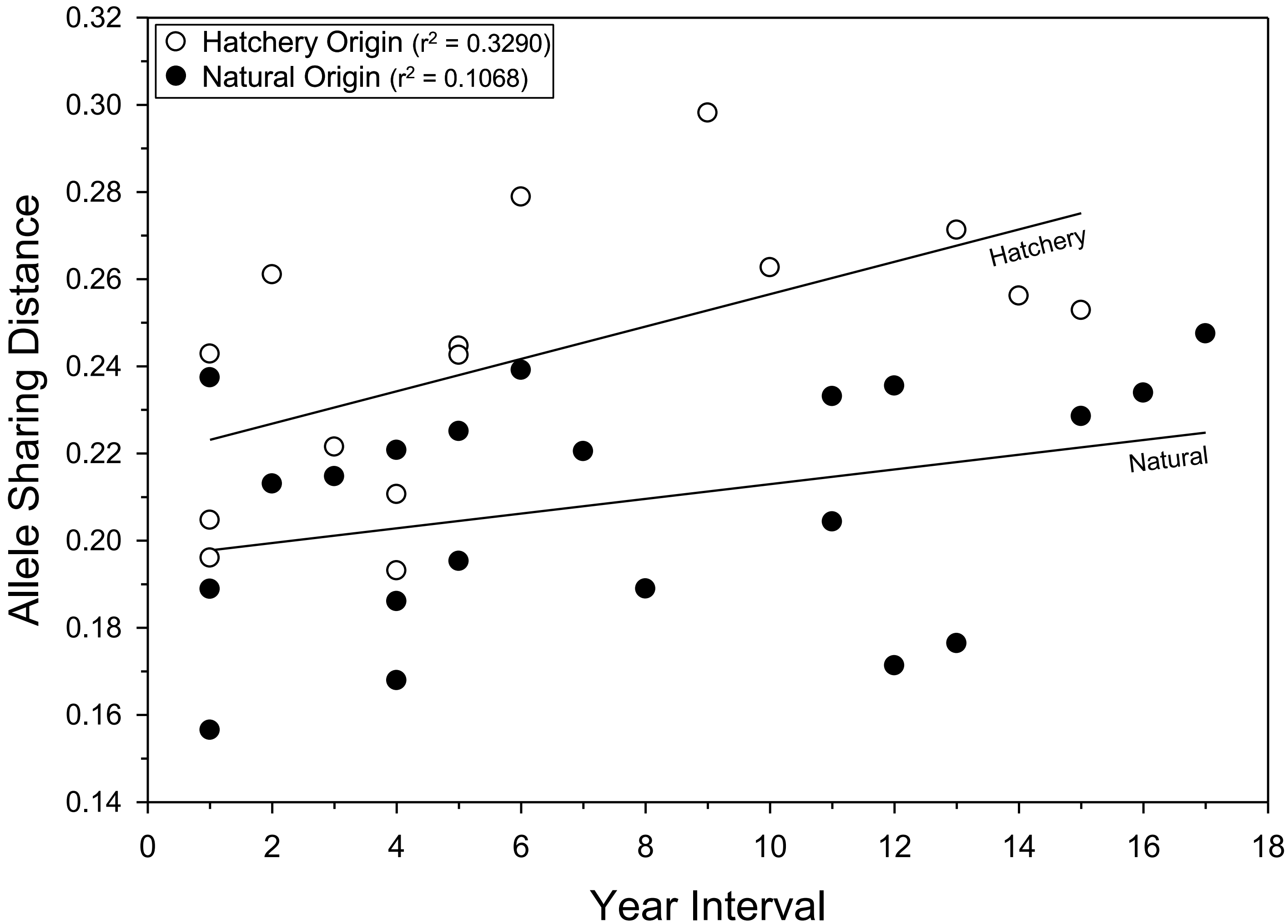

Figure 3. Relationships between the time interval in years and allele sharing distances, with each circle representing the pairwise relationship between two Chiwawa collections. Separate regression lines for the natural- and hatchery-origin collections. The slope for the natural-origin collection is 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.

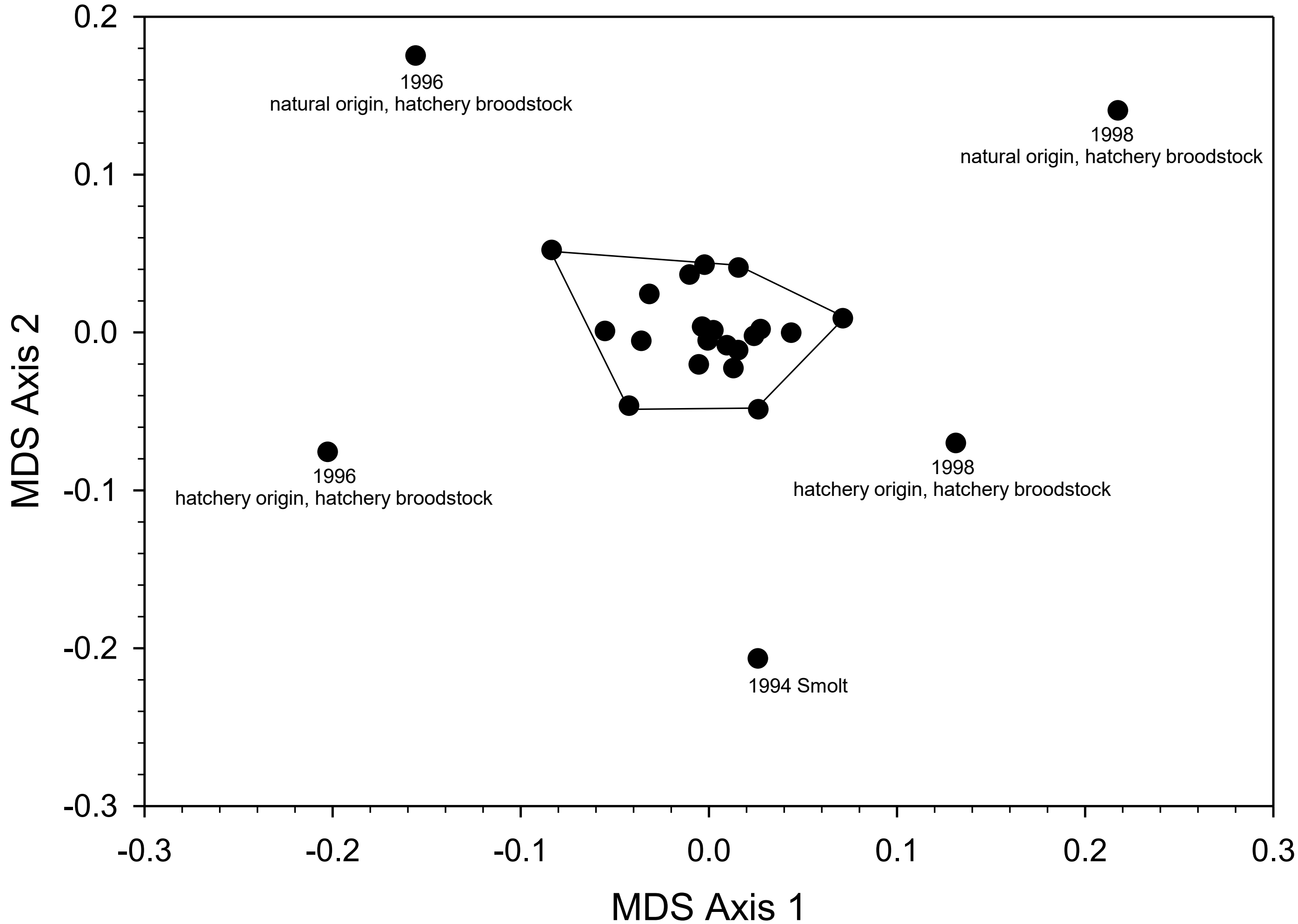

Figure 4. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by four treatment groups, as discussed in the text. Each circle represents a single collection within each of the four treatment groups, and the polygon encloses all groups that are not outliers. Each outlier group is specifically labeled.

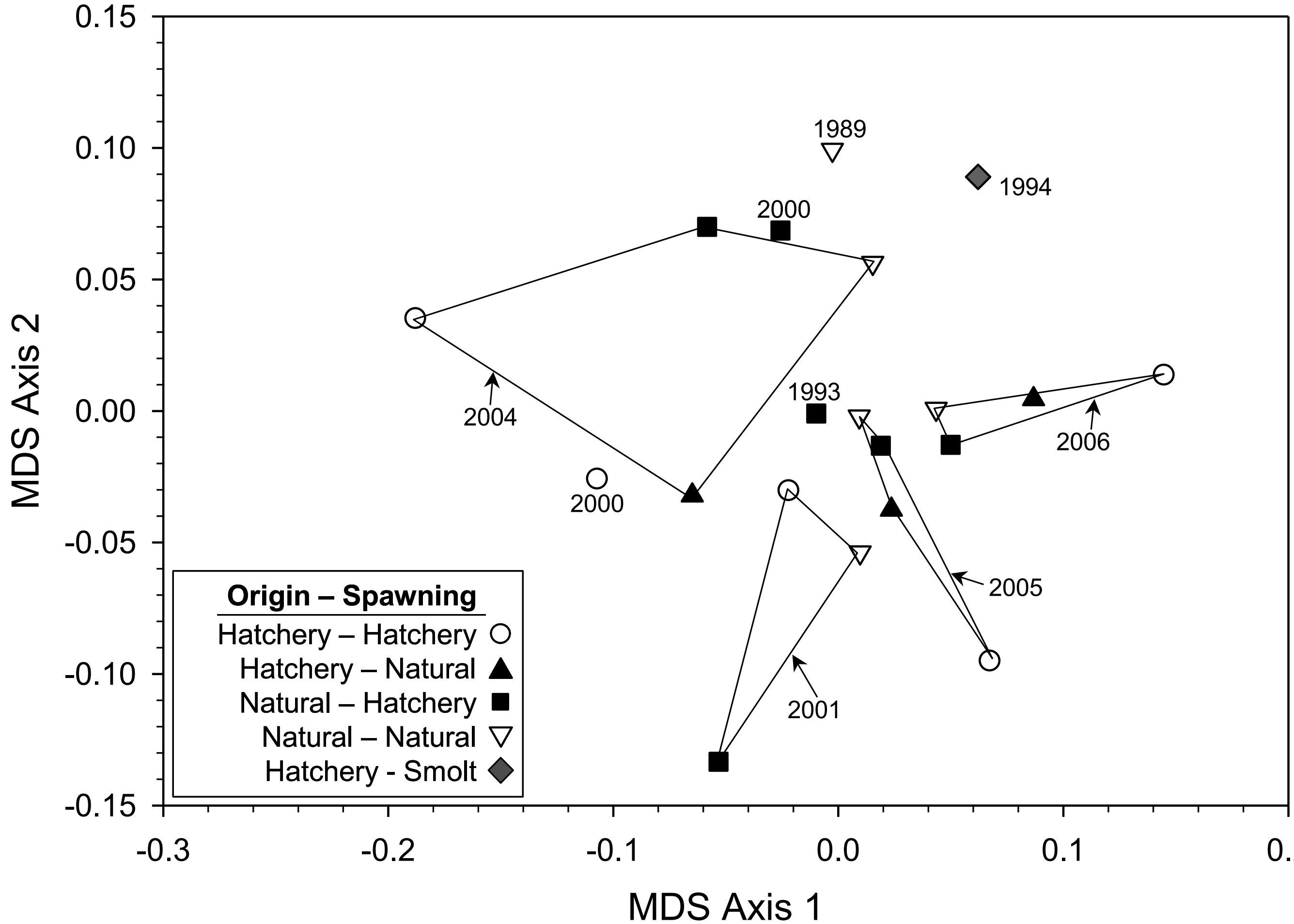

Figure 5. As in Figure 4, but allele-sharing distance matrix recalculated without the five outlier groups shown in Figure 4. Polygons group together treatment groups from the same collection year. Dates associated with symbols also refer to collection year. Collection years 2004-2006 included all four 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.

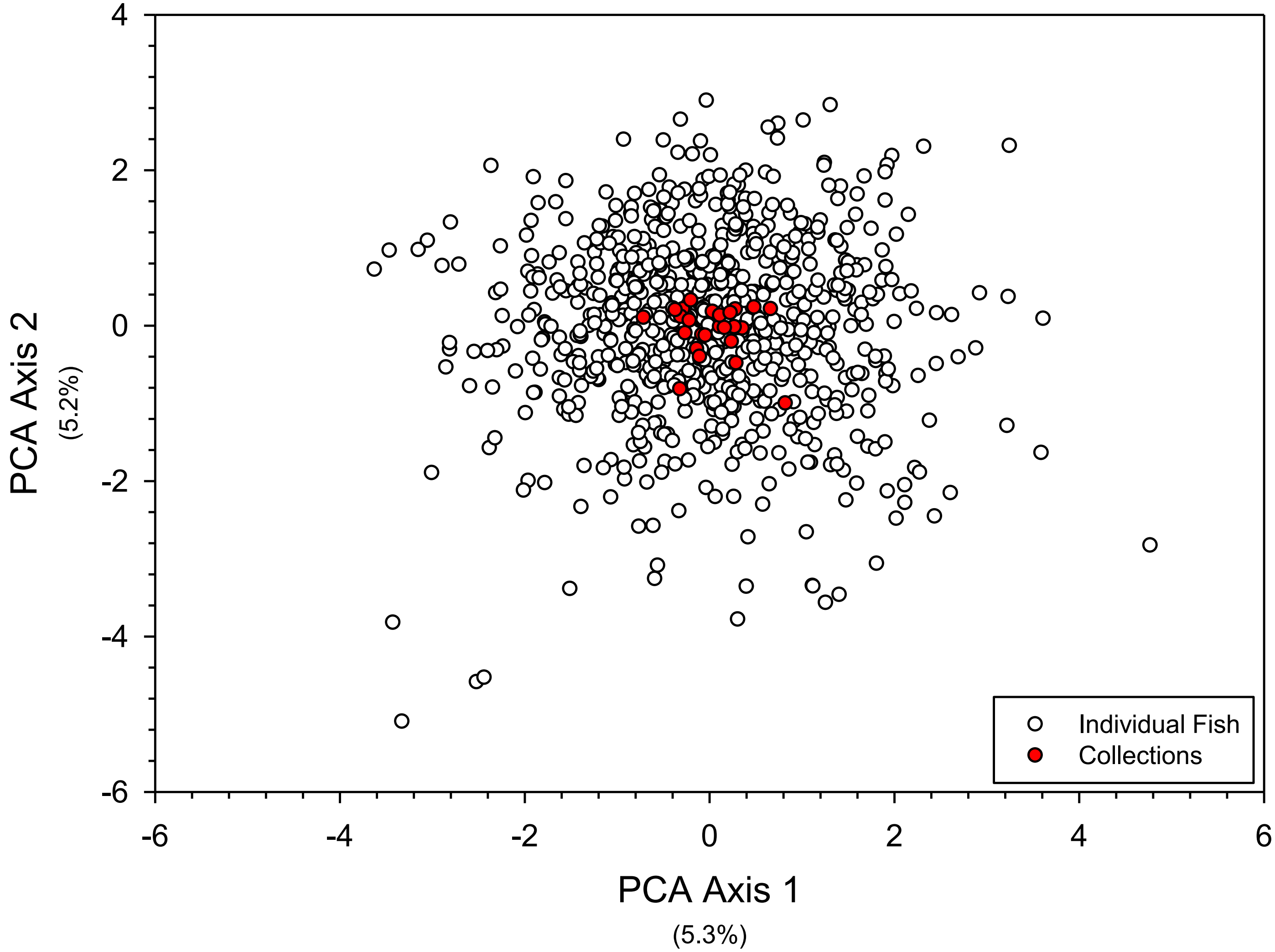

Figure 6. Principal component (PC) analysis of individual fish from the Chiwawa River. Only fish with complete microsatellite genotypes were included in the analysis (n = 757). Open circles are the PC scores for individual fish, and the filled circles are the centroids (bivariate means) for each of the 25 groups discussed in the text. PC axes 1 and 2 account for only 10.5% of the total molecular variance.

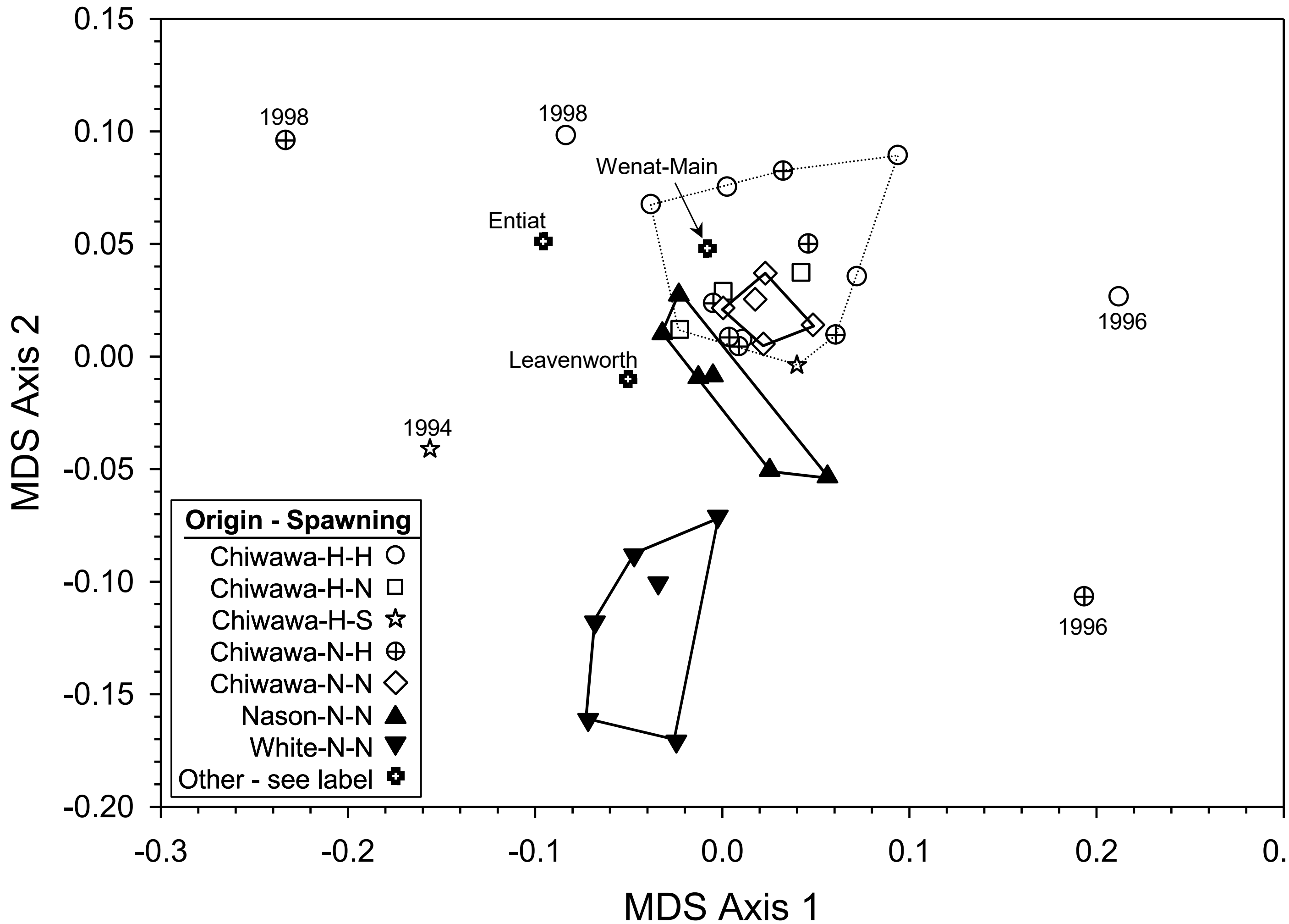

Figure 7. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa origin data set and all other non-Chiwawa collections, except Little Wenatchee River. Legend is read with abbreviations beginning with origin and then spawning location. H=hatchery, N=natural, and 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.

Year	1993	1996	1998	2000	2001	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):								
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):								
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 K

Fish Trapping at the Nason Creek Smolt Trap 2015

Population Estimates for Juvenile Salmonids in Nason Creek, WA

2015 Annual Final Report

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ABSTRACT

In 2015, Yakama Nation Fisheries Resource Management (YNFRM) monitored emigration of Endangered Species Act (ESA) listed Upper Columbia River (UCR) spring Chinook salmon and summer steelhead as well as naturally spawned juvenile coho salmon in Nason Creek. This report summarizes 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, 2015. We collected 745 spring Chinook salmon, 430 summer steelhead, 1 bull trout, and 5 coho; all of natural origin and varying age classes. Daily fish abundances for spring Chinook, steelhead, and coho were expanded by stream discharge-to-trap efficiency regression or pooled estimates. All estimates were made with a 95% confidence interval (CI) with total emigration estimates for BY2013 spring Chinook juveniles and coho juveniles of 57,525 (± 39,889) and 161 (± 714), respectively. We estimated the total BY2012 summer steelhead emigration at the trap to be 25,566 (± 6,020). Egg-to-emigrant survival rates for BY2013 spring Chinook and BY2012 summer steelhead were 5.8% and 3.0%, respectively. The egg-to-emigrant survival rate for BY2011 summer steelhead was 0.9%. Productivity, as measured by emigrants-per-redd, for spring Chinook and summer steelhead, was 271 and 162, respectively. With no coho redds on Nason Creek in 2013, egg-to-emigrant survival and productivity could not be estimated for the 2013 brood.

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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, Arlene Heemsah, Barry Hodges, Tim Jeffris, and Kevin Swager 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) and Mr. Duane Bolser for providing use of the trapping site and accommodating the needs of this project as well as to Peter Graf (Grant County PUD) for administering contracting and funding. Finally, thank you to Mike Hughes, Mclain Johnson, Andrew Murdoch, Ben Truscott, J.B. Walters, and Joshua Williams (Washington Department of Fish and Wildlife), and Tracy Hillman (Bio Analysts, 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 65,600 acres 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. Both smolt trap locations employed in 2014 (see section 2.1 Trapping Equipment and Operations) were downstream from the majority of spring Chinook and steelhead spawning grounds (Figure 1). There are 26.4 rkm along the mainstem accessible to anadromous fish in Nason Creek. Private land ownership comprises 52,300 acres (79.7%) of the watershed while 12,800 acres (19.5%) are federal and 480 acres (0.1%) are state owned (USFS et al. 1996).

The channel morphology of the lower 25 kilometers 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 2015, mean daily discharge for Nason Creek was 285 cfs with mean daily stream temperatures ranging from 0.0°C to 21.3°C (Figure 2 & 3). Spring discharge was extremely limited due to deminished snowpack by the onset of the trapping season. Maximum daily mean discharge in the spring of 2015 was 733cfs; normal maximum mean (12-year) daily flows during spring freshets on Nason Creek are approximately 2,000cfs. The lack of snowpack prompted the early-onset of base-flow conditions (<100cfs) by the end of June. Base-flow conditions persisted into late October, at which time multiple rain-on-snow events pushed Nason Creek into flood conditions.

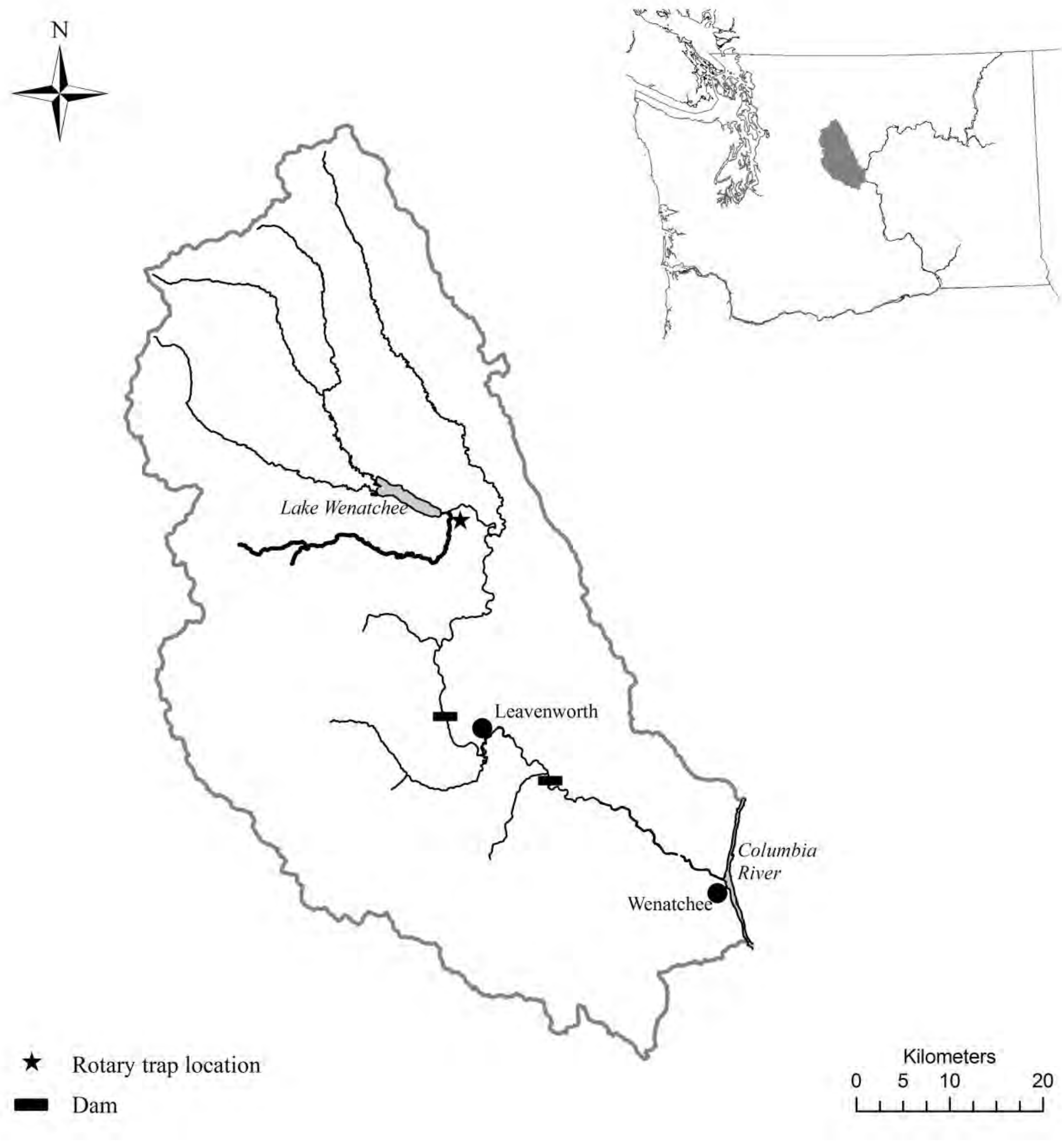


Figure 1. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location.

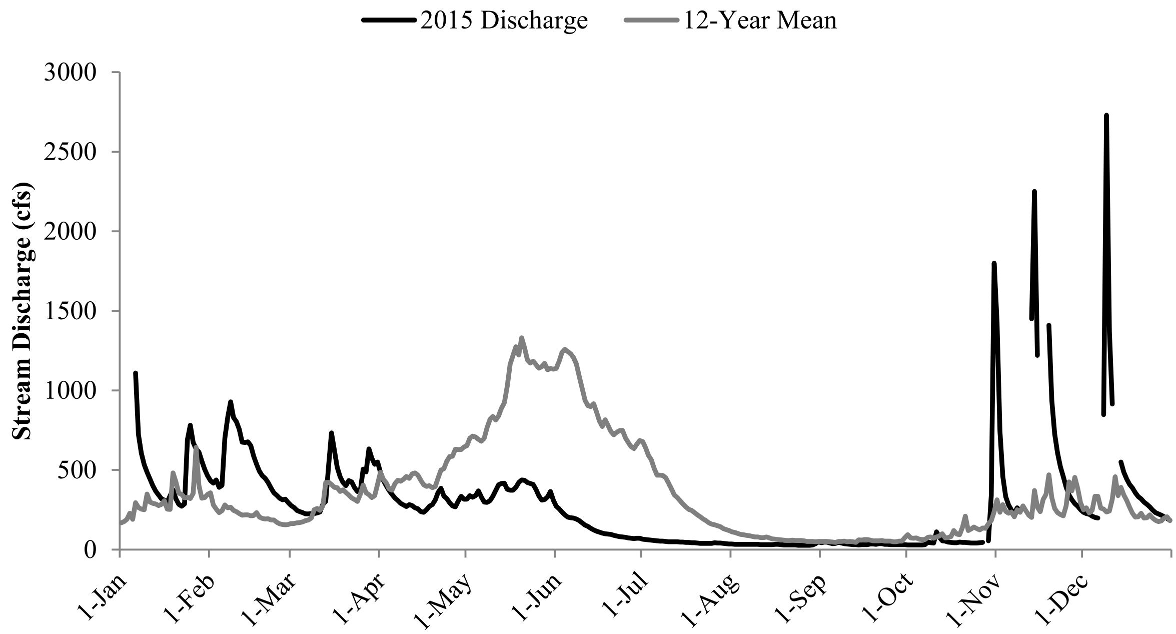


Figure 2. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2015.

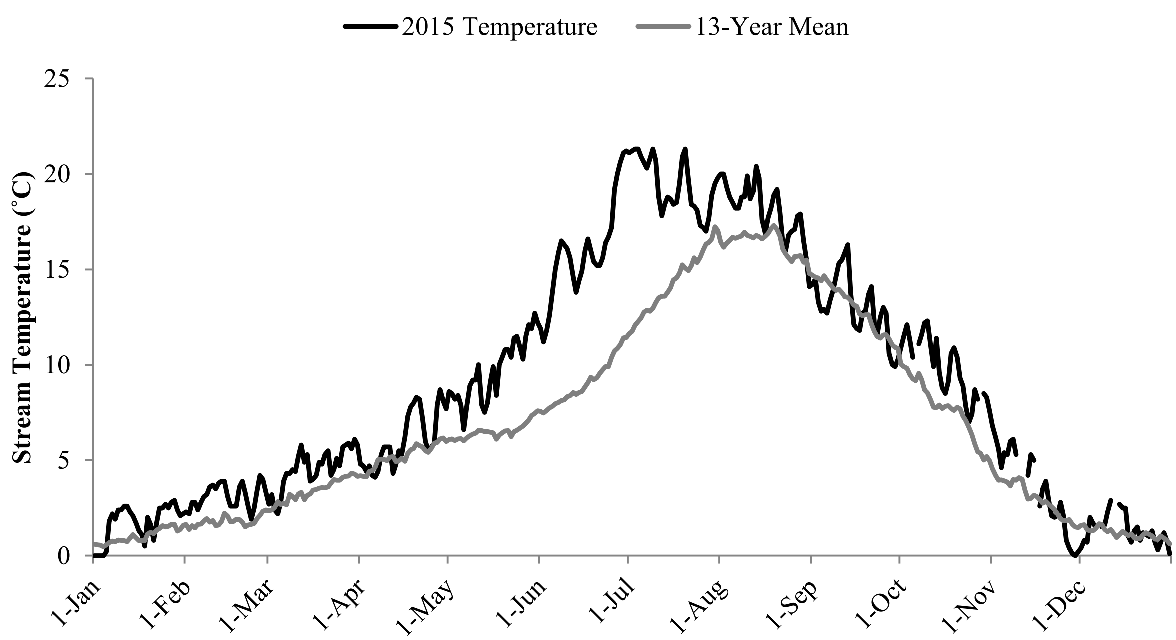


Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station in 2015.

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. Without the threat of vandalism posed during periods of peak use at the previously-used campground location, summer operations at the Bolser location were not modified (daytime suspension).

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 (up to 72 hours; Section 7 permit 2011/05645). 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. During periods when the trap was not operating (e.g. high discharge, high debris or mechanical malfunction), the number of target species captured was estimated. The estimated number of fish captured was calculated using the average number of fish captured three days prior and three days after the break in operation. This estimate of daily capture was incorporated into the overall emigration estimate.

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 oxygen 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 ≥ 60mm 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 P3 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 apposing 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 2015. 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. In light of high abundance, minimum trial sizes could be raised to a more robust mark group with the intention of strengthening existing regression models.

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 abundaces 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,

$$e_k^{obs} = \frac{r_k + 1}{m}. \qquad \textbf{(3)}$$

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,

$$Var\left(\sum_{i=1}^{n}\hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i+1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i\sum_j Cov\left(\frac{(C_i+1)}{\hat{e}_i}, \frac{(C_j+1)}{\hat{e}_j}\right)}_{Part\ B}. \quad \textbf{(4)}$$

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:

$$V\hat{a}r\left(\sum_{i=1}^{n}\hat{N}_i\right) = \underbrace{\sum_i \hat{N}_i^2\left(\frac{N_i\hat{e}_i(1-\hat{e}_i)}{(C_i+1)^2} + \frac{4(1-\hat{e}_i)}{\hat{e}_i}V\hat{a}r(b_0 + b_1 flow_i)\right)}_{PartA} +$$
$$\underbrace{\sum_i\sum_j 4\left(\hat{N}_i(1-\hat{e}_i)\right)\left(\hat{N}_j(1-\hat{e}_j)\right)\cdot\left[\hat{V}ar(b_0) + flow_i flow_j \hat{V}ar(b_1)\right]}_{PartB}$$

where $V\hat{a}r(b_0 + b_1 flow_i) = M\hat{S}E\left(1 + \frac{1}{n} + \frac{(flow_i - \overline{flow})^2}{(n-1)s^2_{flow}}\right)$, 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:

$$\hat{N}_i^{pooled} = \frac{C_i}{\hat{\bar{e}}},$$

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):

$$V\hat{a}r\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i\left(1-\hat{\bar{e}}\right)}{\hat{\bar{e}}}\right)}_{PartA} + \underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\sum_i \hat{N}_i^2}_{PartB} + \underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\sum_i\sum_j \hat{N}_i \hat{N}_j}_{PartC}.$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$V\hat{a}r\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i\left(1-\hat{\bar{e}}\right)}{\hat{\bar{e}}}\right)}_{PartA} + \underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i \hat{N}_j\right]}_{PartB}.$$

The variance of $\hat{\bar{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\bar{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\bar{e}}_k m_k\right)^2}{\bar{m}^2 n(n-1)}$$

where $\bar{m}$ 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 = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

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 Abundance During The Non-Trapping Period

An estimate of spring chinook emmigration 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:

$$\hat{N}_i = \left(\frac{C_i}{\hat{e}_i}\right) \Big/ t_i \text{,}$$

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.

2.5.3 Production and Survival

Production estimates by age class were summed to produce a total emigration estimate. For spring Chinook and coho, estimates of fall migrant parr were added to subsequent spring smolt estimates to generate a single brood year estimate. For steelhead, a single brood year may require up to three years for emigration from Nason Creek to occur. Pending scale analysis, steelhead captured in 2015 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 installed on February 25, and operated in its fixed position for the entirety of the trapping season (March 1 to November 30). Removal of the trap occurred on December 2. We attempted to run the trap continuously 24 hours a day, 7 days per week. Intentional suspension of trapping activities occurred for a prolonged period in the summer-early fall due to extreme base flows (July 18 - October 20; Table 1). Pulling of the trap also occurred in the fall as a precaution during two major flood events. Trap stoppages were most frequent from July through November, as heavy debris loads and ice formation prevented continuous operation.

Table 1. Summary of Nason Creek rotary trap operation.

Date of Trap Operations	Trap Status	Description	Days
March 1 to June 30	Operating	Continuous data collection	119
	Interrupted	Interrupted by debris	3
	Pulled	Intentionally pulled during periods of high flow, low flow, or significant ice formation	0
July 1 to November 30	Operating	Continuous data collection	34
	Interrupted	Interrupted by debris, ice and/or low flows	14
	Pulled	Intentionally pulled during periods of high flow, low flow, or significant ice formation	105

3.2 Daily Captures and Biological Sampling

3.2.1 Spring Chinook Yearlings (BY2013)

Between March 1 and June 30, a total of 152 wild Chinook yearlings were captured at the trap (Figure 4). The majority of these fish were collected following an intial spike in flow immediately following operation commencement. A peak catch of 10 yearling smolts coincided with a secondary spike in discharge occurring on March 27. Following the final freshets of March, catch dropped substantially with the last emigrating Chinook yearling captured on May 21. Although three trap stoppages occurred during this period, they likely did not adversely affect total Chinook smolts captured and therefore, estimates were forgone. Mean FL and weight for Chinook yearlings was 93mm (n = 152; SD = 7.0) and 8.4g (n = 152; SD = 2.2; Table 2), respectively. Tissue sample were collected from 138 fish for an ongoing, parental-based DNA analysis by WDFW. Five wild spring Chinook mortalities were incurred.

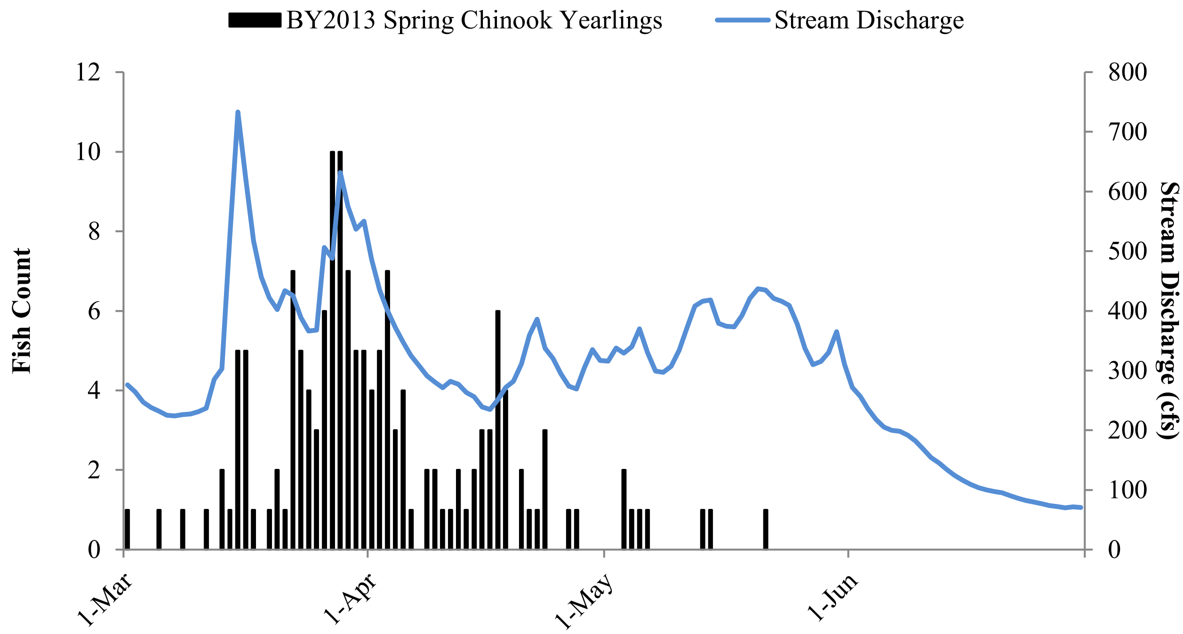


Figure 4. Daily catch of BY2013 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap in 2015.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2013	Wild Spring Chinook Yearling Smolt	93	152	7.0	8.4	152	2.2	1.03
2014	Wild Spring Chinook Subyearling Fry	45	338	9.9	1.0	338	0.9	0.87
2014	Wild Spring Chinook Subyearling Parr	84	210	8.0	6.5	209	1.7	1.08
2013	Hatchery Spring Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.13

3.2.2 Spring Chinook Subyearlings (BY2014)

A total of 210 wild spring Chinook subyearling parr were captured between July 1 and November 30, with an additional 338 subyearling fry captured prior to July 1 (Figure 5). A peak daily capture of 89 subyearling Chinook parr occurred on November 3, following the first fall high-water event of the year. Mean FL and weight among fall subyearling parr was 84mm (n = 210; SD = 8.0) and 6.5g (n = 209; SD = 1.7), respectively. We estimate that an additional 16 Chinook subyearling parr would have been captured during short stoppages (≤3 days) had the trap run without interruption. Estimates of daily abundance during the prolonged period of suspended trapping (July 14 – October 10) were not made due to a lack of documented pre- and post-suspension movement, as well as the duration of the suspenstion. Tissue samples were collected from 213 fish for an ongoing, parental-based DNA analysis by WDFW. A total of 10 subyearling Chinook (9 fry and 1 parr) mortalities occurred in 2015. Causes of death included trapping mortality, tagging/handing mortality, and pre-existing fungal infection/poor condition.

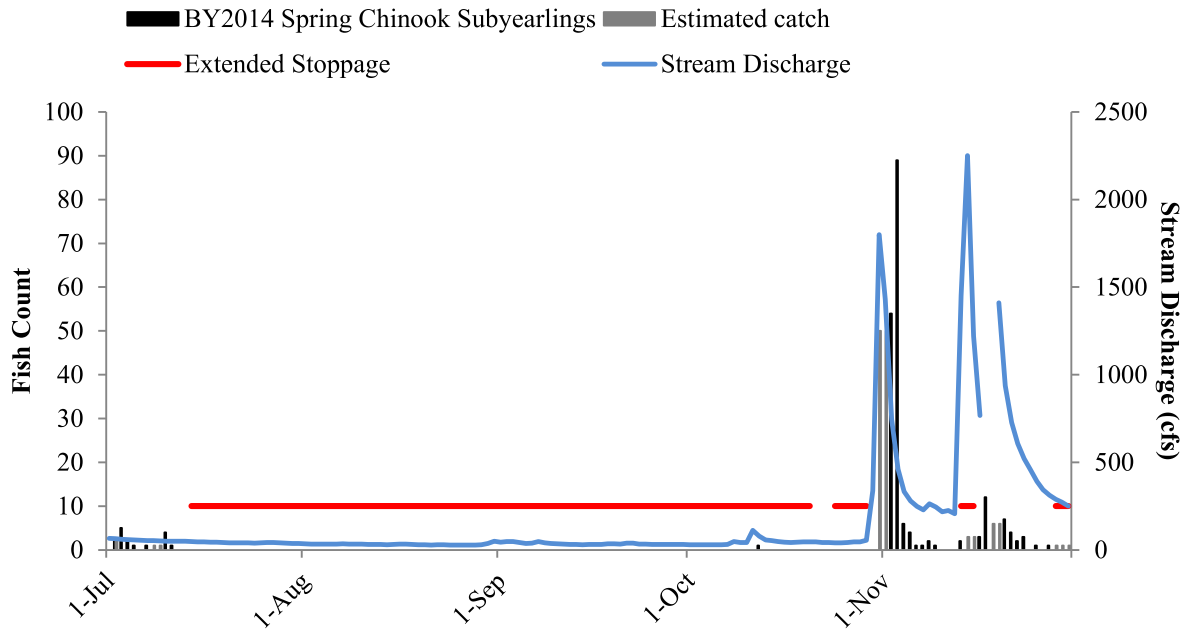


Figure 5. Daily catch of BY2014 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2015.

3.2.3 Hatchery Spring Chinook Smolts (BY2013)

During the months of April and May, a total of 43,082 hatchery spring Chinook smolts were released into Nason Creek (M. Babiar, personal communication, January 14, 2016). All hatchery spring Chinook were released directly from the Grant County Public Utility District (GCPUD) Nason Creek Acclimation Facility located at rkm17.3. Subsequently, a total of 714 smolts were captured with a mean FL and weight of 136mm (*n* =284; *SD* = 12.3) and 29.5g (*n* = 284; *SD* = 8.8), respectively (Figure 6). Hatchery spring Chinook were not captured at the smolt trap beyond May 10. There were no mortalities incurred.

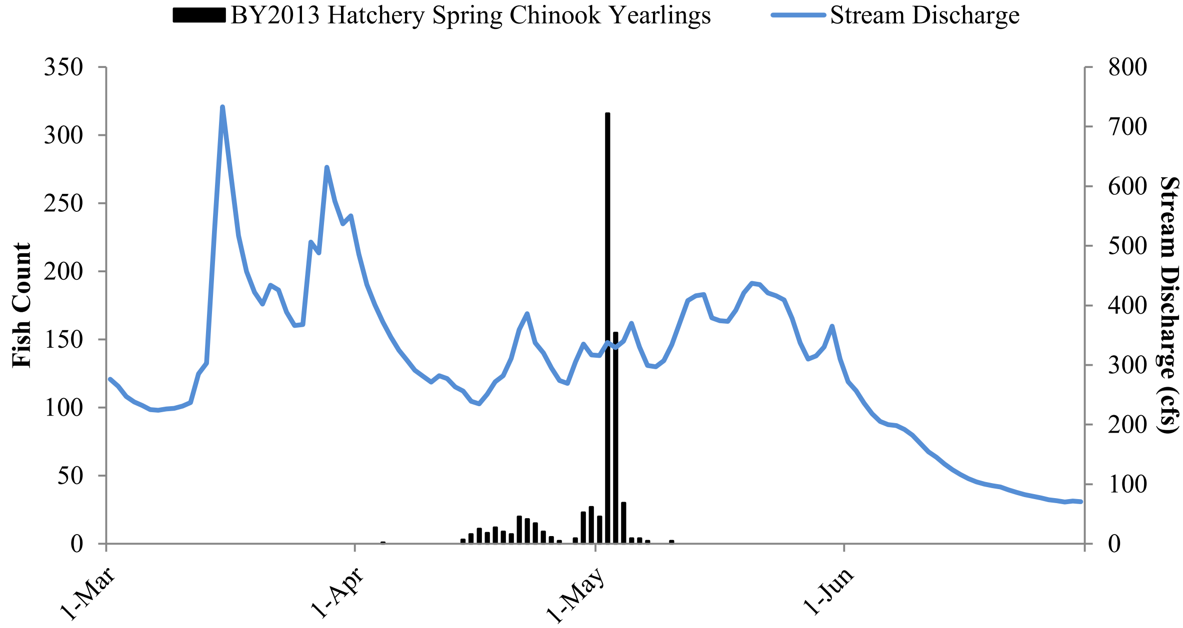


Figure 6. Daily catch of BY2013 hatchery spring Chinook smolts with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.2.4 Summer Steelhead

A total of 430 wild summer steelhead juveniles were captured throughout the season from March 1 to November 30 with a peak catch of 89 juveniles on November 2 (Figure 6). We estimated that an additional 2 age-1 juveniles would have been captured had there been no interruptions to trapping during the migratory period (Mar 1 to July 31). Histogram analysis of known steelhead ages sampled from 2005 to 2014 allowed us to estimate ages of fish captured in 2015 using FL. We estimate that of the total steelhead captured, 182 were young-of-the-year, 233 were age-1, 14 were age-2, and 1 was age-3. Subyearling steelhead caught had a mean FL of 70mm (n = 182; SD = 15.5), and a mean weight of 4.3(n = 176; SD = 2.0). The majority of steelhead juveniles captured were age-1 parr emigrating past the trap in spring. Mean FL and weight of age-1 fish was 88mm (n = 233; SD = 20.2; Table 3) and 8.3g (n = 233; SD = 6.7), respectively. Age-2 steelhead were caught primarily in the spring, with only one fish being captured after July 31. Mean FL and weight of age-2 fish was 149mm (n = 14; SD = 13.5) and 33.7g (n = 14; SD = 8.2), respectively. A single age-3 fish with a FL of 175mm and weight of 51.3g was also captured. Scales were taken from a sub-sample (n = 188) to be used for future age analyses. Two trapping mortalities were incurred (See **3.6 ESA Compliance**).

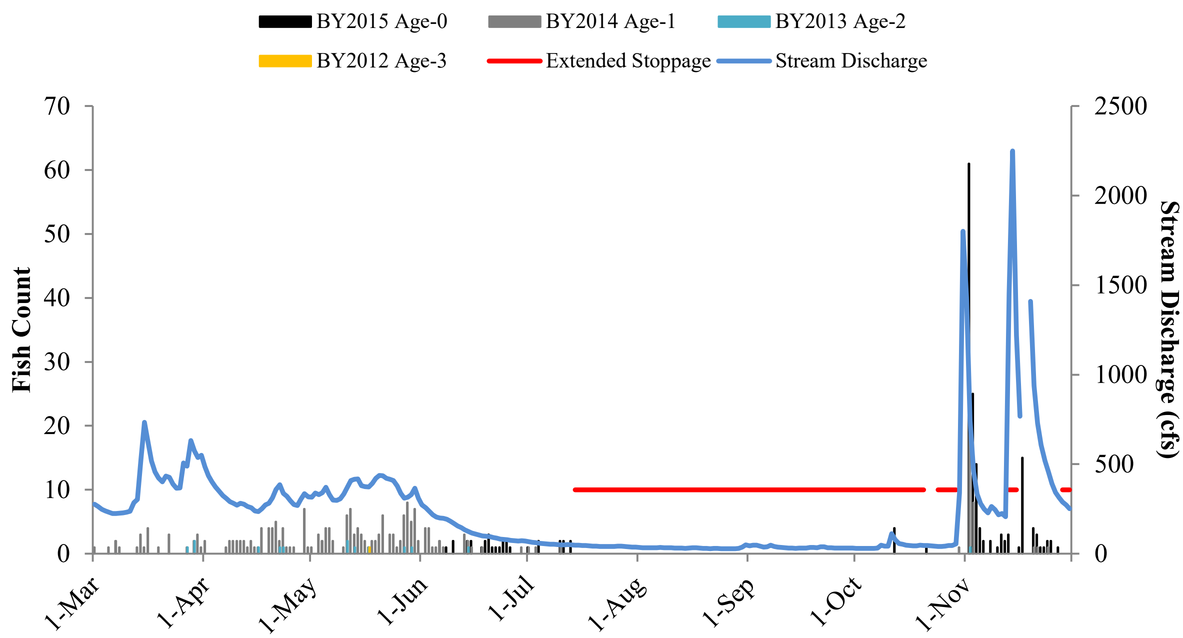


Figure 7. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to November 30, 2015. Estimates of fish passage during trap interruptions are not depicted.

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.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2015	Wild Summer Steelhead (Age-0)	70	182	15.5	4.3	176	2.0	1.06
2014	Wild Summer Steelhead (Age-1)	88	233	20.2	8.3	233	6.7	1.04
2013	Wild Summer Steelhead (Age-2)	149	14	13.5	33.7	14	8.2	1.00
2012	Wild Summer Steelhead (Age-3)	191	1	—	73.8	1	—	1.06
2014	Hatch. Summer Steelhead Smolt	175	273	15.2	51.3	273	12.5	0.94

3.2.5 Hatchery Steelhead Smolts (BY2014)

During April and May, WDFW directly planted a total of 86,613 hatchery summer steelhead smolts into Nason Creek (M. Babiar, personal communication, January 14, 2016). Subsequently, a total of 448 hatchery steelhead were captured at the smolt trap with a mean FL and weight of 175mm (*n* =273; *SD* = 15.2) and 51.3g (*n* = 273; *SD* = 12.5), respectively (Figure 7). The presence of hatchery-origin steelhead at the trap was limited to 45 days after initial release, and did not continue into the summer. Hatchery origin was determined by the presence of coded wire tags (CWT). One mortality was incurred.

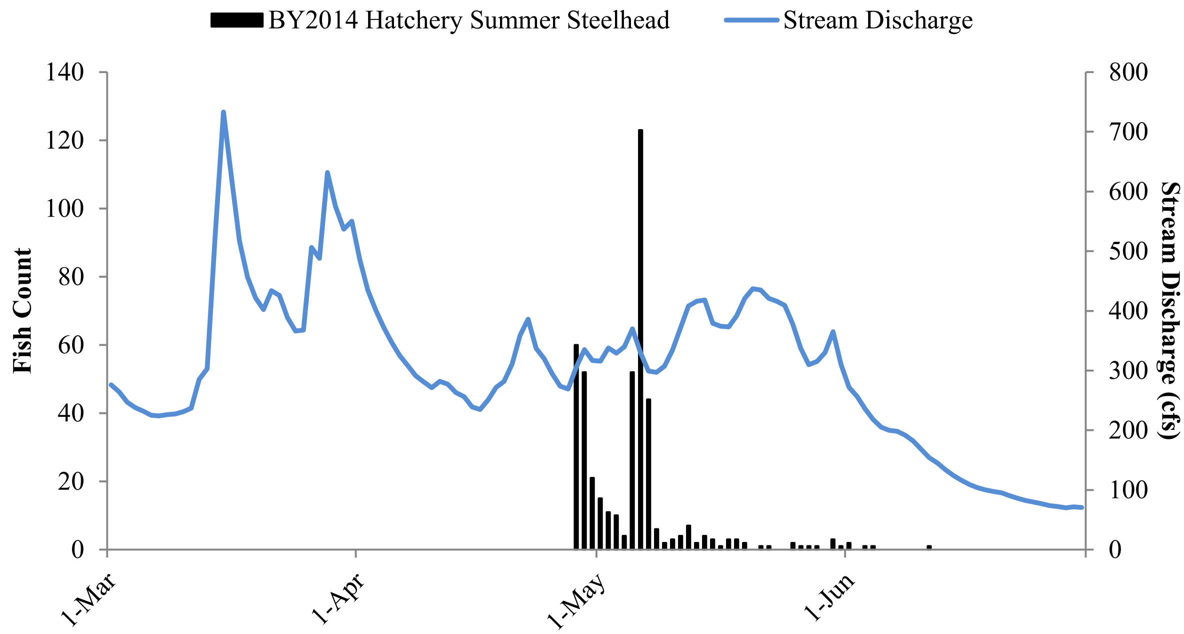


Figure 8. Daily catch of BY2014 hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.2.6 Bull Trout

Bull trout presence at the trap in 2015 was limited to a single fish with a FL of 180mm and weight of 50.1g. The bull trout was released immediately after morphometric measurements were taken. No other sampling/tagging activities were performed.

3.2.7 Coho Yearlings (BY2013)

Two naturally produced coho yearlings were captured during spring emigration between March 1 and June 30 (Figure 8). Mean FL and weight were 109mm (n = 2; SD = 4.9) and 12.0g (n = 2;

SD = 0.1), respectively (Table 5). Scale and tissue samples were not taken from naturally-produced coho smolts in 2015. There were no coho yearling mortalities.

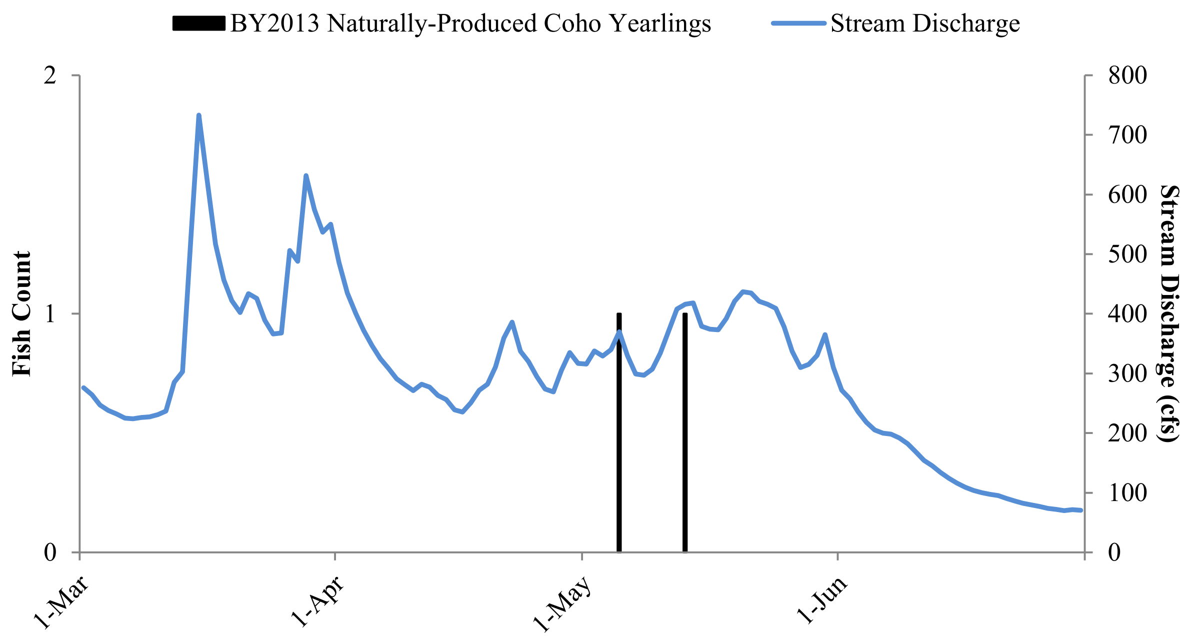


Figure 9. Daily catch of BY2013 naturally-produced coho yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

Table 4. Summary of length and weight sampling of juvenile coho salmon captured at the Nason Creek rotary trap in 2015.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2013	Naturally Produced Coho Yearling Smolts	109	2	4.9	12.0	2	0.1	0.95
2014	Naturally Produced Coho Subyearling Fry	47	7	13.7	1.4	7	1.5	0.86
2014	Naturally Produced Coho Subyearling Parr	69	3	7.0	4.0	3	1.3	1.20
2013	Hatchery Coho Yearling Smolts	131	952	9.9	23.3	952	4.8	1.03

3.2.8 Coho Subyearlings (BY2014)

A total of three naturally produced coho subyearling parr were captured during between July 1 and November 30 (Figure 9). Mean FL and weight were 69mm (*n* = 3; *SD* = 7.0) and 4.0g (*n* = 3; *SD* = 1.3), respectively. An additional seven subyearling coho fry were also captured with a mean FL of 47mm. There were no coho subyearling mortalities.

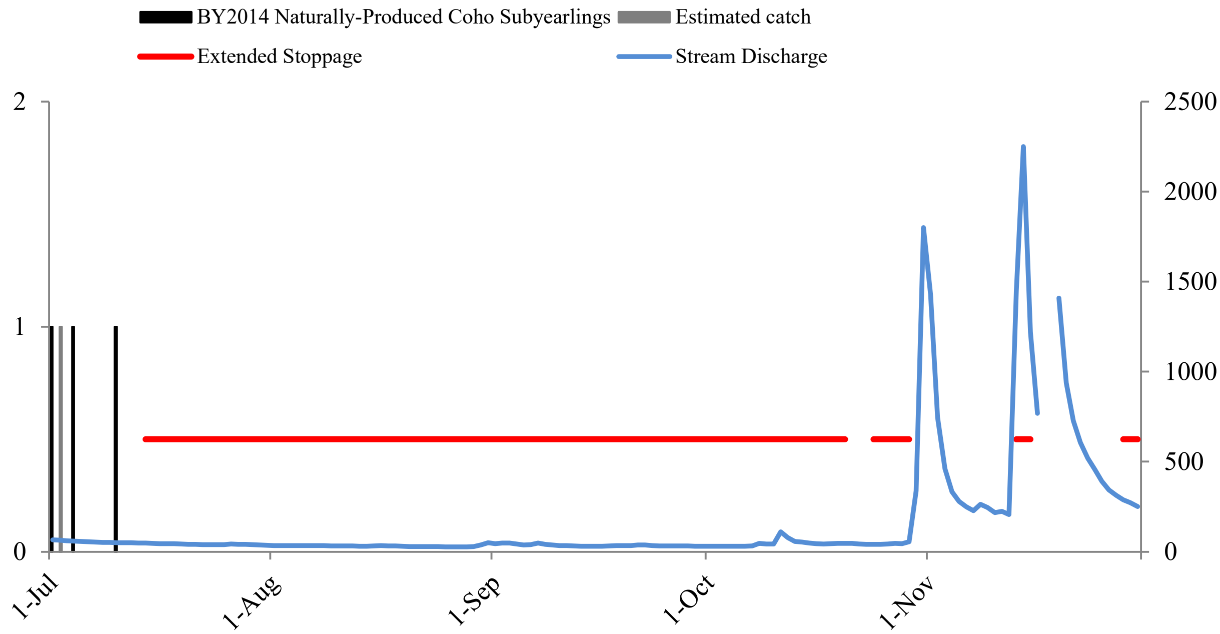


Figure 10. Daily catch of BY2014 naturally-produced coho subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2015.

3.2.9 Hatchery Coho Smolts (BY2013)

A total of 253,242 hatchery coho were released into Nason Creek above the trap in spring of 2015. 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 1,798 hatchery coho were captured at the trap (Figure 10). Mean FL was 131mm (n = 952; SD = 9.9) and mean weight was 23.3g (n = 952; SD = 4.8; Table 2). A peak daily catch of 215 hatchery coho smolts occurred on May 5 following volitional release into Nason Creek. One trapping mortality was 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.

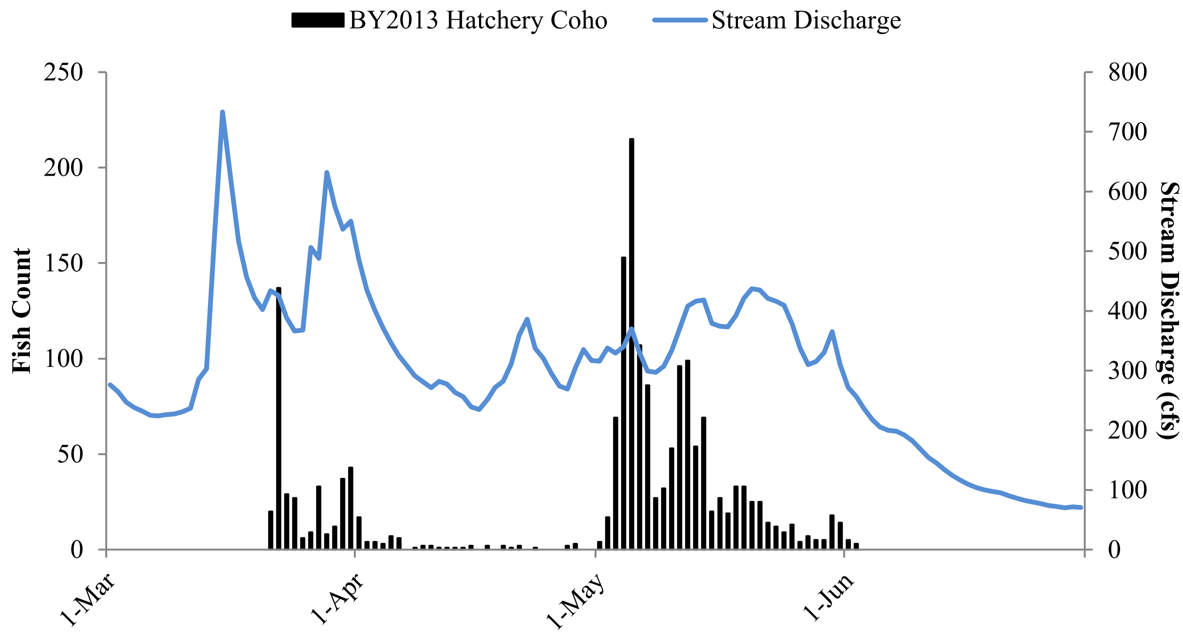


Figure 11. Daily catch of BY2013 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.3 Remote Parr Tagging (BY2013 Spring Chinook)

YNFRM and WDFW personnel PIT tagged and released a total of 1,821 BY2013 spring Chinook parr between September 22 and October 24, 2014. 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.

Between October 1 and March 30, a total of 311 re-sights of the remote tagged Chinook were documented at the NAL array (Figure 12). Of these detections, only 13 were during the winter non-trapping period. PTAGIS event logs for the NAL array indicated that it operated continuously for the duration of this time with no alterations (PTAGIS 2015).

Subsequent to the remote tagging effort, 30 remote-tagged BY2013 spring Chinook were recaptured at the Nason Creek smolt trap. Total spring Chinook catch at the smolt trap was 798 emigrants during the same period. The pooled tag rate for remote-tagged spring Chinook captured at the Nason smolt trap was 3.8%.

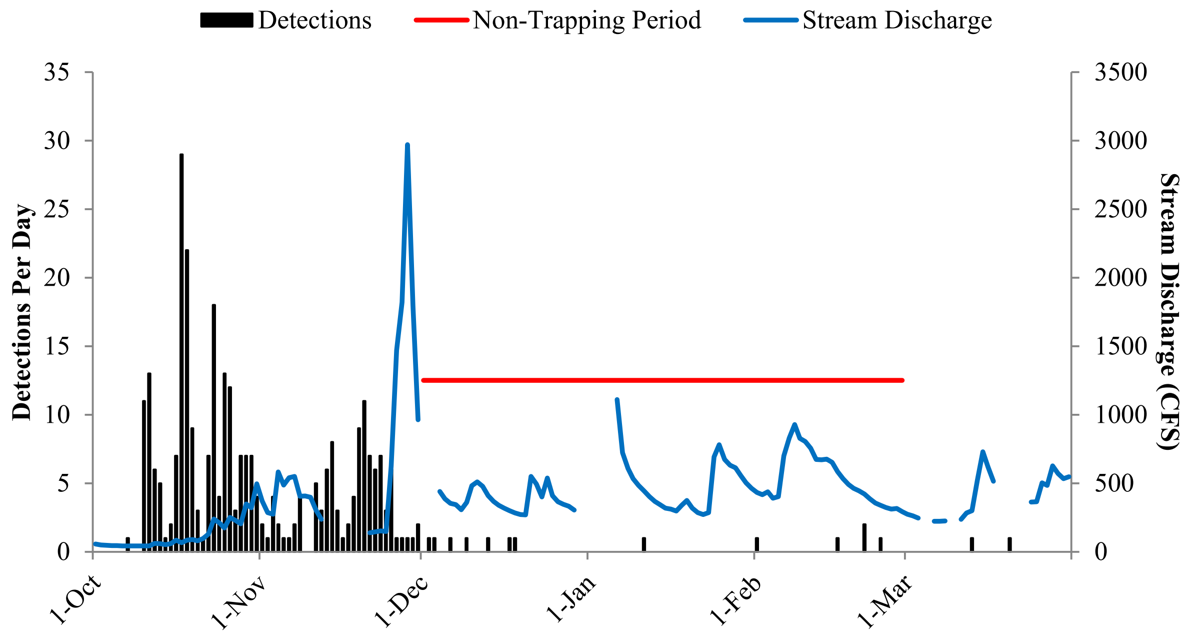


Figure 12. Daily detections of remote-tagged BY2013 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2014 and March 2015.

3.4 Trap Efficiency Calibration and Population Estimates

3.4.1 Spring Chinook Yearlings (BY2013)

Infrequent releases, low abundance, and a lack of recaptures did not allow a species-specific model to be used on BY2013 yearling emigrants. In order to produce an estimate, a pooled efficiency (2.07%) composed of spring Chinook yearling and hatchery-origin coho yearling surrogate trials 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 6,992 (± 32,823; 95% CI) BY2013 Chinook yearlings emigrated in spring of 2015 (Table 7). 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 6,822 (± 9,035; 95% CI) BY2013 spring Chinook emigrated out of Nason Creek during the non-trapping period. Combined with a recalculated BY2013 subyearling estimate of 43,711 (± 20,788; 95% CI), we estimated that a total of 57,526 (± 39,889; 95% CI) BY2013 spring Chinook juveniles emigrated from Nason Creek.

Table 5. Trap efficiency trials conducted with BY2013 wild spring Chinook yearlings and hatchery-origin coho yearling surrogates.

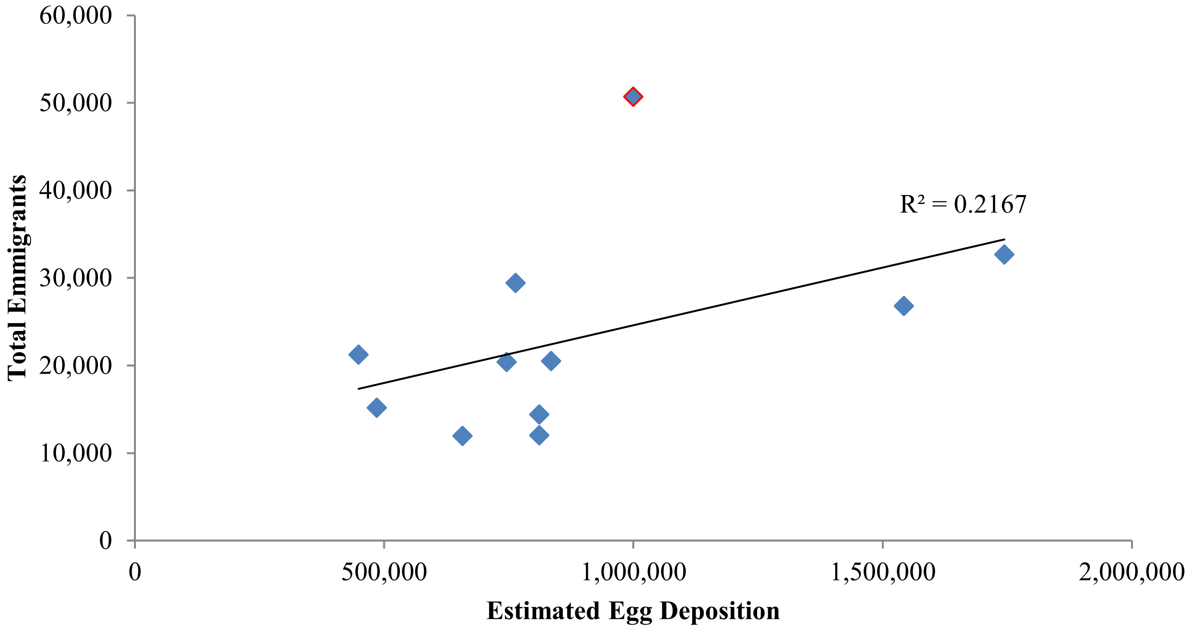
Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (cfs)
Wild Chinook Yearlings	1+	4/23/2015	7	0	337
Wild Chinook Yearlings	1+	4/27/2015	2	0	269

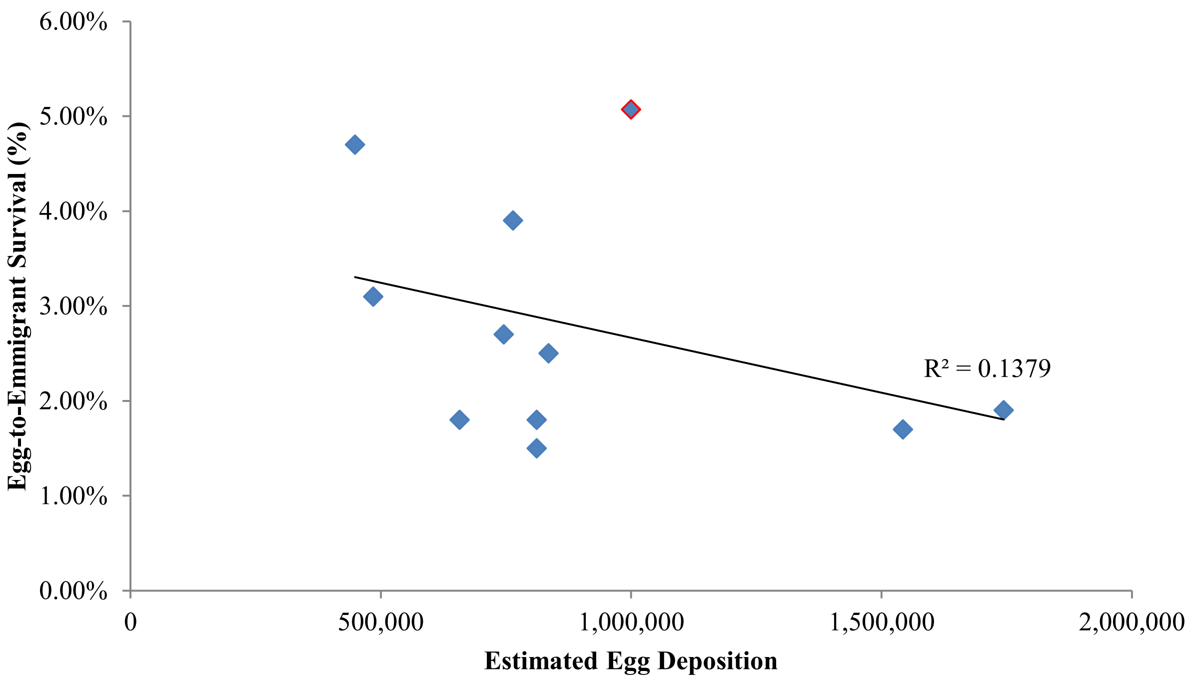
Wild Chinook Yearlings	1+	5/6/2015	5	0	330
Wild Chinook Yearlings	1+	5/10/2015	1	0	334
Wild Chinook Yearlings	1+	5/14/2015	22	0	418
Wild Chinook Yearlings	1+	5/22/2015	1	0	421
Hatchery-Origin Coho Yearlings	1+	5/5/2015	98	2	370
Hatchery-Origin Coho Yearlings	1+	5/12/2015	224	8	408
Hatchery-Origin Coho Yearlings	1+	5/14/2015	101	3	418
Hatchery-Origin Coho Yearlings	1+	5/19/2015	102	0	421
Hatchery-Origin Coho Yearlings	1+	5/23/2015	66	0	416
Total			**629**	**13**	

Table 6. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek spring Chinook salmon.

Brood Year	No. of 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	DNOT		4,683	—	—	—
2003	83	5,844	485,052	8,829		6,358	15,187 ± 1,605	3.1%	183
2004	169	4,799	811,031	11,822		2,597	14,419 ± 2,766	1.8%	85
2005	193	4,327	835,111	11,814		8,696	20,510 ± 5,018	2.5%	106
2006	152	4,324	657,248	4,144		7,798	11,942 ± 1,744	1.8%	79
2007	101	4,441	448,541	15,556		5,679	21,235 ± 2,864	4.7%	210
2008	336	4,592	1,542,912	23,182		3,611	26,793 ± 6,756	1.7%	80
2009	167	4,573	763,691	27,720		1,705	29,425 ± 12,777	3.9%	176
2010	188	4,314	811,032	8,491		3,535	12,026 ± 1,954	1.5%	64
2011	170	4,385	745,450	17,991		2,422	20,413 ± 3,889	2.7%	120
2012	413	4,223	1,744,099	28,110		4,561	32,671 ± 4,863	1.9%	79
2013	212	4,716	999,792	43,711	6,822	6,992	57,525 ± 39,889	5.8%	271
2014	115	4,467	513,705	13,903	—	—	—	—	—
Avg.c	199	4,594	894,905	18,306	—	4,905	23,831	2.9%	132

[a] Data provided by Hillman et al. 2015.
[b] Does not include subyearling fry prior to July 1.
[c] 11-year average of complete brood data, BY2003-2013.
[d] Estimated emigration during the winter non-trapping period (December 1 – February 28).


60,000
50,000
40,000
30,000
20,000
10,000
0
Total Emmigrants
R² = 0.2167
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition


6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Egg-to-Emmigrant Survival (%)
R² = 0.1379
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition

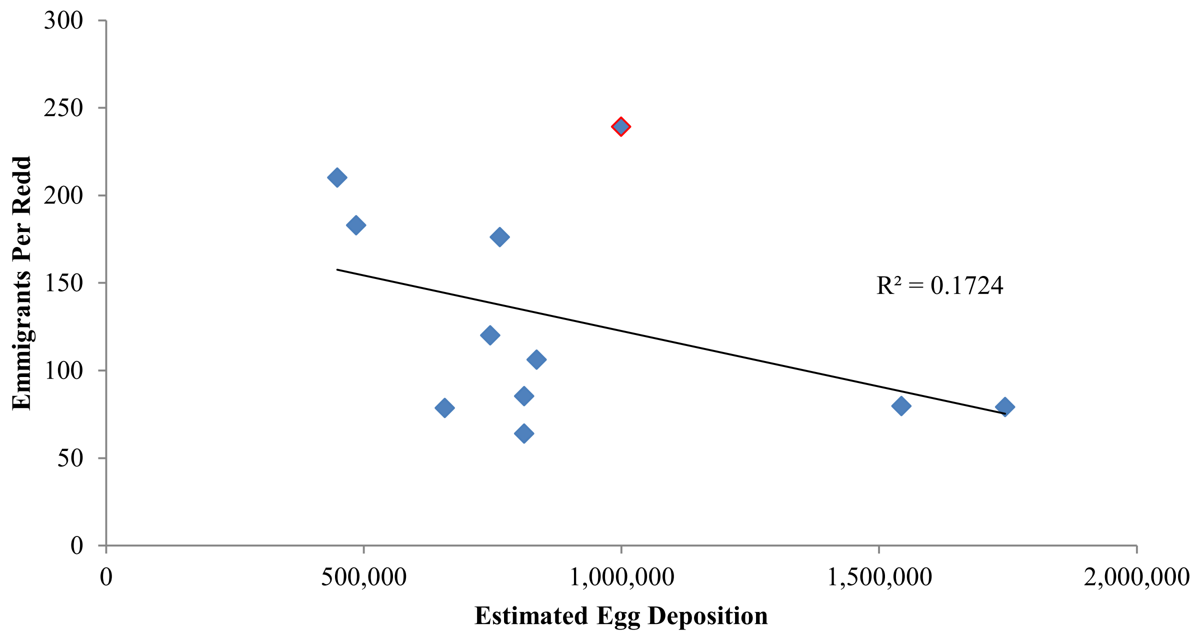


Figure 13. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2013. *2013 brood (denoted by red border) does not include non-trapping estimate.

3.4.2 Spring Chinook Subyearlings (BY2014)

A linear regression model was developed using subyearling mark groups released in the fall of 2014 and 2015. This weighted regression was not significant ($r^2 = 0.36$; $p = 0.09$) at our accepted limit ($\alpha = 0.05$). However, previous comparisons to pooled estimates suggest that linear regression analysis would be a more viable means of estimation despite less than optimal significance. Also, extreme high flows, low yearling Chinook abundance, and sporadic trap operation in the month of November would have greatly hindered the development of a pooled estimate. As a multi-year regression, this initial flow-efficiency relationship represents the starting point from which we will build further estimates. Using this model, we estimated that a total of 13,903 (± 11,963; 95% CI) BY2014 spring Chinook emigrated past the trap in the Fall of 2013 (Table 6).

Table 7. Trap efficiency trials conducted with BY2014 wild spring Chinook subyearlings.

Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (cfs)
Wild Chinook Subyearlings	0	11/3/2015	138	0	460
Wild Chinook Subyearlings	0	11/23/2015	9	0	520

3.4.3 Summer Steelhead

Low abundance of summer steelhead emigrants in the spring of 2015 required a pooled estimate be used in light of the inability to meet minimum mark-group sizes (*n* = 50) for regression analysis (Table 8). Releases of PIT-tagged steelhead were subsequently released every four days upstream at the established release location (Table 9). In a total of 13 separate trials, 116 wild summer steelhead were released upstream with only 1 recapture (0.86%). 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 22,504 (± 3,175; 95% CI) BY2014 age-1, 1,508 (± 897; 95% CI) BY2013 age-2, and 116 (± 436; 95% CI) BY2012 age-3 steelhead emigrated past the trap in 2015 (Table 10). We estimate that total (age 1-3) BY2012 emigration to be 25,566 (± 6,020; 95% CI).

Table 8. Efficiency trials conducted with wild summer steelhead juveniles.

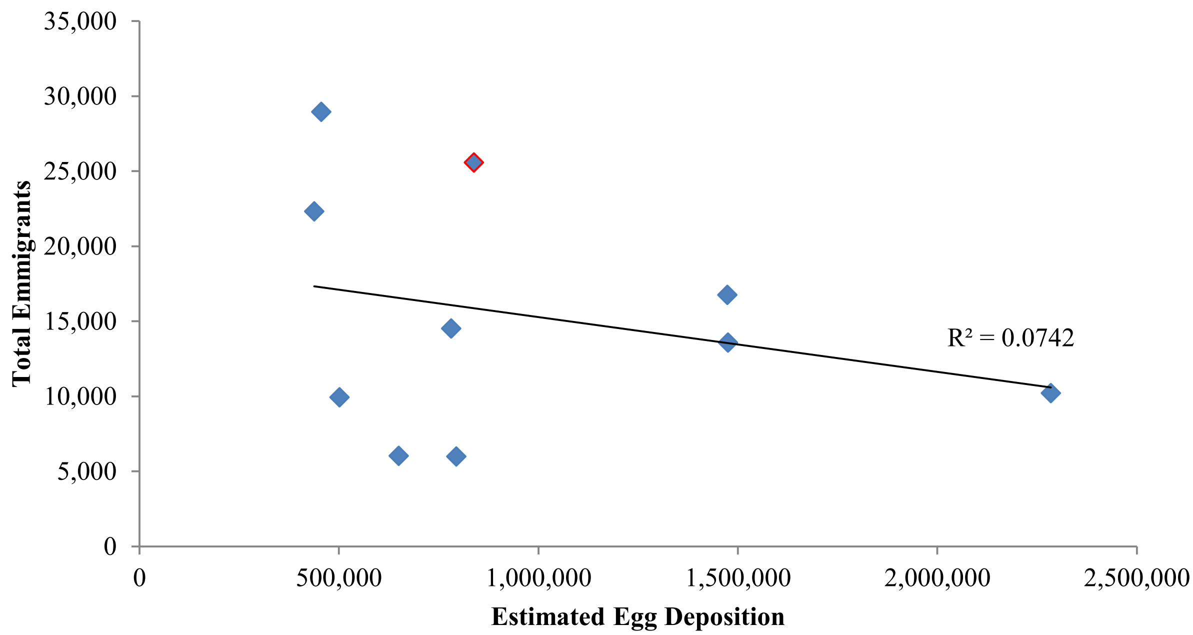
Origin/Species/Stage	Date	Marked	Recaptured	Discharge (cfs)
Wild Steelhead Parr/Smolt	4/23/2015	17	1	337
Wild Steelhead Parr/Smolt	4/27/2015	3	0	269
Wild Steelhead Parr/Smolt	5/2/2015	8	0	338
Wild Steelhead Parr/Smolt	5/6/2015	13	0	330
Wild Steelhead Parr/Smolt	5/10/2015	3	0	334
Wild Steelhead Parr/Smolt	5/14/2015	1	0	418
Wild Steelhead Parr/Smolt	5/18/2015	6	0	392
Wild Steelhead Parr/Smolt	5/22/2015	10	0	421
Wild Steelhead Parr/Smolt	5/26/2015	9	0	337
Wild Steelhead Parr/Smolt	5/30/2015	26	0	365
Wild Steelhead Parr/Smolt	6/4/2015	9	0	218
Wild Steelhead Parr/Smolt	6/8/2015	4	0	192
Wild Steelhead Parr/Smolt	6/16/2015	7	0	109
Total		**116**	**1**	

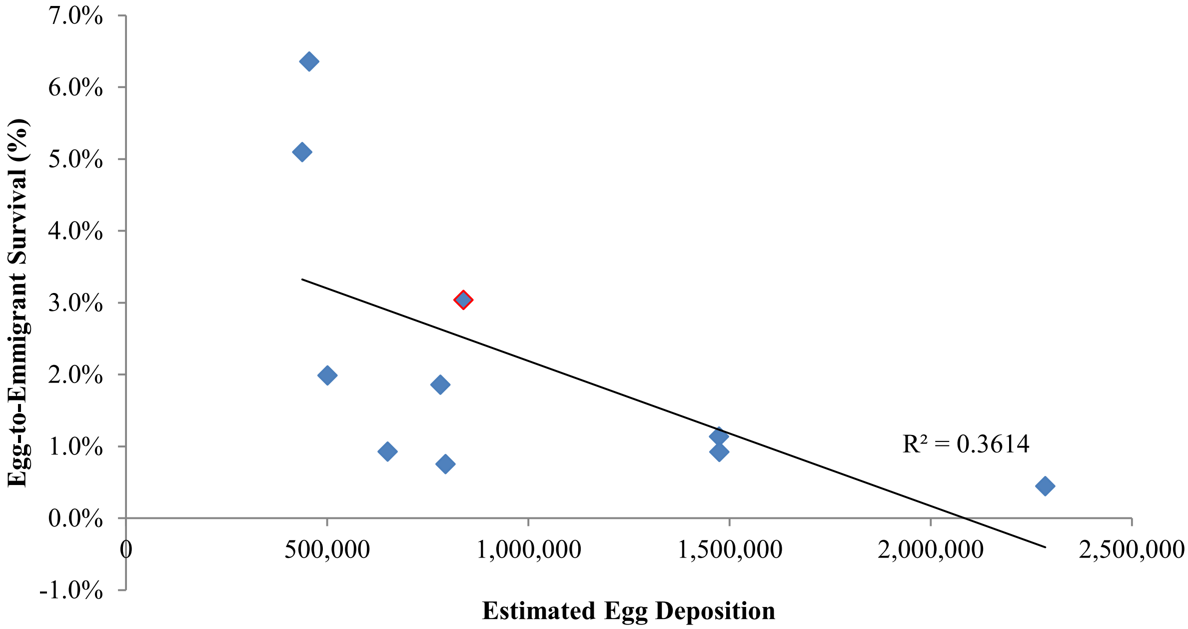
Table 9. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead.

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	0.8%	49
2004	127	5,118	649,986	5,107	906	22	6,035 ± 885	0.9%	48
2005	412	5,545	2,284,540	7,416	2,502	298	10,216 ± 2,147	0.4%	25
2006	77	5,688	437,976	19,609	2,673	37	22,319 ± 5,722	5.1%	290
2007	78	5,840	455,520	26,518	2,325	117	28,960 ± 7,739	6.4%	371

2008	88	5,693	500,984	8,782	1,164	0	9,946 ± 2,382	2.0%	113
2009	126	6,199	781,074	13,606	608	312	14,526 ± 2,868	1.9%	115
2010	270	5,458	1,473,660	12,767	3,999	0	16,776 ± 3,885	1.1%	62
2011	235	6,276	1,474,860	13,109	482	0	13,591 ± 3,525	0.9%	58
2012	158	5,309	838,822	24,637	813	116[c]	25,566 ± 6,020	3.0%	162
2013	135	5,749	777,735	11,837	1,508[c]	—	—	—	—
2014	198	5,831	1,154,538	22,504[c]	—	—	—	—	—
Avg[b]	169	5,769	969,130	13,646	1,653	90	15,380	2.3%	129

[a] Data provided by Hillman et al. 2015
[b] 10-year average of complete brood estimates, BY2003-2012
[c] Pooled estimate





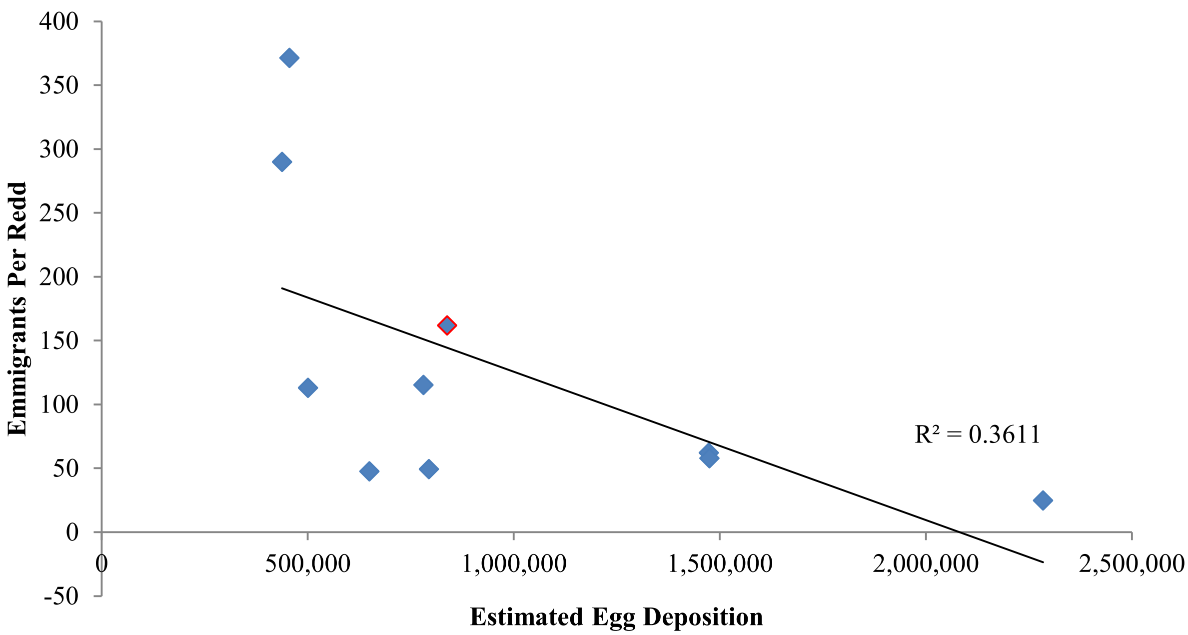


Figure 14. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2012. *2012 brood denoted by red border.

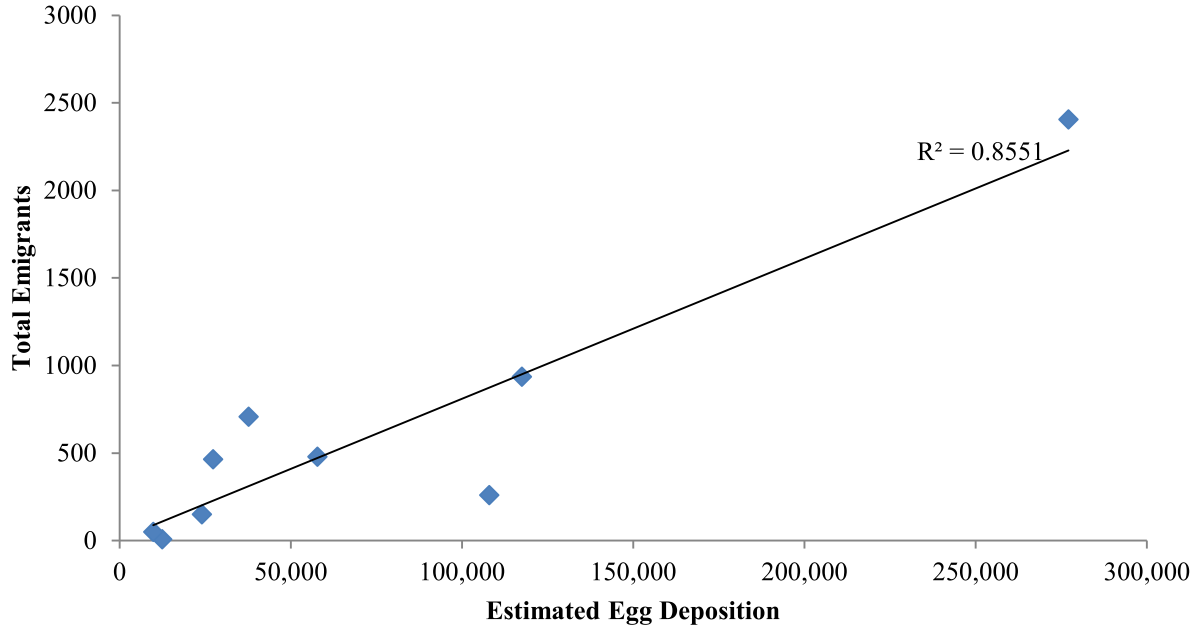
3.4.4 Coho Yearlings (BY2013)

Limited abundance of BY2013 coho yearlings did not provide any opportunities to perform any efficiency trials in the spring of 2015. In lieu of a species-specific model, a pooled estimate using releases of marked hatchery-origin coho smolts was applied to wild coho smolts. In the spring of 2015, we estimated that 91 (± 711; 95% CI) emigrated past the trap (Table 11). This gave us a total BY2013 emigrant estimate of 161 (± 714; 95% CI).

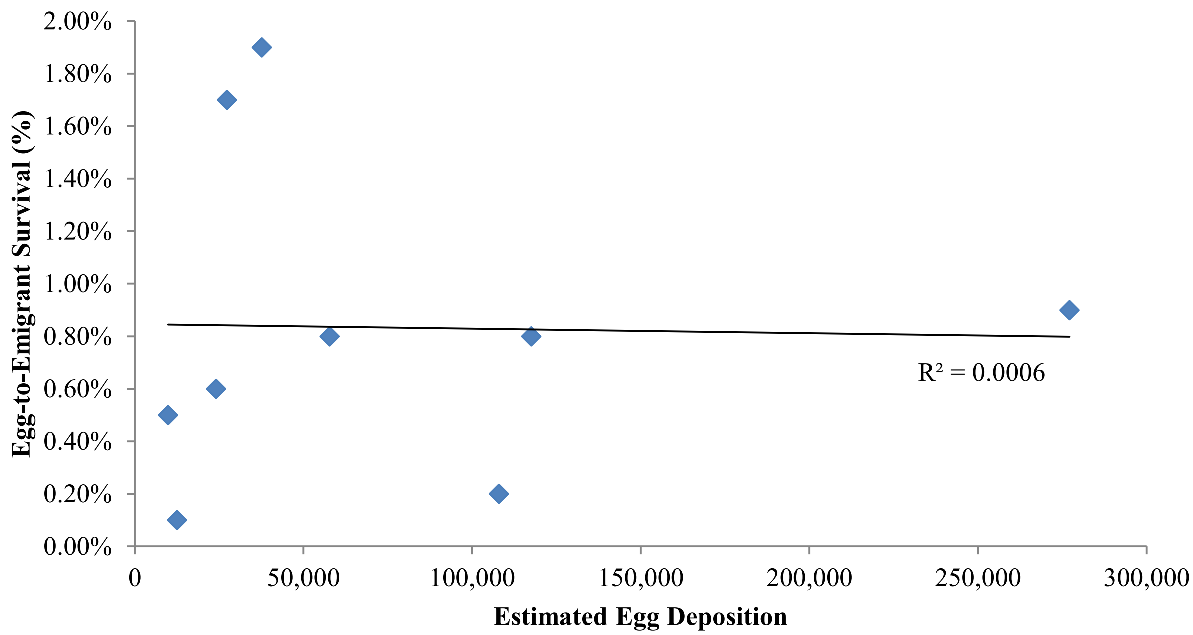
Table 10. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek coho salmon.

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	0.2%	7
2005	41	2,866	117,506	27	910	937 ± 347	0.8%	23
2006	4	3,126	12,504	7	0	7 ± 10	0.1%	2
2007	10	2,406	24,060	14	136	150 ± 104	0.6%	15
2008	3	3,275	9,825	50	0	50 ± 57	0.5%	17
2009	14	2,691	37,674	471	237	708 ± 478	1.9%	51
2010	8	3,411	27,288	27	437	464 ± 231	1.7%	58
2011	89	3,114	277,146	1,018	1,387	2,405 ± 612	0.9%	27
2012	21	2,752	57,792	46	434	480 ± 237	0.8%	23
2013	0	2,973	0	70	91	161 ± 714	NA	NA
2014	16	2,992	47,872	84	—	—	—	—
Avg.[b]	23	2,970	67,174	193	369	562	0.8%	25

[a] Does not include subyearling fry prior to July 1.
[b] 10-year average of complete brood data, BY2004-2013.



3000
2500
2000
1500
1000
500
0
Total Emigrants
R² = 0.8551
0
50,000
100,000
150,000
200,000
250,000
300,000
Estimated Egg Deposition



2.00%
1.80%
1.60%
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
Egg-to-Emigrant Survival (%)
R² = 0.0006
0
50,000
100,000
150,000
200,000
250,000
300,000
Estimated Egg Deposition

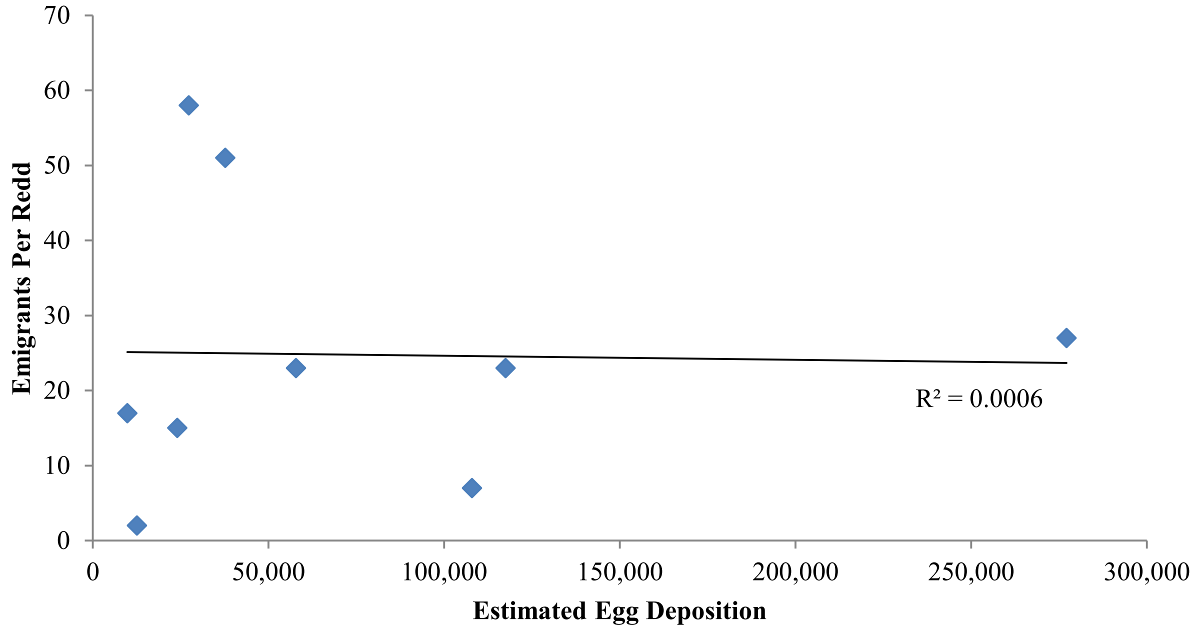


Figure 15. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek naturally-produced coho, BY 2004 to 2012.

3.4.5 Coho Subyearlings (BY2014)

A total of only three coho subyearling parr did not allow us to make any attempts to build a species/age specific a regression model at the new trap location. The subyearling spring chinook flow-efficiency regression model was used to estimate subyearling coho parr emigrants. We estimated that 84 (± 70 ; 95% CI) emigrated past the trap in the fall of 2015 (Table 11).

3.5 PIT Tagging

During the 2015 trapping season, we PIT tagged 361 wild spring Chinook, 383 steelhead, and 2 naturally produced coho (Table 12). All tagging files were submitted to the PTAGIS database. One shed PIT tag (implanted in steelhead parr) was recovered in holding boxes where fish had been held for 24-72 hours after tagging.

Table 11. Number of PIT tagged coho, Chinook, and steelhead with shed rates at the Nason Creek rotary trap in 2015.

Species/Stage	Year-to-date Catch	Year-to-date PIT Tagged	No. of Shed Tags	Percent Shed Tags
Chinook Yearling Smolt	152	142	0	0.00%
Chinook Subyearling Parr (Mar 1 to June 30)	111	28	0	0.00%
Chinook Subyearling Parr (July 1 to Nov 30)	201	191	0	0.00%
Steelhead Parr	388	371	1	0.27%
Steelhead Smolt	12	12	0	0.00%

Coho Yearling Smolt	2	2	0	0.00%
Coho Subyearling Parr	5	0	—	—

* Counts do not include fish with FL<50mm (fry).

During remote tagging efforts in the fall of 2014, 1,893 spring Chinook were PIT tagged by YNFRM and WDFW personnel. Of the total tagged, 78% were held overnight to determine tag retention. Shed rate for this tagging effort was 0.07%.

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 13 are: bull trout *Salvelinus confluentus*, cutthroat trout *Oncorhynchus clarki*, fathead minnow *Pimephales promelas*, longnose dace *Rhinichthys cataractae*, northern pikeminnow *Ptychocheilus oregonensis*, redside shiner *Richardsonius balteatus,* sculpin *Cottus sp.,* sucker *Catostomus sp.,* summer sockeye salmon fry *Oncorhynchus nerka*, and mountain whitefish *Prosopium williamsoni*.

Table 12. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2015.

Species	Total Count	Length (mm)			Weight (g)		
		Mean	N	SD	Mean	N	SD
Bull Trout	1	180	1	—	50.1	1	—
Cutthroat Trout	1	168	1	—	45.3	1	—
Fathead Minnow	2	46	2	12.0	1.1	2	0.9
Longnose Dace	117	92	117	24.8	11.7	116	6.6
Northern Pikeminnow	11	142	11	78.9	58.4	11	78.8
Redside Shiner	8	58	8	13.8	2.8	7	1.1
Sculpin	81	78	81	38.7	12.3	78	17.3
Sucker	39	120	39	91.4	20.7	34	58.5
Summer Sockeye Fry	2	32	2	8.5	0.5	1	—
Whitefish Fry	4	40	4	9.3	0.8	3	0.1
Whitefish	21	97	21	68.8	25.0	20	65.5

3.7 ESA Compliance

The Nason Creek smolt trap was operated under consultation with 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. Lethal take was well below the allowable level of 2% for wild summer steelhead, hatchery summer steelhead, and bull trout (Table 14). Final spring Chinook lethal take for 2015 was at the 2% maximum. Exceedance of this maximum in early March was addressed in a memo sent to NMFS (See Appendix D). Stream temperatures did not exceed 18˚C at any time in which fish were being handled.

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 (BY2013)	152	5*	3.29%
Spring Chinook Subyearling (BY 2014)	548	9*	1.64%
Total Wild Spring Chinook	**700**	**14**	**2.00%**
Total Hatchery Spring Chinook	**714**	**0**	**0.00%**
Steelhead Age-0 (BY2015)	182	1	0.55%
Steelhead Age-1 (BY2014)	233	1	0.43%
Steelhead Age-2 (BY2013)	28	0	0.00%
Steelhead Age-3 (BY2012)	1	0	0.00%
Total Wild Summer Steelhead	**444**	**2**	**0.45%**
Total Hatchery Summer Steelhead	**448**	**1**	**0.22%**
Total Bull Trout	**1**	**0**	**0.00%**
Coho Yearling (BY2013)	2	0	0.00%
Coho Subyearling (BY2014)	5	1	20.00%
Total Naturally-Produced Coho	**7**	**1**	**14.29%**

*Majority occurring during incident detailed in Appendix D.

4.0 DISCUSSION

Operations in 2015 marked the first full season of continuous trapping at the Bolser site. Preliminary trapping this new site has achieved the goal of minimizing interactions with the public; we have yet to encounter any act of vandalism or tampering with the trap since the move. Aside from the benefit of added safety to the public and captured fish, relocation of the Nason Creek trap was intended to improve the quality of data collected via simplified trapping regime and favorable channel morphology. Initial subyearling Chinook releases in the fall of 2014 suggested that the flow-efficiency relationship was statistically significant at the flows tested (r^2 =0.63, p = 0.007). However, in three of the contributing trials, a stoppage or inconsistent operation during the recapture period dictated that they be omitted from any expansions performed (non-continuous operation of the trap in the 3-day recapture period is a violation of our estimation protocol). Although the flow-efficiency regression was ultimately rendered unusable, subyearling Chinook efficiency trials in 2014 were an indication that a consistent flow-efficiency relationship is present at the new site.

Attempts to further develop our flow-efficiency models in 2015 were largely prevented by extreme low spring/summer and high fall flow conditions, as well as low fish abundance. Steelhead and Chinook mark-group releases were generally small ($n \leq 26$), providing little chance for recaptures given potentially low trap efficiency. A single large release of 138 subyearling spring Chinook on November 3 failed to produce any recaptures, initially suggesting a trap efficiency of less than 1.0%. Later examination of daily subyearling spring Chinook catch showed that the release was performed concurrently with a significant drop in abundance, from 89 to 6 fish captured. The release also coincided with a rapidly decreasing hydrograph following a significant peak in discharge. The precipitous drop in catch may have resulted in a lack of active migration, with the spring Chinook subyearlings becoming less prone to downstream displacement as flows subsided. The suspected non-migratory behavior of spring Chinook subyearlings in Nason Creek during that period likely contributed to a lack of recaptures despite the large mark-group size. However, given that the trial occurred during the recognized subyearling spring Chinook migratory period and lacked any violations of release or trapping protocols, it was deemed valid.

With viable regression models unavailable for all species/stages, pooled estimates were predominantly used. These estimates were used as a means to produce some form of emigrant estimate, albeit with a higher degree of bias. All pooled estimates reported are considered provisional, and will be recalculated as viable flow-efficiency regressions are developed.

Spring Chinook

Nason Creek spring Chinook egg-to-emigrant survival rates are generally lower than those of the Chiwawa River and White River populations (Figure 16). However, the 2013 Nason Creek spring Chinook brood deviated from this trend markedly, with an survival rate exceeding those of the other two tributaries. Whereas the Chiwawa River and White River populations saw egg-to-emigrant survival rates typical of their corresponding estimated egg depositions in 2013, Nason Creek produced an outlier value (Figures 13 & 17). The total BY2013 spring Chinook estimate (excluding the non-trapping period) of 50,703 (± 38,852; 95% CI) emigrants greatly exceeded the corresponding 11-year average (n = 23,211).

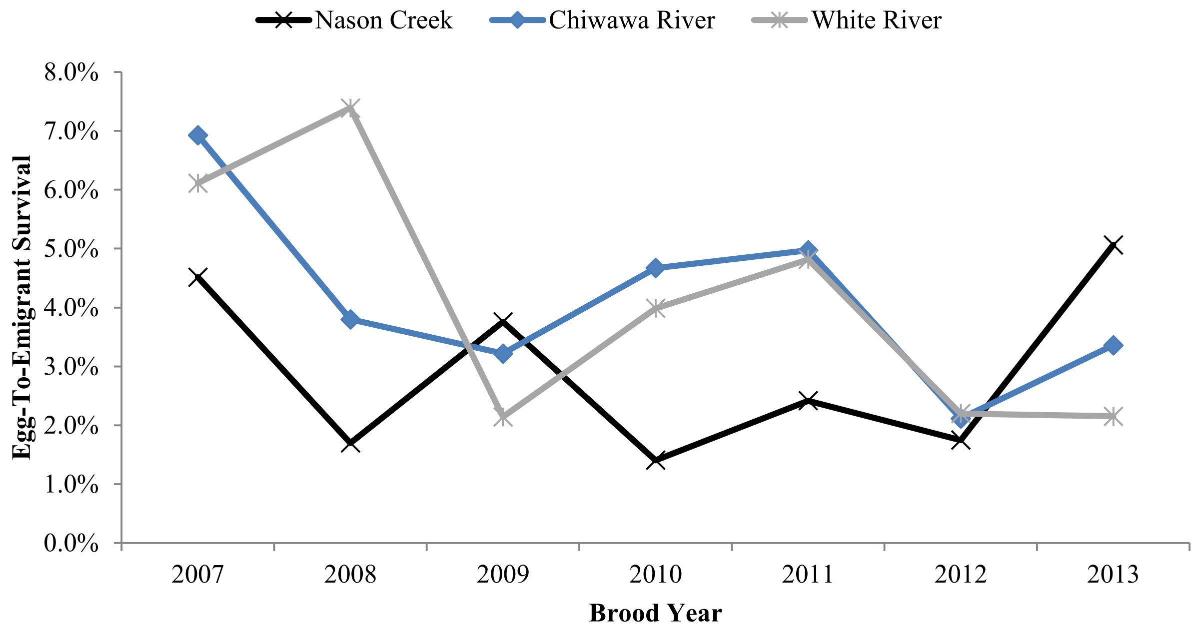


Figure 16. Comparison of wild spring Chinook abundance estimates (BY2007-2013) made at the White River, Nason Creek, and Chiwawa River smolt traps. *Non-trapping estimates not included.

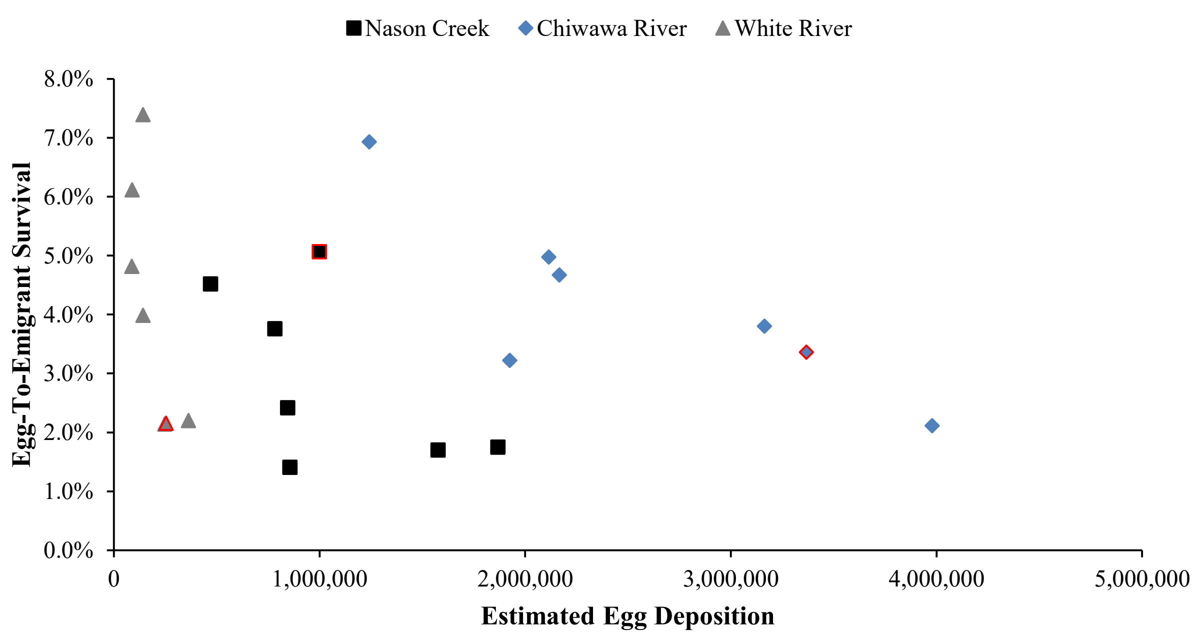


Figure 17. Comparison of egg-to-emigrant survival (BY 2007-2013) and egg deposition for Nason Creek, Chiwawa River, and White River spring Chinook. *Non-trapping estimates not included.

Though possible that the Nason Creek population alone saw above-average survival, it is likely that some degree of overestimation by our modeled and pooled estimates occurred. Composed primarily of smaller ($n \leq 96$) trials, the weighted (mark-group size) model was heavily influenced by the aforementiomned large (n = 138) release in 2015 that did not produce any recaptures. Because the unsuccessful trial was performed at the high end of the discharge range tested, it decreased the slope of the regression, and therefore the trap efficiencies used to expand catch at elevated flows. Additional trials at higher flows will mitigate the effect of this subyearling release outlier and likely produce a lower emigrant estimate when recalculated. Overestimation of the yearling pooled estimate was also likely influenced by a lack of consistent releases throughout the migratory period. We expect that eventual recalculation of BY2013 yearlings will also contribute to a lowering of the overall emigrant estimate.

The non-trapping period estimate of 6,822 (± 9,035; 95% CI) BY2013 migrants suggests that movement out of the system was present in the winter, but at a much lower rate in comparison to the fall. Winter emigration for the 2013 spring Chinook brood accounted for 11.9% of the total estimate, whereas fall subyearling migrants made up a total of 76.0%. Yearling spring emigrants composed a slightly larger proportion than non-trapping period, with 12.1% of the total run. Upon eventual recalculation of the BY2013 trapping estimates, proportion of non-trapping period to total run will likely increase as the smolt trap-derived estimates decrease. Although detections during the winter confirm movement, they are too few and infrequent to determine fine-scale temporal trends in emigration and/or relation to environmental conditions.

Summer Steelhead

The pooled estimate used to expand 2015 steelhead migrants was based on 13 mark-groups; a total of 116 fish released, and 1 recapture. Consequently, the model tended to overestimate emigrant abundance as an efficiency of 0.86% was used to expand all daily catch. With no prior mark-group releases at this location, we are unsure if the low efficiency observed is accurate, or the product of the abnormally low water-year and its potential effects on steelhead migratory behavior. Comparisons of yearling Chinook and hatchery coho efficiencies at the new trap site to those of the old show they are comparatively lower, but not to the degree seen in 2015 summer steelhead migrants.

The total estimate of 25,566 (± 6,020; 95% CI) BY2012 steelhead exceeded the 10-year mean of 15,380 emigrants, and was the second highest estimate in the past 10 broods. Although the model used to expand age-3 fish was admittedly skewed toward overestimation, their contribution to the overall estimate was small (n = 116), and therefore did not impact it greatly. Both models used to calculate the bulk of the estimate (age-1 and age-2) were satistically robust ($\alpha \leq 0.05$); the product of trapping at the former site. The above-average emigrant survival and emigrants per redd of the 2012 brood despite relatively low egg deposition is characteristic of Nason Creek. In previous years, the highest rates of survival have corresponded to the lowest levels of spawner success, suggesting denstiy-dependence.

The migratory timing of summer steelhead captured in 2015 was typical of what we have previously seen in Nason Creek. Of the steelhead caught in the spring migratory period, 81.5% were were age-1, with age-2 (5.4%) and age-3 (0.4%) classes constituting a small portion of the total. The majority of the summer/fall non-migratory period was not trapped as a consequence of low flows. This period is normally dominated by young-of-the-year fry and parr.

Coho

A poor return of adult coho in 2013 required exhaustive measures to collect program broodstock, including increased retention at Tumwater Dam (Kamphaus et al. 2016). As a result, a limited number of adult coho (n =32) were allowed to pass into the upper-basin. Spawner escapement into Nason Creek was estimated at zero fish, with no redds documented during surveys in the fall of 2013. We attribute the capture of natural-origin coho to surveyor error, which may have lead to one or more redds to go unseen.

The BY2013 naturally-produced coho estimate of 161 (± 714; 95% CI) was likely overestimated to some degree by the under-developed models used for expansion. Despite the likely overestimation, the BY2013 estimate was less than the 10-year mean emigrant abundace (n = 562), and the third lowest estimate thus far at Nason Creek. We assume that the comparatively low estimate is a reflection of the poor spawner escapement of 2013. Recalculation of BY2013 emigrants will likely produce and even lower emigrant abudance.

2016 Trap Operations at Nason Creek

Pooled estimates have been used here, and in previous reports as an alternative when regression analysis is not feasible. However, this has proven problematic as each method requires a different efficiency-testing strategy. While flow-efficiency modeling can be built by gauging efficiency at specific flows over multiple years, a pooled estimate is based on regular releases over discrete strata. Pooled estimates based on few, unevenly-spaced releases will utimately be skewed toward the efficiencies of the discrete periods tested, not the entire migratory period. Recognizing the necessity to produce viable models depite potentially low emigrant abundaces in 2016, we have revised our system of efficiency trials to accommodate both pooled, and regression models. Along with the accustomed targeting of specific flows, regular releases at even intervals will occur throughout the year. Regardless of mark group size, or flows tested, migratory juveniles will be transported every three to four days upstream to be released. In doing so, we will ensure that estimates made with either methodology are as sound as possible.

Additionally, we will verify that the location of our upstream release point upholds smolt trapping assumption 3: that marked fish are randomly dispersed in the population prior to recapture. Currently, marked fish are released evenly on both sides of the creek to eliminate the potential bias of a single release point on one bank. In 2016, pre-release scans of both right, and left-bank release-groups will test if recapture probability differs depending on the side of the channel. In the event that recapture rates are markedly different between the two sites, we will pursue a different release point.

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APPENDIX A. Daily Stream Discharge and Stream Temperature

Date	Stream Discharge (CFS)	Water Temperature (˚C)
1/1/2015		0.0
1/2/2015		0.0
1/3/2015		0.0
1/4/2015		0.0
1/5/2015		0.2
1/6/2015	1110	1.8
1/7/2015	723	2.2
1/8/2015	607	1.9
1/9/2015	534	2.4
1/10/2015	485	2.4
1/11/2015	444	2.6
1/12/2015	402	2.6
1/13/2015	368	2.3
1/14/2015	343	2.1
1/15/2015	319	1.7
1/16/2015	311	1.3
1/17/2015	296	1.1
1/18/2015	338	0.5
1/19/2015	375	2.0
1/20/2015	318	1.6
1/21/2015	285	0.8
1/22/2015	272	1.7
1/23/2015	286	2.5
1/24/2015	691	2.5
1/25/2015	781	2.7
1/26/2015	673	2.5
1/27/2015	632	2.8
1/28/2015	613	2.9
1/29/2015	556	2.4
1/30/2015	503	2.1
1/31/2015	463	2.2
2/1/2015	433	2.3
2/2/2015	417	2.2
2/3/2015	438	2.8
2/4/2015	392	2.8
2/5/2015	404	2.4
2/6/2015	701	2.8
2/7/2015	832	3.1
2/8/2015	929	3.2
2/9/2015	829	3.6
2/10/2015	804	3.7
2/11/2015	756	3.5
2/12/2015	675	3.8
2/13/2015	674	3.9
2/14/2015	677	3.9
2/15/2015	653	3.1
2/16/2015	587	2.6
2/17/2015	536	2.6
2/18/2015	492	2.6
2/19/2015	463	3.6
2/20/2015	447	3.9
2/21/2015	422	3.3
2/22/2015	387	2.6
2/23/2015	357	1.9
2/24/2015	341	2.5
2/25/2015	323	3.4
2/26/2015	312	4.2
2/27/2015	317	4.0
2/28/2015	295	3.3
3/1/2015	276	2.7
3/2/2015	264	3.2
3/3/2015	247	2.4
3/4/2015	238	2.2
3/5/2015	232	2.8
3/6/2015	225	3.9
3/7/2015	224	4.3
3/8/2015	226	4.3
3/9/2015	227	4.5
3/10/2015	231	4.4
3/11/2015	237	5.2
3/12/2015	285	5.8
3/13/2015	303	4.9
3/14/2015	526	5.3
3/15/2015	733	3.9
3/16/2015	624	4.0
3/17/2015	517	4.2
3/18/2015	457	4.9
3/19/2015	422	4.8
3/20/2015	402	5.3
3/21/2015	434	5.5
3/22/2015	426	4.2
3/23/2015	389	4.5

3/24/2015	366	5.1	5/8/2015	297	8.9
3/25/2015	368	4.7	5/9/2015	307	9.2
3/26/2015	506	5.7	5/10/2015	334	9.2
3/27/2015	488	5.8	5/11/2015	371	10.0
3/28/2015	632	5.9	5/12/2015	408	7.9
3/29/2015	575	5.6	5/13/2015	416	7.5
3/30/2015	537	6.1	5/14/2015	418	8.0
3/31/2015	550	5.8	5/15/2015	379	9.1
4/1/2015	486	4.8	5/16/2015	374	9.9
4/2/2015	435	4.7	5/17/2015	373	8.4
4/3/2015	401	4.4	5/18/2015	392	10.0
4/4/2015	372	4.7	5/19/2015	421	10.4
4/5/2015	347	4.2	5/20/2015	437	10.8
4/6/2015	325	4.1	5/21/2015	435	10.8
4/7/2015	308	4.4	5/22/2015	421	10.4
4/8/2015	291	5.3	5/23/2015	416	11.4
4/9/2015	281	5.7	5/24/2015	409	11.5
4/10/2015	271	5.7	5/25/2015	378	10.9
4/11/2015	282	5.7	5/26/2015	337	10.3
4/12/2015	277	4.3	5/27/2015	310	11.5
4/13/2015	263	4.8	5/28/2015	315	12.1
4/14/2015	256	5.5	5/29/2015	330	11.9
4/15/2015	239	5.3	5/30/2015	365	12.7
4/16/2015	235	6.2	5/31/2015	310	12.2
4/17/2015	251	7.3	6/1/2015	272	11.9
4/18/2015	272	7.8	6/2/2015	257	11.2
4/19/2015	282	8.0	6/3/2015	236	11.8
4/20/2015	311	8.3	6/4/2015	218	12.6
4/21/2015	359	8.2	6/5/2015	205	13.8
4/22/2015	386	7.2	6/6/2015	200	15.0
4/23/2015	337	6.0	6/7/2015	198	15.9
4/24/2015	320	5.5	6/8/2015	192	16.5
4/25/2015	295	5.7	6/9/2015	182	16.3
4/26/2015	274	5.9	6/10/2015	168	16.1
4/27/2015	269	7.9	6/11/2015	154	15.6
4/28/2015	305	8.7	6/12/2015	145	14.6
4/29/2015	335	8.1	6/13/2015	134	13.8
4/30/2015	317	7.7	6/14/2015	124	14.4
5/1/2015	316	8.6	6/15/2015	116	14.9
5/2/2015	338	8.5	6/16/2015	109	16.0
5/3/2015	329	8.2	6/17/2015	104	16.6
5/4/2015	340	8.4	6/18/2015	100	16.0
5/5/2015	370	7.9	6/19/2015	97.2	15.4
5/6/2015	330	6.6	6/20/2015	95.1	15.2
5/7/2015	299	7.8	6/21/2015	90.3	15.2

6/22/2015	85.9	15.6	8/6/2015	33.7	18.2
6/23/2015	82.1	16.4	8/7/2015	34.1	18.2
6/24/2015	79.6	16.7	8/8/2015	33.1	18.8
6/25/2015	76.9	17.2	8/9/2015	32.3	18.8
6/26/2015	74	19.2	8/10/2015	32.2	19.9
6/27/2015	72.1	20.0	8/11/2015	31.8	18.7
6/28/2015	70.2	20.6	8/12/2015	31.7	19.1
6/29/2015	71.8	21.1	8/13/2015	30.4	20.4
6/30/2015	70.5	21.2	8/14/2015	30.3	19.8
7/1/2015	66.2	21.1	8/15/2015	31.9	17.6
7/2/2015	63.8	21.2	8/16/2015	33.4	16.9
7/3/2015	61.1	21.3	8/17/2015	32.2	17.7
7/4/2015	58.8	21.3	8/18/2015	31.2	18.2
7/5/2015	56.8	20.9	8/19/2015	30	18.9
7/6/2015	55.2	20.6	8/20/2015	28.9	19.2
7/7/2015	53.5	20.3	8/21/2015	28.5	18.0
7/8/2015	52.5	20.8	8/22/2015	28.7	16.4
7/9/2015	50.9	21.3	8/23/2015	28.6	16.0
7/10/2015	49.7	20.7	8/24/2015	28	16.8
7/11/2015	49.5	18.8	8/25/2015	27.5	17.0
7/12/2015	50.2	17.8	8/26/2015	27.5	17.1
7/13/2015	48.9	18.4	8/27/2015	27	17.8
7/14/2015	47.8	18.8	8/28/2015	27.1	17.9
7/15/2015	46.5	18.7	8/29/2015	29	16.5
7/16/2015	45.3	18.4	8/30/2015	37.1	15.5
7/17/2015	44.8	18.5	8/31/2015	49.4	14.1
7/18/2015	43.9	19.5	9/1/2015	43.9	14.2
7/19/2015	42.7	20.9	9/2/2015	47.7	14.5
7/20/2015	41.1	21.3	9/3/2015	48.1	13.3
7/21/2015	40.1	19.7	9/4/2015	42.2	12.8
7/22/2015	39.7	18.4	9/5/2015	37.1	12.9
7/23/2015	39.6	18.3	9/6/2015	38.6	12.7
7/24/2015	39.3	18.1	9/7/2015	48	13.4
7/25/2015	40	17.3	9/8/2015	40.4	13.9
7/26/2015	42.7	17.2	9/9/2015	37.2	14.6
7/27/2015	41.5	17.0	9/10/2015	34.7	15.3
7/28/2015	40.2	17.7	9/11/2015	33	15.5
7/29/2015	38.8	18.9	9/12/2015	32	15.9
7/30/2015	37.2	19.5	9/13/2015	30.6	16.3
7/31/2015	35.9	19.8	9/14/2015	30.1	13.8
8/1/2015	34.7	20.0	9/15/2015	30.5	12.1
8/2/2015	33.9	20.0	9/16/2015	30.8	11.9
8/3/2015	33.1	19.3	9/17/2015	31.4	11.8
8/4/2015	33.7	18.8	9/18/2015	34.3	12.7
8/5/2015	33.2	18.5	9/19/2015	34.2	12.8

9/20/2015	33.4	13.7	11/4/2015	333	4.6
9/21/2015	38.1	14.1	11/5/2015	280	5.4
9/22/2015	38	12.2	11/6/2015	249	5.3
9/23/2015	33.8	11.6	11/7/2015	228	6.0
9/24/2015	32.5	12.5	11/8/2015	263	6.1
9/25/2015	32	13.0	11/9/2015	245	5.3
9/26/2015	32	12.7	11/10/2015		
9/27/2015	31.7	10.6	11/11/2015		
9/28/2015	31.3	10.0	11/12/2015		
9/29/2015	30.8	9.9	11/13/2015	1450	4.2
9/30/2015	30.5	10.3	11/14/2015	2250	5.3
10/1/2015	30.1	10.9	11/15/2015	1220	5.0
10/2/2015	29.7	11.5	11/16/2015		
10/3/2015	29.5	12.1	11/17/2015		2.6
10/4/2015	30	11.3	11/18/2015		3.5
10/5/2015	30.1	10.4	11/19/2015	1410	3.9
10/6/2015	29.9		11/20/2015	938	2.9
10/7/2015	31.9	11.1	11/21/2015	728	2.1
10/8/2015	46.9	11.6	11/22/2015	607	2.0
10/9/2015	42.8	12.2	11/23/2015	520	2.1
10/10/2015	42.2	12.3	11/24/2015	457	2.8
10/11/2015	111	11.0	11/25/2015	391	2.1
10/12/2015	78.3	9.9	11/26/2015	343	0.8
10/13/2015	56.2	11.4	11/27/2015	313	0.4
10/14/2015	53.4	9.6	11/28/2015	288	0.1
10/15/2015	47.9	8.8	11/29/2015	273	0.0
10/16/2015	44.8	8.5	11/30/2015	251	0.2
10/17/2015	43	9.1	12/1/2015	234	0.4
10/18/2015	43.8	10.6	12/2/2015	226	0.8
10/19/2015	46.8	10.9	12/3/2015	222	0.7
10/20/2015	46	10.4	12/4/2015	210	2.0
10/21/2015	45.5	9.3	12/5/2015	203	1.7
10/22/2015	43	8.9	12/6/2015	198	1.5
10/23/2015	41.7	7.8	12/7/2015		
10/24/2015	40.7	7.0	12/8/2015	848	1.5
10/25/2015	40.9	7.4	12/9/2015	2730	1.6
10/26/2015	42.8	8.7	12/10/2015	1370	2.3
10/27/2015	45.7	8.2	12/11/2015	915	2.9
10/28/2015			12/12/2015		
10/29/2015	54.9	8.5	12/13/2015		
10/30/2015	338	8.3	12/14/2015	551	2.7
10/31/2015	1800	7.6	12/15/2015	486	2.5
11/1/2015	1430	6.8	12/16/2015	444	2.5
11/2/2015	745	6.2	12/17/2015	409	1.0
11/3/2015	460	5.6	12/18/2015	387	0.7

12/19/2015	357	1.3
12/20/2015	332	1.5
12/21/2015	318	0.8
12/22/2015	298	1.2
12/23/2015	285	1.1
12/24/2015	269	1.0
12/25/2015	248	1.3
12/26/2015	232	0.7
12/27/2015	225	0.3
12/28/2015	217	0.7
12/29/2015	207	1.2
12/30/2015	197	0.8
12/31/2015	184	0.1

APPENDIX B. Daily Trap Operation

Date	Trap Status	Comments
3/1/2015	Op.	
3/2/2015	Op.	
3/3/2015	Op.	
3/4/2015	Op.	
3/5/2015	Op.	
3/6/2015	Op.	
3/7/2015	Op.	
3/8/2015	Op.	
3/9/2015	Op.	
3/10/2015	Op.	
3/11/2015	Op.	
3/12/2015	Op.	
3/13/2015	Op.	
3/14/2015	No Op.	Stopped - debris
3/15/2015	No Op.	Stopped - debris
3/16/2015	Op.	
3/17/2015	Op.	
3/18/2015	Op.	
3/19/2015	Op.	
3/20/2015	Op.	
3/21/2015	Op.	
3/22/2015	Op.	
3/23/2015	Op.	
3/24/2015	Op.	
3/25/2015	Op.	
3/26/2015	Op.	
3/27/2015	Op.	
3/28/2015	Op.	
3/29/2015	Op.	
3/30/2015	Op.	
3/31/2015	Op.	
4/1/2015	Op.	
4/2/2015	Op.	
4/3/2015	Op.	
4/4/2015	Op.	
4/5/2015	Op.	
4/6/2015	Op.	
4/7/2015	Op.	
4/8/2015	Op.	
4/9/2015	Op.	
4/10/2015	Op.	
4/11/2015	Op.	
4/12/2015	Op.	
4/13/2015	Op.	
4/14/2015	Op.	
4/15/2015	Op.	
4/16/2015	Op.	
4/17/2015	Op.	
4/18/2015	Op.	
4/19/2015	Op.	
4/20/2015	Op.	
4/21/2015	Op.	
4/22/2015	Op.	
4/23/2015	Op.	
4/24/2015	Op.	
4/25/2015	Op.	
4/26/2015	Op.	
4/27/2015	Op.	
4/28/2015	Op.	
4/29/2015	Op.	
4/30/2015	Op.	
5/1/2015	Op.	
5/2/2015	Op.	
5/3/2015	Op.	
5/4/2015	Op.	
5/5/2015	Op.	
5/6/2015	Op.	
5/7/2015	Op.	
5/8/2015	Op.	
5/9/2015	Op.	
5/10/2015	Op.	
5/11/2015	Op.	
5/12/2015	Op.	
5/13/2015	Op.	
5/14/2015	Op.	
5/15/2015	Op.	
5/16/2015	Op.	
5/17/2015	Op.	
5/18/2015	Op.	
5/19/2015	Op.	
5/20/2015	Op.	

5/21/2015	Op.		7/4/2015	Op.	
5/22/2015	Op.		7/5/2015	Op.	
5/23/2015	Op.		7/6/2015	Op.	
5/24/2015	Op.		7/7/2015	Op.	
5/25/2015	Op.		7/8/2015	No Op.	Stopped - bed contact
5/26/2015	Op.				
5/27/2015	Op.		7/9/2015	No Op.	Stopped - bed contact
5/28/2015	Op.		7/10/2015	Op.	
5/29/2015	Op.		7/11/2015	Op.	
5/30/2015	Op.		7/12/2015	Op.	
5/31/2015	Op.		7/13/2015	Op.	
6/1/2015	Op.		7/14/2015	No Op.	Stopped - bed contact
6/2/2015	Op.				
6/3/2015	Op.		7/15/2015	No Op.	Stopped - bed contact
6/4/2015	Op.		7/16/2015	No Op.	Stopped - low flow
6/5/2015	Op.		7/17/2015	No Op.	Stopped - low flow
6/6/2015	Op.		7/18/2015	No Op.	Pulled - low water
6/7/2015	Op.		7/19/2015	No Op.	Pulled - low water
6/8/2015	Op.		7/20/2015	No Op.	Pulled - low water
6/9/2015	Op.		7/21/2015	No Op.	Pulled - low water
6/10/2015	Op.		7/22/2015	No Op.	Pulled - low water
6/11/2015	Op.		7/23/2015	No Op.	Pulled - low water
6/12/2015	Op.		7/24/2015	No Op.	Pulled - low water
6/13/2015	Op.		7/25/2015	No Op.	Pulled - low water
6/14/2015	Op.		7/26/2015	No Op.	Pulled - low water
6/15/2015	Op.		7/27/2015	No Op.	Pulled - low water
6/16/2015	Op.		7/28/2015	No Op.	Pulled - low water
6/17/2015	No Op.	Stopped - debris	7/29/2015	No Op.	Pulled - low water
6/18/2015	Op.		7/30/2015	No Op.	Pulled - low water
6/19/2015	Op.		7/31/2015	No Op.	Pulled - low water
6/20/2015	Op.		8/1/2015	No Op.	Pulled - low water
6/21/2015	Op.		8/2/2015	No Op.	Pulled - low water
6/22/2015	Op.		8/3/2015	No Op.	Pulled - low water
6/23/2015	Op.		8/4/2015	No Op.	Pulled - low water
6/24/2015	Op.		8/5/2015	No Op.	Pulled - low water
6/25/2015	Op.		8/6/2015	No Op.	Pulled - low water
6/26/2015	Op.		8/7/2015	No Op.	Pulled - low water
6/27/2015	Op.		8/8/2015	No Op.	Pulled - low water
6/28/2015	Op.		8/9/2015	No Op.	Pulled - low water
6/29/2015	Op.		8/10/2015	No Op.	Pulled - low water
6/30/2015	Op.		8/11/2015	No Op.	Pulled - low water
7/1/2015	Op.		8/12/2015	No Op.	Pulled - low water
7/2/2015	No Op.	Stopped - bed contact	8/13/2015	No Op.	Pulled - low water
7/3/2015	Op.		8/14/2015	No Op.	Pulled - low water

8/15/2015	No Op.	Pulled - low water	9/29/2015	No Op.	Pulled - low water
8/16/2015	No Op.	Pulled - low water	9/30/2015	No Op.	Pulled - low water
8/17/2015	No Op.	Pulled - low water	10/1/2015	No Op.	Pulled - low water
8/18/2015	No Op.	Pulled - low water	10/2/2015	No Op.	Pulled - low water
8/19/2015	No Op.	Pulled - low water	10/3/2015	No Op.	Pulled - low water
8/20/2015	No Op.	Pulled - low water	10/4/2015	No Op.	Pulled - low water
8/21/2015	No Op.	Pulled - low water	10/5/2015	No Op.	Pulled - low water
8/22/2015	No Op.	Pulled - low water	10/6/2015	No Op.	Pulled - low water
8/23/2015	No Op.	Pulled - low water	10/7/2015	No Op.	Pulled - low water
8/24/2015	No Op.	Pulled - low water	10/8/2015	No Op.	Pulled - low water
8/25/2015	No Op.	Pulled - low water	10/9/2015	No Op.	Pulled - low water
8/26/2015	No Op.	Pulled - low water	10/10/2015	No Op.	Pulled - low water
8/27/2015	No Op.	Pulled - low water	10/11/2015	No Op.	Pulled - low water
8/28/2015	No Op.	Pulled - low water	10/12/2015	No Op.	Stopped - low flow
8/29/2015	No Op.	Pulled - low water	10/13/2015	No Op.	Pulled - low water
8/30/2015	No Op.	Pulled - low water	10/14/2015	No Op.	Pulled - low water
8/31/2015	No Op.	Pulled - low water	10/15/2015	No Op.	Pulled - low water
9/1/2015	No Op.	Pulled - low water	10/16/2015	No Op.	Pulled - low water
9/2/2015	No Op.	Pulled - low water	10/17/2015	No Op.	Pulled - low water
9/3/2015	No Op.	Stopped - low flow	10/18/2015	No Op.	Pulled - low water
9/4/2015	No Op.	Pulled - low water	10/19/2015	No Op.	Pulled - low water
9/5/2015	No Op.	Pulled - low water	10/20/2015	No Op.	Pulled - low water
9/6/2015	No Op.	Pulled - low water	10/21/2015	Op.	
9/7/2015	No Op.	Pulled - low water	10/22/2015	Op.	
9/8/2015	No Op.	Pulled - low water	10/23/2015	Op.	
9/9/2015	No Op.	Pulled - low water	10/24/2015	No Op.	Stopped - low flow
9/10/2015	No Op.	Pulled - low water	10/25/2015	No Op.	Pulled - low water
9/11/2015	No Op.	Pulled - low water	10/26/2015	No Op.	Pulled - low water
9/12/2015	No Op.	Pulled - low water	10/27/2015	No Op.	Pulled - low water
9/13/2015	No Op.	Pulled - low water	10/28/2015	No Op.	Pulled - low water
9/14/2015	No Op.	Pulled - low water	10/29/2015	No Op.	Pulled - low water
9/15/2015	No Op.	Pulled - low water	10/30/2015	No Op.	Stopped - low flow
9/16/2015	No Op.	Pulled - low water	10/31/2015	No Op.	Pulled - low water
9/17/2015	No Op.	Pulled - low water	11/1/2015	No Op.	Pulled - low water
9/18/2015	No Op.	Pulled - low water	11/2/2015	Op.	
9/19/2015	No Op.	Pulled - low water	11/3/2015	Op.	
9/20/2015	No Op.	Pulled - low water	11/4/2015	Op.	
9/21/2015	No Op.	Pulled - low water	11/5/2015	Op.	
9/22/2015	No Op.	Pulled - low water	11/6/2015	Op.	
9/23/2015	No Op.	Pulled - low water	11/7/2015	Op.	
9/24/2015	No Op.	Pulled - low water	11/8/2015	Op.	
9/25/2015	No Op.	Pulled - low water	11/9/2015	Op.	
9/26/2015	No Op.	Pulled - low water	11/10/2015	Op.	
9/27/2015	No Op.	Pulled - low water	11/11/2015	Op.	
9/28/2015	No Op.	Pulled - low water	11/12/2015	Op.	

11/13/2015	No Op.	Pulled - high water
11/14/2015	No Op.	Pulled - high water
11/15/2015	No Op.	Pulled - high water
11/16/2015	Op.	
11/17/2015	Op.	
11/18/2015	No Op.	Pulled - high water
11/19/2015	No Op.	Pulled - high water
11/20/2015	Op.	
11/21/2015	Op.	
11/22/2015	Op.	
11/23/2015	Op.	
11/24/2015	Op.	
11/25/2015	Op.	
11/26/2015	Op.	
11/27/2015	Op.	
11/28/2015	No Op.	Stopped - ice
11/29/2015	No Op.	Stopped - ice
11/30/2015	No Op.	Stopped - ice

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
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	869
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	264
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	173
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	250
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	656
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	434
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	966
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	732
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	358
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	443
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.158	0.409	210
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.034	0.187	1380
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.068	0.263	368
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.136	0.377	876
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.125	0.361	936
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.045	0.213	330
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.194	0.457	274
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.136	0.377	188
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.154	0.403	1230
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.167	0.421	315
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.157	0.408	271
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.476	327
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.077	0.281	958
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.149	0.397	566

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
Wild Chinook Parr	0	10/26/2006	Back	183	50	0.28	0.56	51
Wild Chinook Parr	0	10/30/2006	Back	168	52	0.32	0.60	63
Wild Chinook Parr	0	11/1/2010	Back	254	42	0.17	0.42	198
Wild Chinook Parr	0	11/4/2010	Back	287	49	0.17	0.43	215
Wild Chinook Parr	0	11/7/2010	Back	168	32	0.20	0.46	241
Wild Chinook Parr	0	11/13/2010	Back	185	35	0.19	0.46	131

Wild Chinook Parr	0	11/3/2012	Back	201	25	0.13	0.37	402
Wild Chinook Parr	0	11/7/2012	Back	233	27	0.12	0.35	394
Wild Chinook Parr	0	11/11/2012	Back	328	87	0.27	0.54	217
Wild Chinook Parr	0	11/15/2012	Back	195	34	0.18	0.44	213
Wild Chinook Parr	0	9/30/2013	Back	171	12	0.08	0.28	542
Wild Chinook Parr	0	10/2/2013	Back	213	43	0.21	0.47	328
Wild Chinook Parr	0	10/3/2013	Back	181	41	0.23	0.50	296
Wild Chinook Parr	0	10/7/2013	Back	242	31	0.13	0.37	233
Wild Chinook Parr	0	10/9/2013	Back	203	40	0.20	0.47	303
Wild Chinook Parr	0	11/27/2013	Back	241	55	0.23	0.50	182

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
Wild Chinook Parr	0	7/13/2006	Back	52	8	0.17	0.43	171
Wild Chinook Parr	0	7/17/2006	Back	138	15	0.12	0.35	129
Wild Chinook Parr	0	7/20/2006	Back	74	5	0.08	0.29	113
Wild Chinook Parr	0	7/28/2006	Back	54	5	0.11	0.34	91
Wild Chinook Parr	0	7/31/2006	Back	99	7	0.08	0.29	79
Wild Chinook Parr	0	9/18/2006	Back	55	10	0.20	0.46	46
Wild Chinook Parr	0	7/31/2008	Back	60	15	0.27	0.54	121
Wild Chinook Parr	0	8/12/2008	Back	103	2	0.03	0.17	85.6
Wild Chinook Parr	0	8/22/2008	Back	75	11	0.16	0.41	97
Wild Chinook Parr	0	8/28/2008	Back	72	7	0.11	0.34	81.9
Wild Chinook Parr	0	10/9/2008	Back	110	22	0.21	0.48	63.5
Wild Chinook Parr	0	10/27/2008	Back	51	12	0.26	0.53	56.1
Wild Chinook Parr	0	10/30/2008	Back	84	15	0.19	0.45	53
Wild Chinook Parr	0	11/6/2008	Back	78	8	0.12	0.35	77.7
Wild Chinook Parr	0	11/10/2008	Back	88	0	0.01	0.11	309
Wild Chinook Parr	0	7/14/2009	Back	86	2	0.04	0.19	193
Wild Chinook Parr	0	7/15/2009	Back	105	4	0.05	0.22	179
Wild Chinook Parr	0	7/17/2009	Back	122	8	0.07	0.28	157
Wild Chinook Parr	0	7/20/2009	Back	89	2	0.03	0.19	135
Wild Chinook Parr	0	8/17/2009	Back	73	1	0.03	0.17	58
Wild Chinook Parr	0	9/10/2009	Back	56	7	0.14	0.39	60
Wild Chinook Parr	0	8/8/2010	Back	58	1	0.03	0.19	85
Wild Chinook Parr	0	8/11/2010	Back	114	8	0.08	0.29	77
Wild Chinook Parr	0	9/11/2010	Back	68	9	0.15	0.39	75
Wild Chinook Parr	0	10/12/2010	Back	216	42	0.20	0.46	126
Wild Chinook Parr	0	10/15/2010	Back	192	37	0.20	0.46	95
Wild Chinook Parr	0	10/18/2010	Back	193	36	0.19	0.45	81
Wild Chinook Parr	0	10/22/2010	Back	92	18	0.21	0.47	69
Wild Chinook Parr	0	10/25/2010	Back	60	7	0.13	0.37	78
Wild Chinook Parr	0	10/29/2010	Back	127	0	0.01	0.09	95.1
Wild Chinook Parr	0	8/19/2011	Back	106	5	0.06	0.24	123

Model: Chinook Subyearling (Fall '14-'15) Bolser Site (r^2 = 0.36; p = 0.09)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1)/M	ASIN Transform	Discharge
Wild Chinook Parr	0	7/14/2014	Back	89	7	0.09	0.30	171
Wild Chinook Parr	0	7/21/2014	Back	74	4	0.07	0.26	129
Wild Chinook Parr	0	7/27/2014	Back	72	4	0.07	0.27	113
Wild Chinook Parr	0	10/27/2014	Back	71	3	0.06	0.24	91
Wild Chinook Parr	0	10/30/2014	Back	70	5	0.09	0.30	79
Wild Chinook Parr	0	11/1/2014	Back	96	6	0.07	0.27	46
Wild Chinook Parr	0	11/3/2015	Back	138	0	0.01	0.09	121

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
Wild Steelhead Parr/Smolt	1+	3/20/2007	Back	55	1	0.04	0.19	1230
Wild Steelhead Parr/Smolt	1+	3/31/2007	Back	56	4	0.09	0.30	869
Wild Steelhead Parr/Smolt	1+	4/10/2007	Back	60	8	0.15	0.40	966
Wild Steelhead Parr/Smolt	1+	5/1/2007	Back	52	2	0.06	0.24	783
Wild Steelhead Parr/Smolt	1+	6/9/2007	Back	71	9	0.14	0.38	842
Wild Steelhead Parr/Smolt	1+	6/12/2007	Back	65	8	0.14	0.38	704
Wild Steelhead Parr/Smolt	1+	6/14/2007	Back	61	5	0.10	0.32	687
Wild Steelhead Parr/Smolt	1+	6/21/2007	Back	67	4	0.07	0.28	751
Wild Steelhead Parr/Smolt	1+	4/14/2008	Back	149	46	0.32	0.60	327
Wild Steelhead Parr/Smolt	1+	4/17/2008	Back	75	3	0.05	0.23	274
Wild Steelhead Parr/Smolt	1+	4/28/2008	Back	74	11	0.16	0.41	271
Wild Steelhead Parr/Smolt	1+	5/1/2008	Back	176	29	0.17	0.43	315
Wild Steelhead Parr/Smolt	1+	5/12/2008	Back	55	8	0.16	0.42	663
Wild Steelhead Parr/Smolt	1+	5/15/2008	Back	57	1	0.04	0.19	1390
Wild Steelhead Parr/Smolt	1+	6/9/2008	Back	142	20	0.15	0.39	938
Wild Steelhead Parr/Smolt	1+	6/12/2008	Back	83	10	0.13	0.37	823
Wild Steelhead Parr/Smolt	1+	6/16/2008	Back	81	8	0.11	0.34	1140
Wild Steelhead Parr/Smolt	1+	4/20/2010	Back	121	11	0.10	0.32	675
Wild Steelhead Parr/Smolt	1+	4/22/2010	Back	121	10	0.09	0.31	726
Wild Steelhead Parr/Smolt	1+	6/20/2010	Back	128	11	0.09	0.31	926
Wild Steelhead Parr/Smolt	1+	4/5/2011	Back	52	1	0.04	0.20	761
Wild Steelhead Parr/Smolt	1+	5/22/2011	Back	84	3	0.05	0.22	1540
Wild Steelhead Parr/Smolt	1+	6/12/2012	Back	69	5	0.09	0.30	1170
Wild Steelhead Parr/Smolt	1+	7/26/2012	Back	63	4	0.08	0.29	278
Wild Steelhead Parr/Smolt	1+	4/22/2013	Back	66	6	0.11	0.33	520

Wild Steelhead Parr/Smolt	1+	4/26/2013	Back	50	2	0.06	0.25	642
Wild Steelhead Parr/Smolt	1+	4/30/2013	Back	54	2	0.06	0.24	778
Wild Steelhead Parr/Smolt	1+	5/8/2013	Back	62	0	0.02	0.13	2170
Wild Steelhead Parr/Smolt	1+	5/19/2013	Back	122	15	0.13	0.37	1130
Wild Steelhead Parr/Smolt	1+	5/22/2013	Back	58	4	0.09	0.30	1080
Wild Steelhead Parr/Smolt	1+	5/26/2013	Back	79	3	0.05	0.23	724
Wild Steelhead Parr/Smolt	1+	5/30/2013	Back	92	7	0.09	0.30	849
Wild Steelhead Parr/Smolt	1+	6/3/2013	Back	71	6	0.10	0.32	962
Wild Steelhead Parr/Smolt	1+	6/7/2013	Back	94	4	0.05	0.23	1420
Wild Steelhead Parr/Smolt	1+	6/13/2013	Back	64	2	0.05	0.22	745
Wild Steelhead Parr/Smolt	1+	6/17/2013	Back	115	5	0.05	0.23	883
Wild Steelhead Parr/Smolt	1+	6/29/2013	Back	60	12	0.22	0.48	730
Wild Steelhead Parr/Smolt	1+	7/7/2013	Back	75	9	0.13	0.37	325
Wild Steelhead Parr/Smolt	1+	5/5/2014	Back	55	3	0.07	0.27	1260
Wild Steelhead Parr/Smolt	1+	5/20/2014	Back	57	0	0.02	0.13	1490
Wild Steelhead Parr/Smolt	1+	6/3/2014	Back	75	1	0.03	0.16	1610

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
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	869
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	264
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	173
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	250
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	656
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	434
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	966
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	732
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	358
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	443
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.158	0.409	210
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.034	0.187	1380
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.068	0.263	368
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.136	0.377	876
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.125	0.361	936
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.045	0.213	330
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.194	0.457	274
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.136	0.377	188
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.154	0.403	1230
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.167	0.421	315
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.157	0.408	271

Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.476	327
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.077	0.281	958
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.149	0.397	566

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) Efficiency, ($r^2 = 0.61$; $p = 0.0002$)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Parr	0	11/4/2010	254	95	0.38	0.66	224
Wild Chinook Parr	0	11/7/2010	287	70	0.25	0.52	248
Wild Chinook Parr	0	11/10/2010	168	74	0.45	0.73	169
Wild Chinook Parr	0	11/13/2010	74	41	0.57	0.85	140
Wild Chinook Parr	0	11/18/2010	185	22	0.12	0.36	278
Wild Chinook Parr	0	11/3/2012	201	21	0.11	0.34	384
Wild Chinook Parr	0	11/7/2012	233	31	0.14	0.38	378
Wild Chinook Parr	0	11/11/2012	328	66	0.20	0.47	223
Wild Chinook Parr	0	11/15/2012	195	68	0.35	0.64	219
Wild Chinook Parr	0	11/4/2013	130	51	0.40	0.68	130
Wild Chinook Parr	0	11/8/2013	106	39	0.38	0.66	148
Wild Chinook Parr	0	3/9/2014	65	4	0.08	0.28	880
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	541
Wild Chinook Parr	0	11/4/2014	114	5	0.05	0.23	370
Wild Chinook Parr	0	11/1/2014	96	5	0.06	0.25	583
Wild Chinook Parr	0	11/10/2014	78	8	0.12	0.35	398

APPENDIX D. Historical Morphometric Data

Spring Chinook (2004-2015)

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
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
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
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
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
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
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
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	7.0	8.4	152	2.2	1.0
2015	2014	Wild Chinook Subyearling Fry	45	338	9.9	1.0	338	0.9	0.9
2015	2014	Wild Chinook Subyearling Parr	84	210	8.0	6.5	209	1.7	1.1

2015	2013	Hatchery Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.1

Summer Steelhead (2004-2015)

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
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
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
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
2006	2003	3	Wild Summer Steelhead	197	2	—	73.5	2	—	1
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
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
2008	2007	1	Hat. Summer Steelhead	179.4	389	16.5	55.9	388	14.8	1
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
2009	2008	1	Hat. Summer Steelhead	183.1	280	16.7	60.8	280	18.2	1
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

2010	2009	1	Hat. Summer Steelhead	183.5	531	19.5	61.3	526	19.6	1
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
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
2012	2011	1	Hat. Summer Steelhead	154.8	318	20.9	37.7	318	14	1
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	2.0	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

Coho (2007-2015)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Nat. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2004	2003	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2004	2003	Nat. Orig. Coho Subyearling Parr	—	—	—	—	—	—	—
2004	2002	Hatchery Coho Yearling Smolt	136.6	847	12.8	27.4	820	7.5	1.1
2005	2003	Nat. Orig. Coho Yearling Smolt	114.4	17	8.8	16.2	17	3.6	1.1
2005	2004	Nat. Orig. Coho Subyearling Fry	49.1	9	10.4	1.3	9	0.8	1.1
2005	2004	Nat. Orig. 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. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2006	2005	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Nat. Orig. Coho Subyearling Parr	71	4	13.6	3.8	4	2.9	1.1

2006	2004	Hatchery Coho Yearling Smolt	—	—	—	—	—	—	—
2007	2005	Nat. Orig. Coho Yearling Smolt	92.9	36	12.5	8.7	36	4	1.1
2007	2006	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2007	2006	Nat. Orig. 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. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2008	2007	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2008	2007	Nat. Orig. 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. Orig. Coho Yearling Smolt	103	4	9.7	11.7	4	3.4	1.1
2009	2008	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2009	2008	Nat. Orig. 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. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2010	2009	Nat. Orig. Coho Subyearling Fry	48	2	—	1.3	2	—	1.2
2010	2009	Nat. Orig. 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. Orig. Coho Yearling Smolt	100.2	14	12.7	11.3	14	3.9	1.1
2011	2010	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2011	2010	Nat. Orig. 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. Orig. Coho Yearling Smolt	102.1	17	9.1	11.9	17	3	1.1
2012	2011	Nat. Orig. Coho Subyearling Fry	36	1	—	—	—	—	—
2012	2011	Nat. Orig. 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. Orig. Coho Yearling Smolt	97	81	10	10	81	3.1	1.1
2013	2012	Nat. Orig. Coho Subyearling Fry	47.3	3	1	1	3	1	0.9
2013	2012	Nat. Orig. 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. Orig. Coho Yearling Smolt	96.3	20	9.8	9.9	20	3	1.1
2014	2013	Nat. Orig. Coho Subyearling Fry	36	1	—	—	—	—	—
2014	2013	Nat. Orig. 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	1.1
2015	2013	Nat. Orig. Coho Yearling Smolt	109	2	4.9	12.0	2	0.1402	0.9
2015	2014	Nat. Orig. Coho Subyearling Fry	47	7	13.7	1.4	7	1.4511	0.9
2015	2014	Nat. Orig. Coho Subyearling Parr	69	3	7.0	4.0	3	1.2583	1.2
2015	2013	Hatchery Coho Yearling Smolt	131	952	9.9	23.3	952	4.7946	1.0

Appendix D: Memo to NMFS Re: Exceedance of Allowed Lethal Take

MEMORANDUM

Yakama Nation Fisheries

Columbia River

Honor. Protect. Restore.

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To: Craig Busack

CC: Michelle Guay, Tom Scribner, Keely Murdoch, Bryan Ishida

From: Bryan Ishida

Date: March 15, 2015

RE: Nason Creek Smolt Trap Mortalities - 3/15/15

Dear Mr. Busack,

On March 15, 2015 YN FRM personnel arrived at the Nason rotary smolt trap at 9:00am to find it stopped by a 5'x6"x6" pressure-treated beam that had become wedged between the cone and the starboard pontoon. The halted rotation subsequently caused a small-diameter debris blockage at the rear of the cone preventing movement of fish and additional debris into the livebox. As a result, six wild spring Chinook subyearling fry and four wild spring Chinook yearling smolt mortalities were incurred. With a total of only 37 wild spring Chinook captured since trapping began on March 1, our mortality rate for the species is currently at 27%. The increase in debris load is attributed to a rapid spike in discharge level brought on by heavy rains. At the time of the stoppage, spring night operations (personnel on-site during hours of operation) had not yet commenced.

This event occurred during initial spring operations at the new Nason Creek smolt trap site (rkm 0.3). Due to its location on the outside of a channel bend, this new location appears to be more susceptible to debris stoppages than the previously-used site (rkm 0.9). In order to prevent further such instances, we will increase the duration of our night operations schedule to include high-water events prior to the scheduled May 1start as needed. Upon initial onset of elevated spring flows, we will begin night operations and continue until discharge levels have subsided. Discharge data from the upstream Department of Ecology gauge and snowpack data from nearby snow telemetry (SNOTEL) sites will be used to will be used to predict trends in flow and guide trap operations. Additionally, the Nason Creek smolt trap will also be manned during fall freshets to mitigate the increased stoppage potential at the new site. We will increase our vigilance in the monitoring of high-water events and take the necessary precautions to prevent any further loss of ESA-listed species. Please feel free to contact me with any questions regarding this event.

Sincerely,

Bryan Ishida

Appendix L

Fish Trapping at the White River Smolt Trap during 2015

Population Estimates for Juvenile Spring Chinook Salmon in White River, WA

2015 Annual Final Report

Prepared by:
Bryan Ishida
Cory Kamphaus
Keely Murdoch

YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT
Toppenish, WA 98948

Prepared for:

Public Utility District No. 2 of Grant County
Ephrata, Washington 98823

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, 2015. We used a 1.5 m rotary screw trap to collect 196 juvenile spring Chinook; 2 precocial parr, 11 fry, 151 subyearling parr, and 32 yearling smolts. Daily counts at the trap were expanded via regression analysis derived from mark and recapture trials. We estimated that 3,023 (± 2,728; 95% CI) BY2013 wild spring Chinook smolts and 1,449 (± 421; 95% CI) BY2014 wild spring Chinook parr emigrated past the White River trap. Combined with data collected in 2014, this gives us a total estimate of 5,484 (± 2,836; 95% CI) BY2012 emigrants. Using spring Chinook spawning ground data collected by Washington Department of Fish and Wildlife (WDFW) in 2013, we estimated egg-to-emigrant survival of BY2013 spring Chinook to be 2.2% (102 smolts-per-redd).

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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, Barry Hodges, Tim Jeffris and Kevin Swager who maintained and operated the trap during all hours including nights/weekends through challenging weather conditions. Also thank you to Peter Graf (Grant County PUD) for administering contracting and funding as well as Mike Hughes, Mclain Johnson, John Walters, 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 to 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 2007, Public Utility District No. 2 of Grant County (GCPUD) contracted the Yakama Nation (YN) to operate a rotary trap in the White River. 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.

Data presented will be directly used to address Objective 2 in the Monitoring and Evaluation Plan for PUD Hatchery Programs (Hillman et al. 2013) 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).**

In the fall of 2005, Washington State Department of Fish and Wildlife (WDFW) began smolt trapping in the lower reach of the 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, YN resumed trap operations on the White River for nine months of the year. This document reports data collected between March 1 and November 30, 2015 and provides emigration estimates for spring Chinook salmon yearlings (BY2013) and subyearlings (BY2014) during that time period. Data generated from this project was used to calculate annual egg-to-emigrant survival.

1.1 Watershed Description

The White River drainage encompasses 99,956 acres and originates in alpine glaciers and perennial snow fields (Figure 1; USFS 2004). Elevations in the drainage vary from 1,868 ft. at the Lake Wenatchee surface to 8,575 ft. 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 river kilometers (RK) 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

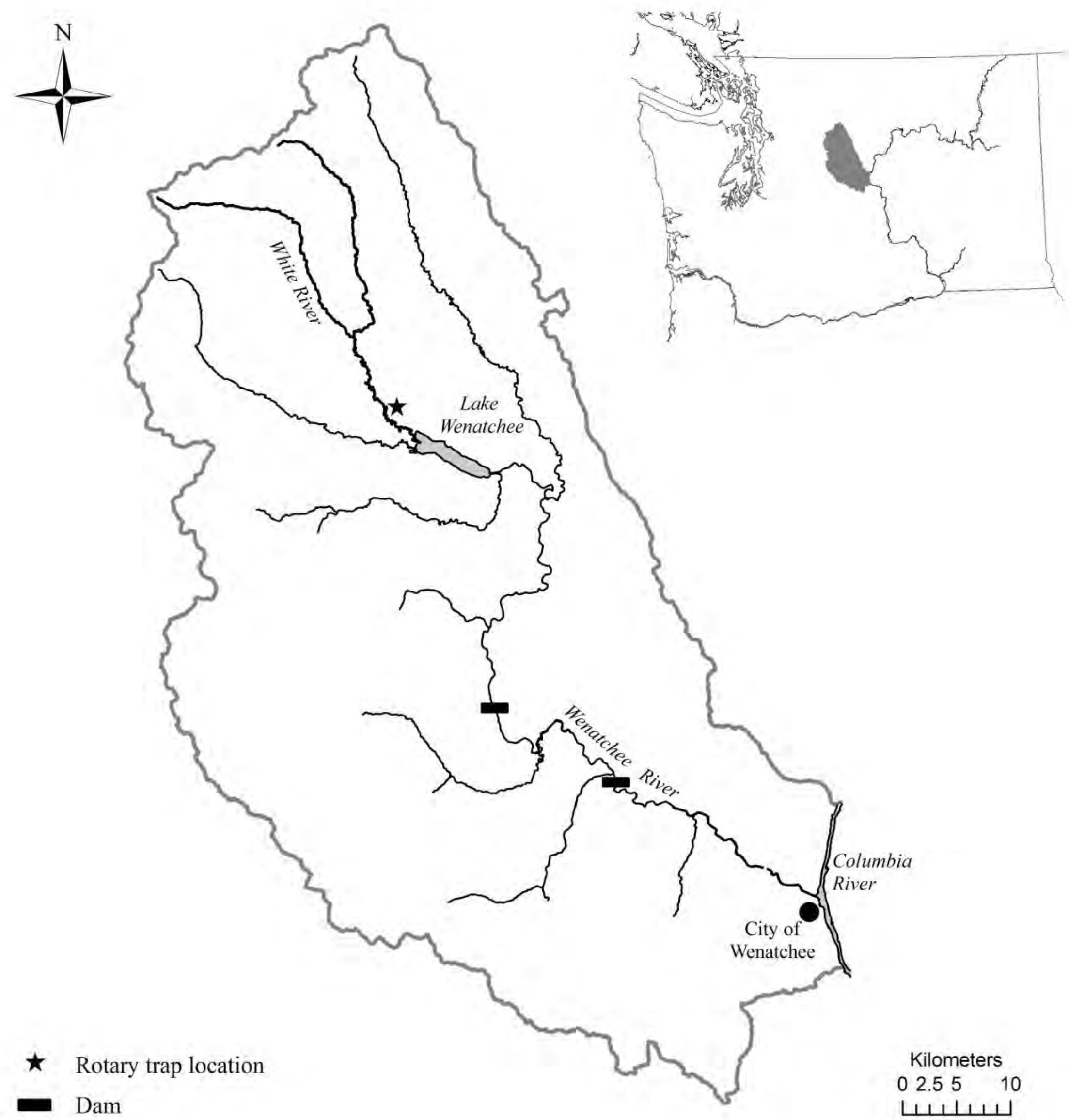


Figure 1. Map of the Wenatchee River subbasin with White River rotary trap location.

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 RK 9.9 of White River. Operation of this station by WDOE is currently maintained with funding provided by GCPUD. In 2015, daily mean stream discharge ranged from 87cfs to 4,280cfs (Figure 2) while mean daily stream temperatures ranged from 0.2°C to

15.9°C (Figure 3). Discharge and temperature data provided by WDOE should be considered provisional and are presented in **Appendix A**.

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 have impacted the

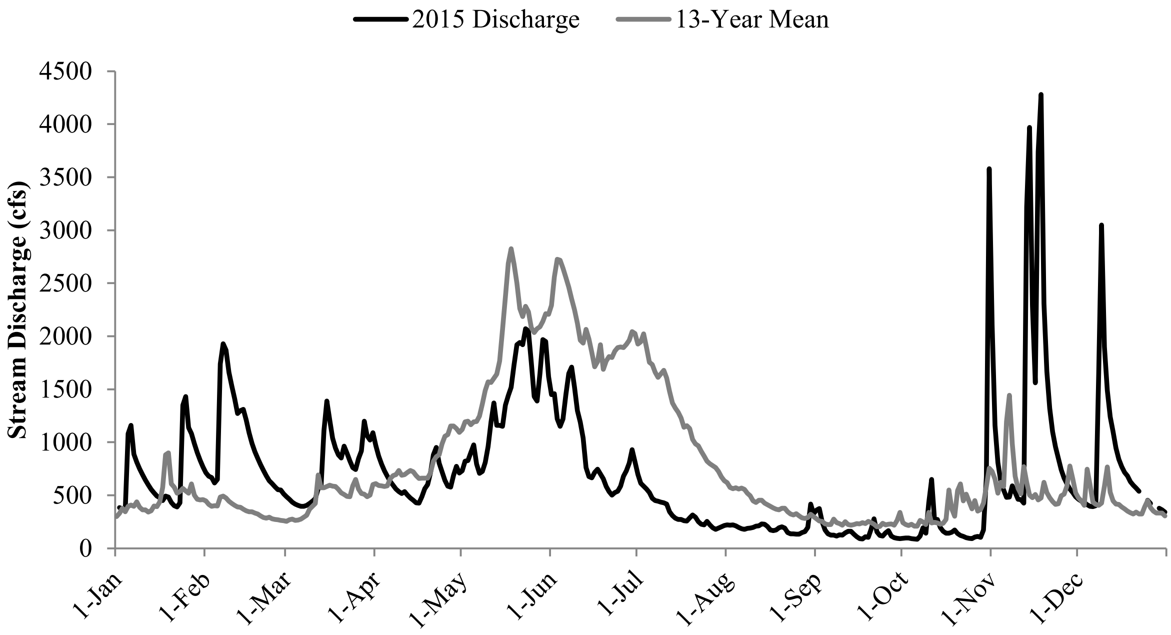


Figure 2. Mean daily stream discharge at the White River DOE stream monitoring station at Sears Creek Bridge in 2015.

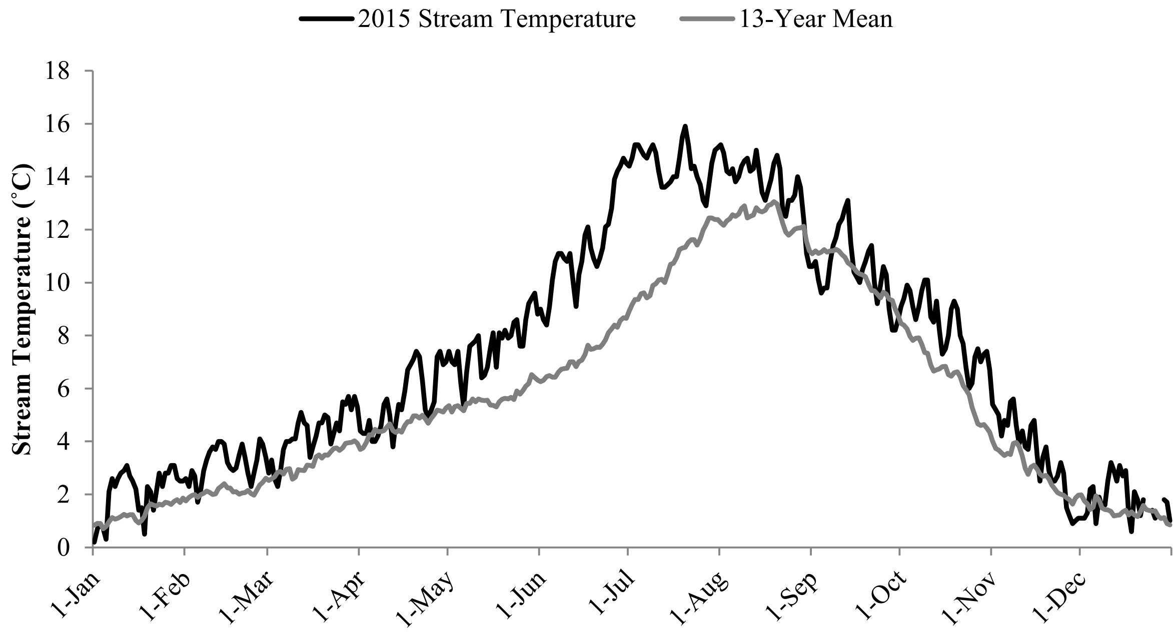


Figure 3. Mean daily water temperatures at the White River DOE stream monitoring station at Sears Creek Bridge in 2015.

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. Rip-rapping, 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 *Salvilinus 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 (**3.4 Incidental Species**).

2.0 METHODS

2.1 Trapping Equipment and Operation

In 2015, a 1.5m diameter cone rotary trap was operated in a single position at all discharge levels. This revised trapping regime was implemented in 2013 to simplify data analysis by eliminating obsolete trap positions that generated very little data. Past attempts at developing a high flow position generated very few efficiency trials resulting in limited trap efficiency data. Operating season-long at a single position, the trap was suspended from a river-spanning cable from which its position could be adjusted perpendicular to stream flow by hand powered winches anchored on a tree on the river-right bank.

The trap was operated 24 hours per day, seven days per week for the majority of the season. During spring snowmelt, operations only occurred during hours of darkness to minimize trap damage and subsequent capture mortality; still enabling sampling during the hours of peak fish movement. When trap operations were suspended, the cone was raised to avoid damage by debris.

During all ranges of river discharge, fish were removed daily. Additional trap checks were necessary during periods of high discharge in the spring and in the autumn due to increased leaf litter. Debris in the live-box was removed continually by a rotating drum screen, located at the rear of the holding box and hydraulically powered by the cone. A record of daily trap operations is provided in **Appendix B**.

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 five-gallon plastic buckets with lids to a stream-side, portable sampling station. Fish were anesthetized in a solution of MS-222 to facilitate sampling and reduce handling stress. Fork length (FL) and weight were recorded for all fish, except large numbers of sockeye (*Oncorhynchus nerka*) fry. For these fish, a representative sample of 25 individuals was measured and weighed 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. Spring Chinook salmon were classified as either natural or hatchery origin by the presence/absence of coded wire tags (CWT's). 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 were taken from spring Chinook salmon and steelhead (small, upper lobe caudal fin clip) and applied to blotter sheets. Samples from both species 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 samples were not collected in 2015.

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 would be released over a broad range of stream discharges in order to determine a trap efficiency-discharge relationship. (See **2.4 Data Analysis**). However, due to low abundance and limited holding time of ESA listed species (reducing the ability to meet trials size requirements on a more consistent basis), marked groups were released whenever the minimum sample size (≥ 20) was obtained. 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, the limited abundance of juvenile emigrants from the White River required that efficiency trials be completed with much smaller sample sizes. YN's continued goal is to increase individual mark-group sizes, when possible, to meet the standard described above.

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 RK upstream to the release location at Sears Creek Bridge (RK 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 **2.5.1 Estimate of Abundance**).

2.3.1 Marking and PIT tagging

All spring Chinook and summer steelhead juveniles with FL of ≥ 60mm were PIT tagged unless the health of an individual was in question (e.g.- fungus). 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).

After marking and/or PIT tagging, 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:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \qquad \textbf{(1)}$$

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,

$$e_k^{obs} = \frac{r_k + 1}{m}\,. \qquad \textbf{(3)}$$

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,

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\ B}. \qquad \textbf{(4)}$$

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:

$$\hat{Var}\left(\sum_{i=1}^{n}\hat{N}_i\right)=\underbrace{\sum_i \hat{N}_i^2\left(\frac{N_i\hat{e}_i(1-\hat{e}_i)}{(C_i+1)^2}+\frac{4(1-\hat{e}_i)}{\hat{e}_i}\hat{Var}(b_0+b_1 flow_i)\right)}_{PartA}+$$

$$\underbrace{\sum_i\sum_j 4\left(\hat{N}_i(1-\hat{e}_i)\right)\left(\hat{N}_j(1-\hat{e}_j)\right)\cdot\left[\hat{Var}(b_0)+flow_i flow_j\hat{Var}(b_1)\right]}_{PartB}$$

where $\hat{Var}(b_0+b_1 flow_i)=M\hat{S}E\left(1+\frac{1}{n}+\frac{\left(flow_i-\overline{flow}\right)^2}{(n-1)s_{flow}^2}\right)$, and $\hat{Var}(b_0)$ and $\hat{Var}(b_1)$ 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, $\hat{\hat{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$V\hat{a}r\left(\sum_{i=1}^{n}\hat{N}_i^{pooled}\right)=\underbrace{\left(\sum_i\frac{\hat{N}_i\left(1-\hat{\bar{e}}\right)}{\hat{\bar{e}}}\right)}_{PartA}+\underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\sum_i\hat{N}_i^2}_{PartB}+\underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\sum_i\sum_j\hat{N}_i\hat{N}_j}_{PartC}\ .$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$V\hat{a}r\left(\sum_{i=1}^{n}\hat{N}_i^{pooled}\right)=\underbrace{\left(\sum_i\frac{\hat{N}_i\left(1-\hat{\bar{e}}\right)}{\hat{\bar{e}}}\right)}_{PartA}+\underbrace{\frac{Var\left(\hat{\bar{e}}\right)}{\hat{\bar{e}}^2}\left[\sum_i\hat{N}_i^2+\sum_i\sum_j\hat{N}_i\hat{N}_j\right]}_{PartB}.$$

The variance of $\hat{\bar{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\bar{e}}\right)=V\hat{a}r\left(\frac{\sum_{k=1}^{n}r_k}{\sum_{k=1}^{n}m_k}\right)=\frac{\sum_{k=1}^{n}\left(r_k-\hat{\bar{e}}_k m_k\right)^2}{\bar{m}^2 n\left(n-1\right)}$$

where $\bar{m}$ is the average release size across all efficiency trial, $\dfrac{\sum_{k=1}^{n}m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96\times\sqrt{\sum\mathrm{var}\left[\hat{N}_i\right]}$

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

In 2015, we operated a 1.5m rotary trap between March 1 and November 30. During this period, the trap operated 24 hours per day, 7 days per week barring inoperable environmental conditions (i.e. heavy debris loads or high discharge), mechanical malfunctions, or periods of suspended trapping due to issues relating to lapsed liability insurance. Trapping was interrupted or intentionally suspended for a total of 49 days (Table 1).

Table 1. Summary of White River smolt trap operation, 2015.

Trap Status	Description	Days
Operating	Continuous data collection	226
Interrupted	Interrupted by debris, ice, tampering, or improper positioning	7
Pulled	Intentionally pulled due to flooding risk or administrative reasons	42

3.2 Daily Captures and Biological Sampling

3.2.1 Wild Spring Chinook Yearlings (BY2013)

A total of 32 wild yearling Chinook smolts were collected between March 1 and June 30, with peak catch occurring on April 9 (n = 4; Figure 4). Mean fork-length (FL) was 103mm (n = 32; SD = 6.9) and mean weight was 13.0g (n = 31; SD = 2.8); see Table 2. PIT tags were implanted into 32 smolts. Genetic samples were also taken from the same 32 fish. An additional two suspected BY2013 Chinook were captured after July 1. Mean FL for these fish was 145mm (n = 2; SD = 13.4) and mean weight was 35.15g (n = 2; SD = 11.4); see Table 2. These fish were identified as precocial parr by their large size, timing of capture, and release of milt during handling. All precocial parr were excluded from emigration estimates. There were no BY2013 spring Chinook mortalities incurred (See **3.4 ESA Compliance**).

3.2.2 Wild Spring Chinook Subyearlings (BY2014)

Spring Chinook fry were captured at the trap between March 15 and June 13 (n = 11). During this period there were no fry trapping mortalities incurred. A total of 151 wild subyearling Chinook parr were collected between July 13 and November 30, with peak catch occurring on September 5 (n = 15; Figure 5). The mean FL for subyearling parr was 96mm (n = 151; SD = 7.4) and the mean weight was 9.9g (n = 148; SD = 2.3); see Table 2. PIT tags were implanted into a total of 149 subyearling Chinook parr. Genetic samples were taken from 150 parr. One Chinook parr was not tagged due to a visible external injury. Additionally, one tag was shed during the 24hr holding period (Table 4). There were no BY2014 spring Chinook mortalities during the 2015 trapping season (See **3.4 ESA Compliance**).

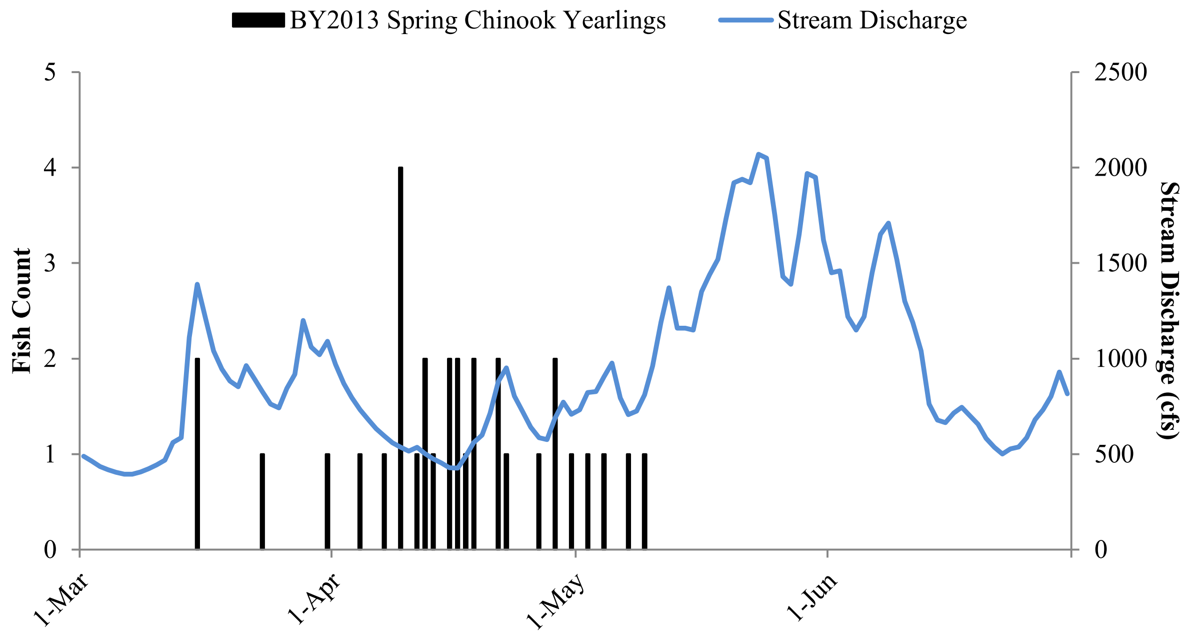


Figure 4. Daily catch of yearling spring Chinook smolt with mean daily stream discharge at the White River rotary trap, March 1 to June 30, 2015.

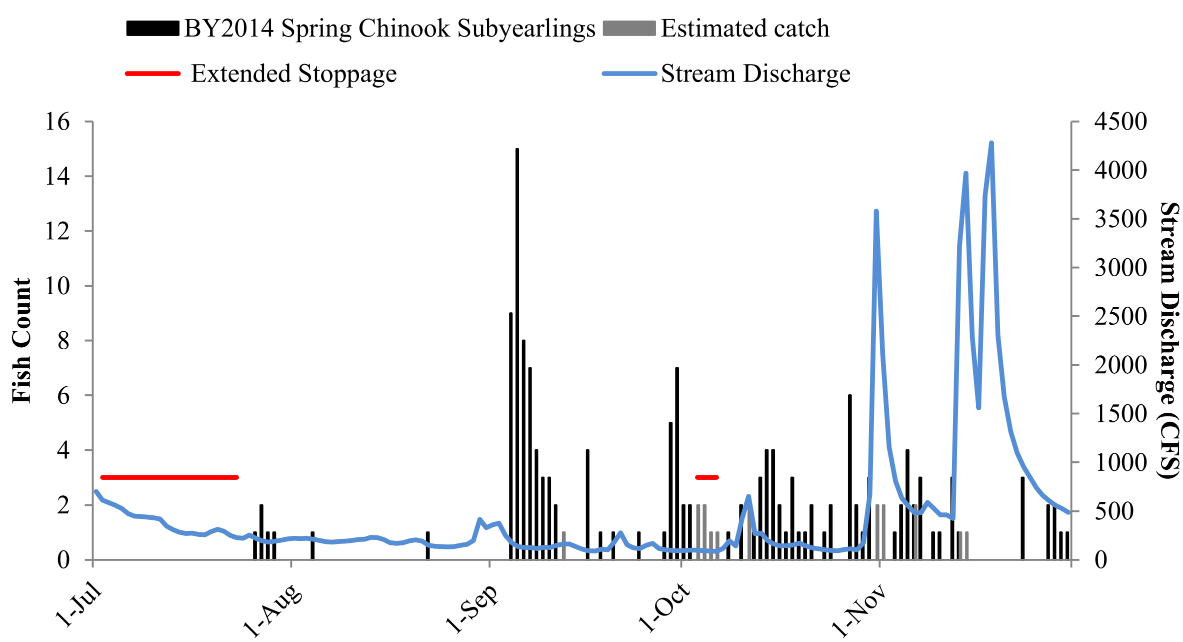


Figure 5. Daily catch of wild subyearling spring Chinook with mean daily stream discharge at the White River rotary trap, July 1 to November 30, 2015.

3.2.3 Hatchery Spring Chinook Yearlings (BY2013)

Hatchery-origin yearling Chinook released downstream of the smolt trap are sometimes caught in the summer months as precocial parr. Direct releases of BY2013 spring Chinook were not performed in the White River or in close proximity to is confluence with Lake Wenatchee (netpen-rearing). There were no hatchery-origin spring Chinook captured at the smolt trap in 2015. Hatchery fish captured at the trap are identified by the presence of CWT tags.

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the White River rotary trap in 2015.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
		Mean	n	SD	Mean	n	SD	
2013	Wild Yearling Smolt	103	32	6.9	13.0	31	2.8	1.14
2013	Wild Yearling Precocial Parr	145	2	13.4	35.2	2	11.4	1.14
2014	Wild Subyearling Fry	38	11	3.3	0.5	10	0.2	0.86
2014	Wild Subyearling Parr	96	151	7.4	9.9	148	2.3	1.11

3.3 Trap Efficiency Calibration and Population Estimates

3.3.1 Wild Spring Chinook Yearlings (BY 2013)

Due to low abundance, no BY2013 natural yearling Chinook efficiency trials were performed in 2015. A composite regression model using previous year's (2008-2012) efficiency trials showed statistical significance ($r^2 = 0.57$; $p = 0.001$) for a 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 2015. 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 2014, we estimated that 2,461 (± 779; 95% CI) BY2013 subyearlings emigrated past the trap. In the spring of 2015, we estimated that 3,023 (± 2,728; 95% CI) emigrated past the trap. Combining the two estimates, total BY2013 wild spring Chinook emigrants was 5,484 (± 2,836; 95% CI; Table 3).

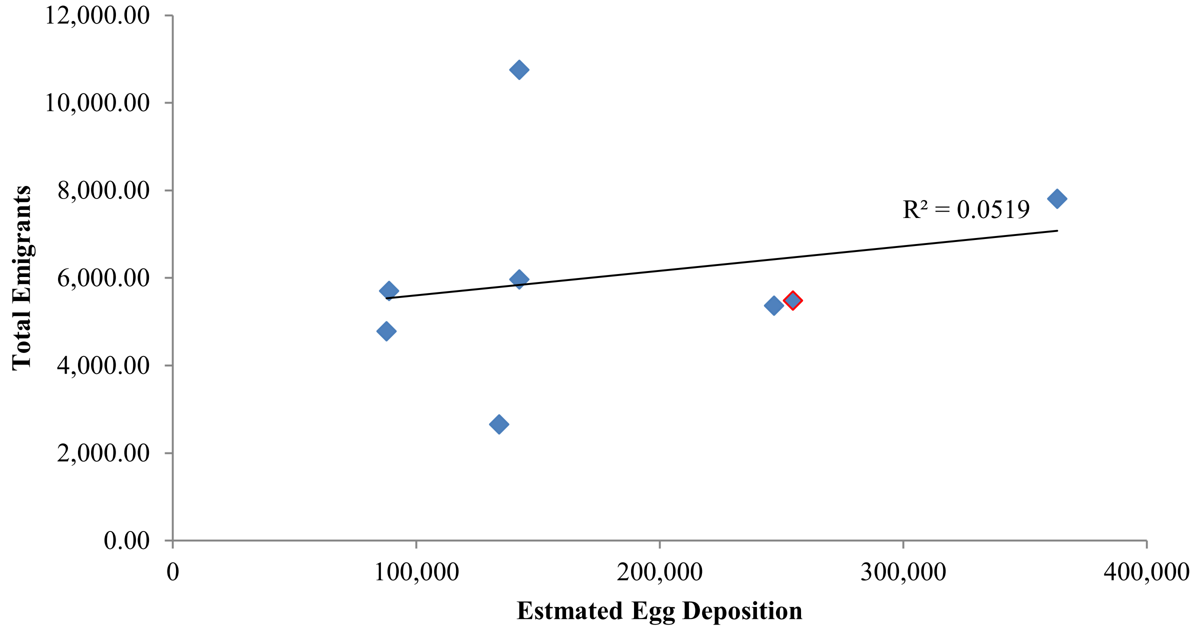
3.3.2 Wild Spring Chinook Subyearling (BY 2014)

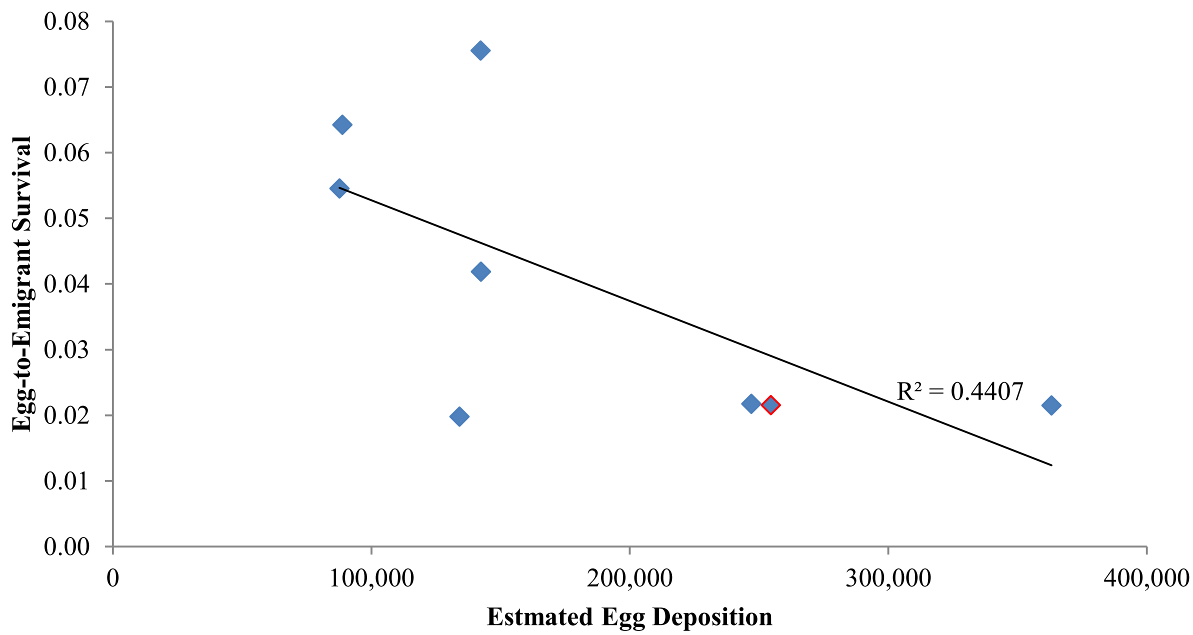
Low parr abundance presented only one opportunity to perform a mark-group release in 2015. Despite being smaller ($n = 39$) than the previously-set minimum mark group size of 50 parr, the efficiency trial was performed due to the low cfs being tested (89.5cfs). Our current strategy to improve the flow-efficiency model includes targeting mark-group releases at discharge levels where data is currently lacking. The updated multi-year composite regression was applied to BY2014 subyearling emigrants. The regression was comprised of all trails conducted fulfilling the minimum number marked ($n \geq 20$) including efforts in which zero recaptured were made (Appendix C). Mark-groups in which validity of the trial could be called into question (suspected trap stoppage or improper pre-release handling of the mark group) were removed. The weighted regression was not significant ($r^2 = 0.12$; $p = 0.086$) 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 in 2015. We estimated that in 2015, 1,449 (± 421; 95% CI) spring Chinook subyearling parr moved past the trap (Table 3).

Table 3. 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	642	2,004	2,646 ± 1,597	2.0%	85
2007	20	4,441	88,820	2,293	3,399	5,692 ± 2,214	6.4%	285
2008	31	4,592	142,352	5,552	5,193	10,745 ± 3,837	7.5%	347
2009	54	4,573	246,942	2,485	2,939	5,424 ± 2,522	2.2%	100
2010	33	4,314	142,362	1,859	4,121	5,980 ± 3,455	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	3,905	3,995	7,900 ± 3,898	2.2%	92
2013	54	4,716	254,664	2,461	3,023	5,484 ± 2,836	2.2%	102
2014	26	4,045	105,170	1,449	—	—	—	—
Avg	41	4,446	182,508	2,791	3,292	6,082	4.0%	179

[a] Number of complete redds in White River (Hillman et al. 2015)
[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.


12,000.00
10,000.00
8,000.00
6,000.00
4,000.00
2,000.00
0.00
Total Emigrants
R² = 0.0519
0
100,000
200,000
300,000
400,000
Estmated Egg Deposition


0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Egg-to-Emigrant Survival
R² = 0.4407
0
100,000
200,000
300,000
400,000
Estmated Egg Deposition

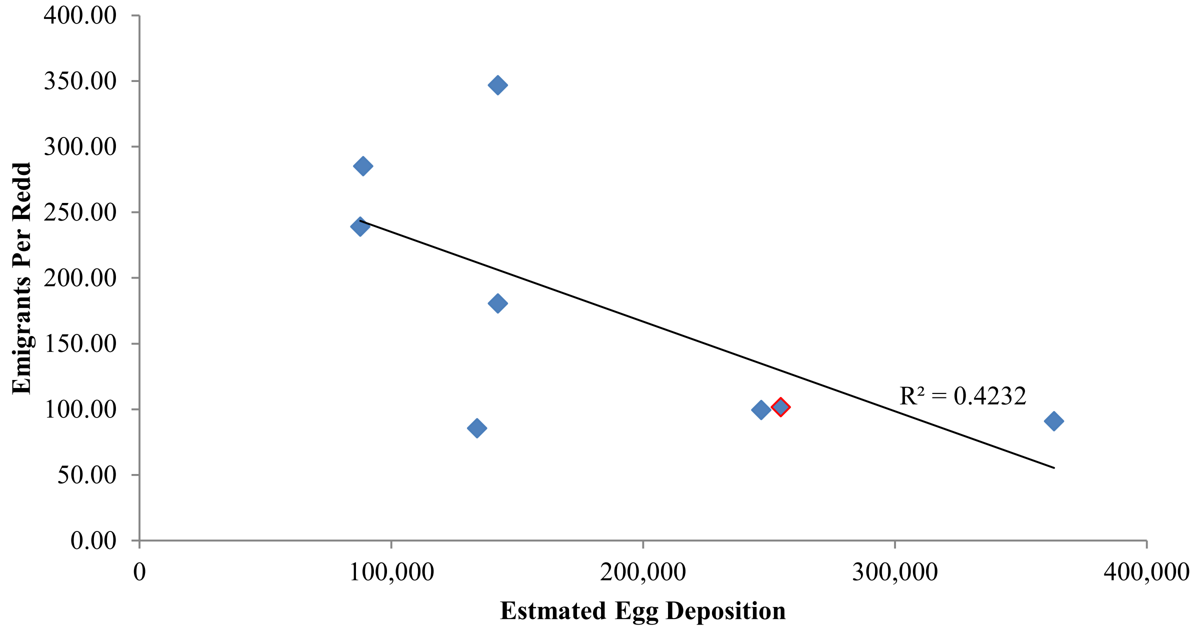


Figure 6. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for White River spring Chinook, BY 2007 to 2013. *BY2013 values denoted by red border.

3.4 PIT Tagging

In 2015, a total of 185 spring Chinook and 6 steelhead were PIT tagged at the trap. PIT tag retention after 24 hours of observation was 100% for all species/stages, with the exception of wild spring Chinook parr (Table 4). There no tagging mortalities (Table 6).

Table 4. Number of PIT tagged spring Chinook and steelhead with shed rates at the White River rotary trap in 2015.

Brood Year	Species/Stage	Total Catch	Total PIT Tagged	Percent Tagged	Percent Tags Shed
2013	Yearling Chinook Smolt	32	32	100.00%	0.0%
2013	Yearling Chinook Precocial Parr	2	2	100.00%	0.0%
2014	Subyearling Chinook Parr	151	149	98.68%	0.7%
*	Steelhead Parr	6	6	100.00%	0.0%

* Brood year unknown

3.5 Incidental Species

Incidental species were enumerated and sampled for length and weight (Table 5). Incidental species included: bull trout *Salvelinus confluentus*, eastern brook trout *Salvelinus fontilalis*, 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 *Oncorhynchus nerka*, sucker *Catostomus sp*., and westslope cutthroat *Oncorhynchus clarkii lewisi*.

Table 5. Summary of length and weight sampling of incidental species captured at the White River rotary trap in 2015.

Species	Total Count	Fork Length (mm)			Weight (g)		
		Mean	*n*	SD	Mean	*n*	SD
Bull Trout Fry	1	28	1	—	—	—	—
Bull Trout Parr	8	147	8	56.3	43.0	8	34.7
Eastern Brook Trout	1	245	1	—	145	1	—
Longnose Dace	12	59	12	22.8	4.0	9	1.9
Mountain Whitefish	93	87	93	36.8	9.5	88	20.4
Northern Pikeminnow	37	128	37	47.7	35.8	35	53.0
Rainbow Trout/Steelhead Parr	6	158	5	54.5	52.3	5	38.6
Redside Shiner	147	73	147	16.2	5.6	142	3.0
Sculpin	172	45	170	22.3	3.1	97	4.4
Sockeye - Kokanee	5	203	5	9.1	90.1	5	10.5
Sockeye Fry	7,212	28	1,200	1.2	—	—	—
Sockeye Parr	5	73	5	10.5	3.7	5	1.5
Sucker	37	140	37	104.6	90.0	28	107.5
Westslope Cutthroat	30	221	30	34.9	103.3	28	50.7

3.6 ESA Compliance

There were no ESA species mortalities incurred in 2015 (Table 6). All fish handled were inspected prior to tagging or further sampling, with only one wild spring Chinook parr warranting immediate release (injury).

Table 6. Summary of White River ESA listed species catch and mortality in 2015.

Species/Stage	Total Catch	Total Mortality	Total % Mortality
Yearling Chinook Smolt	32	0	0.00%
Yearling Chinook Precocial Parr	2	0	0.00%
Subyearling Chinook Parr	151	0	0.00%
Subyearling Chinook Fry	11	0	0.00%
Total Wild Spring Chinook	**196**	**0**	**0.00%**
Bull Trout	9	0	0.00%
Steelhead/Rainbow Trout	6	0	0.00%

4.0 DISCUSSION

Estimations of White River yearling (BY2013) and subyearling (BY2014) wild spring Chinook emigrants in 2015 were calculated using multi-year compounded regressions. Given the overall low abundance of White River spring Chinook, the ability to use mark-group releases over multiple years provides the most effective means of expansion, when pooled and year-specific regression models are impracticable.

Using the multi-year yearling Chinook model, we estimated that 3,023 BY2013 spring Chinook emigrated past the trap in the spring of 2015. This estimation of smolt migrants falls below the 8-year yearling average (n = 3,292), despite above average redd counts. Combined with the previous estimate of 2,482 subyearling emigrants, the total emigrant expansion of 5,505 BY2013 was also below the 8-year average (n = 6,085). Although above-average egg deposition produced a below average estimate of emigrant abundance, the observed BY2013 egg-to-emigrant survival rate (2.2%) was consistent with the inverse relationship between total egg deposition and egg-to-emigrant survival previously observed in the White River. This suggest that the total estimated emigrants for BY2013 although potentially low, is not necessarily atypical of the system.

Base flows extending into mid-September and a brief increase in subyearling catch provided an important opportunity to expand the breadth of our subyearling regression. Efficiency trials at the high and low ends of the hydrograph are generally unfeasible due to inadequate mark-group sizes; active emigration is low at base flows and trap efficiency is extremely low at very high flows. A single, yet significant mark-group release effectively set the lower bound of the subyearling regression at 89.5cfs, a flow representative of near-base discharge on the White River. Using the improved regression model, we estimated that 1,449 BY2014 parr emigrated past the trap in 2015.

Compared to other upper-Wenatchee River tributaries (Chiwawa River and Nason Creek), the White River was the only tributary that did not have an increasing trend in egg-to-emigrant survival for the 2013 brood (Figure 7). Egg-to-emigrant survival in Nason Creek is generally lower than that of the White River, yet the inverse is seen in BY2013. This deviation from previous trends is attributed in part to a suspected overestimate of Nason Creek emigrant abundance; the product of new regression models skewed by limited trials (Ishida et al. 2016). We speculate that the eventual recalculation of the estimate may decrease Nason Creek's BY2013 estimated survival markedly.

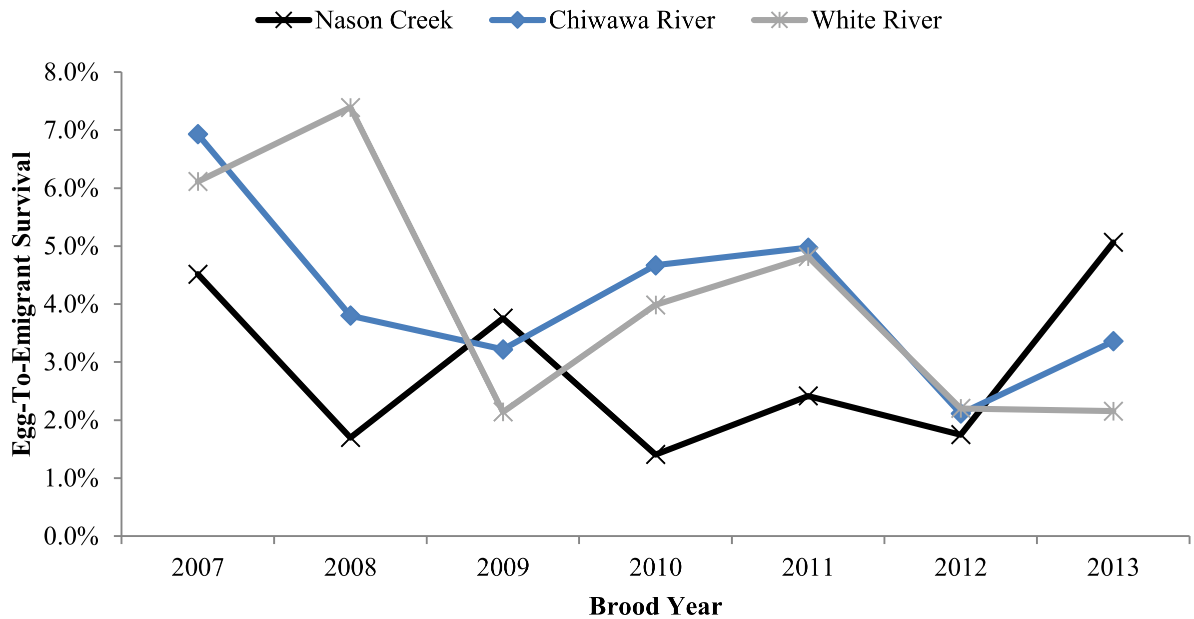


Figure 7. Comparison of wild spring Chinook abundance estimates (BY2007-2013) made at the White R., Nason Cr., and Chiwawa R. smolt traps. Chiwawa R. data provided by Hillman et al. (2015).

In 2016 we will continue to use the methodologies described in this report. Our priority will again be the strengthening of both our subyearling and yearling models through efficiency trials first vetted for adequate size and potential redundancies prior to release. While limited by the low abundance of White River spring Chinook, we remain confident that improvement to our models, albeit potentially slow, will persist through our refined methodologies.

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APPENDIX A: White River Temperature and Discharge Data

Date	Stream Discharge (CFS)	Water Temperature (˚C)
3/1/2015	488	2.8
3/2/2015	464	3.3
3/3/2015	435	2.6
3/4/2015	418	2.3
3/5/2015	405	2.9
3/6/2015	395	3.7
3/7/2015	395	4.0
3/8/2015	406	4.0
3/9/2015	423	4.1
3/10/2015	443	4.1
3/11/2015	468	4.7
3/12/2015	561	5.1
3/13/2015	586	4.7
3/14/2015	1110	4.6
3/15/2015	1390	3.4
3/16/2015	1210	3.8
3/17/2015	1040	4.2
3/18/2015	945	4.7
3/19/2015	883	4.7
3/20/2015	852	5.0
3/21/2015	964	4.9
3/22/2015	896	3.9
3/23/2015	825	4.3
3/24/2015	762	4.7
3/25/2015	742	4.4
3/26/2015	845	5.5
3/27/2015	918	5.4
3/28/2015	1200	5.7
3/29/2015	1060	5.2
3/30/2015	1020	5.7
3/31/2015	1090	5.3
4/1/2015	970	4.4
4/2/2015	870	4.3
4/3/2015	796	4.3
4/4/2015	732	4.8
4/5/2015	681	4.0
4/6/2015	633	4.0
4/7/2015	594	4.2
4/8/2015	560	4.6
4/9/2015	536	5.4
4/10/2015	516	5.6
4/11/2015	536	5.0
4/12/2015	503	3.8
4/13/2015	475	4.7
4/14/2015	453	5.4
4/15/2015	428	5.2
4/16/2015	426	5.9
4/17/2015	488	6.7
4/18/2015	561	6.9
4/19/2015	600	7.1
4/20/2015	714	7.4
4/21/2015	881	7.2
4/22/2015	952	6.3
4/23/2015	804	5.2
4/24/2015	721	4.9
4/25/2015	642	5.2
4/26/2015	586	5.5
4/27/2015	576	7.2
4/28/2015	689	7.4
4/29/2015	772	6.9
4/30/2015	709	7.0
5/1/2015	732	7.4
5/2/2015	823	7.0
5/3/2015	828	6.9
5/4/2015	904	7.4
5/5/2015	977	6.2
5/6/2015	794	5.3
5/7/2015	706	6.6
5/8/2015	726	7.6
5/9/2015	810	7.7
5/10/2015	962	7.8
5/11/2015	1190	8.0
5/12/2015	1370	6.4
5/13/2015	1160	6.5
5/14/2015	1160	6.8
5/15/2015	1150	7.5
5/16/2015	1350	8.1

5/17/2015	1440	6.8
5/18/2015	1520	8.1
5/19/2015	1730	7.9
5/20/2015	1920	8.2
5/21/2015	1940	7.9
5/22/2015	1920	8.0
5/23/2015	2070	8.5
5/24/2015	2050	8.6
5/25/2015	1750	7.6
5/26/2015	1430	7.6
5/27/2015	1390	8.6
5/28/2015	1650	9.2
5/29/2015	1970	9.4
5/30/2015	1950	9.6
5/31/2015	1620	8.8
6/1/2015	1450	9.0
6/2/2015	1460	8.6
6/3/2015	1220	8.4
6/4/2015	1150	9.1
6/5/2015	1220	10.1
6/6/2015	1450	10.8
6/7/2015	1650	11.1
6/8/2015	1710	11.1
6/9/2015	1520	10.9
6/10/2015	1300	10.8
6/11/2015	1190	11.1
6/12/2015	1040	10.0
6/13/2015	762	9.1
6/14/2015	678	10.3
6/15/2015	664	10.8
6/16/2015	715	11.8
6/17/2015	746	12.1
6/18/2015	701	11.3
6/19/2015	657	10.9
6/20/2015	582	10.6
6/21/2015	536	10.9
6/22/2015	501	11.3
6/23/2015	527	12.1
6/24/2015	537	12.2
6/25/2015	586	12.8
6/26/2015	680	13.9
6/27/2015	732	14.2
6/28/2015	803	14.4
6/29/2015	930	14.7
6/30/2015	815	14.5

7/1/2015	699	14.4
7/2/2015	612	14.7
7/3/2015	587	15.2
7/4/2015	559	15.2
7/5/2015	525	15.0
7/6/2015	473	14.8
7/7/2015	449	14.7
7/8/2015	444	15.0
7/9/2015	436	15.2
7/10/2015	430	14.9
7/11/2015	418	14.2
7/12/2015	346	13.6
7/13/2015	310	13.6
7/14/2015	283	13.7
7/15/2015	271	13.8
7/16/2015	273	14.0
7/17/2015	259	14.0
7/18/2015	257	14.7
7/19/2015	288	15.5
7/20/2015	314	15.9
7/21/2015	293	15.2
7/22/2015	250	14.3
7/23/2015	226	14.4
7/24/2015	222	14.0
7/25/2015	254	13.7
7/26/2015	221	13.1
7/27/2015	194	12.9
7/28/2015	180	13.7
7/29/2015	190	14.5
7/30/2015	202	15.0
7/31/2015	215	15.1
8/1/2015	220	15.2
8/2/2015	218	14.9
8/3/2015	220	14.2
8/4/2015	211	14.1
8/5/2015	198	14.3
8/6/2015	186	13.8
8/7/2015	180	14.0
8/8/2015	189	14.4
8/9/2015	191	14.6
8/10/2015	197	14.7
8/11/2015	208	14.2
8/12/2015	212	14.3
8/13/2015	230	15.0
8/14/2015	228	14.2

8/15/2015	206	13.4	9/29/2015	94.7	8.2
8/16/2015	173	13.1	9/30/2015	92.3	8.6
8/17/2015	167	13.5	10/1/2015	95.7	9.1
8/18/2015	173	13.9	10/2/2015	98.4	9.4
8/19/2015	195	14.5	10/3/2015	97.4	9.9
8/20/2015	204	14.8	10/4/2015	91.5	9.7
8/21/2015	190	14.3	10/5/2015	89	9.1
8/22/2015	149	12.6	10/6/2015	86.6	8.6
8/23/2015	138	12.5	10/7/2015	116	9.1
8/24/2015	136	13.1	10/8/2015	193	9.7
8/25/2015	133	13.1	10/9/2015	142	10.1
8/26/2015	134	13.3	10/10/2015	429	10.1
8/27/2015	149	14.0	10/11/2015	650	8.7
8/28/2015	157	13.6	10/12/2015	268	8.5
8/29/2015	196	12.4	10/13/2015	273	9.3
8/30/2015	416	11.1	10/14/2015	197	8.2
8/31/2015	328	10.6	10/15/2015	161	7.3
9/1/2015	359	10.6	10/16/2015	142	7.5
9/2/2015	376	10.8	10/17/2015	144	8.0
9/3/2015	249	10.1	10/18/2015	153	9.0
9/4/2015	173	9.6	10/19/2015	172	9.3
9/5/2015	136	9.8	10/20/2015	140	9.0
9/6/2015	126	9.8	10/21/2015	123	8.0
9/7/2015	126	10.8	10/22/2015	111	7.7
9/8/2015	115	11.4	10/23/2015	101	6.8
9/9/2015	129	11.7	10/24/2015	95.4	6.0
9/10/2015	126	12.2	10/25/2015	92.5	6.2
9/11/2015	147	12.4	10/26/2015	107	7.2
9/12/2015	160	12.8	10/27/2015	111	7.5
9/13/2015	162	13.1	10/28/2015	102	7.0
9/14/2015	134	11.5	10/29/2015	174	7.3
9/15/2015	108	10.4	10/30/2015	675	7.4
9/16/2015	92.8	10.2	10/31/2015	3580	6.7
9/17/2015	89.5	10.0	11/1/2015	2110	5.4
9/18/2015	110	10.5	11/2/2015	1160	5.2
9/19/2015	103	10.8	11/3/2015	809	5.0
9/20/2015	181	11.2	11/4/2015	633	4.2
9/21/2015	278	11.4	11/5/2015	551	4.8
9/22/2015	154	10.0	11/6/2015	480	4.6
9/23/2015	123	9.2	11/7/2015	483	5.5
9/24/2015	115	9.9	11/8/2015	589	5.6
9/25/2015	147	10.6	11/9/2015	525	4.6
9/26/2015	167	10.3	11/10/2015	462	3.9
9/27/2015	114	9.0	11/11/2015	459	4.4
9/28/2015	101	8.2	11/12/2015	426	3.8

11/13/2015	3220	3.7
11/14/2015	3970	4.6
11/15/2015	2290	4.8
11/16/2015	1560	3.5
11/17/2015	3740	2.5
11/18/2015	4280	3.4
11/19/2015	2310	3.8
11/20/2015	1670	2.9
11/21/2015	1320	2.5
11/22/2015	1100	2.5
11/23/2015	958	2.7
11/24/2015	850	3.2
11/25/2015	740	2.8
11/26/2015	662	1.5
11/27/2015	606	1.2
11/28/2015	560	0.9
11/29/2015	525	1.0
11/30/2015	486	1.1

APPENDIX B: Daily Trap Operation Status

Date	Trap Status	Comments
3/1/2015	No Op.	Pulled-administrative
3/2/2015	No Op.	Pulled-administrative
3/3/2015	No Op.	Pulled-administrative
3/4/2015	No Op.	Pulled-administrative
3/5/2015	No Op.	Pulled-administrative
3/6/2015	No Op.	Pulled-administrative
3/7/2015	No Op.	Pulled-administrative
3/8/2015	No Op.	Pulled-administrative
3/9/2015	No Op.	Pulled-administrative
3/10/2015	Op.	
3/11/2015	Op.	
3/12/2015	Op.	
3/13/2015	Op.	
3/14/2015	Op.	
3/15/2015	No Op.	Stopped-debris
3/16/2015	Op.	
3/17/2015	Op.	
3/18/2015	Op.	
3/19/2015	Op.	
3/20/2015	Op.	
3/21/2015	Op.	
3/22/2015	Op.	
3/23/2015	Op.	
3/24/2015	Op.	
3/25/2015	Op.	
3/26/2015	Op.	
3/27/2015	Op.	
3/28/2015	Op.	
3/29/2015	Op.	
3/30/2015	Op.	
3/31/2015	Op.	
4/1/2015	Op.	
4/2/2015	Op.	
4/3/2015	Op.	
4/4/2015	Op.	
4/5/2015	Op.	
4/6/2015	Op.	
4/7/2015	Op.	
4/8/2015	Op.	
4/9/2015	Op.	
4/10/2015	Op.	
4/11/2015	Op.	
4/12/2015	Op.	
4/13/2015	Op.	
4/14/2015	Op.	
4/15/2015	Op.	
4/16/2015	Op.	
4/17/2015	Op.	
4/18/2015	Op.	
4/19/2015	Op.	
4/20/2015	Op.	
4/21/2015	Op.	
4/22/2015	Op.	
4/23/2015	Op.	
4/24/2015	Op.	
4/25/2015	Op.	
4/26/2015	Op.	
4/27/2015	Op.	
4/28/2015	Op.	
4/29/2015	Op.	
4/30/2015	Op.	
5/1/2015	Op.	
5/2/2015	Op.	
5/3/2015	Op.	
5/4/2015	Op.	
5/5/2015	Op.	
5/6/2015	Op.	
5/7/2015	Op.	
5/8/2015	Op.	
5/9/2015	Op.	
5/10/2015	Op.	
5/11/2015	Op.	
5/12/2015	No Op.	Stopped-debris
5/13/2015	Op.	
5/14/2015	Op.	
5/15/2015	Op.	
5/16/2015	Op.	
5/17/2015	Op.	
5/18/2015	Op.	
5/19/2015	Op.	
5/20/2015	Op.	

5/21/2015	Op.	
5/22/2015	Op.	
5/23/2015	Op.	
5/24/2015	Op.	
5/25/2015	Op.	
5/26/2015	No Op.	Stopped-tampering
5/27/2015	Op.	
5/28/2015	Op.	
5/29/2015	Op.	
5/30/2015	No Op.	Stopped-debris
5/31/2015	Op.	
6/1/2015	Op.	
6/2/2015	Op.	
6/3/2015	Op.	
6/4/2015	Op.	
6/5/2015	Op.	
6/6/2015	Op.	
6/7/2015	Op.	
6/8/2015	Op.	
6/9/2015	Op.	
6/10/2015	Op.	
6/11/2015	Op.	
6/12/2015	Op.	
6/13/2015	Op.	
6/14/2015	Op.	
6/15/2015	Op.	
6/16/2015	Op.	
6/17/2015	Op.	
6/18/2015	Op.	
6/19/2015	Op.	
6/20/2015	Op.	
6/21/2015	Op.	
6/22/2015	Op.	
6/23/2015	Op.	
6/24/2015	Op.	
6/25/2015	Op.	
6/26/2015	Op.	
6/27/2015	Op.	
6/28/2015	Op.	
6/29/2015	Op.	
6/30/2015	Op.	
7/1/2015	Op.	
7/2/2015	No Op.	Pulled - administrative
7/3/2015	No Op.	Pulled - administrative
7/4/2015	No Op.	Pulled - administrative
7/5/2015	No Op.	Pulled - administrative
7/6/2015	No Op.	Pulled - administrative
7/7/2015	No Op.	Pulled - administrative
7/8/2015	No Op.	Pulled - administrative
7/9/2015	No Op.	Pulled - administrative
7/10/2015	No Op.	Pulled - administrative
7/11/2015	No Op.	Pulled - administrative
7/12/2015	No Op.	Pulled - administrative
7/13/2015	No Op.	Pulled - administrative
7/14/2015	No Op.	Pulled - administrative
7/15/2015	No Op.	Pulled - administrative
7/16/2015	No Op.	Pulled - administrative
7/17/2015	No Op.	Pulled - administrative
7/18/2015	No Op.	Pulled - administrative
7/19/2015	No Op.	Pulled - administrative
7/20/2015	No Op.	Pulled - administrative
7/21/2015	No Op.	Pulled - administrative
7/22/2015	No Op.	Pulled - administrative
7/23/2015	No Op.	Pulled - administrative
7/24/2015	Op.	
7/25/2015	Op.	
7/26/2015	Op.	
7/27/2015	Op.	
7/28/2015	Op.	
7/29/2015	Op.	
7/30/2015	Op.	
7/31/2015	Op.	
8/1/2015	Op.	
8/2/2015	Op.	
8/3/2015	Op.	
8/4/2015	Op.	
8/5/2015	Op.	
8/6/2015	Op.	
8/7/2015	Op.	
8/8/2015	Op.	
8/9/2015	Op.	
8/10/2015	Op.	
8/11/2015	Op.	
8/12/2015	Op.	
8/13/2015	Op.	
8/14/2015	Op.	
8/15/2015	Op.	
8/16/2015	Op.	
8/17/2015	Op.	
8/18/2015	Op.	

8/19/2015	Op.		10/3/2015	No Op.	Pulled-high flows
8/20/2015	Op.		10/4/2015	No Op.	Pulled-high flows
8/21/2015	Op.		10/5/2015	No Op.	Pulled-high flows
8/22/2015	Op.		10/6/2015	No Op.	Pulled-high flows
8/23/2015	Op.		10/7/2015	Op.	
8/24/2015	Op.		10/8/2015	Op.	
8/25/2015	Op.		10/9/2015	Op.	
8/26/2015	Op.		10/10/2015	Op.	
8/27/2015	Op.		10/11/2015	No Op.	Stopped-debris
8/28/2015	Op.		10/12/2015	Op.	
8/29/2015	Op.		10/13/2015	Op.	
8/30/2015	Op.		10/14/2015	Op.	
8/31/2015	Op.		10/15/2015	Op.	
9/1/2015	Op.		10/16/2015	Op.	
9/2/2015	Op.		10/17/2015	Op.	
9/3/2015	Op.		10/18/2015	Op.	
9/4/2015	Op.		10/19/2015	Op.	
9/5/2015	Op.		10/20/2015	Op.	
9/6/2015	Op.		10/21/2015	Op.	
9/7/2015	Op.		10/22/2015	Op.	
9/8/2015	Op.		10/23/2015	Op.	
9/9/2015	Op.		10/24/2015	Op.	
9/10/2015	Op.		10/25/2015	Op.	
9/11/2015	Op.		10/26/2015	Op.	
9/12/2015	No Op.	Stopped-out of position	10/27/2015	Op.	
9/13/2015	Op.		10/28/2015	Op.	
9/14/2015	Op.		10/29/2015	Op.	
9/15/2015	Op.		10/30/2015	Op.	
9/16/2015	Op.		10/31/2015	No Op.	Pulled-high flows
9/17/2015	Op.		11/1/2015	No Op.	Pulled-high flows
9/18/2015	Op.		11/2/2015	Op.	
9/19/2015	Op.		11/3/2015	Op.	
9/20/2015	Op.		11/4/2015	Op.	
9/21/2015	Op.		11/5/2015	Op.	
9/22/2015	Op.		11/6/2015	No Op.	Stopped-debris
9/23/2015	Op.		11/7/2015	Op.	
9/24/2015	Op.		11/8/2015	Op.	
9/25/2015	Op.		11/9/2015	Op.	
9/26/2015	Op.		11/10/2015	Op.	
9/27/2015	Op.		11/11/2015	Op.	
9/28/2015	Op.		11/12/2015	Op.	
9/29/2015	Op.		11/13/2015	No Op.	Pulled-high flows
9/30/2015	Op.		11/14/2015	No Op.	Pulled-high flows
10/1/2015	Op.		11/15/2015	Op.	
10/2/2015	No Op.	Pulled-high flows	11/16/2015	Op.	

11/17/2015	Op.	
11/18/2015	No Op.	Pulled-high flows
11/19/2015	No Op.	Pulled-high flows
11/20/2015	Op.	
11/21/2015	Op.	
11/22/2015	Op.	
11/23/2015	Op.	
11/24/2015	Op.	
11/25/2015	Op.	
11/26/2015	Op.	
11/27/2015	Op.	
11/28/2015	Op.	
11/29/2015	Op.	
11/30/2015	Op.	

APPENDIX C: Regression Models

Model: Chinook Yearlings (Spring '08-'15) Back Position, (r^2=0.569; p = 0.001)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (cfs)
Wild Chinook Yearlings	4/10/2008	25	2	0.120	0.354	229
Wild Chinook Yearlings	3/26/2009	24	5	0.250	0.524	191
Wild Chinook Yearlings	3/30/2009	34	4	0.147	0.394	193
Wild Chinook Yearlings	4/2/2009	37	10	0.297	0.577	206
Wild Chinook Yearlings	4/5/2009	59	15	0.271	0.548	205
Wild Chinook Yearlings	4/10/2009	36	3	0.111	0.340	385
Wild Chinook Yearlings	3/12/2010	25	1	0.080	0.287	300
Wild Chinook Yearlings	3/16/2010	30	5	0.200	0.464	278
Wild Chinook Yearlings	3/20/2010	21	1	0.095	0.314	283
Wild Chinook Yearlings	4/5/2010	37	1	0.054	0.235	340
Wild Chinook Yearlings	4/9/2010	31	4	0.161	0.413	310
Wild Chinook Yearlings	4/12/2010	58	4	0.086	0.298	288
Wild Chinook Yearlings	4/16/2010	73	2	0.041	0.204	381
Wild Chinook Yearlings	4/14/2012	48	1	0.042	0.206	527

Model: Chinook Subyearlings (Fall '09-'15) Back Position, (r^2=0.130; p = 0.086)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (cfs)
Wild Chinook Subyearlings	8/20/2009	20	2	15.00%	0.398	311
Wild Chinook Subyearlings	8/29/2009	34	4	14.71%	0.394	227
Wild Chinook Subyearlings	10/7/2009	22	2	13.64%	0.378	95
Wild Chinook Subyearlings	10/16/2009	34	6	20.59%	0.471	134
Wild Chinook Subyearlings	11/17/2009	35	3	11.43%	0.345	375
Wild Chinook Subyearlings	11/23/2009	21	0	4.76%	0.22	313
Wild Chinook Subyearlings	11/21/2011	39	2	7.69%	0.281	172
Wild Chinook Subyearlings	10/4/2012	33	5	18.18%	0.441	140
Wild Chinook Subyearlings	10/24/2012	87	6	8.05%	0.288	268
Wild Chinook Subyearlings	10/28/2012	36	1	5.56%	0.238	711
Wild Chinook Subyearlings	10/31/2013	46	7	17.39%	0.43	258
Wild Chinook Subyearlings	11/6/2013	38	9	26.32%	0.539	248
Wild Chinook Subyearlings	11/9/2013	40	6	17.50%	0.432	251
Wild Chinook Subyearlings	11/13/2013	29	2	10.34%	0.327	422
Wild Chinook Subyearlings	11/23/2013	25	3	16.00%	0.412	406
Wild Chinook Subyearlings	11/27/2013	24	0	4.17%	0.206	335
Wild Chinook Subyearlings	9/17/2015	39	4	12.82%	0.366	89.5

Appendix D. Historical Morphometric Data

Spring Chinook (2007-2015)

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	152	7.5	10.4	149	6.3	1.2

[a] Includes residualized non-precocial smolts caught after June 30
[b] "Fry" classification based on age despite FL $\geq$ 50mm

Appendix M

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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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^{o}C for 3 min, denaturation at 95^{o}C for 15 sec, anneal for 30 sec at the appropriate temperature for each locus (Table 2), extension at 72^{o}C for 1 min, repeat cycle (steps 2-4), final extension at 72^{o}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.

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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

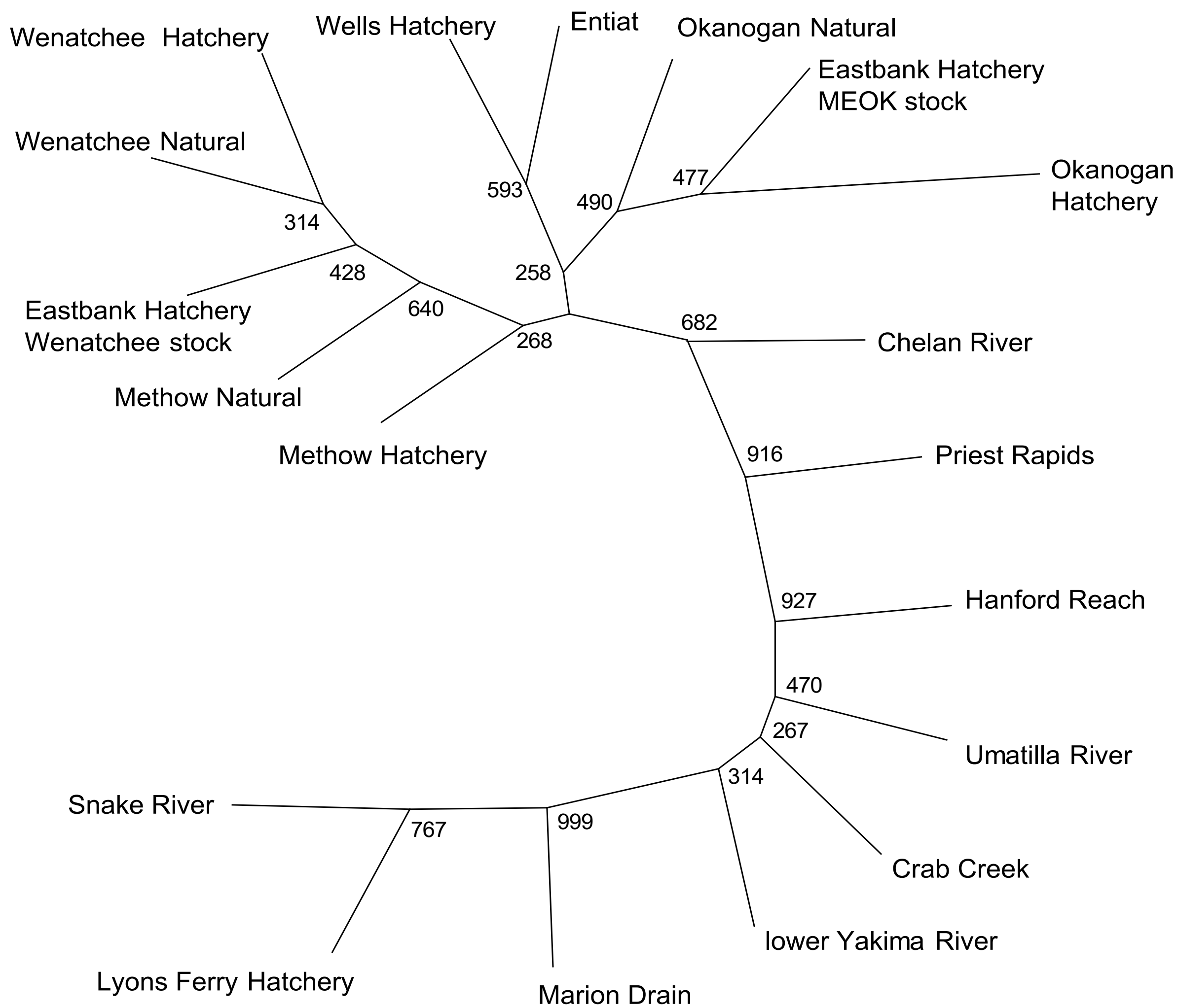

Figure 1. Relationship of natural- and hatchery-origin Chinook collections from the upper Columbia River basin using Cavalli-Sforza and Edwards (1967) chord distance. Bootstrap values are shown at each node.

Appendix N

Summer Chinook Spawning Ground Surveys in the Methow River Basin and Chelan River, 2015

BioAnalysts, Inc.

4725 North Cloverdale Road, Ste. 102
Boise ID 83713

March 10, 2016

To: Chelan and Grant Public Utility Districts

From: Denny Snyder, Keith Watson, and Mark Miller

Re: 2015 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 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 program. The tasks and objectives associated with implementing Grant and Chelan PUDs' Hatchery M&E Plan for 2015 are outlined in Hillman et al. (2013). Figures and tables are presented at the end of this memo. In 2015, The Okanogan Basin was surveyed by the Colville Confederated Tribes (CCT).

METHODS

Spawning ground surveys were conducted by foot and raft beginning the last week of September and ending late-November. We did not use aerial surveys on the Methow River because past work has demonstrated that ground counts were more accurate than aerial surveys (Miller and Hillman 1997). Ground surveys were used to provide more accurate counts and a complete census of Chinook redds within their spawning distribution. Observers floated through sampling reaches and recorded the location and numbers of redds each week. Observers recorded the date, water temperature, river mile, and constructed a drawing of the area where redds were located. A different symbol was used each week to record the number of new and incomplete redds.

To maintain consistency, at least one observer surveyed the same stream reach on successive dates. In areas where numerous summer Chinook spawn, we constructed detailed maps of the river and used the cell-area-method (Hamilton and Bergersen 1984) to identify the number of redds within each cell. Cells 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 grid on 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.

Carcasses of summer Chinook 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 PIT tag detection. 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 this year. We only report the escapement and number of redds for the Okanogan Basin.

RESULTS

Methow

There were 1,231 summer Chinook redds counted within seven reaches of the Methow River (Table 1). No redds were counted in the Chewuch and Twisp Rivers this year. This was the fifth highest redd count observed in the last 25 years for the Methow River (Table 3). Spawning began the last week of September, peaked in early October, and ended the third week of November (Figure 1). Spawning may have started the third week of September given the unusually large number of Chinook on spawning grounds. Stream temperatures in the Methow River when spawning began varied from 9.0-10.0°C in late September. Spawning peaked the last week of September in reaches M6 and M7, while peak spawning occurred in reaches M3-M5 the first week of October. Spawning peaked the second week of October in reaches M1and M2.

Most redds (78%) were located in reaches from the mouth to the town of Twisp (M1-M3) (Table 1). In 2015, reach M1 experienced a dramatic increase in spawning with 350 redds compared to 9 redds observed in 2014. This increase is most likely because the fine sediments that covered spawning areas in 2014, as a result of the Carlton Complex Fires and landslides, were flushed from the system during high spring flows in 2015. Estimated escapement based on expansion of redd counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 3,952 summer Chinook (1,231 redds x 3.21 fish/redd) escaped to the Methow River.

There were 839 summer Chinook salmon carcasses sampled within the seven reaches of the Methow River (Table 2). The presence or absence of an adipose fin could not be determined on one fish. Twenty-one percent of the fish returning to the Methow River were sampled based on the estimated escapement of 3,952 summer Chinook. Ad-clipped hatchery fish made up 19% and naturally produced fish (adipose fin present) made up 81% of the fish sampled (Table 2). Most (94%) of the ad-clipped hatchery fish were located in reaches M1-M3, while naturally produced fish were more evenly distributed among survey reaches (Figure 2). Naturally produced fish made up 100% of the fish sampled in upper reaches (M6 and M7). Females made up 49% of the carcasses examined. Based on sampling 413 female carcasses, average egg voidance was 99%. Seven females (2 %) died before spawning (i.e., they retained all their eggs).

Chelan River

There were 448 redds counted in the Chelan River. Spawning activity began the first week of October and peaked two weeks later (Figure 3). Spawning continued into the last week of November. As more information is collected on time of spawning, the average spawn time will likely not appear bimodal. The majority of spawning occurred in the Powerhouse tailrace (48%), Columbia River tailrace (24%), and in the Habitat channel (20%) (Table 1). Estimated escapement based on expansion of redd counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 1,438 summer Chinook (448 redds x 3.21 fish/redd) escaped to the Chelan River.

There were 363 summer Chinook carcasses sampled in the Chelan River (Table 2). Twenty-five percent of the summer Chinook returning to the Chelan River were sampled based on the estimated escapement of 1,438 fish. Ad-clipped hatchery fish made up 47% and naturally produced fish were 53% of the fish examined. The distribution of ad-clipped hatchery fish and naturally produced fish was similar, except in the pool upstream of the habitat channel where only hatchery fish were recovered (Figure 4). A disproportionate number of fish (compared to redds counts) were sampled in the Columbia River tailrace, because carcasses drifted from upstream spawning areas and settled in the Columbia River tailrace. Females made up 77% of the carcasses examined (Table 2). Mean egg voidance from 281 female carcasses was 84%. Twenty females (7 %) died before spawning. Five Coho were sampled within the Chelan River and these data were submitted to the Yakima Nation (Peshastin Office).

Okanogan Basin

In 2015, CCT conducted summer Chinook surveys in the Okanogan Basin. A total of 4,128 redds were counted in the Okanogan Basin. Based on expanded redd counts, the estimated escapement for the Okanogan basin was 13,272 summer Chinook (Personal Communication, Andrea Pearl, CCT).

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Hillman, T., T. Kahler, G. Mackey, J. Murauskas, A. Murdoch, K. Murdoch, T. Pearsons, and M. Tonseth. 2013. Updated monitoring and evaluation plan for PUD hatchery programs. Report to the Hatchery Committees, Wenatchee, East Wenatchee, and Ephrata, WA.

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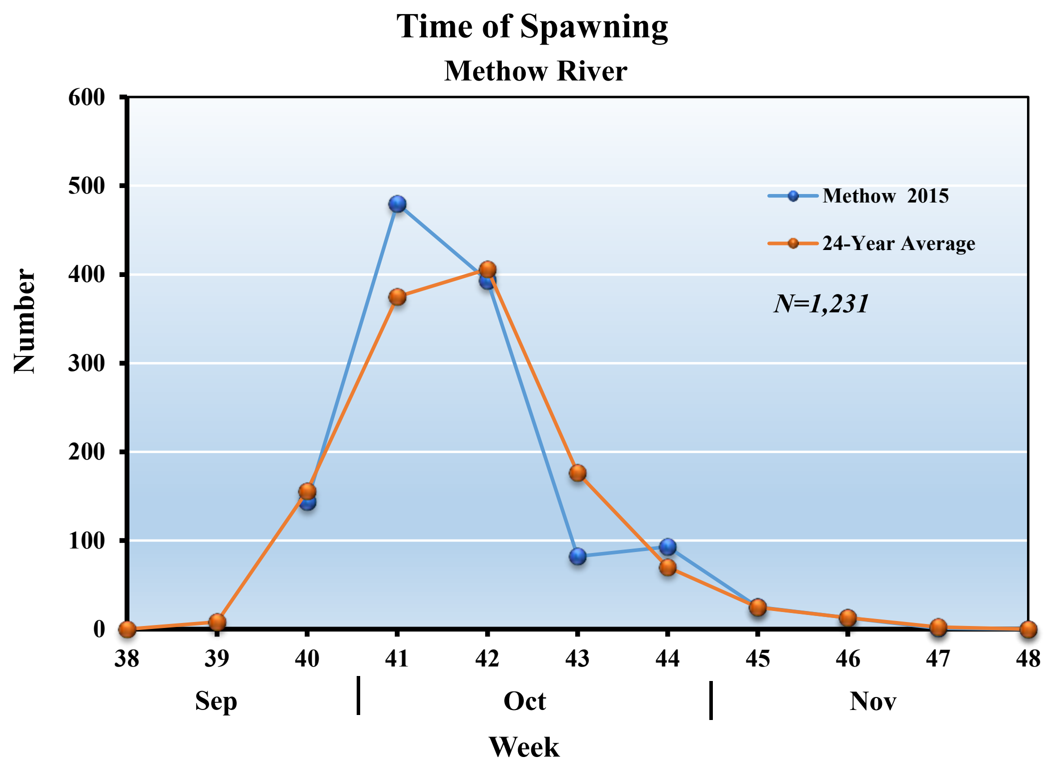


Figure 1. Number of new redds counted each week from late September to mid-November. The figure displays the beginning, peak and end of spawning for summer Chinook in the Methow River in 2015 compared to a 24-year average (1991-2014).

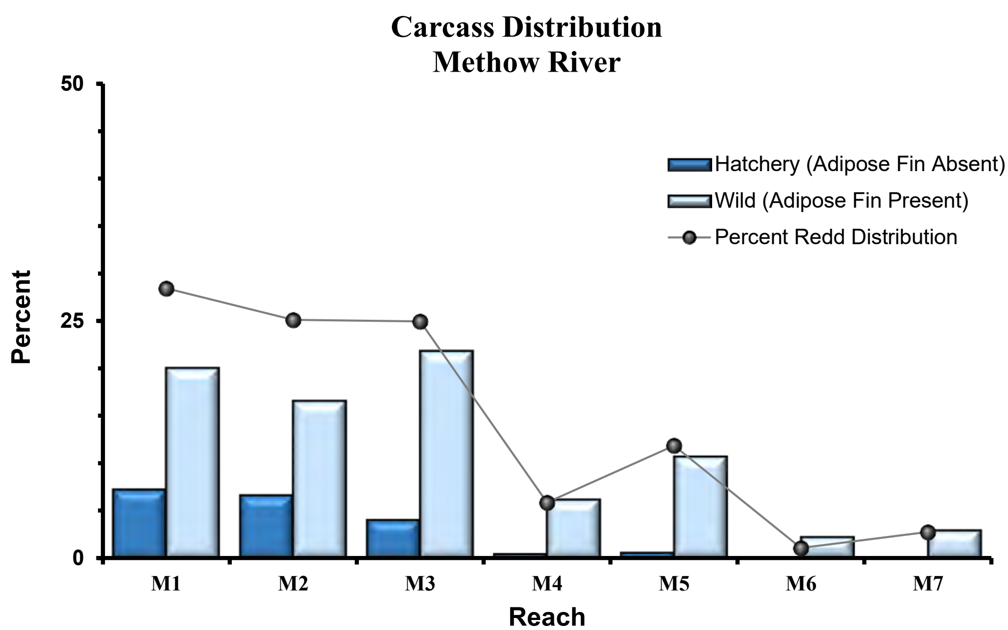


Figure 2. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Methow River, 2015.

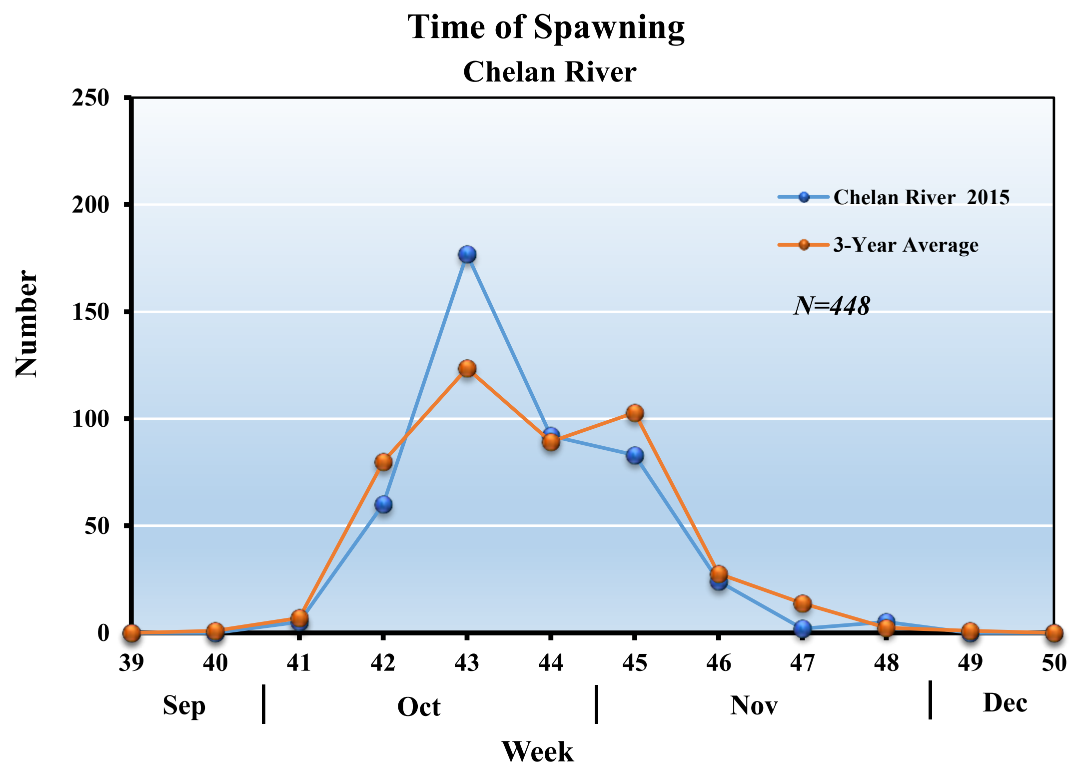


Figure 3. Number of new redds counted each week from late September to mid-November. The figure displays the beginning, peak and end of spawning for summer Chinook in the Chelan River in 2015 compared to a 3-year average (2012-2014).

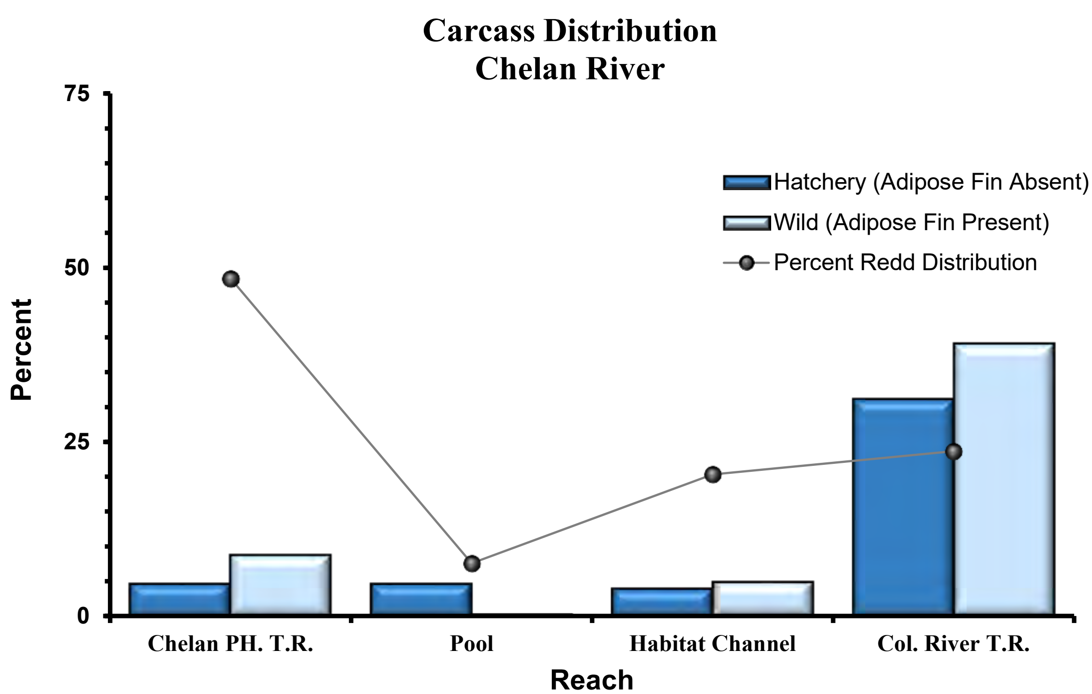


Figure 4. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Chelan River, 2015.

Table 1. Number of summer Chinook redds observed each week within the Methow and Chelan rivers, 2015. Dashes indicate that no survey occurred.

Reach	Location (Rkm)	Sep	Oct					Nov				Dec	Total	Percent
		20-26	27-3	4-10	11-17	18-24	25-31	1-7	8-14	15-21	22-28	29-5		
		39	40	41	42	43	44	45	46	47	48	49		
Methow River														
M1	0.0-23.8	--	0	85	108	37	85	21	13	1	--	--	350	28
M2	23.8-43.8	--	30	120	124	23	8	4	--	--	--	--	309	25
M3	43.8-63.7	--	42	150	104	11	0	0	--	--	--	--	307	25
M4	63.7-72.3	--	9	41	20	2	0	0	--	--	--	--	72	6
M5	72.3-80.1	--	31	74	32	9	0	--	--	--	--	--	146	12
M6	80.1-83.0	--	11	0	2	0	0	--	--	--	--	--	13	1
M7	83.0-96.1	--	21	10	3	0	--	--	--	--	--	--	34	3
Total:		**--**	**144**	**480**	**393**	**82**	**93**	**25**	**13**	**1**	**--**	**--**	**1,231**	**100**
Chelan River														
Powerhouse Tailrace		--	0	2	21	98	48	25	18	1	4	0	217	48
Columbia R. Tailrace		--	0	1	7	25	32	37	3	1	0	0	106	24
Pool		--	0	0	13	15	3	3	0	0	0	0	34	8
Habitat Channel		--	0	2	19	39	9	18	3	0	1	0	91	20
Total:		**--**	**0**	**5**	**60**	**177**	**92**	**83**	**24**	**2**	**5**	**0**	**448**	**100**

Table 2. Number and percent of hatchery (ad-clipped) and naturally produced (not ad-clipped) summer Chinook collected in Methow and Chelan rivers, 2015. The origin of three fish sampled could not be determined in the Methow River.

Reach	Location (Rkm)	Ad-Clipped Hatchery				Naturally Produced				Reach Total
		Male	Female	Total	Percent	Male	Female	Total	Percent	
Methow River										
M1	0.0-23.8	29	31	60	26	71	97	168	74	**229**[1]
M2	23.8-43.8	43	12	55	28	78	61	139	72	**194**
M3	43.8-63.7	22	16	38	17	98	85	183	83	**221**
M4	63.7-72.3	4	0	4	7	20	32	52	93	**56**
M5	72.3-80.1	3	2	5	5	38	52	90	95	**95**
M6	80.1-83.0	0	0	0	0	9	10	19	100	**19**
M7	83.0-96.1	0	0	0	0	11	14	25	100	**25**
Total		**101**	**61**	**162**	**19**	**325**	**351**	**676**	**81**	**839**
Chelan River										
Powerhouse Tailrace		2	15	17	35	3	29	32	65	**49**
Columbia R. Tailrace		24	89	113	44	40	102	142	56	**255**
Pool		5	12	17	94	1	0	1	6	**18**
Habitat Channel		3	20	23	56	4	14	18	44	**41**
Total		**34**	**136**	**170**	**47**	**48**	**145**	**193**	**53**	**363**

[1]. **Origin of one female carcass in Reach 1 could not assigned.**

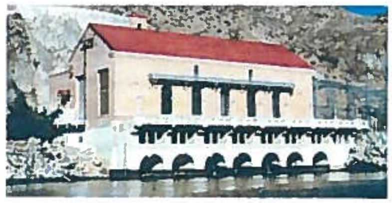
Table 3. Historical aerial and ground redd counts of summer Chinook in the Methow, Chelan, Okanogan, and Similkameen rivers, 1956-2015.

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

[1.] The redd count here is for the entire Okanogan Basin (Similkameen + Okanogan rivers).

APPENDIX U
ROCKY REACH HYDRO PROJECT HABITAT CONSERVATION PLAN 2016 ANNUAL FINANCIAL REPORT, PLAN SPECIES ACCOUNT

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MEMORANDUM

DATE: **January 12, 2017**

TO: **Becky Gallaher, Natural Resources Program Analyst**
Keith Truscott, Director - Natural Resources

FROM: **Debbie Litchfield, Treasurer/Director – Treasury** Debbie Litchfield

RE: **Rocky Reach Hydro Project Habitat Conservation Plan**
2016 Annual Financial Report, Plan Species Account

In accordance with Section 7.4.3 of the Rocky Reach Habitat Conservation Plan attached is the 2016 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: 2016

Beginning Balance:	**1/1/2016**		**$ 2,309,706.03**
Transfers In:			
Rocky Reach Funding		341,705.00	
Interest Earnings		5,840.91	
Total Transfers In			347,545.91
Transfers Out:			
Payments		(270,583.19)	
Bank Service Fees		(20.00)	
Total Transfers Out			(270,603.19)
Ending Balance:	**12/31/2016**		**$ 2,386,648.75**

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.