
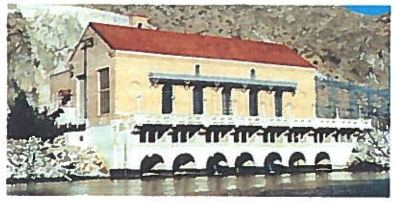


PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
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April 27, 2017

VIA ELECTRONIC FILING

Ms. Kimberly D. Bose, Secretary, and
Mr. Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

Re: **Lake Chelan Hydroelectric Project No. 637**
Article 408, Appendix D Water Quality Certification Condition IV.E. and Settlement Agreement Article 7(c)(2) – 2017 Final Biological Objectives Status Report

Dear Secretary Bose and Deputy Secretary Davis:

On November 28, 2007, the Federal Energy Regulatory Commission (Commission) issued the "*Order Approving Threatened and Endangered Species Plan under Article 408"*[1] requiring that draft and final biological objectives status reports be completed in years 4, 6, 8, and 10 of the license.[2] On May 19, 2010, the Commission ordered the Chelan PUD to file the reports in Years 2013, 2015, 2017 and 2019.[3]

Chelan PUD hereby files the 2017 Final Biological Objectives Status Report. On February 28, 2017, a final draft of this report was provided to the resource agencies, Tribes and non-governmental organizations specified for review. Please refer to Appendix D for the consultation documentation.

Please contact me or Steve Hays at (509) 661-4181 regarding any questions or comments regarding this report.

Sincerely,

Jeffrey G. Osborn
License Compliance Supervisor
jeff.osborn@chelanpud.org
(509) 661-4176

cc: Erich Gaedeke, FERC Portland Regional Office
Breean Zimmerman, Washington Department of Ecology
Chelan River Fishery Forum

Enclosure: 2017 Final Biological Objectives Status Report

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[1] 121 FERC ¶ 62,143 (2007)
[2] 117 FERC ¶ 62,129 (2006)
[3] 131 FERC ¶ 62,151 (2010)

CHELAN RIVER
BIOLOGICAL OBJECTIVES
2017 STATUS REPORT

LICENSE ARTICLE 408

Final

LAKE CHELAN HYDROELECTRIC PROJECT
FERC Project No. 637

April 25, 2017

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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SECTION 1: INTRODUCTION

The Lake Chelan Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). The Federal Energy Regulatory Commission (FERC) license for operation of this project (License), issued on November 6, 2006, authorizes Chelan PUD to operate the Lake Chelan dam and powerhouse for a period of 50 years. As part of the normal operation of the Project, Chelan PUD withdraws water from Lake Chelan for power generation and discharges that water through the powerhouse into an excavated tailrace, which leads to the confluence of the Chelan River and the Columbia River. Flows released from the Chelan Dam follow the natural channel of the Chelan River, joining with the powerhouse tailrace flows and discharging to the Columbia River. As a requirement of the new License, minimum flows were established for the Chelan River and that flow was initiated on October 15, 2009.

The License incorporated conditions regarding biological objectives that were anticipated to be achieved in the Chelan River and Project tailrace. These biological objectives are set forth in the Chelan River Biological Evaluation and Implementation Plan (CRBEIP), which is part of the Lake Chelan Settlement Agreement (October 8, 2003) and is incorporated into the License as Appendix A. The Washington State Department of Ecology (Ecology) incorporated these biological objectives into their 401 Water Quality Certification for the Lake Chelan Hydroelectric Project (Certification) and the FERC, in turn, incorporated the terms and conditions of the Certification into the License. One of the conditions incorporated into the License requires Chelan PUD to file Biological Objectives Status Reports every two years, beginning four years after the effective date of the License. On March 11, 2010, Chelan PUD filed for an extension of time to complete the structural changes to the Project necessary to implement minimum flows and other measures necessary for achievement of the biological objectives, and also to change the dates for the Biological Objectives Status Reports such that they would begin four years after implementation of the minimum flows. On May 19, 2010, FERC granted this time extension, which set the date for the first report to be due April 30, 2013. This third Biological Objectives Status is due April 30, 2017.

The purpose of this Biological Objectives Status Report is to: (1) summarize the results of monitoring and evaluation program detailed in the CRBEIP and evaluate the need for modifications to that program; (2) describe the degree to which the biological objectives have been achieved, and the prospects for achieving those objectives in the next reporting period; (3) review management options taken to meet those biological objectives; and (4) recommend any new or modified restoration and/or monitoring and evaluation measures that are needed to meet, to the extent practicable, the biological objectives. Such recommendations shall contain a schedule for timely implementation. The Chelan River study reaches and biological objectives are shown in Table 1-1.

This report describes the results of monitoring and evaluation programs (M&E) that have been implemented since placement of spawning gravels in the Project tailrace (2008) and completion of the spawning and rearing habitat in Reach 4 of the Chelan River (Habitat Channel) and implementation of minimum flows (October 2009). This report is organized into three sections that pertain to specific biological objectives described in the CRBEIP: (1) biological objectives for Chinook Salmon; (2) biological objectives for Steelhead Trout; and (3) biological objectives for Cutthroat Trout. There are specific measurement objectives for Chinook Salmon and Steelhead Trout in this report, including spawning survey counts, distribution of redds, intragravel dissolved oxygen levels, egg to fry emergence survival rates and presence of rearing juveniles. The measurement objective for Cutthroat Trout is the presence of 200 fish at various age classes.

Table 1-1. Criteria for achievement of biological objectives in the Chelan River.

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Chinook Salmon Spawning Habitat Reach 4 and Tailrace	Areas developed to support spawning meet design habitat characteristics (depth, velocity, and substrate) at the design flow (as-built functionality)	Field measurement to confirm achievement of physical parameters. The presence and success of spawning fish will also be considered in the determination of achievement.	Years 1 – 10, as needed to set flows or further modify channel	Must be met	Must be met
Chinook Salmon Spawning Habitat Use Reach 4 and Tailrace	Distribution of spawning use should reflect distribution of constructed spawning habitat	Spawning use, numbers, distribution and habitat characteristics of selected redds. Qualitative judgment	Years 1 – 10, as needed to set flows	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat measures to achieve this objective are implemented. When no further feasible and reasonable actions exist, CRFF will recommend whether or not Chelan PUD should continue measures implemented
Chinook Salmon Spawning Habitat Quality, Reach 4/Tailrace, Conditions suitable for survival from egg to emergence	Intragravel Dissolved Oxygen ≥ 6.0 mg/l	During all scheduled (non-emergency) powerhouse shutdowns, tailrace intragravel DO monitored hourly. During egg incubation, tailrace and Reach 4 intragravel DO monitored each week hourly for at least one 24-hour period	Years 1-5. Extend if additional measures needed or as recommended by CRFF	Must be met unless determined not a Project effect	Must be met unless determined not a Project effect

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Chinook Salmon Spawning Success, Reach 4/Tailrace, Conditions suitable for survival from egg to emergence	Egg to emergence success equal to > 80% of Methow River average or 70% survival, whichever is less	At least 10% of redds capped and studied for egg to emergence success or other method recommended by CRFF	Years 1-5	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat measures to achieve this objective are implemented. When no further feasible and reasonable actions exist, CRFF will recommend whether or not Chelan PUD should continue measures implemented
Chinook Salmon Juvenile Rearing Habitat Use, Reach 4/Tailrace	Presence and use of available habitat	Snorkel surveys from emergence until fish move into Columbia River (emergence – June). Qualitative judgment	Years 1-5. Extend for next 5 years if fry use is low	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat measures to achieve this objective are implemented. When no further feasible and reasonable actions exist, CRFF will recommend whether or not Chelan PUD should continue measures implemented

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Chinook Salmon Adult Use of Habitat, Reach 4/Tailrace	Adult production of fish produced in Chelan River	Ratio of Chelan River origin/other origin adult carcasses in spawning population	Years 1-10	Maintain Actions. No additional actions needed	Continue until all feasible and reasonable habitat measures to achieve the objectives identified in 7-10 are implemented. When no further feasible actions exist and objectives not attained or the goal not achieved,the CRFF will recommend whether or not Chelan PUD should continue measures implemented
Steelhead Trout Spawning Habitat Reach 4 and Tailrace	Areas developed to support spawning meet design habitat characteristics (depth, velocity, and substrate) at the design flow (as-built functionality)	Field measurement to confirm achievement of physical parameters. The presence and success of spawning fish will also be considered in the determination of achievement.	Years 1 – 10	Must be met	Must be met
Steelhead Trout Spawning Habitat Use Reach 4 and Tailrace	Distribution of spawning use should reflect distribution of constructed spawning habitat	Spawning use, numbers, distribution and habitat characteristics of selected redds. Qualitative judgment. Spawning surveys years 1-2 biweekly, weekly years 3-10, March – May or as needed to set flows	Years 1 – 10, extend if additional measures needed	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat measures are implemented. If can't reach use objective, maintain habitat achieved

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Steelhead Trout Spawning Habitat Quality, Reach 4/Tailrace, Conditions suitable for survival from egg to emergence	Intragravel Dissolved Oxygen ≥ 6.0 mg/l	During all scheduled (non-emergency) powerhouse shutdowns, tailrace intragravel DO monitored hourly. During egg incubation, tailrace and Reach 4 intragravel DO monitored each week hourly for at least one 24-hour period	Years 1-5. Extend if additional measures needed or as recommended by CRFF	Must be met unless determined not a Project effect	Must be met unless determined not a Project effect
Steelhead Trout Spawning Success, Reach 4/Tailrace, Conditions suitable for survival from egg to emergence	Egg to emergence success equal to > 80% of Methow River average or 70% survival, whichever is larger	At least 10% of redds capped and studied for egg to emergence success or other method recommended by CRFF	Years 1-5	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat measures are implemented. If can't reach use objective, maintain best habitat achieved
Steelhead Trout Juvenile Rearing Habitat Use, Reach 4/Tailrace	Fry presence and use of available habitat	Snorkel surveys from emergence until fish move into Columbia River. 8 times per year, only when redds observed in area. Qualitative judgment	Years 3-10	Maintain Actions. No additional actions needed	Determine if Project effect. Continue until all feasible and reasonable habitat are implemented. When no further feasible actions exist and objectives not attained or the goal not achieved, the CRFF will recommend whether or not Chelan PUD should continue measures implemented.

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Steelhead Trout Outmigrant success	Adult production of fish produced in Chelan River – net benefit to ESU	Best professional judgment of CRFF and/or new technology showing adult origin	Years 5-10	Maintain Actions. No additional actions needed	Continue until all feasible and reasonable habitat measures to achieve the objectives identified in 7-10 are implemented. When no further feasible actions exist and objectives not attained or the goal not achieved,the CRFF will recommend whether or not Chelan PUD should continue measures implemented
Cutthroat Trout Habitat, Reaches 1-3	Presence of 200 fish including various age classes. Habitat improvements for Cutthroat Trout, as related to water temperature may include: new, naturally evolved stream channel; riparian shade; thermal refugia/pumping studies; increased flows	Snorkeling surveys, number, distribution, age of resident fish. Cross-sectional and average stream temperature measurements. Flow measurements.	Years 1-5 will serve as establishment. If 200 fish not achieved in year 5, then either continue studies for: A-10 years beyond year 5 of New License to allow natural Cutthroat Trout colonization from Lake Chelan; or B- 5 years beyond year 5 of New License if no natural colonization is evident and test sample of Cutthroat Trout is deemed necessary by CRFF	Maintain actions	Determine if Project effect. Continue until all feasible and reasonable habitat measures are implemented. When no further feasible actions exist and objectives not attained or the goal not achieved, the CRFF will recommend whether or not Chelan PUD should continue measures implemented.

Fish Species and Use	Biological Objective	Measured Parameters	Evaluation Timeframe	Actions if Biological Objective Achieved	Actions if Biological Objective Not Achieved
Cutthroat Trout Create habitat to support a viable population of Cutthroat Trout in Reaches 1-3	200 resident fish	Number of fish via snorkeling surveys as specified in Table 7-10	Years 5-10	Maintain Actions. No additional actions needed	Continue until all feasible and reasonable habitat measures to achieve the objectives identified in 7-10 are implemented. When no further feasible actions exist and objectives not attained or the goal not achieved, the CRFF will recommend whether or not Chelan PUD should continue measures implemented

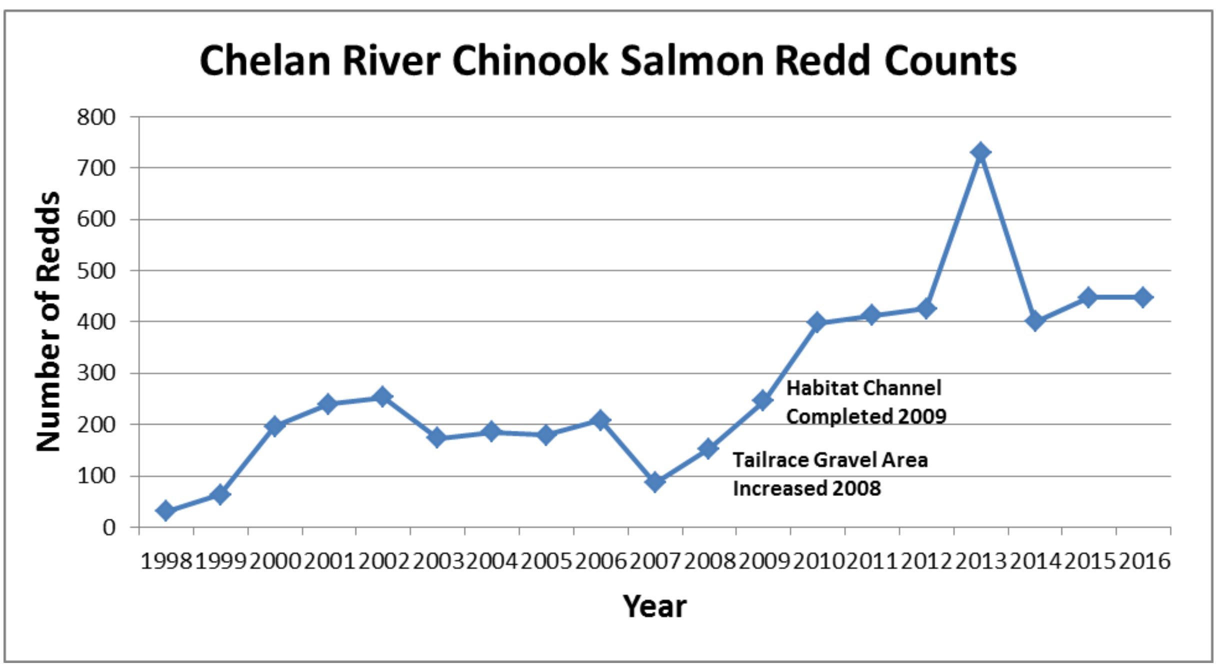
SECTION 2: BIOLOGICAL OBJECTIVES FOR CHINOOK SALMON

2.1 Spawning Habitat for Chinook Salmon Meets Design Characteristics

The CRBEIP states that "salmon and steelhead spawning habitat will be created in Reach 4 and the tailrace, with the objective to create suitable depth, cover, velocity and substrate conditions for these fish. These parameters can be measured independently of fish use, although fish use is the best evidence of achievement. The criteria for achievement are to document that habitat was created and maintained, in accordance with the preference curves established in the IFIM study. Alternatively, if adult fish runs are strong and colonization occurs during the evaluation period, then the presence and success of spawning fish will also be considered in the determination of achievement. Achievement will be evident if spawning fish are distributed in suitable areas in the tailrace, Reach 4 and below the confluence of Reach 4 and the tailrace. Lack of fish will not be termed a failure without evidence that a Project effect prevented fish from using the habitat."

Chinook Salmon spawning has been observed in the Project tailrace at its confluence with the Columbia River since the 1980s, with redd counts prior to 1993 ranging from 16 – 69 redds per year (Chelan PUD, 1991). Documented redd counts (Hillman, et al. 2016) since 1998 (Table 2-1) show that the spawning population increased to around 200 redds prior to construction of the additional habitat beginning in 2008 (Figure 2-1). The fish per redd (FPR) and escapement estimates in Table 2-1 are based on the male:female sex ratio of summer Chinook Salmon sampled at Wells Dam (Hillman, et al. 2016).

Figure 2-1. Chelan River Historical Redd Counts.



The tailrace spawning habitat was created in 2008, with fish use observed in that year. Additional Chinook Salmon and Steelhead Trout spawning habitat was created in 2009, with the habitat available for use by Chinook Salmon in that year. The design parameters (depth, cover, velocity, substrate) defined in the CRBEIP were successfully constructed according to 30%, 60%, 90% and final design plans that were reviewed and approved by the CRFF (Appendix A). Confirmation that suitable spawning habitat for Chinook Salmon was created in the tailrace and in Reach 4 did not require post-construction physical measurements because both areas of new habitat were immediately colonized by Chinook Salmon in the first year following construction and that use has continued.

The full achievement of this biological objective has been documented through spawning survey redd counts, which show use by Chinook Salmon has increased since the construction of this habitat. Since gravel placement in the tailrace and the construction in Reach 4 of the Habitat Channel, the combined Chinook Salmon redd counts in the tailrace, in the Habitat Channel and in the Columbia River below the confluence have increased (Table 2-1). Prior to 2008, the highest redd count was 253. The annual redd counts have increased from an average of 160 redds per year (1998 – 2007) to an average of over 400 redds per year since 2008 when the additional tailrace habitat was constructed.

Table 2-1. Chelan River Chinook Salmon Redd Counts and Escapement Estimates.

Year	FPR	Redds	Escapement
1998	3.00	30	90
1999	2.20	63	139
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	1118
2011	3.10	413	1280
2012	3.07	426	1308
2013	2.31	729	1684
2014	2.75	400	1100
2015	3.21	448	1438
2016	2.01	448	900

2.2 Chinook Salmon Use of Spawning Habitat Throughout Constructed Habitat

Spawning has also been distributed throughout the suitable habitat created in the tailrace and in the Reach 4 Habitat Channel and pool area (Table 2-2). In addition to the increased spawning habitat in the tailrace (completed 2008), the new spawning habitat in Reach 4 has had an average of over 140 redds per year since its construction in 2009.

Table 2-2. Chelan River Chinook Salmon and Coho Salmon Redd Count Distributions.

Year	Tailrace	Reach 4	Columbia R	Total
2008	153	NA	In tailrace count	153
2009	129	79	58	266
2010	234	115	49	398
2011	192	178	48	418
2012	231	139	56	426
2013	320	269	140	729
2014	246	78	76	400
2015	217	125	106	448
2016	207	167	74	448

2.2.1 Temporary Habitat Channel Flow Reduction and Chinook Salmon Spawning Habitat Availability

Flow provided in the Chelan River Habitat Channel for Steelhead Trout and Chinook Salmon is a minimum of 320 cfs by a combination of spill and pumping, per the Chelan River Biological Evaluation and Implementation Plan (CRBEIP). Five pumps are available to meet the minimum spawning flow requirement in the Habitat Channel. The pump station was designed to provide 240 cfs at minimum tailwater elevations (maximum "lift" from intake screen to canal, which means minimum discharge per pump). This assured that the 320 cfs minimum flow would always be provided with the addition of the 80 cfs minimum flow coming from Reaches 1-3. However, at normal tailwater elevations, the 5 pumps often discharge from 250-260 cfs and the total Habitat Channel flows during both the Chinook Salmon and Steelhead Trout spawning periods have frequently been 340-350 cfs, which is 20-30 cfs higher than the minimum design flow.

Ecology, Washington Department of Fish and Wildlife (WDFW), and Chelan PUD staff have observed that water velocities being provided in the Habitat Channel, particularly for Steelhead Trout, were higher than desirable when all pumps are operating. Observations included Ecology's Habitat Suitability Index (HSI) measurements, which showed more suitable habitat at lower flows, flow observations in stream margin habitat and log structures during early rearing of Chinook Salmon fry, and best professional judgment that the Habitat Channel would provide more habitat for Steelhead Trout spawning and juvenile Chinook Salmon rearing at lower flows. A remedy for reducing flows in the Habitat Channel for Chinook Salmon and Steelhead Trout spawning and Chinook Salmon fry early rearing is to reduce the number of pumps operated during the March 15 through May 15 Steelhead Trout spawning period.

These observations led to a decision by the Chelan River Fishery Forum (CRFF) to use adaptive management, as envisioned during the discussions that led to the design of the Habitat Channel, to evaluate conditions for Chinook Salmon and Steelhead Trout spawning under the reduced flow conditions that would be provided if only four pumps were used. The proposed temporary change in pumped flow operation, developed by the CRFF, was as follows:

Proposal

1. Conduct a pump station reduced flow operation during the Chinook Salmon spawning period in 2013
2. Operate 4 pumps instead of 5 pumps from October 15 through November 30, 2013
3. Conduct Chinook Salmon spawning ground surveys, as required by the Lake Chelan comprehensive Settlement Agreement
4. Compare Chinook Salmon redd distribution in the Habitat Channel in 2013 to redd distribution from spawning ground survey redd mapping from 2009 through 2012
5. If Chinook Salmon redd distribution in the Habitat Channel appears to be similar in 2013 to previous years, then conduct the same pump station operation (4 pumps versus 5) during the Steelhead Trout spawning period, March 15 through May 15, in 2014
6. If Chinook Salmon redd distribution in the Habitat Channel appears to be significantly different in 2013 to previous years, then return to 5 pump operation for the Steelhead Trout spawning period in 2014.

Flow conditions for spawning and redd distributions of Chinook Salmon did not demonstrate any reduction in spawning habitat suitability or use with the reduction in flow in 2013. Operation of 4 pumps, instead of 5 pumps, has been used for the past four Chinook Salmon spawning seasons (2013 – 2016). Similarly, flow provided from the pumps has been reduced during the Steelhead Trout spawning seasons from 2014 – 2016.

Information displayed in Table 2-2 demonstrates that Chinook Salmon spawning use of the Habitat Channel and upstream pool area did not decrease following the change in pumped flow. The redd counts for Reach 4 (Habitat Channel and pool) from 2009 – 2012 ranged from 79 - 178 redds, while Reach 4 redd counts from 2013 – 2016 have ranged from 78 – 269 redds. The total number of redds in all areas was somewhat higher during the four years of reduced flows to the Habitat Channel, but the percentage of total redds in the Reach 4 area did not change, with the 2009 – 2012 average being 33 percent in Reach 4, while the 2013 – 2016 average was 30 percent in Reach 4.

Chelan PUD is in the process of seeking a permanent amendment to the Project's license to change the required spawning flows to allow continued operation with four pumps. The proposal is to change the Reach 4 minimum spawning flow requirement from 320 cfs to 260 cfs. This proposal is currently out for review and approval by the CRFF and will be submitted to FERC as a request to amend license Articles 405 and 408, as well as associated documents. An amendment to Ecology's 401 Water Quality Certification is also necessary to amend the minimum spawning flow requirement.

<u>Degree of Achievement of Objectives</u>

Objectives 2.1 and 2.2 have been achieved fully:

M&E Results: The results described above document that the habitat areas constructed to support spawning of Chinook Salmon meet the design criteria, as evidenced by Chinook Salmon successfully spawning in this habitat. The Chinook Salmon redds have been distributed throughout the constructed habitat in Reach 4 and the tailrace.

Objective Achievement: This objective has been achieved fully. Since construction of the habitat, Chinook Salmon redd counts have increased from an average of 160 redds per year (1998 – 2007) to an average of over 400 redds per year since the additional habitat was constructed.

Management Actions Taken: The Project is being operated to maintaining the achievement of this objective by maintain powerhouse generation in the tailrace and providing pumped flow to the Habitat Channel. In addition, Lake Chelan spill levels are being managed to the extent practicable to protect the Reach 4 Habitat Channel from damage due to high flows and to limit bed load accumulations in the tailrace spawning habitat at the Reach 4 confluence. In the summer of 2014, bed load accumulations of river cobble at the confluence of the Reach 4 high flow channel were excavated to reduce the potential of Chinook Salmon redd dewatering during low water conditions in the Columbia River. The river cobbles removed were suitable spawning gravel material and were stockpiled on the shoreline at the site for potential future use. Redd surveys in the fall of 2014 documented Chinook Salmon spawning use in the excavated area, demonstrating that the maintenance operation maintained the depth, velocity and substrate characteristics suitable for Chinook Salmon spawning. Very high spring flows in 2016 deposited even more river bed load in that area, which was removed prior to initiation of Chinook Salmon spawning in 2016. In addition, the pool area upstream of the Habitat Channel was excavated to remove accumulations of river bed material.

Future Actions: The amount of pumped flow needed to provide good spawning conditions in the Habitat Channel was experimentally reduced to provide a minimum flow of 260 cfs instead of the 320 cfs minimum flow required in the Project's license. Monitoring determined that Chinook Salmon redd counts in the Habitat Channel did not decrease as a result of the lower minimum flow. Chelan PUD is in the process of seeking a permanent amendment to the Project's license to change the required spawning flows to a minimum of 260 cfs. Maintenance for management of river bed material will continue as needed.

2.3 Chinook Salmon Tailrace Intragravel Dissolved Oxygen ≥ 6.0 mg/l

The License required that the Project be operated to achieve the CRBEIP biological objective to provide conditions suitable for Chinook Salmon survival from egg to emergence. Specifically, the requirement is to operate the Project powerhouse to maintain intragravel dissolved oxygen (IGDO) levels of 6.0 mg/l or higher to support survival of Chinook Salmon from egg deposition to emergence. If it is not reasonable and feasible to operate the powerhouse to meet this requirement, or if the spawning gravel placed in the tailrace does not have sufficient permeability to meet this requirement, then the CRBEIP allows for alternative actions, such as use of the pump station to increase water circulation in the tailrace or physical modification of the habitat through addition of more permeable substrate and/or use of pumps and pipes under the substrate to create upwelling flows within the spawning gravel.

Studies to determine the level of powerhouse operation needed to meet IGDO requirements were conducted for four incubation seasons from 2011 - 2015. These studies monitored dissolved oxygen meters taking hourly IGDO readings in the egg pockets of 10 redds during each incubation season. Different periods of powerhouse outages and powerhouse flow levels were tested to determine the powerhouse operations necessary to meet the dissolved oxygen requirement. These tests indicated that operation of the powerhouse with one turbine at minimum generation (approximately 800 cfs) maintains intragravel dissolved oxygen levels above 6.0 mg/l. For limited times, powerhouse flow can be shut off with minimal reductions of oxygen levels in the salmon redds, particularly early (December – January) in the incubation season. During the final year of the study, twice daily periods of three hours with no flow from the powerhouse, with one hour of 800 - 1100 cfs flow in between the two periods, maintained oxygen levels above 6.0 mg/l in all ten redds that were monitored during December and January. However, similar operations in February and March demonstrated that oxygen levels dropped below 6.0 mg/l in a number of the monitored redds. The results of the dissolved oxygen studies were presented in detail in the 2013 and 2015 Biological Objectives Status Reports.

<u>Degree of Achievement of Objective</u>

Objective 2.3 has been achieved fully:

M&E Results:.Four years of studies determined that IGDO levels in tailrace redds may fall below 6.0 mg/l if the powerhouse discharge is discontinued for more than three hours. Late in the incubation period (February – March), IGDO levels may fall below 6.0 mg/l in less than three hours. Powerhouse flows of about 800 cfs are sufficient to maintain IDGO levels above 6.0 mg/l.

Objective Achievement: The objective of providing minimum IDGO levels of 6.0 mg/l in tailrace Chinook Salmon redds is achieved by maintaining powerhouse flows with one turbine operating at minimum generation flows (approximately 800 cfs) throughout the spawning and incubation period (October 15 – March 31).

Management Actions Taken: Extensive modeling work has been undertaken by Chelan PUD to develop operating procedures that will manage power generation operations to best meet both the tailrace IDGO requirements and refill timing requirements for recreational use in Lake Chelan. These operating procedures incorporate, at a minimum, operation of one turbine at minimum generation throughout the incubation period to maintain IDGO levels. In the event of an unplanned electrical grid or other system reliability event the operating guidelines require a minimum flow of 800 cfs for one hour out of every 4 hours (1 hour on, 3 hours off). This requirement is effective from December 1 – March 31. During the October 15 – November 30 spawning period, a similar procedure applies but with a higher minimum flow (one turbine at full load, approximately 1,100 cfs) to promote spawning activity. During the 2015 – 2016 spawning and incubation period, there was a three-hour system reliability event on November 19, 2015, with flows restored to 2,530 cfs on the fourth hour. There were no system reliability events during the 2016 – 2017 spawning and incubation season.

Future Actions: Maintenance activities, both at the Project and in areas of the electrical grid that are necessary for operation of the powerhouse, will be planned to avoid the October 15-March 31 spawning and incubation period. Management of Lake Chelan storage will continue to assure operation of the powerhouse as necessary to achieve this objective.

2.4 Egg to emergence success equal to > 80% of Methow River average or 70% survival

Studies of Chinook Salmon egg to emergence survival were also initiated in 2011, in conjunction with the IGDO studies. A set of studies conducted in the Columbia River, Hanford Reach, measured egg to emergence survival for Chinook Salmon, using a technique they developed suitable for placing a known number of eggs in a container with local substrate in a manner that can be done by divers in relatively deep, flowing water (Oldenburg et al. 2012). The Hanford Reach studies used cylindrical egg tubes (CET) to place 100 eyed eggs in the tube, then manually excavated an area to simulate a redd, and burying the CET at the same depth as found in the egg pockets of nearby, natural redds. At the end of the study, the CETs are retrieved and the number of live Chinook Salmon fry counted in the CET provides an estimate of egg to emergence survival. Chelan PUD adapted this study methodology to address the biological objective that egg to emergence survival be either greater than 80 percent of the average egg to emergence survival in good quality spawning areas in the Methow River or meet 70 percent survival outright, whichever is less.

The 2011-2012 study was designed to evaluate egg to emergence survival in four different areas, including: (1) the tailrace in the area filled with gravel to create more spawning habitat; (2) the area at the confluence of the tailrace and Reach 4 of the Chelan River, where the spawning gravel has accumulated as a result of natural processes; (3) in the Columbia River on the alluvial fan formed below the confluence of the Chelan and Columbia rivers; and (4) in the Chelan River Habitat Channel. The new spawning gravels placed in the tailrace and the spawning areas in the Habitat Channel were the areas being tested to determine if the biological objective for egg to emergence survival is being met in these constructed areas. The naturally occurring spawning areas at the confluence of the tailrace and Reach 4 and on the alluvial fan in the Columbia River were meant to serve as a natural control for comparison.

The CET studies were repeated for three years, but the use of CETs was only successful in the Habitat Channel. In the tailrace and in the Columbia River, most of the eggs in CETs died prior to hatching or shortly after hatching, as also happened with CET control sites placed in the tailrace with just a light covering of cobble. This was contrasted with apparently successful incubation and fry survival observed in natural Chinook Salmon redds by divers when replacing or removing dissolved oxygen sensors. However, the CETs did function well in the shallower water and higher velocities of the Habitat Channel. The CET methodology in the tailrace was replaced with monthly direct sampling of Chinook Salmon redds by divers to determine egg to emergence survival. These redd sampling studies were conducted during the 2013-2014 and 2014-2015 incubation periods.

The CET studies in the Habitat Channel have demonstrated that egg to emergence survival exceeds 70 percent. The average survival of eggs to emergent fry in the CETs placed in the Habitat Channel was 81percent, while control CETs in the Habitat Channel had 90 percent survival. The CET survival data in the Habitat Channel, from upper (A) to lower (E) spawning sections, is in Table 2-3.

Table 2-3. Habitat Channel CETs Egg – Emergent Fry Survival.

Location/year	**Section**	**Live Fry**	**Dead Fry**	**Dead Eggs**	**Notes**
Habitat Channel	A	94	0	6	
2011-2012	B	53	0	-	Eggs not countable
	C	59	0	-	Eggs not countable
	D	43	0	-	Eggs not countable
	E	96	0	4	
Habitat Channel	A	91	0	9	
2012-2013	B	98	0	4	
	C	95	0	5	
	D	90	1	10	
	E	98	0	2	
Habitat Channel	A	40	34	4	Tube Washed Out
2013-2014	B	89	0	-	Eggs not countable
	C	94	0	2	
	D	77	0	6	
	E	97	0	2	
Average Survival	**All Sections**	**81%**			
Habitat Channel	Control	85	2	11	
2011-2012	Control	93	1	2	
	Control	75	0	16	
Habitat Channel	Control	91	0	8	
2012-2013	Control	93	0	6	
	Control	88	0	11	
	Control	95	0	6	
Habitat Channel	Control	99	0	0	
2013-2014	Control	92	1	3	
	Control	94	0	0	
	Control	86	0	4	
Average Survival	**All Controls**	**90%**			

Survival of Chinook Salmon eggs and pre-emergent fry in redds in the tailrace was measured for two incubation periods, 2013-2014 and 2014-2015, by hand excavating into egg pockets of redds. Active egg pockets have been excavated by divers until either eggs or hatched fry are located, at which time an underwater airlift tube is used to collect approximately 80-100 embryos. The contents of each sample were enumerated as either live or dead, eggs or fry, to estimate the survival rate for that redd. At the conclusion of each sample, the excavated egg pocket and surrounding area was refilled with the excavated material to prevent further disturbance to the redd. The sampling design was to sample one redd in each zone of the tailrace, from upstream to downstream, in the vicinity of each of the 10 dissolved oxygen probes. The sampling events were scheduled to occur five times over the course of the incubation period.

These events have been in December at time of oxygen probe placement, once in January, once in early February, once late February or early March and at time of oxygen probe removal in late March.

The redd samples in 2013-2014 had an overall survival rate of 87 percent (Table 2-4). The redd samples in 2014-2015 had an overall survival rate of 86 percent (Table 2-5). It is noteworthy that these survival rates were reached despite having a number of periods with no powerhouse flow for oxygen probe installation in December and later redd sampling events and, in 2013-2014, extensive periods of time with only minimum generation flows from the powerhouse.

The other finding of the tailrace redd sampling is that most Chinook Salmon fry had completely absorbed the yolk sac by the time of the March 25, 2014 sampling. The findings were similar during sampling on March 24, 2015. This level of development is consistent with the accumulated temperature units from surface water temperatures, which predicts that over 1000 temperature units would have been accumulated by that date for 95 percent of the redds that year. Accumulation of 1000 temperature units is commonly considered to be the average incubation period for emergence timing of Chinook Salmon. In the late March sampling events, many of the fry were actively swimming away when the redd was excavated and had to be counted or netted because they were too quick for capture with the airlift tube.

<u>Degree of Achievement of Objective</u>

Objective 2.4 has been achieved fully:

M&E Results:. Three years of CET egg to emergence studies in the habitat channel achieved an average survival of 81 percent. Two years of hand excavation studies of egg to emergence survival in tailrace Chinook Salmon redds demonstrated an average survival rate of over 86 percent.

Objective Achievement: The objective that Chinook Salmon egg to emergence survival be at least 70 percent in the constructed spawning habitat in the tailrace and Habitat Channel has been achieved fully.

Management Actions Taken: Project operations provided for continuation of minimum generation flows during the October – March spawning and incubation period to ensure that favorable survival conditions were maintained in the tailrace. Minimum flows of 80 cfs were maintained in the Habitat Channel. Accumulations of gravel and cobble in the tailrace below the confluence with the high flow channel in Reach 4 were removed in 2014 and 2016 to prevent Chinook Salmon redds on high points in the deposition zone that could be subject to dewatering during low Columbia River flows.

Future Actions: Continue to operate the Project to maintain minimum generation flows from October 15 – March 31 and maintain minimum flows in the Habitat Channel. Maintenance for management of river bed material at the confluence with the Reach 4 high flow channel will continue as needed.

Table 2-4. Tailrace Redd Excavation Egg – Emergent Fry Survival, 2013-2014.

Date	Location	Live Egg	Dead Egg	Live Fry	Dead Fry	% Survival	Mean of Samples
12/15/2013	T1	130	1	0	0	99%	
12/15/2013	T2	88	2	0	0	98%	
12/15/2013	T3	83	13	7	0	87%	
12/15/2013	T4	0	0	118	4	97%	
12/15/2013	T5	118	21	0	0	85%	
12/15/2013	C1	186	3	0	0	98%	
12/15/2013	C2	11	2	96	2	96%	
12/15/2013	C3	62	0	0	0	100%	
12/15/2013	C4	104	2	1	0	98%	
12/16/2013	C5	1	0	36	26	59%	
	Total	783	44	258	32	93.2%	91.8%
1/16/2014	T1	113	3	3	2	96%	
1/16/2014	T2	0	6	97	1	93%	
1/16/2014	T3	150	3	1	1	97%	
1/16/2014	T4	7	2	1	0	80%	
1/16/2014	T5	153	1	8	1	99%	
1/15/2014	C1	0	4	64	2	91%	
1/15/2014	C2	123	3	0	0	98%	
1/15/2014	C3	16	2	44	4	91%	
1/15/2014	C4	0	4	61	10	81%	
1/15/2014	C5	5	0	45	1	98%	
	Total	454	25	321	20	94.5%	92.5%
2/4/2014	T1	0	2	81	2	95%	
2/4/2014	T2	54	4	14	3	91%	
2/4/2014	T3	0	0	78	6	93%	
2/4/2014	T4	0	0	98	3	97%	
2/4/2014	T5	0	0	64	2	97%	
2/4/2014	C1	0	0	97	0	100%	
2/5/2014	C2	0	2	73	1	96%	
2/5/2014	C3	2	2	65	1	96%	
2/5/2014	C4	0	1	70	2	96%	
2/5/2014	C5	0	1	119	2	98%	
	Total	56	10	678	20	96.1%	95.8%
2/25/2014	T1	0	2	108	0	98%	
2/25/2014	T2	0	2	139	0	99%	
2/25/2014	T3	0	4	99	0	96%	
2/25/2014	T4	0	59	3	0	5%	
2/25/2014	T5	0	2	95	0	98%	
2/25/2014	C1	0	86	4	0	4%	
2/25/2014	C2	0	79	32	0	29%	
2/26/2014	C3	0	0	1	133	1%	
2/26/2014	C4	0	0	144	2	99%	
2/26/2014	C5	0	0	84	5	94%	
	Total	0	232	601	140	61.8%	62.3%
3/25/2014	T1	0	3	87	0	97%	
3/25/2014	T2	0	4	100	0	96%	
3/25/2014	T3	0	1	127	0	99%	
3/25/2014	T4	0	3	69	0	96%	
3/25/2014	T5	0	14	73	0	84%	
3/25/2014	C1	0	13	115	1	89%	
3/25/2014	C2	0	0	114	0	100%	
3/25/2014	C3	0	3	104	0	97%	
3/26/2014	C4	0	0	92	6	94%	
3/26/2014	C5	0	0	97	3	97%	
	Total	0	38	891	10	94.9%	94.9%
Grand Total		**1293**	**349**	**2749**	**222**	**87.6%**	**87.4%**

Table 2-5. Tailrace Redd Excavation Egg – Emergent Fry Survival, 2014-2015.

Date	Location	Live Egg	Dead Egg	Live Fry	Dead Fry	% Survival	Mean of Samples
12/10/2014	T1	201	15	0	0	93%	
12/10/2014	T2	191	2	0	0	99%	
12/10/2014	T3	75	0	0	0	100%	
12/10/2014	T4	95	1	0	0	99%	
12/10/2014	T5	261	3	0	0	99%	
12/11/2014	C1	151	3	0	0	98%	
12/11/2014	C2	87	29	0	0	75%	
12/11/2014	C3	53	18	0	0	75%	
12/11/2014	C4	119	2	24	0	99%	
12/11/2014	C5	108	1	0	0	99%	
	Total	1341	74	24	0	95%	94%
1/6/2015	T1	67	2	0	0	97%	
1/6/2015	T2	72	2	0	0	97%	
1/6/2015	T3	92	5	0	0	95%	
1/6/2015	T4	0	1	67	1	97%	
1/5/2015	T5	104	0	0	0	100%	
1/5/2015	C1	131	3	0	1	97%	
1/5/2015	C2	79	4	0	0	95%	
1/5/2015	C3	0	2	64	0	97%	
1/5/2015	C4	4	80	5	0	10%	
1/5/2015	C5	78	3	0	0	96%	
	Total	627	102	136	2	88%	88%
2/10/2015	T1	0	0	102	0	100%	
2/10/2015	T2	0	0	33	0	100%	
2/10/2015	T3	0	99	1	0	1%	
2/10/2015	T4	0	93	20	0	18%	
2/10/2015	T5	0	4	36	1	88%	
2/10/2015	C1	2	4	64	0	94%	
2/10/2015	C2	0	0	113	1	99%	
2/11/2015	C3	11	2	108	11	90%	
2/11/2015	C4	0	0	88	3	97%	
2/11/2015	C5	0	3	56	0	95%	
	Total	13	205	621	16	74%	78%
3/11/2015	T1	0	0	89	4	96%	
3/11/2015	T2	0	1	65	1	97%	
3/11/2015	T3	0	2	84	1	97%	
3/11/2015	T4	0	0	88	1	99%	
3/11/2015	T5	0	0	89	1	99%	
3/12/2015	C1	0	2	112	2	97%	
3/12/2015	C2	0	0	78	2	98%	
3/12/2015	C3	0	0	124	4	97%	
3/12/2015	C4	0	30	72	3	69%	
3/11/2015	C5	0	0	98	2	98%	
	Total	0	35	899	21	94%	94%
3/24/2015	T1	0	2	98	12	88%	
3/24/2015	T2	0	1	98	2	97%	
3/24/2015	T3	0	2	74	44	62%	
3/24/2015	T4	0	0	83	0	100%	
3/24/2015	T5	0	13	68	0	84%	
3/24/2015	C1	0	6	74	0	93%	
3/24/2015	C2	0	1	75	21	77%	
3/24/2015	C3	0	0	96	34	74%	
3/24/2015	C4	0	2	57	9	84%	
3/24/2015	C5	0	3	0	108	0%	
	Total	0	30	723	230	74%	76%
Grand Total		**1981**	**446**	**2403**	**269**	**86.0%**	**86.0%**

2.5 Juvenile Rearing Habitat – Chinook Salmon Use Available Habitat From Emergence - June

The Biological Objective to provide early rearing habitat for Chinook Salmon fry is that the available habitat, particularly habitat constructed in Reach 4, is used by Chinook Salmon fry from time of emergence until they move out into the Columbia River. Snorkel surveys have been conducted in the tailrace and Reach 4 in 2010 (May only), and with surveys in April, May, June, August, September and November from 2012 - 2016. Due to high spill levels, the July 2012 survey was cancelled. In addition to snorkel surveys, Chinook Salmon fry have been observed in Reach 4 during Steelhead Trout spawning surveys and other activities. Some of the surveyors have attempted to distinguish Chinook Salmon fry from Coho Salmon fry and have given separate counts for each species, however it is very difficult to make that determination without actually having the fish in hand. Chinook Salmon and Coho Salmon counts have been combined in Table 3-1, but separate counts are provided in the survey data spreadsheet in Appendix A.

Table 2-6. Chelan River Chinook Salmon and Coho Salmon Fry Counts.

Year	Location	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Nov.
2010	Tailrace	-	-	0	-	-	-	-	-
2010	Channel	-	-	3945	-	-	-	-	-
2010	Pool	-	-	845	-	-	-	-	-
2012	Tailrace	0	0	2670	285	-	0	0	0
2012	Channel	0	0	2312	0	-	0	0	0
2012	Pool	0	8	0	-	-	0	0	0
2013	Tailrace	0	25	9000	5	0	0	0	0
2013	Channel	0	0	3845	1	1	0	0	0
2013	Pool	0	5	30	1	1	0	0	0
2014	Tailrace	0	4090	3000	0	0	0	0	0
2014	Channel	0	11035	4710	0	0	0	0	0
2014	Pool	0	2600	22	0	0	0	0	0
2015	Tailrace	0	50	100	0	0	0	0	0
2015	Channel	0	2073	95	0	0	0	0	0
2015	Pool	2	0	393	0	0	0	0	0
2016	Tailrace	1250	NS	2679	0	0	0	0	0
2016	Channel	3304	NS	6637	6	1	0	0	0
2016	Pool	1236	NS	0	0	0	0	0	0

Chinook Salmon fry have been observed using the available habitat in each year surveyed. Prior to 2016, the observation of few Chinook Salmon fry in March and April was due to surveys being conducted in the daytime when water temperatures were low (<12 °C). The survey in April 2014 was later in the month (4/24) and water temperatures had been warmer for over a week prior to the survey (>12 °C). Monthly surveys were conducted in 2016, with nighttime surveys in January, February, March and December. There was no April survey in 2016 due to high flows and the snorkel survey was scheduled for the first week in May when spill flows could be reduced for two days in order to complete the snorkel surveys and a separate macroinvertebrate study. The nighttime surveys observed two Chinook Salmon fry in mid-January and 307 in late February, with large numbers of Chinook Salmon fry rearing in the shallow shoreline margins by the end of March (water temperature 8.8 °C). The results of the monthly snorkel surveys are presented in detail in a separate report (Appendix B).

Chinook Salmon fry have moved out of the pool, Habitat Channel and tailrace by the June surveys, which have been conducted after mid-June. Water temperatures during the June surveys have ranged from 17 °C – 19 °C. Water temperatures from late April – May range from 12 °C – 17 °C, which results in rapid growth for Chinook Salmon fry in the Chelan River and tailrace. The larger members of the population have been observed in deeper and swifter water on the outside edge of the log structures during May surveys.

<u>Degree of Achievement of Objective</u>

Objective 2.5 has been achieved fully:

M&E Results:. Snorkel surveys have confirmed that large numbers of Chinook Salmon fry are rearing in shallow water, low velocity habitat in the tailrace, Habitat Channel and pool. The highest use coincides with beginning of emergence in March and continues through May and into June. Most Chinook Salmon fry have moved out of the Chelan River habitats by late June.

Objective Achievement: The objective to provide early rearing habitat for Chinook Salmon fry has been met, with extensive use of shallow water, low velocity rearing habitat

Management Actions Taken: Log structures, boulder clusters and extensive plantings of willows and other riparian shrubs were included during construction of the Habitat Channel. These habitat features, particularly inundated willow zones and log structures, were observed to harbor large numbers of Chinook Salmon fry during snorkel surveys.

Future Actions: Continue Lake Chelan storage management to avoid, to the extent practicable, very high flows in the Chelan River that could damage riparian zones in the Habitat Channel. Manage river bed material accumulations to prevent extensive deposition in the Habitat Channel.

2.6 <u>Evidence of Adult Production from Chinook Salmon Produced in Chelan River</u>

Chinook Salmon from the Upper Columbia summer Chinook Salmon stock that spawns in the tailrace and Reach 4 Habitat Channel are adapted to simultaneously rear and migrate downstream toward the ocean as they grow. However, to be certain that the spawning and rearing habitat created in the tailrace and Reach 4 of the Chelan River is providing suitable conditions to support this life history, the CRBEIP contains the Biological Objective that there be evidence of naturally produced adult Chinook Salmon returning to this habitat as an indication of achievement. In addition to spawning surveys, the carcasses of Chinook Salmon that died after spawning are collected and examined for marks, primarily a clipped adipose fin indicating the presence of a coded wire tag (CWT) in the snout. The snouts of carcasses are collected and processed for extraction and identification of the CWT, which identifies fish from hatchery releases and other programs. In addition, a sample of scales is also taken, if possible, and the scales are analyzed to determine the age of the fish and whether of natural or hatchery origin. The information from both sources is combined to produce an estimate of the composition of the spawning population by origin and brood year.

Prior to construction of the tailrace spawning habitat and Habitat Channel spawning and rearing channel, carcasses had been collected from the summer Chinook Salmon that were spawning in the gravel deposits below the confluence of the Chelan and Columbia rivers. These fish historically were a mix of natural and hatchery origin fish. The marked hatchery fish were predominately produced by the Turtle Rock and Wells hatchery programs, while the unmarked fish could be a combination of natural production from the existing habitat and unmarked fish from both these hatcheries and other sources. Over time, an increase in either the ratio of natural origin Chinook Salmon carcasses or in the total number of unmarked Chinook Salmon using the tailrace and Habitat Channel would indicate that adult production has increased following creation of this habitat. Since the number of spawners is variable due to different survival between years, the ratio of natural to hatchery origin spawners might be expected to be the least variable, provided that hatchery release numbers, locations and stray rates remained constant from year to year. However, that has not been the case. Since 2007 part of the Turtle Rock fish production was released directly into the Chelan tailrace. The Turtle Rock program was relocated in fall of 2011 to a new rearing facility at the Chelan tailrace and all fish are now released at that location. The release of yearling summer Chinook Salmon smolts into the Chelan tailrace went from about 100,000 – 200,000 smolts from 2007 and 2011, to 500,000 – 600,000 from 2012 - 2015 (Hillman et al, 2016). The increase in these direct releases has affected the size of the spawning population due to the influx of returning adult Chinook Salmon that are homing back to the release site. The ratio of hatchery produced spawners, compared to naturally produced spawners, would be expected to increase, particularly since smolt to adult survival rates are high for the hatchery releases. If the ratio of hatchery produced spawners did not increase, then a logical inference would be that natural production of adult returns to the Chelan River has increased over time.

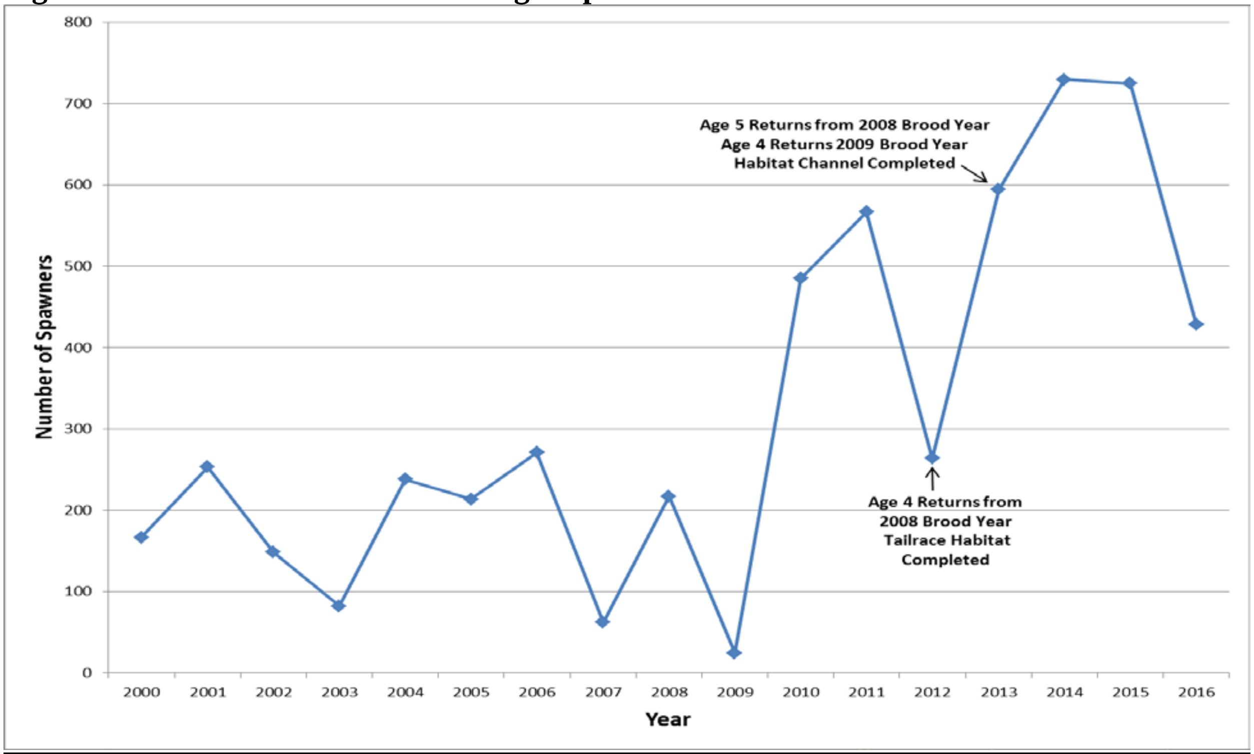
The production of natural origin adult Chinook Salmon from the Chelan tailrace and Habitat Channel can be estimated by comparing historical to current and future numbers of natural origin fish using that spawning area. The increase in the quantity and quality of habitat for both spawning and initial fry rearing would be expected to result in an increase in the number of naturally produced Chinook Salmon spawning in the Chelan River. The total number of spawners is estimated from redd counts using a fish per redd factor (Table 2-1). The proportion of natural origin fish in the spawning population for that year can be estimated from carcass surveys, as discussed above. The product of that proportion and the total number of spawners yields an estimate of natural origin Chinook Salmon in the spawning population. If the rate of natural origin Chinook Salmon straying into the Chelan River from other spawning populations is relatively constant, then an increase in the natural origin spawning population in the Chelan tailrace and Habitat Channel would be evidence of adult production originating from this habitat. The number of natural origin Chinook Salmon using the Chelan tailrace and Habitat Channel has been higher since 2010 than prior to construction of these habitat areas (Table 2-6; Figure 2-2). However, the first two years of higher returns were prior to the year that the first adults (four-year-old) could return from fish that spawned in the expanded tailrace habitat in 2008. High survivals and increased spawning escapements of summer Chinook Salmon have been observed in both natural and hatchery origin populations over the past decade. Thus, there has been some increase in the number of natural origin Chinook Salmon using the Chelan River spawning habitat that is independent of returning adults produced from that habitat. In spite of the large increase in the number of hatchery smolts released into the Chelan tailrace, the proportion of naturally produced fish in the spawning population has been high for the past three years (Table 2-8). The combination of sustained higher numbers and a higher proportion of naturally produced Chinook Salmon in the spawning population, despite a major increase in the release of hatchery smolts into the tailrace, indicates that adult Chinook Salmon production has increased since construction of the new spawning and rearing habitat.

Table 2-7. Natural and Hatchery Origin Chinook Salmon Spawning in the Chelan Tailrace and Habitat Channel.

Return Year	Hatchery	Wild	Hatchery	Wild
Return Year	Proportion		Number of Fish	
	Hatchery	Wild	Hatchery	Wild
2000	0.65	0.35	304	166
2001	0.74	0.26	731	253
2002	0.74	0.26	433	149
2003	0.80	0.20	337	82
2004	0.43	0.57	178	238
2005	0.59	0.41	310	214
2006	0.36	0.64	149	271
2007	0.67	0.33	127	62
2008	0.56	0.44	280	217
2009	0.96	0.04	600	25

Return Year	Hatchery	Wild	Hatchery	Wild
Return Year	Proportion		Number of Fish	
	Hatchery	Wild	Hatchery	Wild
2010	0.57	0.43	633	485
2011	0.56	0.44	713	567
2012	0.80	0.20	1044	264
2013	0.65	0.35	1090	594
2014	0.34	0.66	370	730
2015	0.50	0.50	713	725
2016	0.52	0.48	471	429

Figure 2-2. Chelan River Natural Origin Spawners.



<u>Degree of Achievement of Objective</u>

Objective 2.6 has been achieved based on the available evidence:

M&E Results:. Spawning surveys and carcass surveys have demonstrated an increase in the number of natural origin spawners in the Chelan River. The combination of sustained higher numbers and a higher proportion of naturally produced Chinook Salmon in the spawning population, despite a major increase in the release of hatchery smolts into the tailrace, indicates that adult Chinook Salmon production has increased since construction of the new spawning and rearing habitat.

Objective Achievement: The objective that there be evidence of adult production of Chinook Salmon produced in the Chelan River has been achieved based on the increase in natural origin spawners since construction of the additional spawning and rearing habitat. This is further confirmed by a high proportion of naturally produced adult Chinook Salmon in the carcass surveys.

Management Actions Taken: Construction of additional spawning and rearing habitat in the tailrace and Reach 4 of the Chelan River was completed in 2008 and 2009. Powerhouse operations have been managed to assure high egg to emergence survival in the tailrace. Minimum flows have been maintained Reach 4 to maintain high egg to emergence survival and shallow water rearing habitat.

Future Actions: Continue Lake Chelan storage management, powerhouse operations and minimum flows to the Chelan River to protect the habitat from high flows and to maintain the conditions that lead to high egg to emergence survival and good rearing habitat.

SECTION 3: BIOLOGICAL OBJECTIVES FOR STEELHEAD TROUT

3.1 Spawning Habitat for Steelhead Trout Meets Design Characteristics

The CRBEIP states that "salmon and Steelhead Trout spawning habitat will be created in Reach 4 and the tailrace, with the objective to create suitable depth, cover, velocity and substrate conditions for these fish. These parameters can be measured independently of fish use, although fish use is the best evidence of achievement. The criteria for achievement are to document that habitat was created and maintained, in accordance with the preference curves established in the IFIM study. Alternatively, if adult fish runs are strong and colonization occurs during the evaluation period, then the presence and success of spawning fish will also be considered in the determination of achievement. Achievement will be evident if spawning fish are distributed in suitable areas in the tailrace, Reach 4 and below the confluence of Reach 4 and the tailrace. Lack of fish will not be termed a failure without evidence that a Project effect prevented fish from using the habitat."

Steelhead Trout spawning has been observed in the Habitat Channel in six of the seven years since Steelhead Trout spawning flows were first provided in 2010. The number of redds has varied, with 11 redds in 2010, 21 redds in 2011, 7 redds in 2012, 21 redds in 2013, 0 redds in 2014, 3 redds in 2015 and 2 redds in 2016. The Steelhead Trout redd surveys since 2011 were made weekly, beginning in late March and continuing into June or until high flows precluded further observations. Surveys are conducted by observing from high points overlooking the tailrace and pool area and walking both shores of the Habitat Channel. Steelhead Trout redds have not been observed in the tailrace, except for the shoreline margin in flow exiting the Habitat Channel (one redd each in 2011 and 2013).

While the number of redds observed per year has decreased since 2013, this decrease coincides with a decrease in the number of Steelhead Trout adults available to populate the Chelan River. The number of Steelhead Trout counted passing over Rocky Reach Dam averaged nearly 19,000 per year from 2009 – 2012 (13,100-29,547), whereas the Steelhead Trout return from 2013 – 2015 averaged about 10,000 per year (9,204-10,894). Most of the Steelhead Trout return is during the summer and fall of the year preceding spawning, thus these dates match the spawning years of 2010 – 2013 and 2014-2016. There are no releases of hatchery Steelhead Trout into the Chelan River.

The first redds have been observed in late March, with the majority of spawning initiated in early to mid-April. In 2011, one redd was initiated at the end of May. In the Habitat Channel, more Steelhead Trout redds (2011-2016) have been observed in the downstream sections than in the upper sections. However, this may in part be due to greater ability to observe redds in the lower section. The snorkel surveys in 2016 observed Steelhead Trout adults, likely on a redd, in the upper part of the Habitat Channel in water too deep to observe the redd from shore. A few redds have also been observed in the pool formed by the hydraulic control structure. Most of the redds have been in the vicinity of cover from either boulders or log structures or in deep water runs near structure. Steelhead Trout redds were located in areas with smaller substrate, primarily in small gravels less than two inches in diameter. There are limited amounts of this smaller substrate except in the lower part of the Habitat Channel and in the pool area.

Another factor that may be affecting the habitat available for Steelhead Trout spawning is that velocities in some areas of the Habitat Channel are greater than desired to provide the preferred velocities for this species. The pumping station is designed to provide 240 cfs under low tailwater conditions, which when combined with the 80 cfs minimum flow in Reach 1 of the Chelan River yields the design minimum spawning flow of 320 cfs. In spring, when Steelhead Trout spawning occurs, the tailwater level is usually not low and the discharge from the pumps under that condition typically result in Habitat Channel flows of 340 cfs or greater. Depth and velocity measurements taken in 2011 and 2013 at Steelhead Trout redds found most were within the expected preferences for this species, but some redds were deeper than 30 inches (8 of 34) or with mid-depth velocities exceeding three feet per second (4 of 34). Also, the higher flows reduce the available low velocity habitat preferred by Chinook Salmon fry, which are rearing in the Habitat Channel from April – June. The Chelan River Fishery Forum has approved testing a lower flow during the Steelhead Trout spawning period, which is discussed in Section 3.2.1. Future operations at that lower flow are being requested as a permanent modification to the Project's license.

The Habitat Channel was constructed to provide spawning and rearing habitat for Chinook Salmon and Steelhead Trout, with an expectation that the wood and boulder cover and riffle habitat would provide suitable conditions for Steelhead Trout spawning and early rearing. It appeared that the availability of suitable small gravel substrate has diminished over time, including some of the areas of the Habitat Channel where Steelhead Trout redds had been observed. To provide more small gravel substrate, the CRFF approved the addition of 70 cubic yards of small gravel to various locations in the Habitat Channel. This gravel was placed in late summer of 2014. Two of the five redds observed in 2015 – 2016 were in locations where small gravel was added, while the other three were in locations that already had adequate small gravel available.

Ecology and WDFW have been measuring Habitat Channel cross-sections for depth, velocity, substrate and cover. These data have been modeled to estimate weighted useable area for Steelhead Trout spawning, with 15 transects extrapolated to predict the percent of the channel suitable for Steelhead Trout spawning conditions based on current Washington State preference curves for Steelhead Trout spawning. The modeling study evaluated the percent of the channel with suitable substrate, combined depth/velocity, and overall useable area for Steelhead Trout spawning (Jim Pacheco, CRFF presentation 2015). The addition of gravel in 2014 improved the proportion of suitable channel bed from 37.6% useable to 41.4% useable substrate. Evaluation of depth/velocity suitability at different flows showed that lower flows would increase suitable spawning area in the Habitat Channel. The overall useable area estimates, with the 2014 gravel addition, were 13.5% useable area at 300 cfs flow and 16.0% useable area at 250 cfs flow.

Degree of Achievement of Objective

Objective 3.1 has been achieved based on the available evidence:

M&E Results:. Steelhead Trout spawning has been observed in the Habitat Channel in six of the seven years since Steelhead Trout spawning flows were first provided in 2010. The number of redds has varied, with 11 redds in 2010, 21 redds in 2011, 7 redds in 2012, 21 redds in 2013, 0 redds in 2014, 3 redds in 2015 and 2 redds in 2016. The lower number of Steelhead Trout redds from 2014 – 2016 coincides with low Steelhead Trout run size returning to habitats upstream from Rocky Reach Dam. Depth and velocity measurements taken in 2011 and 2013 at Steelhead Trout redds found most were within the expected preferences for this species, but some redds were deeper than 30 inches (8 of 34) or with mid-depth velocities exceeding three feet per second (4 of 34). The addition of small gravel in 2014 improved the proportion of suitable channel bed from 37.6% useable to 41.4% useable substrate. Evaluation of depth/velocity suitability at different flows showed that lower flows would increase suitable spawning area in the Habitat Channel. The overall useable area estimates, with the 2014 gravel addition, were 13.5% useable area at 300 cfs flow and 16.0% useable area at 250 cfs flow.

Objective Achievement: The objective that spawning habitat for Steelhead Trout meets design criteria is met based on the fact that Steelhead Trout redds have been observed in six of seven years, most Steelhead Trout redds observed were at depths and velocities within the preferences for this species, and habitat modeling by Ecology found useable spawning habitat existed in the Habitat Channel.

Management Actions Taken: Lower flows during the spawning period have been evaluated and implemented on a trial basis from 2014-2016. Small gravel of the size preferred by Steelhead Trout was added to the Habitat Channel in 2014, resulting in an increase in the useable substrate area. The gravel additions were located in areas with suitable depths and velocities for Steelhead Trout spawning.

Future Actions: Provide reduced flows during the Steelhead Trout spawning period, pending approval by the CRFF and FERC. Monitor the availability of small gravel in areas with preferred depths and velocities for Steelhead Trout spawning and replenish as needed.

3.2 Steelhead Trout Use of Spawning Habitat Throughout Constructed Habitat

The distribution of Steelhead Trout redds within the Habitat Channel was fairly even between the upper and lower parts of the channel in 2010 and 2011. However, by 2013 the preponderance of redds was in the lower channel areas, while the upper part of the channel had only three of the 20 redds observed in the Habitat Channel. This observation is concurrent with the observation that some of the small gravel patches in the upper Habitat Channel that were previously used by spawning Steelhead Trout appeared to have diminished. The Habitat Channel has changed over time, with a more pronounced thalweg and some shallow shoreline areas now growing willows and trapping sand. This is a natural evolution of the stream channel in response to annual flow cycles. As previously mentioned, 70 cubic yards of small gravel was placed in the upper and middle sections of the Habitat Channel. The gravel additions were focused on areas where Steelhead Trout redds had been observed in 2011, but not present in 2013, as well as in other areas with suitable cover that appeared to have the preferred depths and velocities but lacked suitable substrate for Steelhead Trout spawning. As mentioned, two of the five redds observed in 2015-2016 were in a location where small gravel had been depleted and was replenished in 2014. The probable deep water redd location that was observed during the 2016 snorkel surveys was also in a location where gravel was added in 2014, but the existence of this redd could not be confirmed during daytime redd surveys This probable redd was in the uppermost section of the Habitat Channel, where few redds have been observed since 2013.

Very high spill flows occurred during 2016 in May and most likely small gravel was moved downstream, depleting some of the areas where gravel was placed in 2014. The Steelhead Trout population migrating past Rocky Reach dam in 2016 was the lowest (5,728) since 1999, thus there could be few Steelhead Trout available to spawn in the Habitat Channel in 2017. However, a Steelhead Trout egg to emergence study is scheduled to take place in the Habitat Channel in 2017 and the presence of small gravel areas suitable for Steelhead Trout spawning will be evaluated during that study.

Degree of Achievement of Objective

Objective 3.2 was achieved in 2010-2011, but distribution has not been even since then

M&E Results:. The distribution of Steelhead Trout redds within the Habitat Channel was fairly even between the upper and lower parts of the channel in 2010 and 2011. However, by 2013 the preponderance of redds was in the lower channel areas, while the upper part of the channel had only three of the 20 redds. Small gravel additions in 2014 were intended to replenish gravel suitability in the upper Habitat Channel for the 2015 and 2016 spawning seasons, but few Steelhead Trout redds were observed in these years.

Objective Achievement: The objective that Steelhead Trout use of spawning habitat be dispersed throughout the constructed habitat appeared to be met in the first three years of monitoring, but has not been met since 2013. Replenishment of small gravel in the Habitat Channel has been initiated with the intent to improve distribution of Steelhead Trout spawning.

Management Actions Taken: Lower flows during the spawning period have been evaluated and implemented on a trial basis from 2014-2016. Small gravel of the size preferred by

Steelhead Trout was added to the Habitat Channel in 2014, resulting in an increase in the useable substrate area. The gravel additions were located in areas with suitable depths and velocities for Steelhead Trout spawning and directed towards increasing useable habitat in the upper part of the Habitat Channel.

Future Actions: Provide reduced flows during the Steelhead Trout spawning period, pending approval by the CRFF and FERC. Monitor the availability of small gravel in areas with preferred depths and velocities for Steelhead Trout spawning and replenish as needed.

3.3 Steelhead Trout Tailrace/Reach 4 Intragravel Dissolved Oxygen ≥ 6.0 mg/l

Since there have not been any Steelhead Trout redds in the tailrace that are dependent on powerhouse flows, there has been no need to provide powerhouse flows during the Steelhead Trout incubation period. The only redds observed were adjacent to the shoreline above the Chelan Falls highway bridge in flowing water coming from the Habitat Channel. Although suitable substrate and velocities exist in some parts of the tailrace, no Steelhead Trout have used it for spawning, possibly due to lack of any boulder, wood or vegetative cover. Also, the substrate in the Habitat Channel spawning area is porous and free of sediments, thus Steelhead Trout redds would not lack intragravel flow. Water quality monitoring in the Habitat Channel has demonstrated that the surface water meets the water quality standards for dissolved oxygen during the Steelhead Trout spawning and incubation season. Since the Habitat Channel is never without sufficient flow to maintain intragravel dissolved oxygen, there is no need to monitor intragravel dissolved oxygen.

Degree of Achievement of Objective

Objective 3.3 is achieved because Steelhead Trout redds only occur in areas with continuous flow

M&E Results:. No Steelhead Trout redds have been observed in areas without continuous flow.

Objective Achievement: This objective is achieved because no Steelhead Trout redds have been observed in areas that are dependent on powerhouse flows to maintain IGDO ≥ 6.0 mg/l.

Management Actions Taken: Continuous flow has been maintained at required levels in all areas where Steelhead Trout redds have been observed.

Future Actions: This objective has been met by nature of maintaining continuous flow and by design of the clean substrate in the Habitat Channel. If in the future a landslide or other natural disaster were to cause heavy deposition of fine sediments into the Habitat Channel, then the substrate would need to be restored to a clean gravel condition through excavation and replacement or other suitable method. Steelhead Trout egg to emergence survival studies discussed in the next section will also confirm that IGDO ≥ 6.0 mg/l since lower IGDO would not meet the 70 percent survival objective.

3.4 Egg to emergence success equal to > 80% of Methow River average or 70% survival

The survival from egg to emergence of Steelhead Trout has not been evaluated due to technical issues that make such evaluation difficult. Since Steelhead Trout are listed as threatened under the Endangered Species Act (ESA), actions to disturb redds such as redd capping or excavation are considered a "take" and prohibited except under permits. An experiment using egg baskets will be conducted in 2017 and will use surplus hatchery Steelhead Trout eggs from a stock not listed under the ESA. However, it is difficult to find hatchery Steelhead Trout eggs that match the timing of Steelhead Trout spawning in the Habitat Channel. The study design includes collection of adult Steelhead Trout in March or April from a source where late arriving fish can be captured.

Degree of Achievement of Objective

Objective 3.4 has not yet been evaluated. The expectation is that the egg to emergence survival will meet the objective based on the studies done for Chinook Salmon egg to emergence survival. A study will be conducted in 2017.

3.5 Juvenile Rearing Habitat – Steelhead Trout Use Available Habitat Until Enter Columbia River

Steelhead Trout emergence timing in the Chelan River is predicted to occur in June, based on spawning timing and accumulated temperature units. There were no Steelhead Trout fry or parr observed during snorkel surveys in 2012 because high spill flows began prior to emergence of Steelhead Trout, which made the snorkel survey ineffective and may also have flushed emerging Steelhead Trout fry out of the Habitat Channel. However, in 2013 the snorkel surveys in June and July found Steelhead Trout fry in the Habitat Channel and upstream in the pool (Appendix A). Steelhead Trout fry (mostly 40 mm size range) were observed on June 15 in very shallow boulder/cobble areas of the stream margin. In July, the Steelhead Trout were larger and flow was lower (82 cfs), with the parr inhabiting midstream areas behind large boulder/cobbles. Only a few parr were observed in August. Since there were no Steelhead Trout redds in 2014, there were no Steelhead Trout fry observed. There were no Steelhead Trout fry or parr observed during snorkel surveys in 2015, either.

The monthly surveys conducted in 2016 documented use of the Habitat Channel and tailrace by parr and pre-smolt sized *O. mykiss* during the months of December – March. Since only one Steelhead Trout fry or parr was observed in May – June, it is unknown whether these fish present in winter were Steelhead Trout or Rainbow Trout that either migrated in from the Columbia River or migrated downstream from the upper Chelan River. Parr (*O. mykiss* < 6 inches long) counts ranged from 41 in March to 6 in December and 14 in both January and February. Pre-smolt sized *O. mykiss* (6-9 inches long) counts ranged from 5-13 fish during those months, however there were 37 fish of that size counted in July.

The pool, Habitat Channel and tailrace were also used by larger *O. mykiss* (9-12 inches; > 12 inches) throughout the year. The highest count of 9-12 inch fish was 33 in November. These fish could also include pre-smolt or residual Steelhead Trout that migrated out the next spring since there were not any *O. mykiss* in that size class observed in May or June.

<u>Degree of Achievement of Objective</u>

Objective 3.3 was likely achieved in 2013, but it is not known if in other years due to high flows.

M&E Results:. High flows in June and July have prevented observations of Steelhead Trout fry and parr rearing in all years, except 2013, when sufficient numbers of Steelhead Trout redds were present to provide Steelhead Trout fry to seed the available rearing habitat.

Objective Achievement: This objective was likely achieved in 2013, but it is unknown if Steelhead Trout fry have used Reach 4 for rearing. Since high flows in June and July would occur in the absence of the Project, there may not be a Project Effect even if Steelhead Trout fry are unable to rear in the Habitat Channel due to high flows.

Management Actions Taken: Management of the Lake Chelan storage to meet recreation target elevations and minimize high flows in the Chelan River has been in effect since 2009. However, spill occurs in June during Steelhead Trout emergence in most years due to the amount of inflow from snow melt entering Lake Chelan. This natural occurrence may limit the suitability of the Reach 4 Habitat Channel for Steelhead Trout fry rearing even though spill flows in May have not prevented use of rearing habitat for Chinook Salmon fry.

Future Actions: Continue to manage refill of Lake Chelan to minimize high flows in the Chelan River in June and July to the extent practicable.

3.6 <u>Evidence of Adult Production from Steelhead Trout Produced in Chelan River</u>

This objective has not been evaluated due to lack of a suitable method. Since Steelhead Trout do not die after spawning, there are no carcasses to evaluate. The CRBEIP recognized that measurement of this objective would require either new technology or best professional judgment of the CRFF regarding whether Steelhead Trout spawning in the Chelan River would be successful in producing smolts and adults.

SECTION 4: BIOLOGICAL OBJECTIVES FOR CUTTHROAT TROUT

4.1 Cutthroat Trout Presence of 200 Fish of Various Age Classes

The CRBEIP provided for restoring flows to Reaches 1-3 of the Chelan River with the objective that a population of 200 Cutthroat Trout, of various age classes, would become established in the river. The initial five years following reestablishment of flows was set to wait and see if 200 Cutthroat Trout would recruit to the Chelan River from Lake Chelan during the annual spill period. If, after year 5, a population of 200 fish has not been achieved, then the CRBEIP provided for either extending the evaluation for another ten years to allow natural colonization from Lake Chelan or to stock Cutthroat Trout into the Chelan River to determine if they could survive and persist. If Cutthroat Trout failed to survive and persist, then habitat improvements directed toward reducing water temperatures were to be pursued.

Snorkel surveys were initiated in 2012 and originally included Reach 2 and the very upper portion of Reach 3. However, due to safety concerns from large rocks falling into Reach 2 from unstable hillsides, snorkel surveys in Reaches 2 and 3 were discontinued in 2015. This safety concern makes it difficult to determine if the objective of 200 fish in Reaches 1-3 has been met since only Reach 1 is being surveyed. However, surveys in Reach 1 are adequate to determine if Cutthroat Trout can survive and persist, even if the Reach 1 population is less than 200 fish throughout the year.

Snorkel surveys have determined that Cutthroat Trout have been slowly colonizing from Lake Chelan, but in the first years there were more Rainbow Trout coming out of the lake than Cutthroat Trout (Table 4-1). This is probably a result of there being more Rainbow Trout than Cutthroat Trout present in Lake Chelan. Successful rearing of Cutthroat Trout to catchable size has led to a shift in fish stocking in Lake Chelan and the number of Cutthroat Trout entering the Chelan River from the lake has likely increased. However, since five years had passed without sufficient recruitment of Cutthroat Trout from Lake Chelan via spillway flows, stocking of Cutthroat Trout directly into the Chelan River was initiated in 2014.

The snorkel surveys did find Cutthroat Trout of more than one age class in 2014. The November survey found Cutthroat Trout as small as 7 inches and as large as 15 inches, which probably represents at least two age classes. However, through 2014 there had not been any young of year or yearling sized Cutthroat Trout or Rainbow Trout observed in Reaches 1-3. In order to determine if younger age classes of Cutthroat Trout can survive and persist in Reaches 1-3, the CRFF agreed that Cutthroat Trout fry and fingerlings should be planted in Reach 1 prior to surveys in 2015. Approximately 2,000 Cutthroat Trout about one inch in length (272 fish per pound) were planted below the Low Level Outlet in October, 2014. None of these fish were observed during the November survey, but water temperature was cold enough (9.4 °C) that such small fish were likely hiding in the substrate. However, no Cutthroat Trout smaller than 6 inches in length were observed during the April 2015 survey, thus it is unlikely that any of the fall stocked Cutthroat Trout parr survived the winter.

Stocking of 200 Cutthroat Trout fingerlings, ranging in size from 4 – 7 inches (7.1 fish per pound), was initiated on March 24, 2015 and repeated on May 3, 2016. These fish, stocked in about equal numbers at two locations, just below the Low Level Outlet and about the midpoint of Reach 1, did survival and were readily observed during subsequent snorkel surveys and sampling by angling. Also, these fish grew through the summer as evidenced by changes in the size categories recorded during snorkel surveys and were in good condition (Figure 4-1). During monthly snorkel surveys in 2016, the Cutthroat Trout were classified into four size categories (<6, inches, 6-9 inches, 9-12 inches and >12 inches). While it is difficult to estimate fish size during snorkeling, the proportion of fish in the 6-9 inch category decreased over the summer, while the proportion of fish in the 9-12 inch and greater than 12 inch categories increased (Stevenson et al. 2017; Appendix B). During the September survey, no Cutthroat Trout smaller than the 9-12 inch category were observed and by the December survey the proportion of Cutthroat Trout in the greater than 12 inch category was double the number in the 9-12 inch category. There were no Cutthroat Trout less than 3 inches in length observed during the snorkel surveys in 2016, thus it is unlikely that any successful reproduction of Cutthroat Trout occurred in Reach 1 during 2016 (Stevenson et al. 2017; Appendix B).

The number of Cutthroat Trout in Reach 1 of the Chelan River counted during snorkel surveys increased from January (6 fish) to July (214 fish), then decreased from August to December (Table 4-1). The number of Cutthroat Trout observed in December (62 fish) was ten times greater than observed in January and nearly three times greater than the number observed in November, 2015 (22 fish). The peak count of 214 fish in July most likely included fish from the May stocking event and Cutthroat Trout that entered Reach 1 from Lake Chelan. In addition to the Cutthroat Trout counted in Reach 1, there were also 68 Cutthroat Trout (60 in 9-12 inch size) counted in the pool and Habitat Channel during the June survey. Spillway flows in May and June exceeded 9,000 cfs and 6,000 cfs, respectively, thus Cutthroat Trout observed in the Reach 4 pool and Habitat Channel likely represented downstream movement of these fish from Reaches 1 – 3 of the Chelan River.

The snorkel surveys have determined that some colonization of adult Cutthroat Trout has occurred, but no young age classes (less than 3 inches in length) have been observed thus far in either Cutthroat Trout or Rainbow Trout. Planting of test fish for these younger age classes was initiated in the fall of 2014 to provide a means to evaluate the suitability of the Reach 1 habitat for these smaller fish, but none were documented as having survived the winter. Natural reproduction of Cutthroat Trout would occur in spring and young of year parr would be expected to approach 1 inch by early fall, but there have been no observations thus far of fish in this size class. Surveys of Reaches 2 and 3 have proven to not be feasible due to safety concerns. A number of large rocks recently fallen into Reach 2 were noted during the November 2014 survey.

The frequency of rock fall is sufficient to warrant suspension of snorkel surveys in Reach 2 for safety reasons. Future surveys will be limited to Reach 1. However, sufficient habitat area may exist in Reach 1 to support a Cutthroat Trout population of 200 fish, thus future measurement of progress toward meeting this objective may be possible with the reduced survey area. Since the December survey ended the year with at least 62 Cutthroat Trout in Reach 1, with an unknown number of these fish in Reaches 2 and 3, it is likely that the 200 fish of various age classes in Reaches 1-3 is an objective that can be achieved and documented in the future.

The absence of small, young of year, Cutthroat Trout in surveys thus far is more likely due to lack of a spawning population rather than lack of suitability of the habitat to support rearing fry and parr. The prevalence of annual high spill flows and lack of low velocity habitat in Reach 1 may be unfavorable for Cutthroat Trout reproduction. However, natural reproduction of Cutthroat Trout is not a required biological objective for Reaches 1-3. The requirement that the 200 Cutthroat Trout be of various age classes was intended to assure that Cutthroat Trout be able to survive throughout the year. Cutthroat Trout that carry over from one year to the next would contribute to a population of various age classes.

Table 4-1. Cutthroat Trout and Rainbow Trout counted in snorkel surveys in Chelan River Reach 1-3.

NS- No Survey		2012			2013			2014		
		March	August	November	April	August	November	April	August	November
Cutthroat Trout	R1	0	NS	0	5	0	0	19	11	20
	R2	0	NS	NS	0	0	0	2	2	1
	R3	8	NS	NS	3	2	0	NS	NS	NS
Rainbow Trout	R1	7	NS	12	5	0	1	5	58	51
	R2	0	NS	NS	0	11	7	5	39	32
	R3	5	NS	NS	5	0	0	NS	NS	NS
		2015			2016					
		April	September	November	January	February	March	May	June	July
Cutthroat Trout	R1	20	24	22	6	12	18	82	189	214
Rainbow Trout	R1	11	24	46	22	39	41	22	34	41
		August	September	October	November	December				
Cutthroat Trout	R1	129	111	86	72	62				
Rainbow Trout	R1	31	44	32	38	14				

Figure 4-1. Cutthroat Trout stocked in Reach 1 on 3/24/15 and recaptured 6/24/15 (photo by Graham Simon, WDFW).

Degree of Achievement of Objective

Objective 4.1 will likely be achieved by 2018 with continued stocking.

M&E Results:. Recruitment of Cutthroat Trout from Lake Chelan via spillway flows did not provide enough Cutthroat Trout colonizing Reach 1 for evaluation, thus stocking was initiated. Survival and growth of fingerling Cutthroat Trout stocked in the spring of 2015 was promising and snorkel surveys in 2016 ended the year with 62 Cutthroat Trout observed in December. Stocking of one-inch-long Cutthroat Trout in the fall did not appear to be successful. Snorkel surveys in Reaches 2 and 3 have not been possible due to safety concerns.

Objective Achievement: This objective will likely be achieved by 2018 with continued stocking of Cutthroat Trout, but it may be necessary to survey Reaches 2 and 3 in order to confirm presence of at least 200 Cutthroat Trout. Cutthroat Trout stocked in 2015 and 2016 continued to grow and survive through the high water temperatures in July, August and September.

Management Actions Taken: Management of the Lake Chelan storage to meet recreation target elevations and minimize high flows in the Chelan River has been in effect since 2009. Cutthroat Trout stocking of fingerling-sized fish began in 2015.

Future Actions: Continue to stock fingerling-sized Cutthroat Trout in the spring and continue to evaluate survival through the summer and subsequent winter in Reach 1.

4.2 Create Habitat to Support a Viable Population of Cutthroat Trout in Reaches 1-3

The CRBEIP has the objective of taking reasonable and feasible actions to improve habitat in Reaches 1-3 if necessary to establish a viable population of Cutthroat Trout. The primary measures envisioned as potentially necessary were related to management of high summer water temperatures. The temperature modeling study completed in 2016 (WEST Consultants, 2016) determined that a small decrease in daily maximum water temperature (up to 1 °C) could be achieved by increasing July minimum flows from 80 cfs to 200 cfs. However, Cutthroat Trout have shown to survive summer water temperature, most likely by finding hyporheic flow as a refuge during peak daytime temperatures. An increase in minimum flow to reduce daytime high temperature by 1 °C would also increase nighttime minimum temperature by the same amount (West Consultants, 2016). If the Cutthroat Trout are relying on hyporheic flow to mitigate peak water temperatures in the afternoon, they are likely also finding relief during the nighttime when minimum water temperatures are 3-5 degrees cooler than the afternoon peak (West Consultants, 2016). Increased flows that may reduce, through mixing, the hyporheic refuge area during daytime and increase the nighttime minimum water temperature may not provide any benefit to the Cutthroat Trout population.

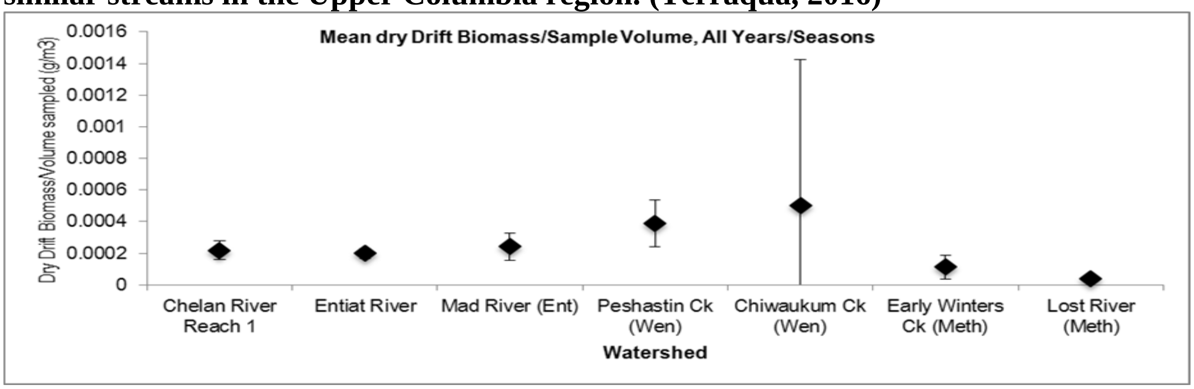
Improvement in the amount of riparian vegetation in Reach 1 would potentially improve habitat for Cutthroat Trout through three mechanisms, localized water temperature cooling, increased cover and low velocity habitat during high flows, and increased coarse and fine particulate organic material to provide a food source for aquatic insects (which are a food source for Cutthroat Trout). A riparian feasibility study has been conducted which determined that it is feasible to increase shoreline riparian vegetation through planting of a willow band and some limited riparian zones on point bars and other river bends that would be partially inundated during high flows (Herrera Environmental Consultants, 2015). Although development of a mature riparian zone in Reach 1 would only reduce daytime peak water temperatures by 0.2 °C (West Consultants, 2016), the increase in shade, organic inputs and high flow refugia for small fish would all increase the quality of Reach 1 habitat for Cutthroat Trout. A riparian planting plan for Reach 1 will be developed in 2017, with riparian zone planting of willows and other species at a later time.

The other component necessary to support a Cutthroat Trout population in Reaches 1-3 is a source of food. As previously described, the physical condition and growth of Cutthroat Trout observed in Reach 1 has been healthy, with no indications of food being a limiting factor. The CRBEIP calls for sampling of the benthic macroinvertebrate community to determine if conditions (flows, water temperature) have allowed the development of a benthic community commensurate with the potential of the location. Since Reach 1 is lake fed and the water source is both warm and oligotrophic, the potential for development of a diverse benthic community is limited to its site potential. The CRBEIP stated that the benthic community in the Chelan River upstream of the Lake Chelan Dam would be a suitable reference site for Reach 1. The upstream pool of potential colonizers will define if the benthic community in Reach 1 has developed a diversity that meets or exceeds that of the upstream source of colonizers. The Reach 4 tailrace, which also has access for colonizing benthic organisms from the Columbia River, is also mentioned as a reference for comparison. In regards to providing nutrition for a Cutthroat Trout population, the abundance and food value of the macroinvertebrate drift community (organisms suspended in the stream, whether from aquatic benthic or terrestrial origin) is of greater importance. Monitoring and analysis of the drift community has been adopted in the Upper Columbia region as a more appropriate method for evaluating salmonid habitat value than evaluation of the diversity of the benthic macroinvertebrate community (Pacific Northwest Aquatic Monitoring Partnership, Columbia River Aquatic Habitat Monitoring Program).

The benthic macroinvertebrate population and the macroinvertebrate drift community were sampled in Reach 1 and the Reach 4 Habitat Channel in 2016. Also, benthic samples from above the Lake Chelan Dam and both benthic and drift samples were collected for use as reference comparisons. The benthic community in Reach 1 was both more abundant and slightly higher in diversity than samples taken from above the Lake Chelan Dam (Terraqua, 2017; Appendix C). Benthic kick net sample abundance was not compared to other streams outside the Chelan River area, but diversity (taxa richness) was compared to data from a number of other streams. In these comparisons, the diversity of the benthic macroinvertebrate community in both Reach 1 and the Habitat Channel was low compared to other salmonid habitats in the region. Other lake-fed or warm water streams were included in the comparisons, but all had higher diversity than the Chelan River, thus lack of diversity is not necessarily due solely to either temperature or the low productivity of the lake water. One factor, for which there were no reference streams for comparison, is the rate of colonization that should be expected for a recently restored stream (from no flow for most of the year to a minimum flow) and with limited nearby source pools for colonizers.

The drift community had taxonomic composition and abundance that was similar to that of six reference streams from the Wenatchee, Entiat and Methow watersheds (Figure 4.2; Terraqua, 2017; Appendix C). In short, the favorable abundance and composition of the macroinvertebrate drift community is supportive of meeting the biological objective for establishment of a Cutthroat Trout population in Reaches 1-3 of the Chelan River.

Figure 4-2. Total drift fauna biomass in Reach 1 of the Chelan River compared with 6 similar streams in the Upper Columbia region. (Terraqua, 2016)



Degree of Achievement of Objective

Objective 4.2 has been achieved.

M&E Results:. Cutthroat Trout stocked in Reach 1 during 2015 and 2016 have survived through the months of July – September when water temperatures are high. Water temperature modeling studies determined that Reach 1 has a significant amount of hyporheic exchange, which moderates daytime peak water temperatures and may provide cool water refugia for Cutthroat Trout. The Cutthroat Trout that were stocked in 2015 and 2016 demonstrated good growth rates and condition factor. The macroinvertebrate drift community, the prime source of food for Cutthroat Trout, had taxonomic composition and abundance that was similar to that of six reference streams from the Wenatchee, Entiat and Methow watersheds. Thus, the food supply is adequate to sustain a Cutthroat Trout population of 200 fish.

Objective Achievement: This objective has been achieved. Cutthroat Trout have demonstrated survival throughout the year, with healthy growth and condition of fish evident during sampling and snorkel surveys.

Management Actions Taken: Management of the Lake Chelan storage to meet recreation target elevations and minimize high flows in the Chelan River has been in effect since 2009. Minimum flows have been maintained throughout the year.

Future Actions: A riparian planting plan is being prepared in 2017, which will be followed by planting of willows and other riparian vegetation. Macroinvertebrate studies of both the benthic and drift communities are continuing in 2017, with the objective to determine the abundance and diversity for a second year. This study may help determine if benthic macroinvertebrate species diversity is limited by characteristics specific to the Chelan River or if colonization is limited by lack of an upstream source of colonizing organisms. Over time, development of riparian vegetation will increase the habitat value of Reach 1 for a more diverse benthic and drift macroinvertebrate community, which should also increase food sources for Cutthroat Trout.

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APPENDIX A: SNORKEL SURVEY DATA FOR THE CHELAN RIVER

Chelan River Habitat Channel Snorkel Fish Survey

Chelan River Habitat Channel Snorkel Fish Survey

5/20/2010 Flow/Temperature in Channel - 200 cfs/14.0 C Flow/Temperature in Tailrace (powerhouse) - 0 cfs/14.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	75		2	0		0	20	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	66	0	0	36		1	0		4	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	135	0	0	92		1	0		0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	293	0	0	3		0	5		0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	1300	0	0	17		1	0		0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	402	0	0	66		1	1		0	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	1748	75	0	40		5	0		0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	1	30	0	1		0	0		0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	845	0	0	69		11	0		1	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	4790	105	0	399		22	6		5	20	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

3/29/2012 Flow/Temperature in Channel - 338 cfs/7.5 C Flow/Temperature in Tailrace (powerhouse) - 800 cfs/7.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	5	0	1	0	0	0	0	0	0	8		1	0		0	0	0	0	0	0	0	0
Habitat Channel	0	0	0	1	0	0	2	0	0	0	0		2	0		0	0	0	0	0	0	0	0
Total	0	5	0	2	0	0	2	0	0	0	8		3	0		0	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

4/17/2012 Flow/Temperature in Channel - 342 cfs/10.5 C Flow/Temperature in Tailrace (powerhouse) - 800 cfs/11.2 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	0		9	0		0	0	0	0	0	0	0	0
#1	0	0	0	1	0	0	0	0	0	0	4		0	0		0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	27		0	0		0	0	0	0	0	0	0	0
#3	0	2	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0
#5	0	1	0	0	0	1	0	0	0	0	8		0	0		1	0	0	0	0	0	0	0
#6	0	0	0	1	0	0	0	0	0	0	10		2	0		2	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	8	0	0	35		3	0		3	0	0	0	0	0	0	0
Total	0	3	0	2	0	1	0	8	0	0	84		14	0		6	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

5/16/2012 Flow/Temperature in Channel - 393 cfs/17.3 C Flow/Temperature in Tailrace (powerhouse) - 2230 cfs/16.8 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	2660	10	0	14	0	3	0		4	0	0	3	75	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	14	0	3	0		0	0	1	0	1	0	0	0
#2	0	0	0	2	0	0	0	0	0	0	343	0	1	0		5	0	0	0	0	4	4	4
#3	0	0	0	2 (12", Tripl.)	0	0	0	287	50	0	28	0	4	0		0	0	0	0	0	0	0	0
#4	0	0	0	2 (12", Tripl.)	0	0	3	228	0	0	52	0	1	0		0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	4	660	200	0	100	0	4	0		1	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	787	100	0	107	0	9	0		0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
Pool	0	0	0	3	0	0	0	0	0	0	680	0	10	0		6	0	0	0	0	0	0	0
Total	0	0	0	9	0	0	7	4622	360	0	1338	0	35	0		16	0	1	3	76	4	4	4

Chelan River Habitat Channel Snorkel Fish Survey

6/20/2012 Flow/Temperature in Channel - 3261 cfs/16.8 C Flow/Temperature in Tailrace (powerhouse) - 2300 cfs/16.6 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	239	46	0	24		20	0		11	0	3	2	40	0	25	400
Habitat Channel	0	0	0	0	0	0	0	0	0	0	0		7	0		55	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	239	46	0	24		27	0		66	0	3	2	40	0	25	400

JULY SURVEY CANCELLED - HIGH SPILL

AUGUST REACH 1-3 SURVEYS CANCELLED - SAFETY POLICY ISSUES REGARDING ACCESS/SPILLWAY TAGOUTS

Chelan River Habitat Channel Snorkel Fish Survey

8/24/2012 Flow/Temperature in Channel - 83 cfs/19.7 C Flow/Temperature in Tailrace (powerhouse) - 2410 cfs/21.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	1	0	0	0	0	0	0	0	0	0	1	111	23	0	1005	0	0	0	1 (20")	0	0	0	0
Habitat Channel	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Pool	1	0	0	3 (18")	0	0	0	0	0	0	16	0	6	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	3	0	0	0	0	0	0	21	111	29	0	1005	0	0	0	1	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

9/12/2012 Flow/Temperature in Channel - 84 cfs/16.9 C Flow/Temperature in Tailrace (powerhouse) - 2420 cfs/18.8 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat Channel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	1 (12"-15")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

11/15/2012 Flow/Temperature in Channel - 338 cfs/10.8 C Flow/Temperature in Tailrace (powerhouse) - 2460 cfs/11.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Habitat Channel	36	0	3	10 (8"-14")	0	6 (12"-18")	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	36	0	3	10	0	6	0	0	0	0	25	1	0	1	0	0	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

3/11/2013 Flow/Temperature in Channel - 84 cfs/6.2 C Flow/Temperature in Tailrace (powerhouse) - 843 cfs/7.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	1	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0
Habitat Channel	0	3	0	2 (14",18")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	4	0	2	0	0	0	1	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

4/10/2013 Flow/Temperature in Channel - 342 cfs/10.4 C Flow/Temperature in Tailrace (powerhouse) - 2368 cfs/10.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	1	0	0	0	0	0	25	0	0	54	1	0	0	0	0	0	0	0	0	0	0	0
#1	0	2	0	1 (12"-16)	0	0	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	0
#2	0	2	0	0	0	0	0	0	0	0	72	1	0	0	0	0	0	0	0	0	0	0	0
#3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	1	0	1 (12"-16)	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	1 (12"-16)	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	3	0	4 (12"-16)	0	0	0	5	0	0	158	1	1	0	1	1	0	0	0	0	0	0	0
Total	0	10	0	7	0	0	0	30	0	0	418	3	1	0	1	1	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey

5/15/2013 Flow/Temperature in Channel - 240 cfs/16.9 C Flow/Temperature in Tailrace (powerhouse) - 2281 cfs/16.6 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	9000	0	0	55	0	15	0	0	3	0	0	8	229	0	0	0
#1	0	0	0	2 (12"-16)	0	0	0	0	0	0	200	0	0	0	0	5	0	0	0	30	0	0	0
#2	0	0	0	1 (12"-16)	0	0	0	980	10	0	425	0	0	0	0	1	0	0	0	0	0	0	0
#3	0	0	0	2 (Notes)	0	0	0	940	0	0	90	0	1	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	5 (Notes)	0	0	0	1294	1	0	150	0	0	0	1	0	0	0	0	0	0	0	0
#5	0	0	0	2 (12"-16)	0	0	0	380	1	0	100	1	1	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	0	2 (12"-16)	0	0	225	13	0	225	0	7	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	1 (12"-16)	0	0	0	1	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	2 (12"-16)	1 (12"-16)	0	0	21	9	0	825	0	18	0	0	18	0	0	0	0	0	9	0
Total	0	0	0	15	3	0	0	12841	34	0	2076	1	42	0	1	27	0	0	8	259	0	9	0
Notes				Rainbow Notes - Section3 = 1 Triploid 18", 1 RB 12"-16"; Section 4 = 2 Triploid 18", 1 possible Steelhead presmolt < 6", 2 RB 12"-16"																			
								Chinook Fry Notes - Salmonid fry (assumed Chinook) have been using the leakage water and tailrace backwater in the spill overflow since early April. This area is too shallow to snorkel															

Chelan River Habitat Channel Snorkel Fish Survey

6/14/2013 Flow/Temperature in Channel - 203 cfs/19.1 C Flow/Temperature in Tailrace (powerhouse) - 2387 cfs/18.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	5	0	0	81	0	25	0	0	40	0	0	3	0	0	0	0
#1	0	0	0	1 (12"-16)	0	0	0	0	0	0	20	0	0	0	0	30	0	0	0	0	0	0	0
#2	0	0	0	1 (12"-16)	0	0	0	0	0	0	250	0	0	0	0	700	0	0	0	0	0	0	0
#3	0	0	0	4 (12"-16)	0	0	0	0	0	10	20	0	0	0	0	100	30	0	0	0	0	0	0
#4	0	0	0	1 (12"-16)	0	0	0	0	0	20	130	0	0	0	0	110	40	0	0	0	0	0	0
#5	0	0	0	2 (12"-16)	1 (12"-16)	0	0	0	0	50	125	0	2	0	0	110	30	0	0	0	0	0	0
#6	0	0	0	3 (12"-16)	1 (12"-16)	0	0	0	0	13	70	0	3	0	0	50	20	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	1	0	24	335	2	0	0	0	753	0	0	0	0	0	0	0
Pool	0	0	0	1 (12"-16)	3 (12"-16)	0	0	1	0	139	236	10	14	0	0	202	0	0	0	0	0	4	0
Total	0	0	0	13	5	0	0	7	0	256	1267	12	44	0	0	2095	120	0	3	0	0	4	0
Notes	1 Tench in Pool, numerous smallmouth fry in pool and throughout Habitat Channel									Rainbow/steelhead Fry - 40mm-80mm size range with most near the 40mm part of range - inhabiting very shallow cobble/boulder habitat at stream margins													
														Pikeminnow on Section 7 were moving back and forth between pool, under log structure and Section 7 - may have double counted									

Chelan River Habitat Channel Snorkel Fish Survey

7/18/2013 Flow/Temperature in Channel - 82 cfs/20.1 C Flow/Temperature in Tailrace (powerhouse) - 2428 cfs/21.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	1	0	0	1 (12")	0	0	0	0	0	0	78	1943	30	0	0	2	0	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	0	0	12	0	5	8	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
#3	1	0	0	0	0	0	0	0	0	14	0	88	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	2 (<10")	0	0	0	0	1	18	10	8	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	1 (16")	1 (12")	0	0	0	0	9	38	54	3	0	0	17	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	3	0	0	5 (2-18",3-16")	1 (12"-16")	0	0	1	0	0	48	34	9	0	0	54	0	0	0	0	0	0	0
Total	5	0	0	9	2	0	0	1	1	87	174	2133	50	0	0	73	0	0	0	0	0	0	0
Notes	Chinook in tailrace was a jack, one sculpin counted in Section 3									Rainbow/steelhead Parr - 30mm-60mm size range inhabiting mid stream areas behind largecobble/boulder riffle mex substrate, distinctive parr marks													

Chelan River Habitat Channel Snorkel Fish Survey

8/15/2013 Flow/Temperature in Channel - 87 cfs/22.2 C Flow/Temperature in Tailrace (powerhouse) - 2420 cfs/23.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	1 (12"-16")	0	0	0	0	0	0	0	13	27	0	0	0	0	0	0	17	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	3	0
#2	0	0	0	0	0	0	0	0	0	3	0	3	22	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	2	0	0	21	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0	0	0	4	1	9	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	2 (12"-16")	0	0	0	0	0	0	11	14	5	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	2 (12"-16")	0	0	0	0	0	0	13	2	32	0	0	0	0	0	0	0	0	2	0
Pool	0	0	0	0	0	0	0	0	0	0	2	0	7	0	0	0	0	0	0	0	0	3	0
Total	0	0	0	5	0	0	0	0	0	5	31	33	148	0	0	0	0	0	0	17	0	8	0
Notes																							

Chelan River Habitat Channel Snorkel Fish Survey

9/10/2013 Flow/Temperature in Channel - 85 cfs/20.2 C Flow/Temperature in Tailrace (powerhouse) - 2450 cfs/22.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	4	0	0	0	0	0	0	0	0	0	0	126	21	0	0	0	0	0	0	0	30000	3	0
#1	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	200	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	50	0	0
#3	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	40	0	0
#6	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	10	0	0
#7	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	1000	0	0
Pool	1	0	0	2 (6"-8")	0	0	0	0	0	0	17	12	2	0	0	0	0	0	0	0	1340	0	0
Total	5	0	0	2	0	0	0	0	0	0	18	191	23	0	0	0	0	0	0	0	32640	3	0
Notes	Turbid due to gravel relocation in progress																						

Chelan River Habitat Channel Snorkel Fish Survey

10/3/2013 Flow/Temperature in Channel - 84 cfs/15.7 C Flow/Temperature in Tailrace (powerhouse) - 2470 cfs/16.6 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	20	0	0	0	0	0	0	0	0	0	0	29	3	12	0	0	0	0	0	0	15000	2	0
#1	2	0	0	2 (>6")	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
#2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	600	0	0
#3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0
#4	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	90	0	0
#5	0	0	0	1 (>6")	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	510	0	0
#6	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0
#7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	45	0	0	2 (>6")	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	550	0	0
Total	70	0	0	5	0	0	0	0	0	0	48	29	4	13	0	0	0	0	0	0	16781	2	0
Notes	Two sockeye in pool																						

Chelan River Habitat Channel Snorkel Fish Survey

11/5/2013 Flow/Temperature in Channel - 85 cfs/11.4 C Flow/Temperature in Tailrace (powerhouse) - 2390 cfs/13.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
#1	42	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
#2	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#3	58	0	0	0	0	2 (12"-14")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#4	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#5	77	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#6	46	5	0	2 (>12")	0	1 (12"-14")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#7	48	0	0	1 (>12")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	442	6	0	3	1	3	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Habitat Channel Snorkel Fish Survey
3/13/2014 Flow/Temperature in Channel - 82 cfs/7.1 C Flow/Temperature in Tailrace (powerhouse) - 1260 cfs/7.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	3	0	5	0	0	0	0	0	0	154	0	0	0	0	8	0	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	3	0	5	0	0	0	0	0	0	154	0	0	0	0	8	0	0	0	0	0	0	0

Chelan River Habitat Channel Snorkel Fish Survey
4/23/2014 Flow/Temperature in Channel - 287 cfs/11.3 C Flow/Temperature in Tailrace (powerhouse) - 1270 cfs/11.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	4090	0	0	1	2	0	0	0	8	0	0	0	6	0	0	0
#1	0	0	0	1 (>12")	0	0	0	25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	1400	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	1 (>12")	0	0	0	2700	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	1700	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	3070	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	1650	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	2(>12")1(<12)	0	0	0	490	0	0	22	0	20	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	1 (12")	0	0	0	2600	0	0	125	0	2	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	6	0	0	0	17725	0	0	404	2	22	0	0	8	0	0	0	6	0	0	0
Notes	19 Hatchery Chinook smolts in the swim area																						

Chelan River Habitat Channel Snorkel Fish Survey
5/21/2014 Flow/Temperature in Channel - 205 cfs/17.2 C Flow/Temperature in Tailrace (powerhouse) - 2500 cfs/16.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	3000	0	0	2	0	0	0	0	0	0	0	0	200	3000	0	0
#1	0	0	0	0	0	0	0	0	0	0	1200	0	0	0	9	0	0	0	0	3	0	0	0
#2	0	0	0	0	0	0	0	3110	0	0	100	0	2	0	0	2	0	0	0	0	0	0	0
#3	0	0	0	0	1	0	0	550	0	0	37	0	3	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	1(12")2(14)	2	0	0	750	0	0	60	0	2	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	100	0	0	300	0	6	0	0	12	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	200	0	0	30	0	6	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	1	0	0	0	0	0
Pool	0	0	0	0	0	0	0	22	0	0	325	0	11	0	0	17	0	0	0	0	0	0	0
Total	0	0	0	3	3	0	0	7732	0	0	2114	0	30	0	9	31	0	1	0	203	3000	0	0
Notes	300 Chinook fry in the swim area							4710															

Chelan River Habitat Channel Snorkel Fish Survey
6/17/2014 Flow/Temperature in Channel - 207 cfs/17.1 C Flow/Temperature in Tailrace (powerhouse) - 2510 cfs/16.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	6	2	6	0	0	2	0	0	6>24"	108	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	30	5	3	0	0	65	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0
#3	0	0	0	4(16")	0	0	0	0	0	0	100	6	5	0	0	400	0	0	0	0	0	0	0
#4	0	0	0	1(8")	1	0	0	0	0	0	200	800 fry	2	0	0	500	0	0	0	0	0	0	0
#5	0	0	0	1(12")	0	0	0	0	0	0	400	0	3	0	0	1000	0	0	0	0	0	0	0
#6	0	0	0	3(12")1(18")	0	0	0	0	0	3 parr	150	2, 1000 fry	0	0	0	150	0	0	0	0	0	0	0
#7	0	0	0	12(12")	1	0	0	0	0	0	500	5, 1000 fry	0	0	0	500	0	0	0	0	0	0	0
Pool	0	0	0	1(16")	1	0	0	0	0	0	700	15	25	0	0	550	0	0	0	0	0	0	0
Total	0	0	0	23	3	0	0	0	0	3	2086	35	44	0	0	4167	0	0	6	108	0	0	0
Notes	Swim Area-12 smallmouth<12", 4>12", 12 Bluegill, 3 Tench, stickleback				Rainbow Notes - Section 6 = 18" was Triploid							Smallmouth plus 2800 fry											

Chelan River Habitat Channel Snorkel Fish Survey
7/9/2014 Flow/Temperature in Channel - 1003 cfs/22.0 C Flow/Temperature in Tailrace (powerhouse) - 2460 cfs/21.6 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	53	0	0	0	0	0	0	0	0	0	18	6	15	0	0	5	0	0	9	0	1 school	0	0
#1	0	0	0	0	0	0	0	0	0	0	400	2	5	0	0	1500	500	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	1 parr	0	0	210	5, 50 fry	1	0	0	500	200	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	400	3	1	0	0	200	250	200	0	0	0	0	0
#4	0	0	0	4 (4")	0	0	0	0	0	0	50	1	1	0	0	800	0	0	0	0	0	0	0
#5	0	0	0	3 (8")	1(10")	0	0	0	0	0	70	0, 400 FRY	9	0	0	5	0	0	0	0	0	0	0
#6	0	0	0	3(<12")	0	0	0	0	0	0	100	4, 200 fry	18	0	0	420	500	1000	0	0	0	0	0
#7	0	0	0	1	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	0
Pool	7	2	0	0	0	0	0	0	0	0	800	0	10	0	0	800	0	0	0	0	0	0	0
Total	60	2	0	11	1	0	0	1	0	0	2048	21	66	0	1	4230	1450	1200	9	0	1 school	0	0
Notes	Swim Area-7 smallmouth<12", 1>12"											Smallmouth plus 650 fry											

Chelan River Habitat Channel Snorkel Fish Survey

8/28/2014 Flow/Temperature in Channel - 84 cfs/21.4 C Flow/Temperature in Tailrace (powerhouse) - 2480 cfs/22.9 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	20	0	0
#1	0	0	0	0	0	0	0	0	0	0	0	10	20	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	5	6	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	1(6")	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
#5	0	0	0	3(>12")	0	0	0	0	0	0	0	6	1	0	0	1	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	0	0	0	14	6	6	0	0	0	6	0	0	0	0	0	0
#7	0	0	0	3(12")	1(8")	0	0	0	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0
Pool	161	0	0	1 (>12")	0	0	0	0	0	0	18	12	14	0	0	0	0	0	0	0	0	0	0
Total	161	0	0	8	1	0	0	0	0	0	33	54	49	0	0	1	7	0	0	0	20	0	0
Notes	Pool had 2 dead Chinook adults																						

Chelan River Habitat Channel Snorkel Fish Survey

9/25/2014 Flow/Temperature in Channel - 87 cfs/18.2 C Flow/Temperature in Tailrace (powerhouse) - 2460 cfs/19.1 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	124	0	0	1(9")	0	0	0	0	0	0	1	4	1	0	0	0	0	0	0	0	800	0	0
#1	1	0	0	1(22")	0	1(24")	0	0	0	0	15	4	0	0	0	0	0	0	0	0	3000	0	0
#2	0	0	0	0	0	0	0	0	0	0	5	4	3	0	0	0	0	0	0	0	150	0	0
#3	1	0	0	2(8")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0
#4	0	0	0	3(8",10",18")	0	0	0	0	0	1 parr	4	3	8	0	0	0	0	0	0	0	50	0	0
#5	0	0	0	2(8"),2(12")	0	0	0	0	0	0	3	4	2	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	5(12")	2(12")	0	0	0	0	0	9	4	3	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	1	0	0
Pool	375	0	0	2(6"), 3(12") 1(20")	0	0	0	0	0	0	30	6	5	0	0	0	0	0	0	0	0	0	0
Total	501	0	0	22	2	1	0	0	0	1	67	33	26	0	0	0	0	0	0	0	4201	0	0
Notes	Dead Chinook Adults - #1-1, #2-2, Pool-3											Swim Area-18 smallmouth<12", many stickleback											

Chelan River Habitat Channel Snorkel Fish Survey

11/25/2014 Flow/Temperature in Channel - 287 cfs/9.5 C Flow/Temperature in Tailrace (powerhouse) - 2340 cfs/9.6 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	100s+	8	0	0	0	2(13"), 1(15") 1(21")	3(11")	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0
#1	3	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
#2	5	0	0	1(15"),1(17")	0	1(21")	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
#3	1	0	0	1(11")	0	0	2(11")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	1(21")	0	2(15"),1(17")	0	1(17")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	1	1(15")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	1(11"), 1(13") 2(15")	0	1(13")	1(15")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	1(11")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	1(15"), 2(19")	0	1(7")	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0
Total	9 + 100s	9	1	14	0	8	7	0	0	0	170	0	16	0	0	0	0	0	0	0	0	0	0
Notes	Swim Area-565 stickleback																						

Chelan River Habitat Channel Snorkel Fish Survey

3/10/2015 Flow/Temperature in Channel - 82 cfs/7.2 C Flow/Temperature in Tailrace (powerhouse) - 2360 cfs/8.2 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	3(14"-16")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Habitat Channel Snorkel Fish Survey

4/15/2015 Flow/Temperature in Channel - 287 cfs/9.7 C Flow/Temperature in Tailrace (powerhouse) - 2360 cfs/10.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	50	0	0	6	0	1	0	0	0	0	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#2	0	2	0	0	0	0	0	595	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	473	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#4	0	1	0	0	0	0	0	205	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	800	0	0	25	0	1	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	2(12"-14")	0	0	0	0	0	0	47	1	0	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	1	0	0	0	0	0	0	0	0	190	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	4	0	2	0	0	0	2123	0	0	377	1	2	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Habitat Channel Snorkel Fish Survey

5/20/2015 Flow/Temperature in Channel - 85 cfs/16.0 C Flow/Temperature in Tailrace (powerhouse) - 2360 cfs/15.3 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	100	0	0	536	5	3	0	0	36	0	0	3	41	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0
#2	0	0	0	0	1(12")	0	0	20	0	0	261	0	3	0	0	6	1	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	112	0	5	0	0	0	0	0	0	0	0	0	0
#4	0	0	0	6(10"-14"),1 T	0	0	0	0	0	0	90	0	13	0	0	44	0	0	0	0	0	0	0
#5	0	0	0	4(10"-14")	1(12")	0	0	25	0	0	107	0	14	0	0	22	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	50	0	0	53	0	14	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	0	3(10"-16")	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0	0	0
Pool	0	1	0	3(10"-14")	1(13")	0	0	393	0	0	500	0	34	0	0	5	0	0	0	0	0	0	0
Total	0	1	0	13	6	0	0	588	0	0	1667	5	92	0	0	113	1	0	3	44	0	0	0
Notes				The 1 T in #4 was a triploid >16"																			

Chelan River Habitat Channel Snorkel Fish Survey

6/17/2015 Flow/Temperature in Channel - 139 cfs/20.4 C Flow/Temperature in Tailrace (powerhouse) - 1250 cfs/21.8 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	1	0	0	0	0	0	0	830	7	2	0	0	2200	0	0	0	0	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	3	4	4	0	0	250	525	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	720	1	5	0	0	2500	30	0	0	0	0	0	0
#3	0	0	0	0	1	0	0	0	0	0	575	0	1	0	0	1500	1500	1	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	0	1500	2	2	0	0	1000	20	3	0	0	0	0	0
#5	0	0	0	1	0	0	0	0	0	0	320	0	3	0	0	300	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	0	0	0	350	4	13	0	0	350	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	20	0	1	0	0	20	0	0	0	0	0	0	0
Pool	0	0	0	2	0	0	0	0	0	0	800	0	24	0	0	1300	0	1	0	0	0	0	0
Total	0	0	0	4	1	0	0	0	0	0	5118	18	55	0	0	9420	2075	5	0	0	0	0	0
Notes										Electroshock 2 steelhead fry		2150 bass fry snorkel count											

Chelan River Habitat Channel Snorkel Fish Survey

7/15/2015 Flow/Temperature in Channel - 139 cfs/22.8 C Flow/Temperature in Tailrace (powerhouse) - 1240 cfs/24.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	0	0	0	0	0	0	0	0	0	0	49	51	29	0	0	243	0	0	1(24")	12	0	0	0
#1	0	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0	0	0	200	13	1	0	0	265	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	20	0	9	0	0	5	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0	0	o	87	1	1	0	0	17	0	0	0	0	0	0	0
#5	0	0	0	0	2(7")	0	0	0	0	0	74	4	2	0	0	2	0	0	0	0	0	0	0
#6	0	0	0	0	0	0	0	0	0	0	55	30	6	0	0	6	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0	0	0	25	3	0	0	0	25	0	0	0	0	0	0	0
Pool	0	0	0	0	1(5")	0	0	0	0	0	94	27	28	0	0	114	2	0	0	0	0	0	0
Total	0	0	0	0	3	0	0	0	0	0	606	134	76	0	0	677	2	0	1	12	0	0	0
Notes	1 adult sockeye in pool																					8 pumpkinseeds	

Chelan River Habitat Channel Snorkel Fish Survey

9/18/2015 Flow/Temperature in Channel - 83 cfs/17.0 C Flow/Temperature in Tailrace (powerhouse) - 1150 cfs/18.7 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	70	0	0	1(11"), 1 Trip	0	0	0	0	0	0	2	92	6	0	0	1	2	0	0	0	4050	0	0
#1	0	0	0	1(12"), 1 Trip	0	0	0	0	0	0	4	50	0	0	0	0	0	0	0	0	0	0	0
#2	0	0	0	1(8")	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0
#3	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
#4	1	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
#5	1	0	0	1(14")	1(10")	0	0	0	0	0	0	2	8	0	0	0	0	0	0	0	0	0	0
#6	0	0	0	1(12")	0	0	0	0	0	0	36	1	7	0	0	0	0	0	0	0	0	0	0
#7	0	0	0	2(10",18")	0	0	0	0	0	0	0	3	7	0	0	0	0	0	0	0	0	0	0
Pool	132	0	0	0	1(14")	0	0	0	0	0	5	3	13	0	0	0	0	0	0	0	5000	0	0
Total	204	0	0	9	2	0	0	0	0	0	47	161	53	0	0	1	2	0	0	0	9050	0	0
Notes	14 adult sockeye in pool, 1 in #6		Triploid in #1 >10 lbs. estimated																				

Chelan River Habitat Channel Snorkel Fish Survey

10/16/2015 Flow/Temperature in Channel - 84 cfs/16.0 C Flow/Temperature in Tailrace (powerhouse) - 2410 cfs/16.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Tailrace	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
#1	1	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	0	0	0	0	0
#2	26	1	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
#3	17	0	0	1(13")	0	1(13")	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
#4	8	0	0	1(14")	0	1(14")	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
#5	6	0	0	0	2(12")	1(18")	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
#6	16	1	0	1(10")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#7	3	0	0	3(10",13",13")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	77	0	0	1 Trip(20")	2(10")	0	0	0	0	0	0	10	3	0	0	0	0	0	0	0	0	0	0
Total	158	2	0	7	4	4	0	0	0	0	33	10	4	0	0	0	0	0	0	1	0	0	0
Notes	2 adult sockeye in pool, 1 in #3																						

Chelan River Reach 1-3 Snorkel Fish Survey

3/20/2012 Flow/Temperature in River - 83 cfs/6.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	7	0	0	0	0	0	0	1		0	0		0	0	0	0	0	0	0	0
Reach 2	0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	0
Reach 3	1	0	0	5	8	0	0	0	0	0	0		1	0		0	0	0	0	0	0	0	0
Total	1	0	0	12	8	0	0	0	0	0	1		1	0		0	0	0	0	0	0	0	0

Chelan River Reach 1-3 Snorkel Fish Survey

11/13/2012 Flow/Temperature in River - 84 cfs/10.9 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	12 (10"-15")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chelan River Reach 1-3 Snorkel Fish Survey

4/9/2013 Flow/Temperature in River - 83 cfs/11.2 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	5 (10"-15")	5 (10"-15")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 3	0	0	0	5 (10"-15")	3 (10"-15")	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	10	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Chelan River Reach 1-3 Snorkel Fish Survey

8/16/2013 Flow/Temperature in River - 87 cfs/22.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 2	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 3	0	0	0	0	2 (> 6")	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Reach 1-3 Snorkel Fish Survey

11/5/2013 Flow/Temperature in River - 85 cfs/14.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	1 (12"-14")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 2	0	0	0	7 (12"-14")	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Reach 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	8	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Reach 1-3 Snorkel Fish Survey

4/22/2014 Flow/Temperature in River - 88 cfs/12.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	5 (6"- >12")	19 (8"- 18")	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Reach 2	0	0	0	5 (12"-16")	2 (12"-14")	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	10	21	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Notes																							

Chelan River Reach 1-3 Snorkel Fish Survey

8/25/2014 Flow/Temperature in River - 85 cfs/22.1 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	58 (>6")	6(<6")5(>6")	0	0	0	0	0	0	125	2	0	10	0	0	0	0	0	0	0	0
Reach 2	0	0	0	39 (>6")	2 (>6")	0	0	0	0	0	0	70	4	0	0	0	0	0	0	0	0	0	0
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	97	13	0	0	0	0	0	0	195	6	0	10	0	0	0	0	0	0	0	0
Notes	1 Tench >6"																						

Chelan River Reach 1-3 Snorkel Fish Survey

11/24/2014 Flow/Temperature in River - 83 cfs/9.4 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	51	20	0	0	0	0	0	0	7	0	0	0	1	0	0	0	0	0	0	0
Reach 2	0	0	0	32	1(9")	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	83	21	0	0	0	0	0	0	7	0	0	0	1	0	0	0	0	0	0	0
Notes	5 Tench >6"; Rainbow Reach 1 - 1-7",6-9",15-11",1-12",7-13",6-15", 15>12"; Cutthroat Reach 1 - 2-7",4-9",4-11",8-13",2-15"																						
	Reach 2 survey incomplete - too dark; Rainbow Reach 2 - 2-9:,2-11",25-13",3-15"																						

Chelan River Reach 1-3 Snorkel Fish Survey
4/16/2015 Flow/Temperature in River - 85 cfs/11.3 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	11	20	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Reach 2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	11	20	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
				Cutthroat - 16 (>12"), 4 (8"-12")		Rainbow - 10 (>12"), 1 (8"-12")			3 Tench >6"														

Chelan River Reach 1-3 Snorkel Fish Survey
9/17/2015 Flow/Temperature in River - 83 cfs/17.0 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth <6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	24	24	0	0	0	0	0	0	111	143	0	10	0	0	0	0	0	0	0	0
Reach 2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	24	24	0	0	0	0	0	0	111	143	0	10	0	0	0	0	0	0	0	0
Notes				Cutthroat - 4 (>12"), 20 (8"-12")		Rainbow - 14 (>12"), 10 (8"-12")																	

Chelan River Reach 1-3 Snorkel Fish Survey
11/9/2015 Flow/Temperature in River - 84 cfs/12.5 C

Stream Section	Adult Chinook	Adult Steelhead	Adult Coho	Rainbow	Cutthroat	Bull Trout	Whitefish	Chinook Fry	Coho Fry	Rainbow Fry/Parr	Sucker	Smallmouth ≤6"	Smallmouth >6"	Shiner	Pikeminnow <6"	Pikeminnow >6"	Chiselmouth	Peamouth	Walleye	Carp	Stickleback	Bluegill	Cyprinid Fry
Reach 1	0	0	0	46	22	0	0	0	0	0	0	14	21	0	0	0	0	0	0	0	0	0	0
Reach 2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reach 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	0	0	0	46	22	0	0	0	0	0	0	14	21	0	0	0	0	0	0	0	0	0	0
				Cutthroat - 5 (>12"), 17 (≤12")		Rainbow - 11 (>12"), 35 (≤12")																	

APPENDIX B: SNORKEL SURVEYS IN THE CHELAN FALLS HABITAT CHANNEL AND TAILRACE, AND REACH 1 OF THE CHELAN RIVER, WA - 2016

Snorkel Surveys in the Chelan Falls Dam Habitat Channel and Tailrace, and Reach 1 of the Chelan River, WA - 2016

Submitted to:

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April 4, 2017
Final Report

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1.0 Introduction

Chelan Public Utility District (PUD) completed a number of measures to improve fish habitat in the Chelan River under the terms of a new license agreement for the Lake Chelan Hydroelectric Project (FERC Project No. 637; issued in 2006). One of the measures was to improve spawning and rearing habitat for summer/fall Chinook and steelhead in the tailrace and lower reach (Reach 4) of the Chelan River. Chelan PUD constructed a habitat channel and associated systems (i.e., 5 pump station, delivery canal, and head-gate structure) to increase spawning and rearing habitat. Additional improvements included the removal of a gravel bar in the Tailrace Zone, and subsequent addition of spawning substrate which resulted in approximately 1.5 to 1.75 additional acres of spawning habitat within that zone. Also, substrate was removed along the left bank downstream of the Habitat Channel within the Confluence Zone to decrease the likelihood of redds becoming dewatered during tailrace fluctuations. Collectively, these alterations were completed by October 15, 2009.

In addition to modifications within the Lake Chelan Hydroelectric Project tailrace, the PUD provided year-round flows within Reaches 1-3 of the Chelan River for the first time in 75 years. Within those reaches, a baseline flow of 80 cfs is provided year-round independent of the runoff forecast. However, flow is supplemented during the May 15 to July 15 period based on the level of winter snow deposition and the forecasted runoff level. In dry water years, no supplementation is provided (i.e., flows remain at the 80 cfs baseline for the full year). In an average water year, flows are augmented to maintain flows of 200 cfs during the mid-May to mid-July period; and in a wet water year, flows are augmented to 320 cfs. In addition, excess water is spilled from the Lake Chelan Dam in most years during the months of May through July.

As detailed in the Lake Chelan Settlement Agreement, Attachment B, Section 7, Chelan PUD is obligated to assess the presence and habitat use of fish using snorkel evaluations. As such, portions of the Chelan River were snorkeled monthly beginning in January 2016 and concluded December 2016. This report summarizes findings from those efforts.

1.1 Study Objectives

Specific objectives of this study are to:

1. Snorkel the Lower Chelan River Habitat Channel (Reach 4; Sections 1–7 including the upstream pool) and the Chelan Falls Tailrace (from the buoy line downstream from the powerhouse to the Boat Restricted Buoy line), and enumerate observed fish by species and length; and

2. Establish and snorkel index sites of the Upper Chelan River from the spillway at the Lake Chelan outlet to the top of the Canyon Reach (Reach 1), and enumerate observed fish by species and length.

1.2 Study Site

The Chelan River is located in Chelan County in north-central Washington and is the outlet for Lake Chelan. Lake Chelan is 453 meters deep and 89 kilometers in length, and has minimum and maximum pool elevations of 328.9 and 335.3 meters (msl), respectively. The lake is typically drawn down beginning in early October for power production and flood control, with the lowest lake level normally attained in April. The lake is then refilled through May and June with refill achieved on or before June 30, with the lake being held near maximum pool through the first weekend in September for recreational purposes. Spill typically occurs during May through July when inflows exceed the amount needed for power generation and lake level management.

The Lake Chelan Hydroelectric Project was completed in 1927, and was authorized for power production and recreation. The original powerhouse configuration included two vertical shaft Francis-type turbine generators, producing 24 MW each, for a total plant capacity of 48 MW at 2,016 cfs. In 2009 and 2010, the original turbines were replaced with higher capacity units capable of producing 29.6 MW each, with a total plant capacity of 59.2 MW. After this alteration, the hydraulic capacity of the powerhouse increased to 5,200 cfs. The spillway for the Lake Chelan Hydroelectric Project is located at the outlet of Lake Chelan, and consists of a total of 8 spillbays with an overall hydraulic capacity of 29,000 cfs.

The Chelan River is about 6.6-km long and has a vertical drop of 122 m as it flows from Lake Chelan to the Columbia River at R.K. 809.9 (Hillman et al. 2000). As defined within the Lake Chelan Settlement Agreement, the Chelan River is partitioned into four reaches; for this evaluation, snorkel observations were conducted within Reaches 1 and 4, and within the tailrace of the powerhouse. The upper Chelan River, which extends from the spillway located at the lake outlet to the top of the Canyon Reach, is also referred to as Reach 1 and is approximately 3.69 km in length (Figure 1). This reach is low gradient (approximately 1 percent), and consists primarily of large cobble and small boulders. Gravel that occurs in this reach is located within the margins of the river channel. Reach 1 is moderately confined, and consists of glacial moraine deposits which are highly erosive. This erosion process contributes a substantial amount of sand and gravel to the Chelan River, which for the most part is transported out of the river during annual high spill events (CPUD 2003). Habitat within Reach 1 consists primarily of riffles and pools. However, there is a large multiple channel section that includes three main channels; this multiple channel is approximately 0.6 km in length. Vegetation within Reach 1 is sparse and consists primarily of alders and cottonwoods with occasional conifer stands (CPUD 2003). Reaches 2 and 3 of the Chelan River extend from the downstream margin of Reach 1 to the bottom of the canyon (downstream margin of Reach 3). Within these reaches there is a series of waterfalls that preclude upstream passage of fish into Reach 1.

The Habitat Channel, also referred to as Reach 4, extends from the mouth of the Chelan River Gorge to the powerhouse tailrace. This reach is approximately 0.79 km in length and consists of a pool at the upper end of the reach, and seven sections downstream from the pool. This reach has a very low gradient (0.4 percent), and is an active alluvial zone where cobbles and gravel from upper reaches are deposited after being flushed through the Chelan River Gorge during annual high spill events. The primary substrates within Reach 4 are gravels and cobbles of various size and small boulders.

The Chelan tailrace is an excavated channel that has a relatively low gradient (4.2 m/km). The dominant substrate in the tailrace consists of gravel, cobble, and boulders, most of which were carried in by high flow events from the Chelan River. The majority of the spawning is concentrated in the main channel at depths that range from 1.2 - 5.5 meters (Giorgi 1992). The Chelan Falls Tailrace survey site begins approximately 135 meters downstream from the powerhouse and terminates at the Boat Restricted Buoy line (Figure 2).

Throughout 2016, snorkel surveys were conducted at three primary locations; the Upper Chelan River (Reach 1), the Habitat Channel (Reach 4) and the Tailrace area. Surveys were conducted on a monthly basis, with the exception of April when unexpectedly high flows did not permit surveys. This report summarizes data collected during the monthly snorkel surveys and provides a general overview of data collected during 2016. Detailed monthly summaries were prepared throughout the year, and provide a more detailed summary for each individual month (Stevenson 2016a-i).

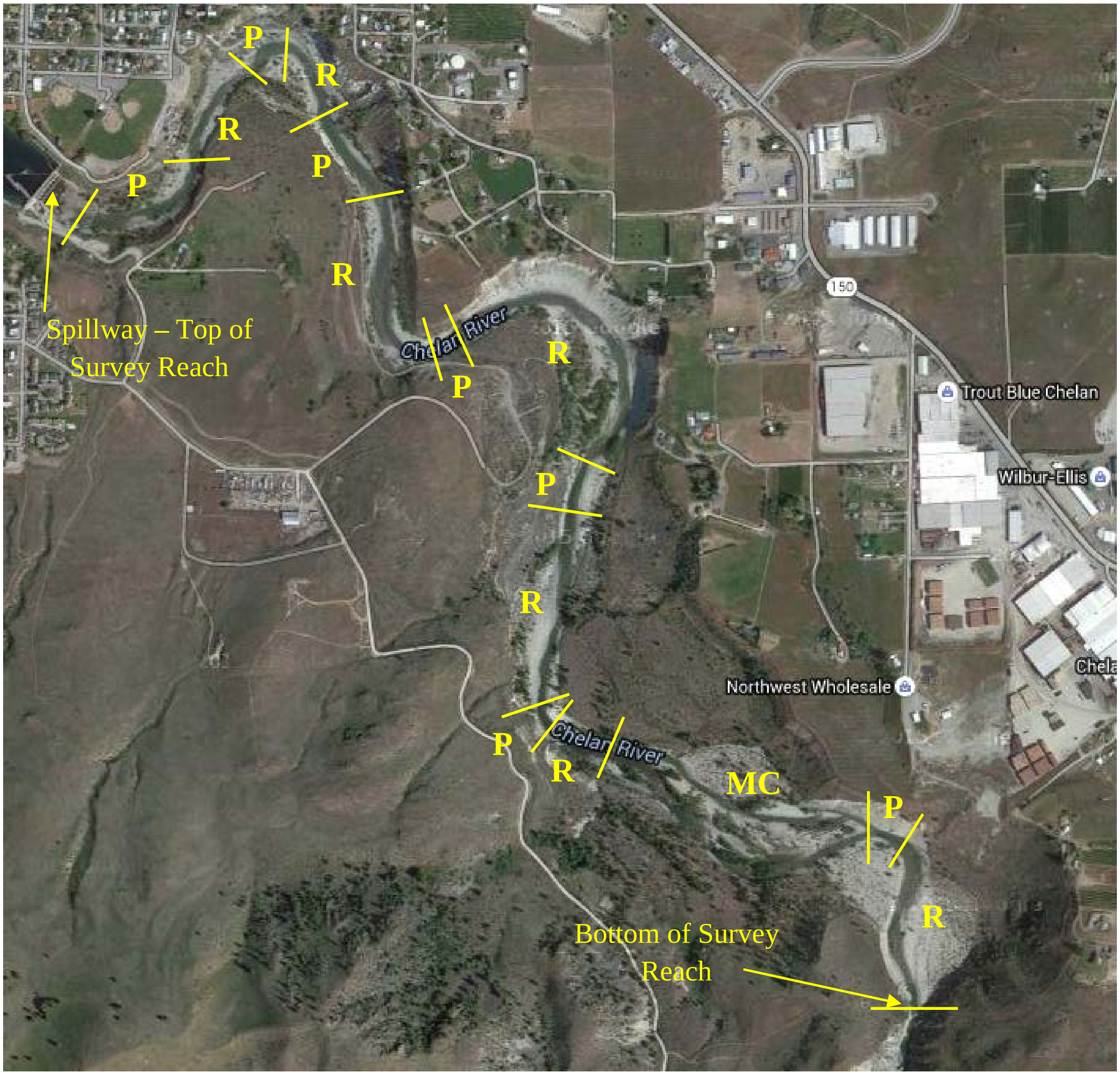


Figure 1. Aerial view of the Upper Chelan River (Reach 1), which extends from the spillway (lake outlet) to the top of the Canyon Reach, with identified habitat units (R = Riffle, P = Pool and MC = Multiple Channel).

Figure 2. Aerial view of the Lower Chelan River, which extends from the top of the pool upstream from Section 7 to the bottom of Section 1 (S1-S7), and the Chelan Falls Tailrace.

2.0 Methods and Environmental Data

Snorkel surveys were conducted on a monthly basis, with Reach 1 surveyed on one day and Reach 4 and the Tailrace surveyed on another. Exceptions to this format included the sampling of all survey areas on a single day in July, and the exclusion of sampling in April. For consistency, surveys were conducted around the 20th of each month, beginning with the January 2016 survey. However, due to unexpected early snow pack melting and subsequent runoff, Lake Chelan had nearly reached maximum lake level in late April, necessitating spill within the Chelan River. As such, it was not possible to snorkel at that time. As a result of increased spill towards the latter part of April, it was possible to suspend spill for a brief period during the first week of May, which allowed snorkel surveys on May 3rd and 4th.

Daytime and nighttime snorkel surveys were used to assess fish abundance and was based on water temperature. In a study assessing observer efficiency, Hillman et al. (1992) found that when water temperatures fall below 9°C, most juvenile salmonids seek cover within the substrate during daylight hours, and observer efficiency drops to less than 20%. As such, when water temperatures were less than 9°C, surveys were conducted at night to improve observer efficiency. Conversely, when water temperatures were greater than 9°C, daytime surveys were conducted. Based on these criteria, we snorkeled at night for the months of January, February, March and December and during the day for all other months.

Data were recorded for each location within a field notebook documenting the total number of fish observed by species and length. In the Habitat Channel, fish were enumerated by section number (i.e., Sections 1-7 and the uppermost pool). For all salmonids, length was recorded into bins of less than 6”, 6” to 9”, 9” to 12”, or over 12” in length. For northern Pikeminnow and smallmouth bass, fish were categorized as being less than or greater than 6”. All other species were recorded as either juvenile or adult. In this report, results are based on the total number of a given species, with some discussion of spatial and temporal occurrence along with size. Detailed counts by size for a given species are presented in Appendix A, which summarizes cumulative counts for all of 2016; additional detailed information is also presented in the individual monthly summaries (Stevenson 2016a-i).

2.1 Chelan Falls Tailrace and Habitat Channel

Whenever possible, it was desirable to snorkel upstream so that disturbed silt and detritus would not interfere with visibility. However, due to the depth and velocity of water within the tailrace area, that was not possible. Within that location, observers entered the water at the upstream boundary of the site and drifted downstream to the end of the sample area. Visibility remained favorable during all snorkel surveys.

Within the Habitat Channel, two observers snorkeled either up or downstream within the near-shore lanes, dependent on flow conditions. During periods of higher flows, it was necessary to snorkel downstream; when flows were lower, it was possible to snorkel upstream. In all flow conditions, it was necessary to snorkel downstream within the mid-channel lanes due to water depth. For the Habitat Channel, each individual section was snorkeled with data recorded by section (e.g., Upper Pool, Section 7, Section 6, etc.).

2.2 Reach 1

Within Reach 1, the survey began at the most downstream index site and progressed upstream to the lake outlet. For each habitat unit snorkeled, two observers snorkeled the near shore lanes, and a third and sometimes fourth observer (dependent on visibility) snorkeled the mid-channel lanes.

For pools, the entire habitat unit was snorkeled. In the multiple channel, most of the habitat unit was snorkeled except when shallow water prevented observations. Similarly, within riffles most of the habitat unit was snorkeled unless shallow depths prevented observations. In very long riffle habitat units only index areas were snorkeled. In some instances, where the whole habitat unit was not snorkeled, the location of snorkeling was based on historic observations.

2.3 Flows and Water Temperature

Mean daily temperatures during the study period varied from about 3°C to 24°C in the different sections of the study area (Reaches 1-4 and powerhouse tailrace) (Table 1; Figure 3). Temperatures were very similar throughout the study period in the different reaches. Temperatures in January, February, March and December were the coolest (<9°C) and necessitated nighttime snorkel observations while for all other months, daytime snorkel observations were used. As expected, the warmest stream temperatures occurred in July and August.

Stream flow in Reach 1 and Reach 4 were similar accept during periods when the tailrace pumps were used to augment flows in Reach 4 (Table 1; Figure 3). This was most noticeable in mid-October when flows were increased to enhance conditions for spawning summer/fall Chinook salmon. Stream flows peaked on several occasions in both reaches as spill from Lake Chelan was initiated. Flows in the powerhouse tailrace were generally between 2,300-2,500 cfs for most of the study period except for an extended period between mid-March and early May when mean daily flows were about 1,200 cfs. Stream flows in the powerhouse tailrace decreased occasionally for brief periods from late June to late September.

Table 1. Mean daily flow (cfs) and water temperature (°C) for Reach 1, Reach 4 and the Tailrace of the Chelan River for the dates when snorkel surveys were conducted, 2016. Please note that the temperature data reported for Reach 1 was recorded at the Low Level Outlet, which is located at the Chelan River Dam.

	Reach 1			Reach 4			Tailrace		
Month	**Date**	**Flow (cfs)**	**Temp (°C)**	**Date**	**Flow (cfs)**	**Temp (°C)**	**Date**	**Flow (cfs)**	**Temp (°C)**
January	20	87	5.1	19	87	5.0	19	2,335	5.3
February	23	84	6.1	22	84	6.1	22	2,352	6.3
March	30	84	9.0	29	287	8.8	29	1,267	8.9
April	---	---	---	---	---	---	---	---	---
May	3	89	13.9	4	290*	16.3	4	985	16.4
June	29	634*	20.5	29	634*	22.0	29	2,355	21.5
July	27	83	21.3	28	83	23.0	28	2,381	22.8
August	29	81	21.5	30	81	21.2	30	1,114	21.6
September	23	85	18.6	24	85	17.4	24	1,563	18.3
October	29	87	14.1	30	290	---	30	2,406	14.2
November	29	254	10.7	30	254	---	30	2,325	10.7
December	20	88	5.8	21	88	---	21	2,516	5.8

Notes:
No survey was conducted in April, 2016 due to high flows.

Flows with an asterisk in Reach 1 and 4 were adjusted mean daily flows to reflect discharge at the time of the survey. The flow of 290 cfs on May 4 occurred at the time of the survey. Shortly after the survey was completed, spill was ramped up and the mean daily flow was 3,776 cfs. Similarly, on June 29 mean flow at the time of the surveys was 634 cfs although the mean daily flow for that date was 943 cfs. All other flows reflect mean daily flow for the entire day.

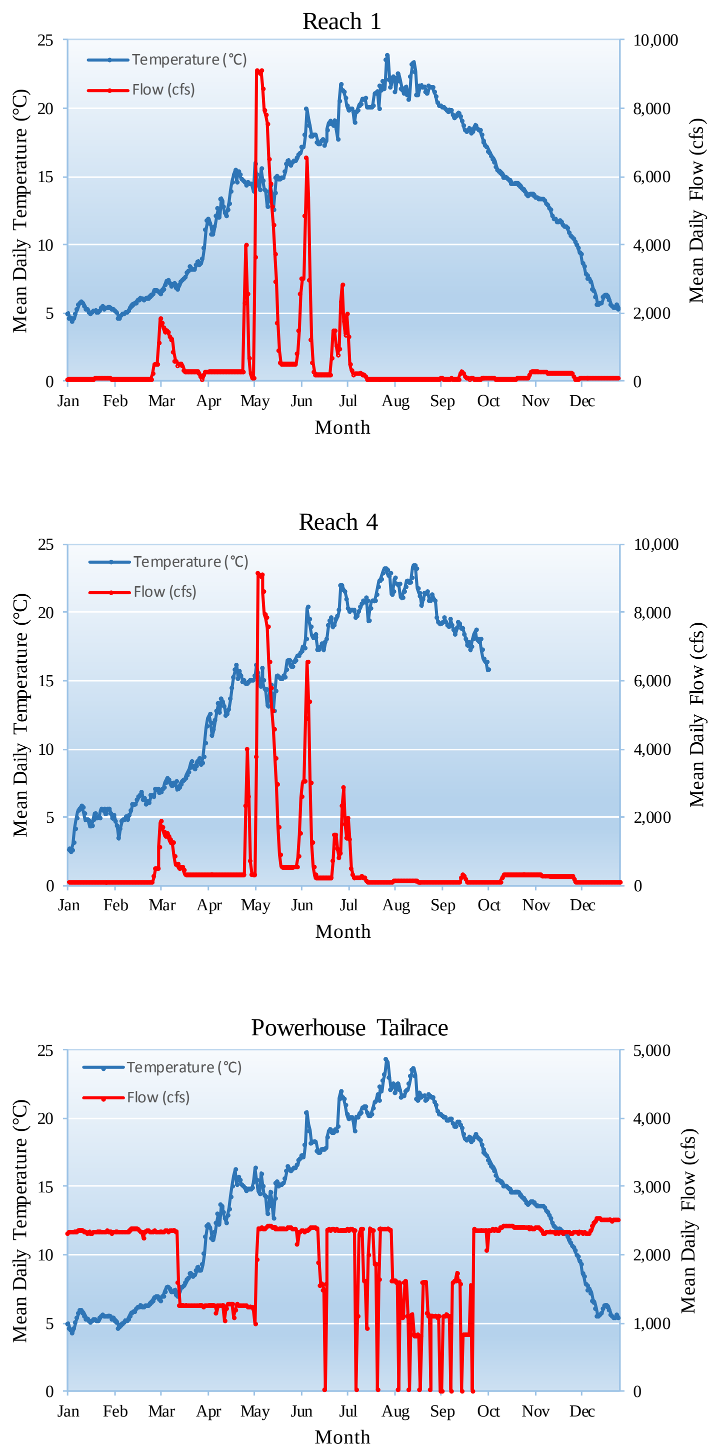


Figure 3. Mean daily flow (cfs) and temperature (°C) for Reach 1, Reach 4 and the Tailrace of the Chelan River, 2016. Please note that temperature data for Reach 1 is incomplete at this time.

3.0 Results and Discussions

Collectively, a total of 35,191 fish were observed during snorkel surveys conducted in 2016. Of those, 2,245 fish were observed in Reach 1, 21,482 fish within the Habitat Channel, and 11,464 fish within the Tailrace (Appendix A; Tables A-1 and A-2). The results provide information regarding relative abundance, distribution and diversity throughout the study area.

It should be noted that while the following discussions include all species observed in 2016, only species of interest are presented in graphical and tabular form within the body of the report; incidental, or non-species of interest observations are enumerated in Appendix A. Within this document, a species of interest refers to a species that is listed under the Endangered Species Act (ESA; e.g., bull trout), a species that is identified within the Lake Chelan Settlement Agreement to be monitored, or a species that may have a significant impact on other species through predation or some other means (e.g., smallmouth bass and northern pikeminnow).

3.1 Reach 1

Within Reach 1, the most frequently observed species of interest was westslope cutthroat trout (*Oncorhynchus clarki lewisi*), with a total of 981 observations (Table 2; Figure 4). The next most frequently observed species was smallmouth bass (*Micropterus dolomieui*), with a total of 824 observations. Other species of interest included 358 rainbow trout (*O. mykiss*) and 50 northern pikeminnow (*Ptychocheilus oregonensis*). Observations of non-species of interest included 1 adult Chinook (*O. tshawytscha*), 2 cyprinid fry (*Rhinichthys sp.*), 2 adult suckers (*Catostomus sp.*), 19 adult tench (*Tinca tinca*), 4 adult mountain whitefish (*Prosopium williamsoni*) and 4 adult trout of unknown species (Appendix A; Table A-2).

The number of westslope cutthroat trout observed varied over the year (Table 2; Figure 5). The greatest number of westslope cutthroat trout were observed in July (214 fish) and the fewest observed in January (6 fish). There were 200 westslope cutthroat trout 6-8 inches in length released into Reach 1 on May 4, 2016 that along with recruitment from Lake Chelan contributed to observations thereafter. The most numerous size class observed in Reach 1 was from 9-12 inches (74%) and greater than 12 inches (18%) suggesting that growth and/or recruitment to Reach 1 is occurring. No juvenile sized (≤ 3 inches) westslope cutthroat trout were observed during the year, which suggests that little or no reproduction occurred in 2016. Westslope cutthroat trout were most often observed in pool (74%) and multiple channel habitats (17%) and the least abundant in riffle habitat (9%).

Table 2. The number of observations by month for westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) in Reach 1 of the Chelan River, 2016.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cutthroat Trout	6	12	18	0	82	189	214	129	111	86	72	62	981
Northern Pikeminnow	1	0	1	0	0	7	29	8	3	0	1	0	50
Rainbow Trout	22	39	41	0	22	34	41	31	44	32	38	14	358
Smallmouth Bass	48	34	87	0	77	95	184	256	23	8	0	12	824
Total	77	85	147	0	181	325	468	424	181	126	111	88	2,213

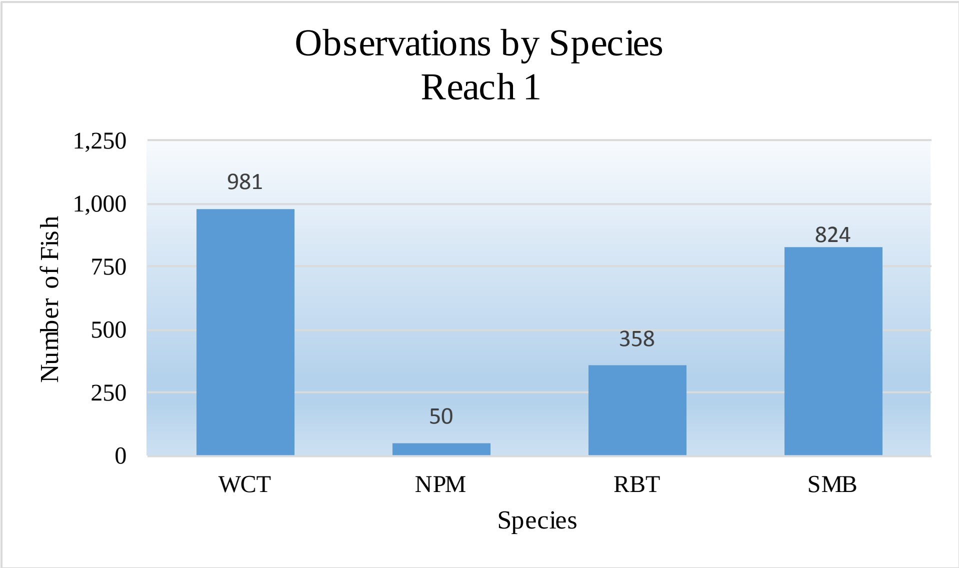


Figure 4. The number of westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) observed in Reach 1 of the Chelan River, 2016.

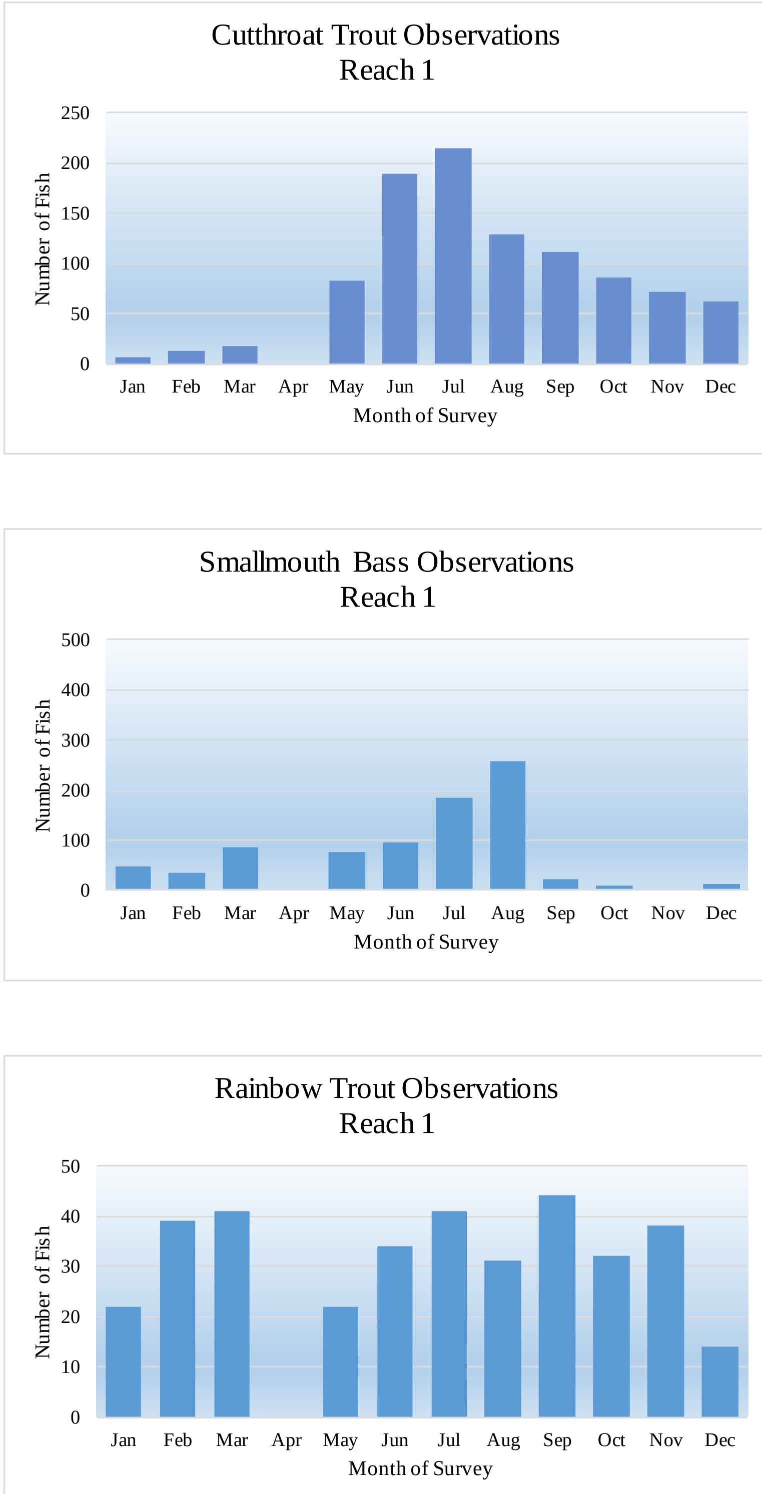


Figure 5. The number of westslope cutthroat trout, smallmouth bass and rainbow trout observed during monthly surveys in Reach 1 of the Chelan River, 2016.

Smallmouth bass were the second most abundant fish species observed in Reach 1 (Table 2; Figure 5). The abundance of smallmouth bass changed over time with most fish observed in August (256 fish), and the fewest in November (no fish). To some extent, prevailing stream temperatures likely influenced the number of fish observed. That is, as water temperature decreased, smallmouth bass concealed themselves in cover making them more difficult to observe. However, it is unlikely that declining water temperature fully explains the reduction in smallmouth bass observations throughout the study area. The greatest decrease in smallmouth bass observations within Reach 1 were noted for the August and September surveys, with 256 and 23 observations, respectively. At this time, water temperatures were in excess of 20°C. It is more likely that water temperature influenced observer efficiency during surveys conducted in October, November and December when temperatures began to decline sharply. A more plausible explanation in regard to the decline in smallmouth bass observations is that they began to move downstream and ultimately took up residence in deep pools within Reaches 2 and 3, or migrated downstream and eventually entered the Columbia River.

There were nearly equal percentages of juvenile (< 6 inches - 56%) and adult (> 6 inches - 44%) smallmouth bass observed in Reach 1. There was no nest building or defending behavior observed for smallmouth bass in Reach 1. This may explain why no bass less than 3 inches were observed. Smallmouth bass also appeared to favor available pool (60%) and multiple channel habitats (28%) more than riffle habitat (12%).

A total of 358 rainbow trout were observed in Reach 1, with 30 (8%) observed in riffle habitat, 219 (61%) in pool habitat, and 109 (31%) within the multiple channel (Table 2; Figure 5). Rainbow trout were primarily classified into the larger size classes with 171 fish in the 9-12" group (47.8%) and 170 greater than 12" (47.5%). Only 15 rainbow trout were estimated to be in the 6-9" group (4.2%) and 2 were less than 6" (0.6%). No rainbow trout spawning was observed during the snorkel surveys, as were no young-of-the-year.

Northern pikeminnow were also observed in Reach 1 (50 fish) but their abundance was very concentrated with 43 fish observed in the uppermost pool surveyed (Table 2; Figure 6). All of the northern pikeminnow observed were greater than 6 inches suggesting that little or no reproduction occurs within Reach 1. This also suggests that recruitment to Reach 1 is likely from Lake Chelan. Other fish species were observed within Reach 1 but their abundance was very low (Appendix Table A-2).

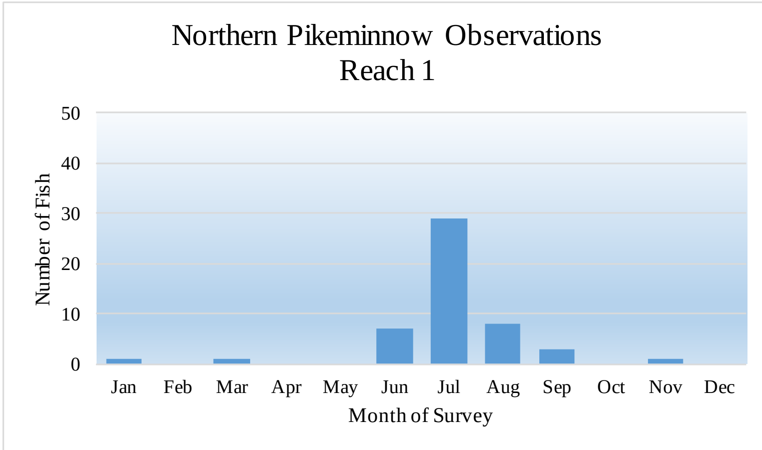


Figure 6. The number of northern pikeminnow observed during monthly surveys in Reach 1 of the Chelan River, 2016.

3.2 Habitat Channel

Within the Habitat Channel, the most frequently observed species of interest was Chinook salmon, with a total of 11,874 observations (Table 3; Figure 7). Chinook fry made up the majority of observations for this species (n = 11,405), but also included 445 adult Chinook and 24 yearling Chinook. Observations of other species of interest included 3,240 northern pikeminnow, 1,104 smallmouth bass, 339 rainbow trout, 107 westslope cutthroat trout and 13 bull trout (*Salvelinus confluentus*).

Non-species of interest observed within the Habitat Channel included 4,482 adult suckers, 127 cyprinid fry (dace), 112 three-spine stickleback (*Gasterosteus aculeatus*), 36 mountain whitefish, 15 chiselmouth (*Acrocheilus alutaceus*), 9 adult sockeye (*O. nerka*), 5 adult bullhead (*Ameiurus sp.*), 5 peamouth (*Mylocheilus caurinus*), 5 adult steelhead (*O. mykiss*), 4 bluegill (*Lepomis macrochirus*), 3 sculpin (*Cottus sp.*) and 2 adult coho (*O. kisutch*) (Appendix A; Table A-1). The majority of adult suckers were observed during the May and June snorkel surveys (n = 4,349), which coincides with the expected spawning period for both bridgelip (*C. Columbianus*) and largescale (*C. macrocheilus*) suckers; the species most likely inhabiting the Chelan River at various times throughout the year.

Chinook that spawn within the Chelan River are classified as summer/fall Chinook (Chapman et al. 1994). Summer/fall Chinook are an ocean-type race of the species, and migrate to the ocean as subyearlings. Emergence of Chinook fry began in late December, with peak observations occurring in May (Table 3; Figure 8). Few Chinook fry were observed after the peak in May. This suggests that most natural origin subyearlings Chinook moved out of the Chelan River and migrated into the Columbia River before June. While most of the juvenile Chinook were subyearlings, there was a few yearling Chinook observed.

Adult Chinook were first observed in May and June in low numbers, with a moderate increase in July and August. However, significant numbers of adult summer/fall Chinook were not observed until September, with peak abundance and spawning occurring in mid- to late-October (Table 3; Figure 8).

Bull trout were first observed within the Habitat Channel during the September survey, and were subsequently observed each month through December (Table 3; Figure 9). Bull trout observations were relatively low, ranging between 1 and 6 individuals for any given survey. Timing of observations for bull trout coincided with the typical time period when bull trout spawn. It should be noted, however, no bull trout appeared to be in the process of building a redd, spawning, or defending a redd. In October, one bull trout was observed in a summer/fall Chinook redd next to a female Chinook. The bull trout was actively gulping substrate within the redd and expelling the substrate. This behavior suggests that the bull trout was actively feeding on Chinook eggs within the redd. Given these observations, it is more likely that the bull trout moved into the Habitat Channel for feeding opportunities.

Table 3. The number of observations by month for bull trout (BT), Chinook adults (CK-Adult), Chinook yearlings (CK-1), Chinook fry (CK-0), westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) in the Habitat Channel of the Chelan River, 2016.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bull Trout	0	0	0	0	0	0	0	0	1	6	3	3	13
Ck-Adult	0	0	0	0	1	6	31	11	229	166	1	0	445
Ck-1	5	3	15	0	0	0	0	0	0	0	0	1	24
Ck-0	2	218	4,540	0	6,637	7	1	0	0	0	0	0	11,405
Cutthroat Trout	0	7	3	0	7	68	13	3	3	2	0	1	107
Northern Pikeminnow	0	0	0	0	91	2,996	150	0	3	0	0	0	3,240
Rainbow Trout	24	23	46	0	8	36	45	40	29	11	36	41	339
Smallmouth Bass	3	9	32	0	218	324	328	158	29	0	0	3	1,104
Total	34	260	4,636	0	6,962	3,437	568	212	294	185	40	49	16,677

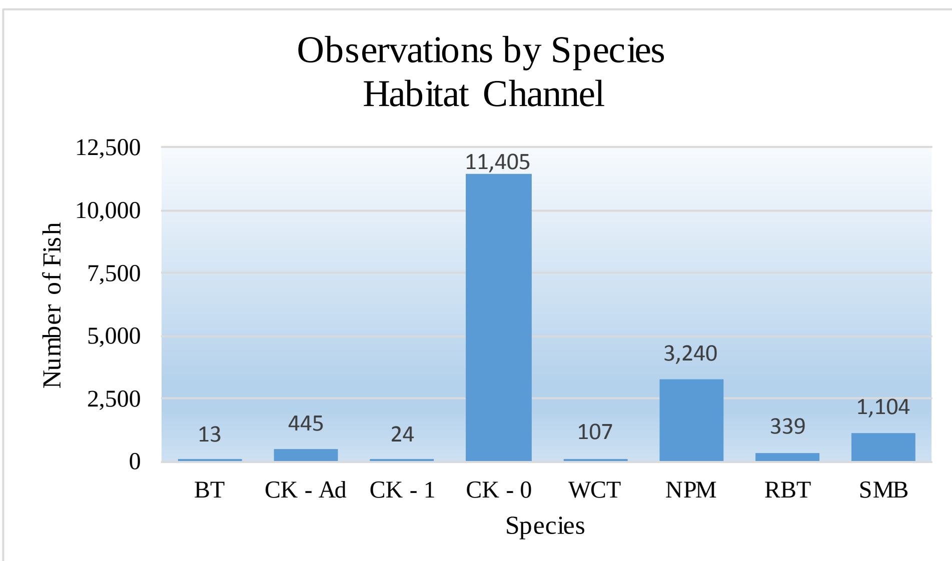


Figure 7. The number of observations by species for bull trout (BT), Chinook adults (CK-Ad), Chinook yearlings (CK-1), Chinook fry (CK-0), westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) in the Habitat Channel of the Chelan River, 2016.

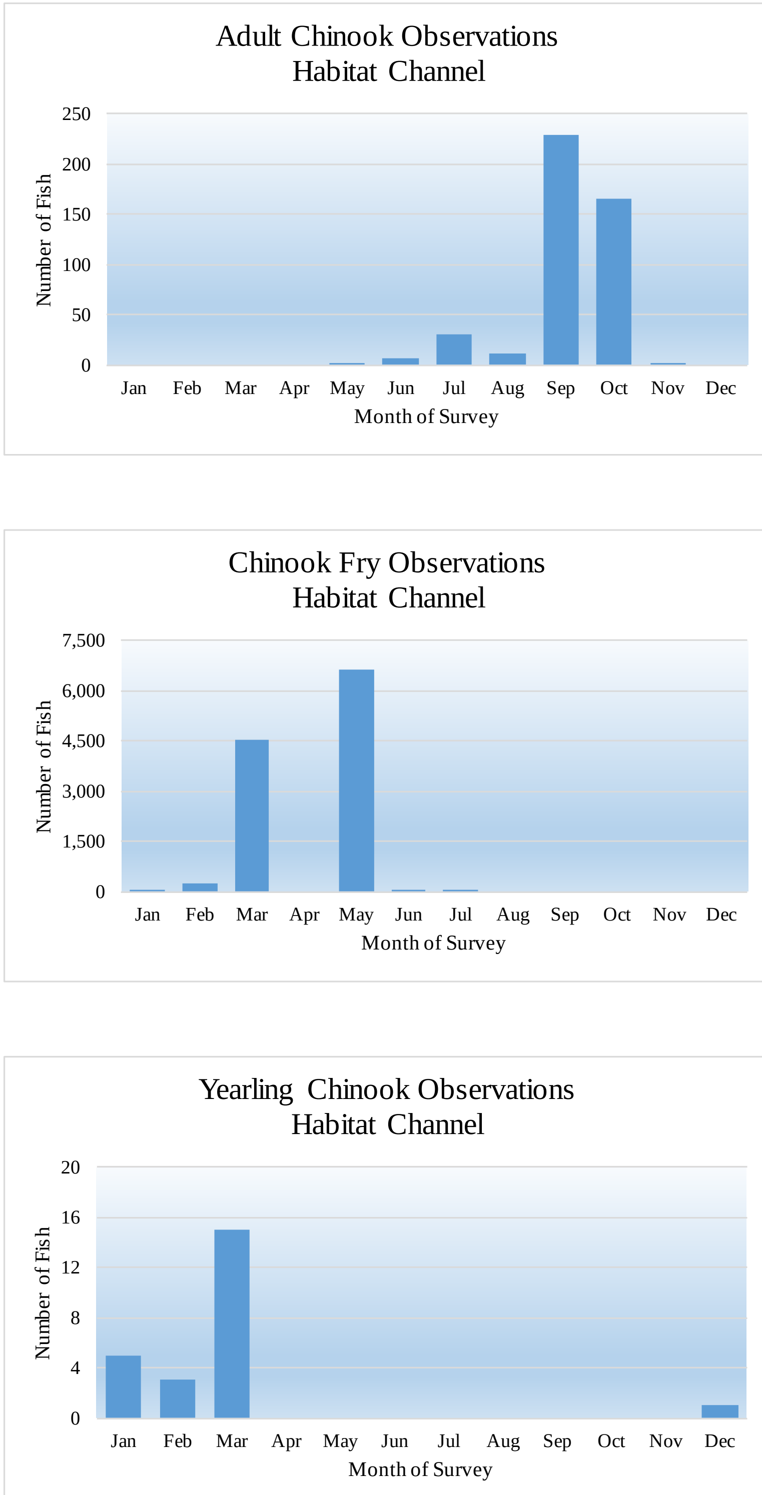
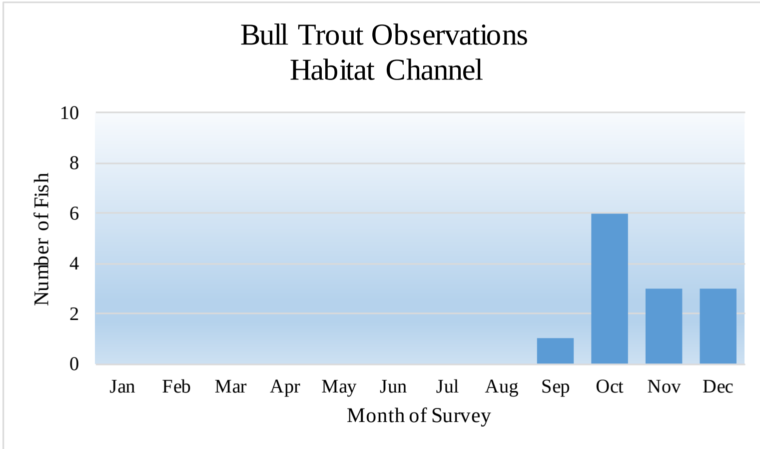
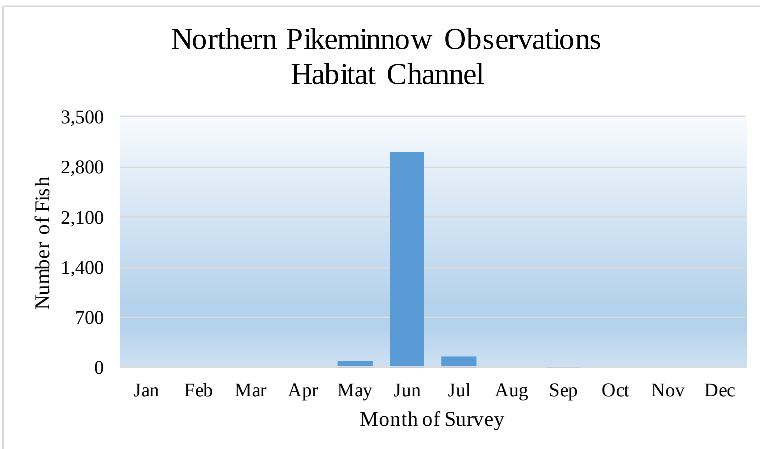


Figure 8. The number of Chinook adults, fry and yearlings observed during monthly surveys in the Habitat Channel of the Chelan River, 2016.





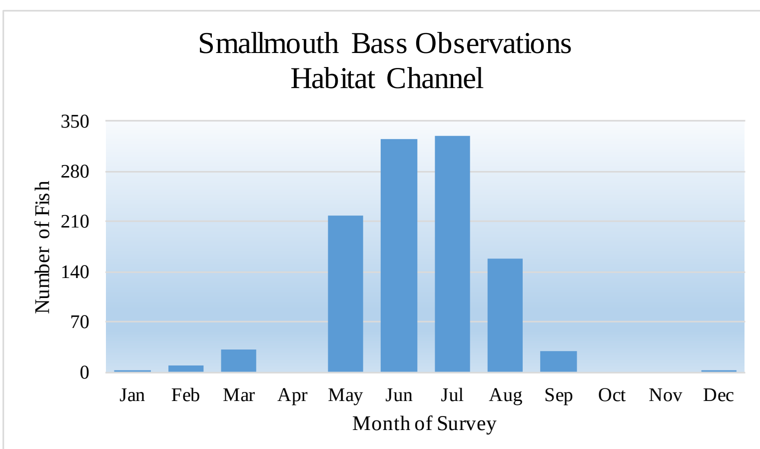


Figure 9. The number of bull trout, northern pikeminnow and smallmouth bass observed during monthly surveys in the Habitat Channel of the Chelan River, 2016.

Northern pikeminnow were the second-most abundant species observed. Northern pikeminnow were observed from May through July, but peaked during the month of June (n=2,996; Table 3; Figure 9). This increase in abundance coincides with the typical spawning period of northern pikeminnow in Washington state (Wydoski and Whitney 2003). This observation and the absence of northern pikeminnow in either the Habitat Channel or Tailrace during other months of survey suggests that northern pikeminnow do not utilize these areas to any great extent except for the purpose of reproduction.

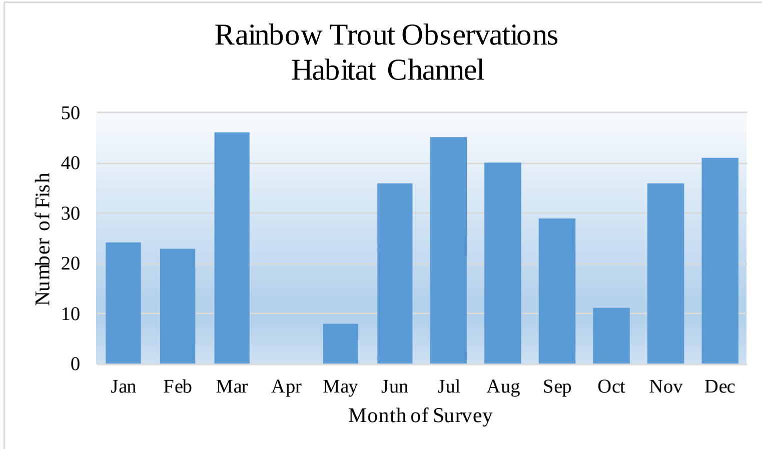
Within the Habitat Channel, smallmouth bass were observed throughout the year, but observations were most pronounced May through August (Table 3; Figure 9). As discussed above, the decreased rate of observation outside the peak period was likely due in part to smallmouth bass seeking cover during periods of cold water temperature, making them more difficult to observe. However, the factor most likely responsible for the decline in observation after spawning and nest defense is the emigration of smallmouth bass into the Columbia River.

During the survey conducted on May 4, a total of 31 smallmouth bass nests in various states of construction were observed within the Habitat Channel (Stevenson 2016d). The following month, during the June 29 survey, over 5,400 smallmouth bass fry were observed within Sections 2-6 of the Habitat Channel (Stevenson 2016e). Of the 1,104 smallmouth bass observed (not including fry) within the Habitat Channel during 2016, 55.7% (n=615) were less than 6” in length, and 44.3% were greater than 6” (n=489).

In addition to the species discussed above, rainbow trout were observed within the Habitat Channel during the 2016 surveys. For this species, between 8 and 46 fish were observed during any given survey, and individuals of this species were observed in every month when surveys were conducted (Table 3; Figure 10). Of the 339 rainbow trout observed within the Habitat Channel, 18.9 % were less than 6” in length, 20.9% were between 6 and 9”, 39.5% were between 9 and 12”, and 20.6% were greater than 12” in length.

Given the number of small individuals observed throughout the year, and the consistency of observations for this species, it appears that rainbow trout utilize the Habitat Channel for both rearing and residency. It should be noted that there were six adult steelhead observed in the habitat channel. Four were observed from January to May and one was observed in both July and December. It is possible that some of the smaller individuals that are classified as rainbow trout are actually progeny of spawning steelhead within the Habitat Channel.

During the 2016 period, a total of 107 westslope cutthroat trout were counted within the Habitat Channel (Table 3; Figure 10). With the exception of the survey conducted in June, the number of westslope cutthroat trout was typically low and ranged between 0-13 observations for this species in any given month. However, in June the number of cutthroat observed during that survey was 68 fish. As mentioned earlier, a total of 200 westslope cutthroat trout were released on May 4 within Reach 1. On the same day following the release, and after our survey had concluded, spill was initiated from Lake Chelan and flows within Reach 1 peaked at 9,024 cfs by the end of the day. Spill continued at a relatively high level for the next two weeks, and did not fall below 8,500 cfs for the first five days following the release of the westslope cutthroat trout (Table 1; Figure 3).



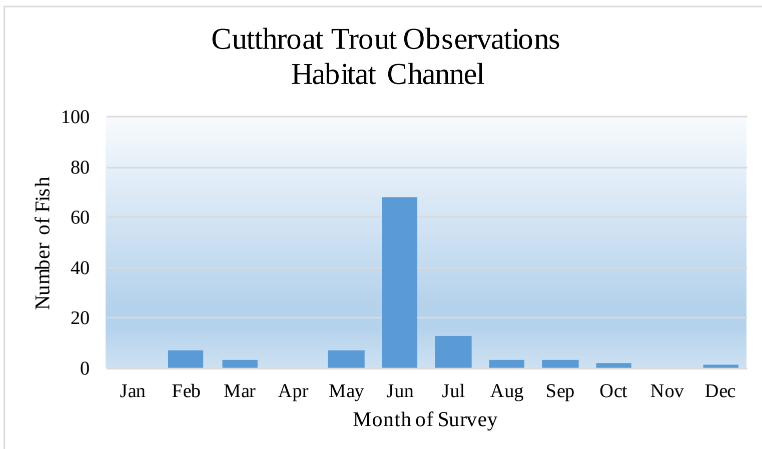


Figure 10. The number of rainbow and westslope cutthroat trout observed during monthly surveys in the Habitat Channel of the Chelan River, 2016.

It is likely that the influx of westslope cutthroat trout into the Habitat Channel in June was due to the initiation of spill following the release in Reach 1, with the fish being transported into the lower river.

3.3 Chelan Falls Tailrace

As with the Habitat Channel, the most frequently observed species within the tailrace was Chinook salmon, with a total of 4,541 observations (Table 4; Figure 11). Of those, 4,018 were subyearling Chinook, 504 were adult Chinook and 19 were yearling Chinook. Observations of other species of interest included 2,946 northern pikeminnow, 778 smallmouth bass, 35 rainbow trout and 5 westslope cutthroat trout. Non-species of interest included 1,902 suckers, 705 cyprinid fry (dace), 431 three-spine stickleback, 35 bluegill (*Lepomis macrochirus*), 21 redside shiner (*Richardsonius balteatus*), 22 mountain whitefish, 19 carp (*Cyprinus carpio*), 9 walleye (*Stizostedion vitreum*), 5 sculpin, 4 tench, 2 largemouth bass (*Micropterus salmoides*), 2 adult sockeye, 1 bull trout and 1 adult steelhead (Appendix A; Table A-1).

For adult Chinook, peak observations occurred during the month of October, with a total of 405 fish; observations in September for adult Chinook was 57 fish (Table 4; Figure 12). As discussed in Section 3.2, peak counts in the Habitat Channel occurred during the month of September, followed by October. This may suggest that as adult Chinook enter the Chelan River, they occupy the Habitat Channel first, then the Tailrace area.

Chinook fry observations in the Tailrace began in February and increased until May, with a peak observation of 2,679 fish (Table 4; Figure 12). This pattern is the same as observed in the Habitat Channel but with fewer fish observed. However, while the Tailrace had a total of 504 adults observed compared to 445 adults in the Habitat Channel, there were nearly three times as many juveniles observed in the Habitat Channel as in the Tailrace (11,405 in the Habitat Channel vs. 4,018 in the Tailrace). This observation is likely due to the difference in habitat between the two sites. Within the Habitat Channel, flows are augmented with water provided through the pump station, delivery canal and head-gate system during the period of March through May. As such, water inundates areas of riparian habitat, which is dominated by willows with low water velocities providing excellent habitat. Most of our observations of Chinook fry in the Habitat Channel were within the inundated stream margins. This area provided excellent habitat and protection from larger predators. Conversely, the Tailrace lacks similar habitat, and is dominated by large cobble and boulders, higher water velocities with little slack water habitat, and little to no instream cover.

It is likely that Chinook fry that have emerged from redds within the Tailrace move to the Columbia River more quickly after emergence than fry that emerge from redds within the Habitat Channel. The pattern of observations for yearling Chinook in the Tailrace was similar to the Habitat Channel. That is, there were few yearling Chinook observed with a slight increase beginning early in the year and peaking in May, with a total of 15 fish (Table 4; Figure 12).

Table 4. The number of observations by month for bull trout (BT), Chinook adults (CK-Ad), Chinook yearlings (CK-1), Chinook fry (CK-0), westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) in the Tailrace of the Chelan River, 2016.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CK-Adult						3	27	11	57	405	1		504
CK-1		1	3		15								19
CK-0		89	1,250		2,679								4,018
Cutthroat Trout	0	0	0	0	0	0	0	0	0	5	0	0	5
Northern Pikeminnow	0	0	4	0	4	1,288	1,645	0	4	1	0	0	2,946
Rainbow Trout	1	1	18	0	0	0	1	0	0	5	6	3	35
Smallmouth Bass	1	0	30	0	24	144	270	297	12	0	0	0	778
Total	2	91	1,305	0	2,722	1,435	1,943	308	73	416	7	3	8,305

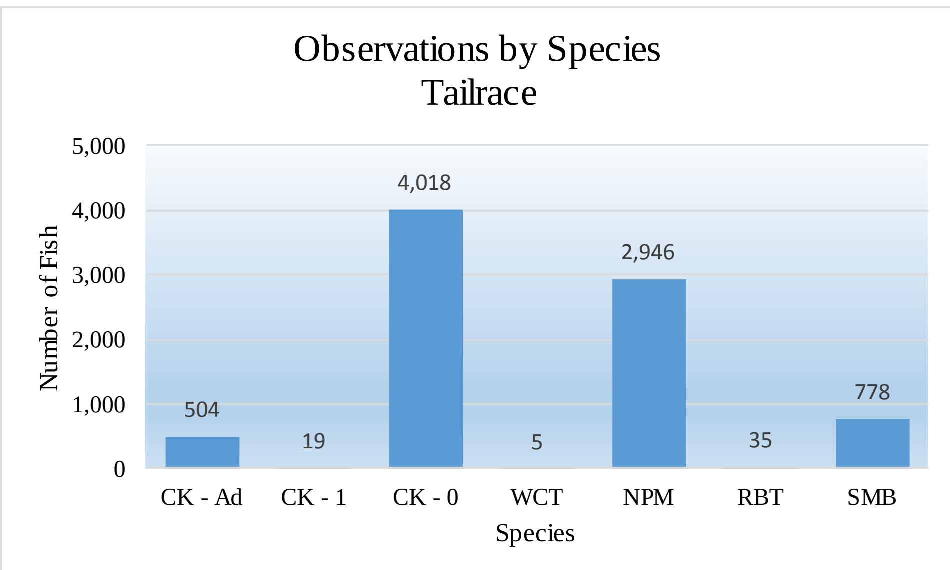
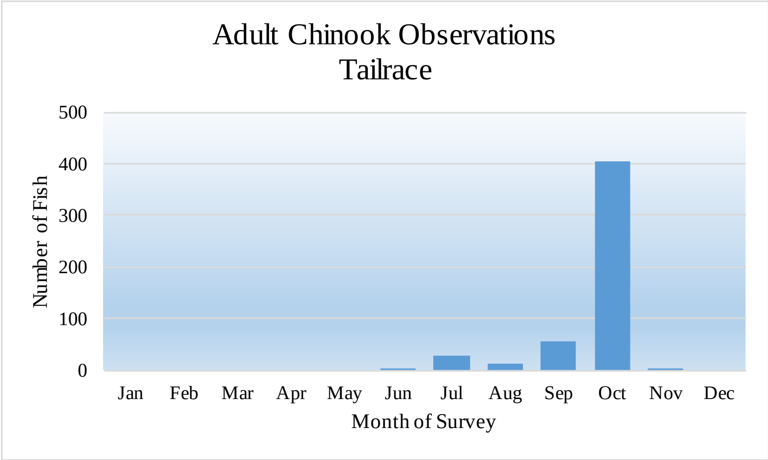
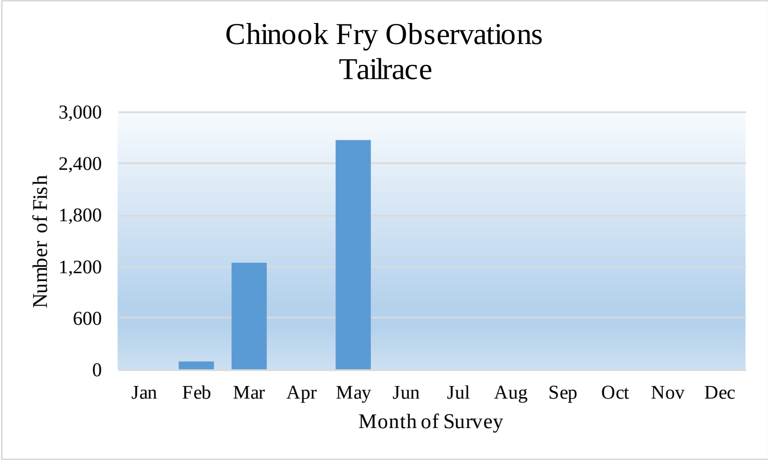


Figure 11. The number of observations by species for Chinook adults (CK-Ad), Chinook yearlings (CK-1), Chinook fry (CK-0), westslope cutthroat trout (WCT), northern pikeminnow (NPM), rainbow trout (RBT) and smallmouth bass (SMB) in the Tailrace of the Chelan River, 2016.





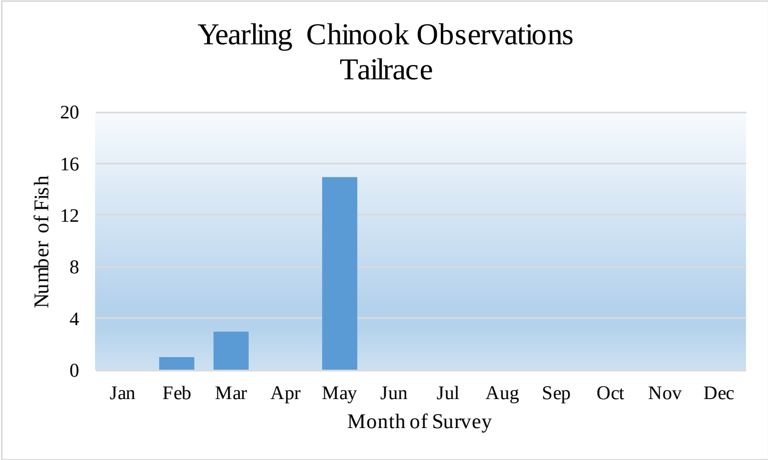
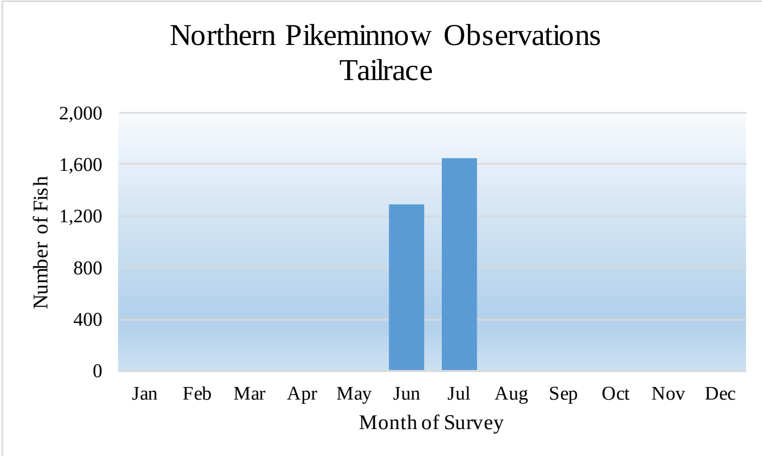


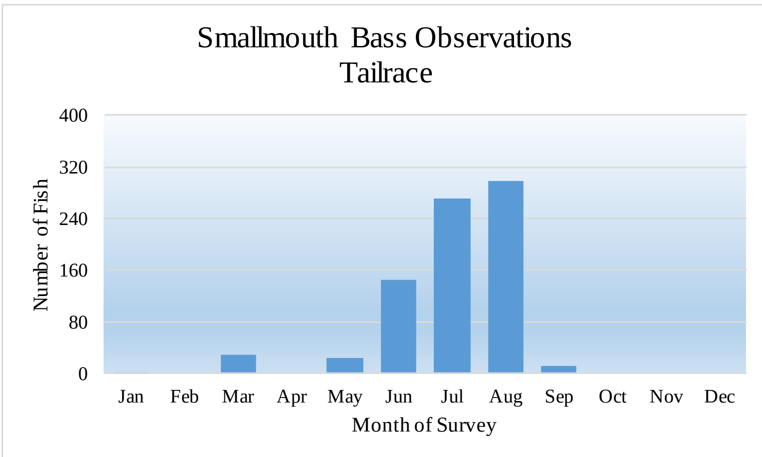
Figure 12. The number of Chinook adults, fry and yearlings observed during monthly surveys in the Tailrace of the Chelan River, 2016.

Northern pikeminnow were second only to Chinook in regard to the overall number of fish observed in 2016 (n=2,946). Northern pikeminnow were observed primarily during the months of June and July, with limited sightings in March, May, September and October (Table 4; Figure 13). As discussed in the previous section, the limited observations of northern pikeminnow at times other than during spawning suggests northern pikeminnow do no utilize the Chelan River and tailrace to any extent other than to reproduce.

During surveys conducted within the tailrace of the Chelan Falls powerhouse in 2016, there were a total of 778 smallmouth bass observed (Appendix Table A-1; Table 4; Figures 11 and 13). Of those, 642 (82.5%) were less than 6” in length and 136 (17.5%) were greater than 6”. In addition to the sub-adult and adult smallmouth bass within the Tailrace, 4 smallmouth nests were counted in May (3 within the Tailrace and 1 within the swim area adjacent to the Tailrace) and 1,500 fry in June (Stevenson 2016e). The lack of smallmouth nests and fry observed in the Tailrace relative to the Habitat Channel suggests that sub-adults are migrating out of the Habitat Channel and rearing to some extent in the Tailrace. The significant decrease in smallmouth bass observations between August and September (297 vs. 12 fish) suggests that smallmouth bass migrate into the Columbia River after spawning and nest defense.

A limited number of rainbow trout (n=35) and westslope cutthroat trout (n=5) were observed within the Tailrace during 2016 snorkel surveys compared to observations within the Habitat Channel (Table 4; Figures 13 and 14). This was not unexpected given the habitat variation between the two locations. Within the Habitat Channel there is substantial instream structures including large boulders, engineered log structures, overhead riparian vegetation and slack water areas. This habitat does not exist for the most part within the Tailrace.





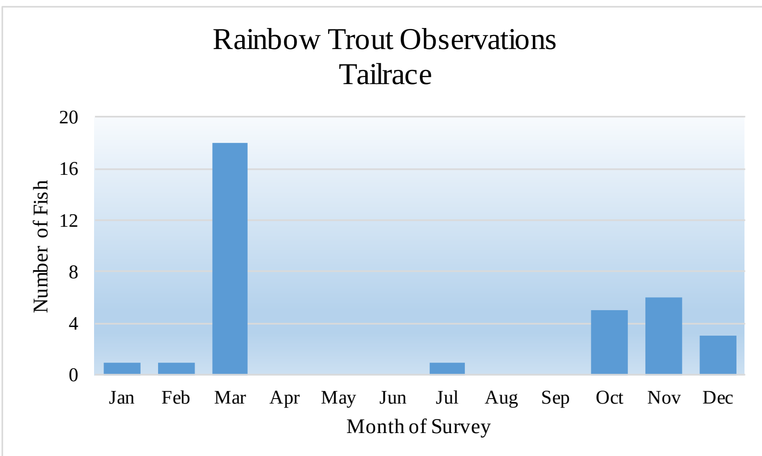


Figure 13. The number of northern pikeminnow, smallmouth bass and rainbow trout observed during monthly surveys in the Tailrace of the Chelan River, 2016.

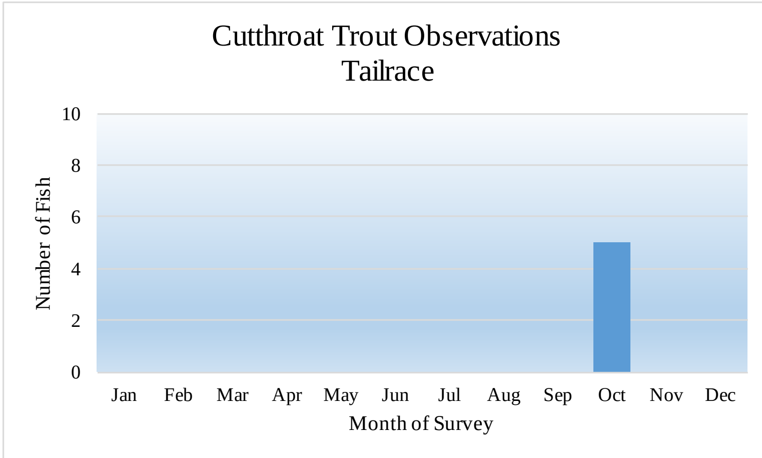


Figure 14. The number of westslope cutthroat trout observed during monthly surveys in the Tailrace of the Chelan River, 2016.

4.0 Acknowledgments

We would like to thank a number of individuals who made this effort possible. First, we thank Mr. Steve Hays and Mr. Jeff Osborn with the Public Utility District, No. 1 of Chelan County for their efforts in planning and implementing this project. We would also like to thank the Chelan PUD project operators and security personnel that helped coordinate our efforts. Finally, we would like to thank BioAnalysts, Inc. field personnel who snorkeled day and night, often during adverse conditions; specifically, we thank Keith Watson, Jeff Reeves, Larry Melampy and Sara Anzalone.

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Appendix A

Table A-1. Cumulative summary of fish observation during snorkel surveys of the Chelan Falls tailrace, Habitat Channel and swim area, 2016.

Species	Tailrace	1	2	3	4	5	6	7	Pool	Total
Bluegill	35	0	2	0	0	0	0	0	2	39
Bullhead	0	0	0	0	0	0	0	0	5	5
Bull Trout 9-12"	0	0	0	0	0	0	0	0	3	3
Bull Trout ≥12"	1	1	3	0	3	1	0	0	2	11
Carp	19	0	0	0	0	0	0	0	0	19
Chinook - Adult	504	21	39	20	14	24	14	8	305	949
Chinook - Yearling	19	0	4	2	0	2	2	0	14	43
Chinook - Subyearling	4,018	244	2,586	1,209	2,646	1,425	1,958	3	1,334	15,423
Chiselmouth	0	0	3	0	5	0	0	0	7	15
Coho - Adult	0	0	0	0	0	0	0	0	2	2
Cutthroat 9-12"	5	1	0	1	15	9	3	2	57	93
Cutthroat ≥12"	0	0	1	0	0	2	2	1	13	19
Dace	705	111	9	6	0	0	1	0	0	832
Largemouth Bass >6	2	0	0	0	0	0	0	0	0	2
Peamouth	0	0	0	0	0	0	0	0	5	5
Pikeminnow <6"	4	0	0	0	0	0	0	0	0	4
Pikeminnow ≥6"	2,942	1,652	464	43	55	89	154	1	782	6,182
Rainbow <6"	16	2	17	12	6	6	10	0	11	80
Rainbow 6-9"	2	3	11	5	6	9	17	10	10	73
Rainbow 9-12"	4	2	10	14	23	15	35	17	18	138
Rainbow ≥12"	13	5	8	3	11	4	13	5	21	83
Sculpin	5	1	0	0	0	2	0	0	0	8
Redside Shiner	21	0	0	0	0	0	0	0	0	21
Smallmouth <6"	642	81	92	28	70	76	67	21	180	1,257
Smallmouth ≥6"	136	44	47	23	35	50	62	26	202	625
Sockeye - Adult	2	0	0	0	0	0	0	0	9	11
Steelhead - Adult	1	0	0	1	1	0	2	0	1	6
Stickleback	431	84	12	6	10	0	0	0	0	543
Sucker	1,902	379	751	267	417	1,133	342	35	1,158	6,384
Tench	4	0	0	0	0	0	0	0	0	4
Walleye	9	0	0	0	0	0	0	0	0	9
Whitefish <6"	1	0	1	0	0	0	0	0	0	2
Whitefish ≥6"	21	7	4	4	7	2	8	0	3	56
Total	11,464	2,638	4,064	1,644	3,324	2,849	2,690	129	4,144	32,946

Table A-2. Cumulative summary of fish observation during snorkel surveys of Reach 1 of the Chelan River, 2016. Note that the habitat units are in order (left to right) from the downstream site to the upstream site.

Species	Riffle	Pool	Channel	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Total
Chinook - Adult	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cutthroat <6"	0	0	0	0	0	0	0	0	0	0	3	0	0	0	7	10
Cutthroat 6-9"	1	2	4	0	0	0	1	0	3	1	12	0	5	9	42	80
Cutthroat 9-12"	5	100	139	4	42	0	75	0	16	12	32	0	45	39	206	715
Cutthroat ≥12"	2	29	27	1	5	0	30	0	11	1	4	0	9	13	44	176
Cyprinid - Fry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Pikeminnow ≥6"	0	5	0	0	1	0	0	0	0	0	1	0	0	0	43	50
Rainbow <6"	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Rainbow 6-9"	0	1	5	2	0	0	5	0	1	0	1	0	0	0	0	15
Rainbow 9-12"	7	27	51	1	19	0	27	0	3	2	3	0	4	7	20	171
Rainbow ≥12"	5	23	52	1	22	0	26	0	8	1	1	0	4	4	23	170
Smallmouth <6"	6	20	161	8	14	0	31	0	16	4	52	0	35	39	76	462
Smallmouth ≥6"	8	20	66	7	19	0	25	0	6	3	39	0	11	28	130	362
Sucker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Tench	0	0	0	0	0	0	0	0	0	0	1	0	0	0	18	19
Unknown Trout	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Whitefish ≥6"	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0	4
Total	34	232	506	24	122	0	220	0	64	26	150	0	113	140	614	2,245

APPENDIX C: MACROINVERTEBRATE INVESTIGATTTION CHELAN RIVER, WASHINGTON

ANNUAL REPORT

MACROINVERTEBRATE INVESTIGATION:

CHELAN RIVER, WA

April 20, 2017

Prepared by

Terraqua, Inc.

for the

Public Utility District #1 of Chelan County

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This Final Investigation Report was prepared by Terraqua for the Public Utility District #1 of Chelan County (Chelan PUD), Project No. 15-73. For more information or to request data/reports for this project, please contact Steve Hays, steve.hays@chelanpud.org

Project Location

Chelan River, Chelan County, Washington
T27N R22E 13; R23E 18-19, 29-30

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ABSTRACT

This annual report summarizes data collection and analysis results for the 2016 implementation of the Chelan River Macroinvertebrate Investigation (Chelan PUD 15-73). The results of this study are intended to provide a baseline for measuring success in meeting the Biological Objectives outlined in the Lake Chelan Settlement Agreement. We describe the biomass and taxonomic diversity of drift and benthic macroinvertebrate communities encountered in the restored sections of the Chelan River in May and August of 2016, and compare these communities with upstream and downstream reference sites and comparison streams in the same ecoregion. We found that the biological diversity of the benthic community in the restored sections of the Chelan River was generally comparable or greater than in the reference sections, but lower in taxa richness (B-IBI = 14-24) than regional comparison streams. The drift community was similar in biomass and diversity to regional comparison streams. Fieldwork and data analysis were completed by Terraqua, Inc., and laboratory and analytical support were provided by Rhithron Associates, Inc. for the Public Utility District #1 of Chelan County.

INTRODUCTION

This study took place in the Chelan River, which drains Lake Chelan, WA (T27N R22E 13; R23E 18-19, 29-30; Figure 1) into the upper Columbia River. The Lake Chelan Hydroelectric Project (Dam; FERC No. 637) serves a dual purpose of generating power and regulating the level of Lake Chelan. The Lake Chelan Settlement Agreement (SA; October 2003) was developed during the FERC relicensing process for the Project. The SA established a minimum flow of 80 cfs for the Chelan River, which had previously been dry from August-May in most years since the dam began operation in 1926, and called for habitat improvement features in an engineered "habitat channel" and the dam's tailrace to provide spawning habitat in the lower river. A number of criteria were established by the SA to measure components leading to success in achieving the Biological Objectives, including water quality requirements and standards for egg to fry survival. Other monitoring and evaluation activities specified in the SA include fish surveys and monitoring of benthic macroinvertebrate populations, which is the subject of this research project.

Mandatory monitoring and evaluation activities that have been implemented through the SA track and document progress towards achievement of established Biological Objectives and provide information to inform adaptive management strategies. The Biological Objective in Reaches 1-3 of the Chelan River is to create habitat to support a viable cutthroat trout population of 200 fish. The Biological Objectives for the Habitat Channel and tailrace spawning areas are to provide spawning and rearing habitat for Chinook salmon and steelhead, to document that these fish are using the new habitat, and to show evidence that adult fish production (returning adults) originated from fish spawning in this habitat.

The macroinvertebrate population structure in the Chelan River is previously unstudied, except for samples in the tailrace in 1999. Macroinvertebrate colonization of the upper river is probably limited to aerial colonization or downstream drift of invertebrates or material via spillway input from Lake Chelan, which may be dominated by taxa not suited to residence in riverine habitat. The tailrace and Habitat Channel may be populated through all three possible routes: aerial colonization, downstream drift, and upstream dispersal. Productivity in all reaches of the Chelan River may be limited by high summer stream temperatures, poor nutrient input from the highly oligotrophic Lake Chelan, and subject to periods of possible scouring during regulated spill. Any macroinvertebrate population prior to initiation of minimum flows in October 2009 was likely eradicated seasonally when the river went dry.

The goal of this project was to determine baseline condition of the benthic and drift macroinvertebrate population assemblage in the Chelan River in order to provide a metric for measuring success in meeting the Biological Objectives outlined in the Lake Chelan SA. The study area encompassed the entire Chelan River excluding the gorge, which is considered poor habitat for macroinvertebrates and unsafe for researcher access. The river was stratified into four primary areas of interest: 1) above the Lake Chelan Dam (0.75 rkm); 2) "Reach 1" (sub-stratified into upper, middle and lower sections) between the dam and the top of the Chelan River Gorge (3.45 rkm); 3) the engineered Habitat Channel located within "Reach 4" (0.55 rkm); and 4) the powerhouse tailrace near the Columbia River confluence (0.2 rkm) (Figure 1). In the SA, the area above the Lake Chelan Dam and the powerhouse tailrace were specified as reference areas, while the restoration objective for Reach 1 and the Habitat Channel was to achieve a benthic community with comparable or greater density and species diversity than these reference areas.

Water in Reach 1 flows from Lake Chelan either through a low-level outlet structure or from the spillway. The bed of this relatively low gradient (1%) section is primarily composed of large cobbles and small boulders, with smaller cobbles and gravels generally limited to the margins of the river channel. This reach is moderately confined by hill slopes composed of glacial moraine deposits. Most fine bed materials are flushed out of the river during annual spill events, but pockets of medium-sized cobble and small gravels exist in some areas. Channel width through Reach 1 averages 28 m, and is primarily confined to a single channel except for a short (~640 m) braided section near the lower end of the reach. Riparian vegetation is scarce throughout Reach 1, with the most significant stands of riparian cover existing along the braided section.

The Habitat Channel is an engineered sinuous stream channel parallel to and upstream of the main tailrace. It is watered by the mainstem Chelan River, but has supplemental flow pumped from the tailrace during peak salmonid spawning periods in the spring and fall. Substrate varies from large cobbles to small gravel and some areas of sands. Riparian vegetation is thick, and primarily dominated by willows.

The section of the Chelan River above the dam is backwatered and typically slow water velocity and depths >2 m. Substrate is composed of small and large cobbles, gravels, sand and some fines. The section of river below the tailrace and Habitat Channel contains similar substrate and depths, but is also influenced by eddy flows as it joins the Columbia River. It is primarily watered by the tailrace but also includes flows from the Habitat Channel and an ephemeral floodplain channel, primarily hugging the north shore of this section.

The project collected drift and benthic macroinvertebrate samples. Concurrent metrics included stream flow velocity and water temperature at each drift net transect, water temperature at each benthic sample site, and alkalinity within each stratum at the time of sampling. The study leveraged existing Chelan PUD and U.S. Geological Survey data sources for average annual temperature and total stream discharge.

Objectives

- Assess abundance, taxonomic classification and biological health of the benthic macroinvertebrate community of the Chelan River;
- Assess biomass, abundance, taxonomic classification, resource category and size distribution of the drift macroinvertebrate community of the Chelan River;
- Assess biomass of organic debris in the Chelan River;
- Identify taxonomic classification of the benthic macroinvertebrate community immediately upstream of the Lake Chelan Hydroelectric Dam and the benthic and drift macroinvertebrate communities immediately downstream of the tailrace in order to determine the contribution of these habitats via upstream dispersal or downstream drift to the macroinvertebrate communities in the Chelan River; and

- Compare Chelan River macroinvertebrate community structure with that of comparable stream systems, with an emphasis, where possible, on other lake-fed, warm-water salmonid-bearing streams in the Pacific Northwest.

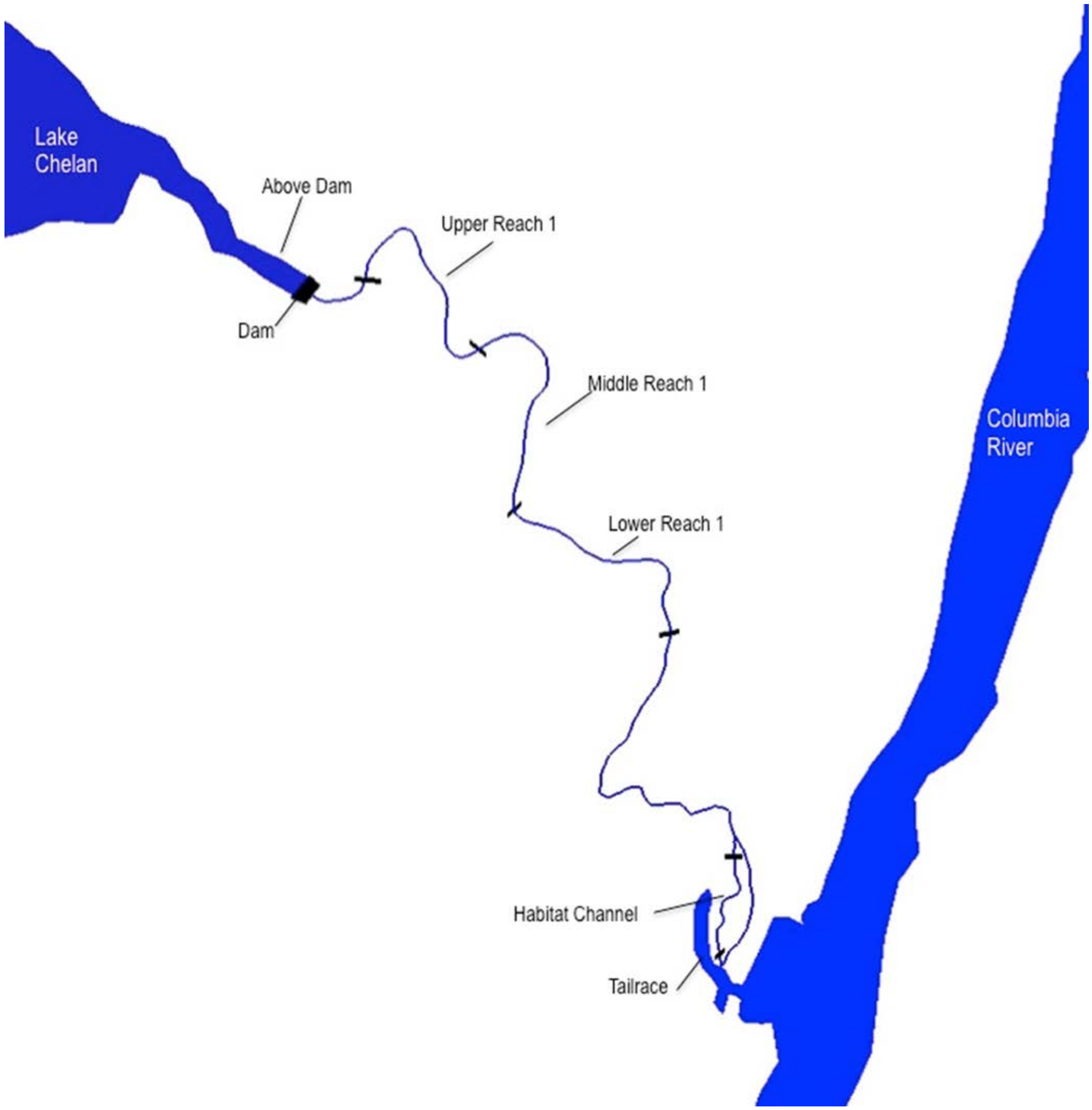

FIGURE 1. Study area within the Chelan River, WA in 2016. Benthic samples were collected in all 6 strata. Drift samples were collected in all strata except Above Dam.

METHODS

Organization and Schedule

Sampling was scheduled to represent the macroinvertebrate community during two seasons. Spring sampling took place May 2-4, 2016, and summer/fall sampling took place August 30-31, 2016. An additional benthic sample was collected above the dam in July to improve data quality as discussed later (Figure 2). Sampling in both seasons was scheduled to avoid conflict with concurrent fish snorkel surveys being conducted in multiple reaches, and to allow safe and effective sampling below an average 85 cfs discharge threshold. This was challenging during the May sample event when discharge had to be increased at the spillway to mitigate for an unseasonably high lake surface elevation, and the sampling timeframe was, in essence, contrived. Discharge averaged 86 cfs throughout the sampling timeframe in August (Figure 3), and was irrelevant in July as sampling only took place above the dam. Access permission was obtained from the Chelan PUD, and sites were accessed by vehicle and on foot, except for above the dam where a small motorized vessel was used.

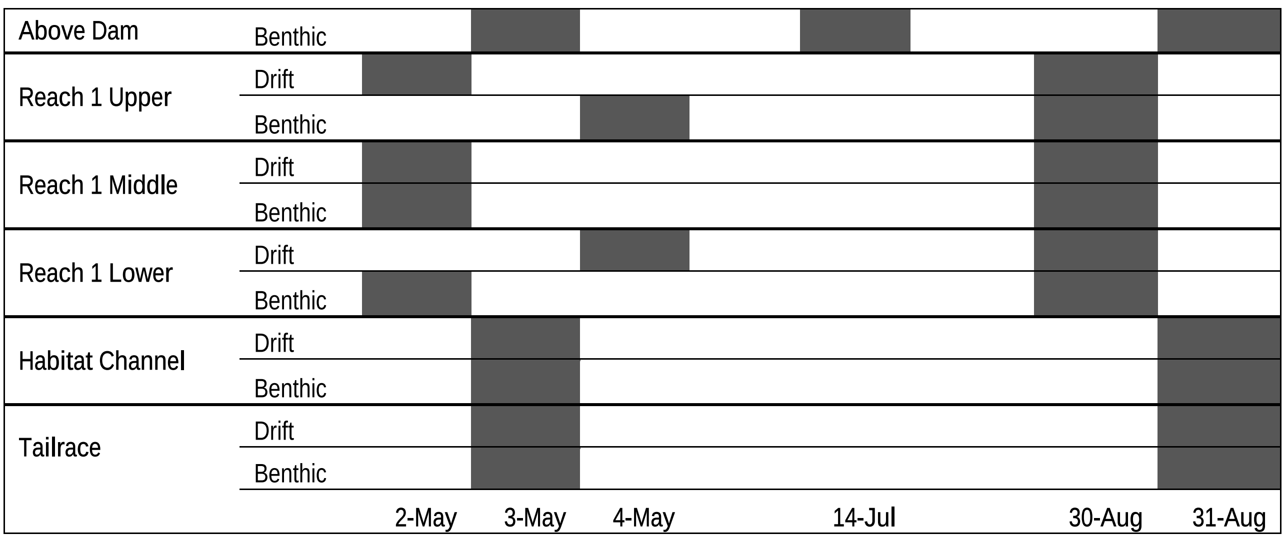

FIGURE 2. Sampling schedule for drift and benthic macroinvertebrate sampling in the Chelan River, 2016.

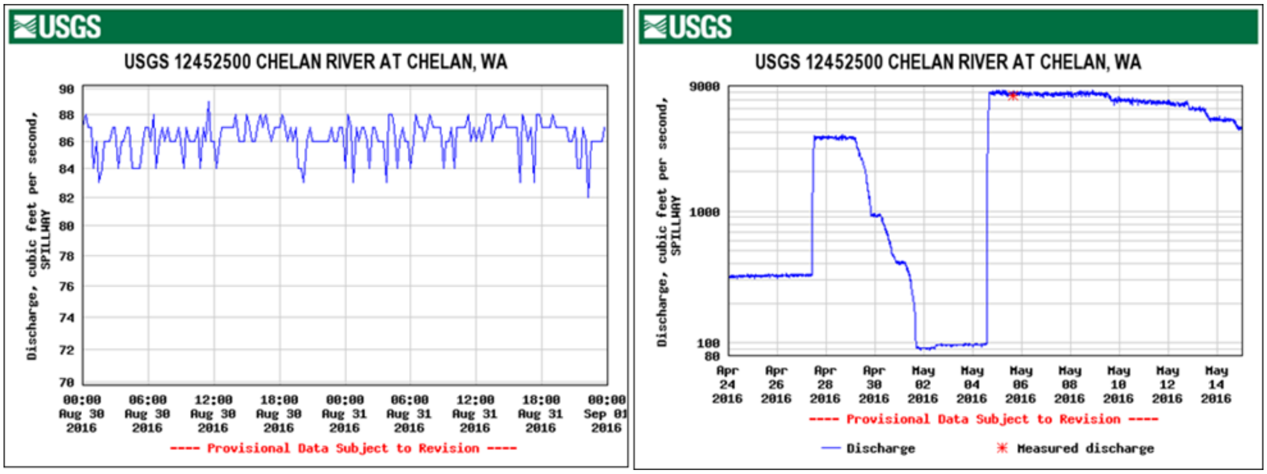

FIGURE 3. Chelan River discharge (cfs) measured ¼ mile downstream from Chelan Dam (from waterdata.usgs.gov), showing ramp down window for sampling May 2-4, 2016 and measured discharge during sampling Aug. 30-31, 2016.

Sampling Process Design

Drift Sampling

We used a probabilistic design for drift macroinvertebrate site selection within Reach 1 and the Habitat Channel, and a targeted design in the tailrace section, with a total of five drift samples collected during each of the sample events (May and August). No drift samples were collected during the extra July sample event as this was targeted exclusively at collecting a replacement benthic sample above the dam. A master sample list defined potential drift sampling transects at 50 m intervals along the linear extent of each sampling area. Transects were then assigned a random number (rank) using MS Excel, and sorted by rank to assign use order within each strata. If the first use order site had to be rejected for any reason, then the next use order site was chosen for sampling. Rejected transects are permanently replaced (Appendix A). Reach 1 was divided into three spatially balanced strata (upper, middle, lower), and the Habitat Channel comprised a single stratum. Drift nets were set in suitable habitat, per protocol, within a maximum of 50 m upstream of each selected transect. The same drift transects were sampled during the spring and summer/fall sample events in Reach 1 and the Habitat Channel. A targeted site was chosen for drift sampling in the Tailrace, with a different site chosen for each season because of modified channel conditions. Each site represented the best available substrate for protocol adherence at the time of the event.

Benthic Sampling

Benthic macroinvertebrate sampling sites were selected randomly by field crews to represent eight different riffle or fast-water habitats within each stratum, using professional judgment to determine suitable sites during each season. All of the eight sites within each of the six strata (Upper, Middle and Lower Reach 1, Habitat Channel, Above-Dam and Tailrace) were composited into a single sample representing that stratum, for a total of six benthic samples collected during the May and August sample events, and one benthic sample during the July sample event.

Additional Data

Stream flow, depth and temperature were measured at the inlet of the drift sampling nets at each transect at the beginning and end of each set. Stream temperature and depth were also measured concurrent to each replicate benthic sample collected. Alkalinity was measured near the mid-point of each stratum, once per sample event. GPS coordinates were recorded for all replicates. Spillway data were provided in real time by Chelan PUD and summary discharge data were provided by USGS.

Sampling Procedures

Benthic sampling within wadeable areas (all but Above Dam) followed Washington Department of Ecology (WA-DOE) and Pacific Northwest Aquatic Monitoring Program (PNAMP) protocols (Adams 2010, Hayslip 2007). Within each of the five wadeable sampling strata, a total of 8 ft^2 of stream bottom was sampled and composited into a single sample for taxonomic processing, as previously discussed. One sample jar was used for each stratum, but samples could be split into multiple jars if additional capacity were needed. All wadeable benthic samples were collected using a 1 ft x 1 ft D-frame kick net with 500 µm mesh. Some samples collected within the tailrace stratum exceeded recommended depth for sampling, making collection difficult but possible. All samples were deemed viable and representative of the population in this area. Water depth, temperature and GPS coordinates were recorded at each replicate site.

In May, a modified benthic sampling protocol was employed above the dam, using an extendable D-frame kick net and brush. However, poor sample quality forced revision of this method, and in July we tested dredge sampling as an alternative method. Thereafter, benthic samples were collected by boat in the stratum above the Dam, using a 6”x6”x6” AMS Ekman dredge sampler. A total of 8 replicate samples were collected, filtered through a 500 µm mesh net and composited into a single sample for taxonomic processing. All samples were deemed viable and representative of the population in this area.

Drift sampling followed Bonneville Power Administration’s Columbia Habitat Monitoring Program protocols (CHaMP 2015). At each of the five transects, two replicate samples were collected within suitable riffle or fast-water habitat. Drift nets (40 cm x 20 cm, 1000µm mesh) were set for a minimum of 3 hours at each transect. Replicate nets were set as far apart as possible for the available habitat. All drift samples were collected starting at least 2 hours after sunrise, and completed at least 2 hours before sunset. Replicate samples were considered as a single sample per transect for taxonomic processing, and were contained in one sample jar per stratum. Water temperature, depth and flow velocity entering the mouth of each net was recorded at the start and end of sampling. GPS coordinates were also collected for each net location.

Containers, Preservation, Holding Times

All samples containing invertebrates and/or organic matter were retained in plastic sample jars with 95% ethanol. Jars were labeled with project name, site ID or stratum, date, time, replicate and sample type. All sample jars were stored on ice or in a refrigerator within 8 hours of collection, and shipped (decanted prior to shipping) to Rhithron for taxonomic processing within 24 hours of sampling conclusion. Chain of Custody (CoC) forms were included in each shipment. Samples were received by Rhithron in good condition for each sample event, and recharged with ethanol for storage and subsequent taxonomic processing.

Data Management and Quality Assurance/ Quality Control

Field metadata were recorded electronically using a custom data collection form built in MDC GISCloud on an Apple iPad. Metadata associated with the start and end of each replicate drift sample included site ID, date, time, stream temperature, depth, flow velocity and GPS coordinates. Metadata associated with each benthic sample included stratum, replicate number, date, time, stream temperature and GPS coordinates. Additionally, alkalinity measurements with associated GPS coordinates and date/time were recorded for each stratum on the date of sampling. The entire survey extent was within range of cellular data services, and therefore each data entry was automatically and immediately backed up to a cloud server. Data were downloaded and backed up to a laptop computer at the end of each day of sampling, and consolidated into a single MS Excel database file at the completion of all sampling. Data QA/QC was completed by the lead investigator within 4 weeks following each sampling event. No errors or omissions exist in the data, all physical samples were present and accounted for, and all metadata are deemed to be complete and accurate. Taxonomic processing was completed and data delivered by Rhithron on August 9th (May, July) and October 3rd (August).

Taxonomic Analysis

Benthic samples were sorted according to Plotnikoff and Wiseman (2001) and drift samples were sorted according to CHaMP protocols to obtain representative subsamples with a minimum of 500 or 600 organisms, respectively. Briefly, samples were mixed before sorting and evenly spread onto a Caton sub-sampling tray (Caton 1991) with 30 grids. The contents of randomly selected grids were sorted and individual taxa were identified until the minimum number of organisms was reached. After obtaining the subsample, benthic samples were then scanned for large or rare individuals. Total body length was measured for drift samples. If the individual was damaged, body length was estimated by comparing with other individuals of the same taxon and maturity stage.

After obtaining the subsamples, drift samples were coarsely sorted by resource class (aquatic, terrestrial, aquatic/terrestrial) for dry biomass measurement. Filters (47mm glass, Whitman Glass-Fiber Filters types GF/A, 1.6 micron pore size) in aluminum boats were pre-ashed at 500°C for 20 minutes, placed in a desiccation chamber to cool to room temperature, and weighed. Filters were placed in a filtration apparatus and moistened with de-ionized water before samples were added. Filters were dried at 105°C until constant weight was reached for a minimum of 2 hours and weighed. The same method was used to measure ash free dry weight of detritus.

Quality control was performed to assess initial sample processing and subsampling. On a random selection of 10% of the samples an independent sorter re-examined 25% of the sorted substrate using the same Caton grid method described above. Organisms that were missed were counted and added to the results from the original sort. Taxonomic identification was checked by an independent taxonomist by randomly selecting two samples and re-identifying all organisms. Sorting efficiency was 99.1% and taxonomic precision was 97.9%. Both are within industry standards (Stribling *et al.* 2003).

Data Analysis

Multivariate analyses were used to explore differences at the assemblage level and assess the similarities of taxonomic diversity and biomass among strata, as used by Favaro *et al.* (2014) and Maitland *et al.* (2016), for benthic and drift communities separately. Among the many similarity indices used for ordination in community ecology research, the Bray-Curtis similarity index (Clarke and Warwick 2001) has been found to be one of the best methods (see Quinn and Keough 2002). In this study, Bray-Curtis similarity indices (Clarke and Warwick 2001) were calculated for all strata pairs based on macroinvertebrate abundance data, and ordinated using non-metric multidimensional scaling (NMDS). NMDS is unconstrained by environmental variables, and thus reflects only similarities between taxonomic composition data.

For the benthic data, six sample strata (Above Dam, Reach 1 Upper, Reach 1 Middle, Reach 1 Lower, Habitat Channel, Tailrace) were compared, and for the drift data the same strata were compared except for the Above Dam strata which was not sampled for drift, making a total of five sample strata for drift data. We combined the species abundance data of both sampling periods to perform the NMDS because of the small sample sizes and high variations between the two sampling periods.

Goodness of fit (stress value) was also calculated in the ordination analysis for both communities (benthic and drift), in order to determine how well the ordination summarizes the observed distances between strata. For this study, we could not determine the relationship between community composition and environmental conditions because of limited environmental data so we illustrated how much the communities varied between strata.

Once we determined the variation of community assemblages, we further calculated similarities between sample strata for each sampling period, and a combination of both between paired strata in order to understand the contribution of organisms between strata via upstream or downstream dispersal. We hypothesized that downstream dispersal of organisms from above the dam would result in community structures of high similarity between the three main reaches (Above Dam, Reach 1, Tailrace/Habitat Channel), and that significantly different community structure between these reaches meant that downstream dispersal was not a significant mechanism for recruitment.

For this hypothesis, we used both the Bray-Curtis similarities index (Clarke and Warwick 2001) and Sørensen similarities index (Chao *et al*. 2005). Bray-Curtis similarities index (Clarke and Warwick 2001) is based on taxonomic abundance data; however, in some cases taxa abundance and its variation or noise is often high, which might create a bias in the results (Pandit *et al.* 2009). We therefore also used Sørensen similarities index (Chao *et al.* 2005), which is based only on taxa presence/absence; and also provides greater weight to taxa common to all strata than to those found in only one stratum. The following equations were used for this study for both benthic and drift community structure.

Bray-Curtis Similarities Index:

$$d^{BCD}(i,j) = 1 - \frac{\sum_{k=0}^{n-1} |y_{i,k} - y_{j,k}|}{\sum_{k=0}^{n-1} (y_{i,k} + y_{j,k})}$$

where d^{BCD} is the similarity in community compositions between two strata, $y_{i,k}$ is the taxa at stratum one, and y_{jk} is the taxa at stratum two.

Sørensen Similarities Index:

$$1 - \frac{2a}{(2a + b + c)}$$

where a is the number of species common to both strata, b is the number of species unique to the first stratum, and c is the number of species unique to the second stratum.

Benthic Index of Biotic Integrity (B-IBI) were calculated by Rhithron for each strata/period using standardized equations (Fore and Wisseman 2012; Karr and Chu 1999). Ten individual metric scores ranging from one through 10 are added together to generate a total B-IBI score, which ranges from 1-100. B-IBI scores are used as an indicator of overall stream health based on undisturbed reference streams, with ranges representing: Very Poor [0,20), Poor [20,40), Fair [40,60), Good [60,80), or Excellent [80,100]. These qualifiers are part a standard scoring system, independent of the stream or ecoregion, and are commonly used to compare B-IBI scores based on other reference streams in the area. However, they do not necessary mean that a stream is of poor health just because it has a low score. For example, if a site has a low B-IBI score but surrounding reference sites also have low B-IBI scores, the site is geographically isolated from recruitment sources for indicator taxa, or the sampled area contains mostly habitat naturally unsuited to benthic colonization, we could conclude that this score represents the natural condition of the stream, independent of disturbance (Elbrecht *et al.* 2014).

We compared B-IBI metric scores for Chelan River benthic macroinvertebrate communities to other streams in Eastern Washington to estimate the status of colonization and diversity for baseline conditions. Comparison categories included reference streams, lake-fed streams, high-temperature streams, and the Palouse River, which best matched the Chelan River for annual flow regime and average summer temperatures. All data used for comparison were the most recent available and for which a majority of sampling occurred in July-August summer conditions; Chelan River data were collected primarily in spring and late summer/fall conditions.

Benthic reference streams are included in the WA-DOE's Ambient Stream Biological Monitoring Project (ASBMP). The streams included in this project were chosen as a point of comparison for what benthic invertebrate compositions might be expected given pristine or undisturbed conditions. Reference streams are categorized into eight Washington ecoregions, which are considered to be areas of similar benthic invertebrate compositions (Wiseman 2003) within a similar range of environmental conditions. We chose nine reference streams (see Appendix B) that were geographically closest to the Chelan River with elevations under 600 m and bankfull widths greater than 30 m. However, given the Chelan River's unique geomorphology as compared to any of the reference streams existing in the ASBMP database, the nine reference streams chosen do not necessarily represent what pristine conditions might look like in the Chelan watershed, or even represent an attainable restoration objective for this system, but were the best available data.

We could not source data for any lake-fed streams with similar discharge and temperature as the Chelan River within our ecoregion, so we compared lake-fed steams and high temperature streams separately. Data were available for two lake-fed rivers in Eastern Washington with benthic invertebrate data: 1) the Cle Elum River and 2) the confluence of the Yakima and Cle Elum Rivers below where the Cle Elum River flows out of Lake Cle Elum. The Cle Elum River flows from Hyas Lake in the Alpine Lakes Wilderness area, the site is colder (10.5°C) and at a higher elevation (1,054 m) than the Chelan River, and although discharge data is not available it is likely lower. The site at the confluence of the Yakima and Cle Elum Rivers has higher discharge (3,700 cfs) but similar high average summer temperature (18.7°C) to the Chelan River, although this is still much cooler than the >23°C summer peak water temperatures that enter the Chelan River from the outlet of Lake Chelan.

We found three Eastern Washington streams with similar temperature ranges as the Chelan River (19.2 - 23°C). Discharge data was not available for these streams, so we used our best judgment to exclude rivers with much higher or lower discharge than the Chelan River. The Palouse River, a tributary to the Snake River, was chosen as the best match to the Chelan River for both temperature and discharge regimes in the Eastern Washington ecoregion. It has temperatures in the mid-20s in August, similar summer low flows, and large intra-annual discharge variations.

A standardized biotic index scoring system has not been developed to use for drift macroinvertebrate communities as the ASBMP has done for benthic macroinvertebrate communities in Washington. However, a common use of drift macroinvertebrate data is to compare total biomass with bioenergetic needs of fish in order to predict carrying capacity. We compared drift macroinvertebrate taxonomic diversity and total biomass for the Chelan River to other rivers within the CHaMP network. Additionally, we investigated similarities in community composition by taxa presence/absence at all comparison streams using Sørenson Similarities Indices (Chao *et al*. 2005).

CHaMP collects drift macroinvertebrate data at hundreds of sites annually throughout the Columbia River Basin. We chose to narrow down comparison stream selection to the Wenatchee, Methow and Entiat River subbasins, which were the closest geographic proximity to the Chelan River. Data were not available for any directly lake-fed rivers in the CHaMP network, so comparison streams were chosen based on similar channel width and discharge profiles to the Chelan River. Temperature profiles were not directly compared, but all comparison streams experience high temperatures (>18°C) at times during the summer. None of the comparison streams can be considered as directly analogous to the Chelan River, again due to the unique geomorphology of the Chelan watershed. Two rivers were chosen from each Upper Columbia subbasin: Entiat River and Mad River (Entiat subbasin), Peshastin Creek and Chiwaukum Creek (Wenatchee subbasin), and Lost River and Early Winters River (Methow subbasin). While Chiwaukum Creek is colder and heavily forested compared to the Chelan River, it does experience summer temperatures exceeding 18^0C, the temperature threshold for selecting comparison streams.

For all comparison streams, taxonomic diversity (abundance of individual taxa) and total drift biomass (g/m^3) metrics were averaged across all available years (2011-2015) and site visits (varies by river and study design panel). For the Chelan River, these metrics were averaged across both periods and all strata.

RESULTS

Summary Data

Taxonomic analysis was completed by Rhithron. Technical summary reports and raw taxonomic data are available upon request. Summary statistics were compiled showing overall abundance and taxa richness for each strata by period and collection method, strata by year, and combined for the entire river by period and year (Table 1). Taxa richness represents the number of unique taxa encountered for a sample group, so is not necessarily additive when lumping groups, for example, a taxon that occurs in two strata will be counted twice to report taxonomic richness of those 2 strata separately, but is only counted once when lumping the two strata.

Total taxonomic richness of combined benthic and drift macroinvertebrate communities was 100. Taxonomic richness was higher in the August period than May for both benthic and drift communities. Overall taxonomic richness was generally higher for the benthic community than the drift community, but abundance was orders of magnitude higher for drift than benthic. However, there was a high amount of variability in these metrics when comparing drift and benthic taxonomic diversity and abundance between strata and periods. Drift abundance was still relatively higher than benthic abundance across all strata and periods, but the combined total metrics were biased high by two outlier samples taken in the habitat channel and tailrace where a single taxon (Cladocera in Tailrace in August and Copepoda in Habitat Channel in May) dominated abundance within those samples. There were a total of 19 taxa common between drift and benthic communities, with common taxa occurring in all strata where both drift and benthic communities were sampled. This suggests that passive downstream dispersal may be an important mechanism for distribution/recruitment of the benthic community.

B-IBI scores were calculated for each strata/period (Table 2). Chelan River B-IBI were generally low, with the lowest score (14) above the dam in August (14) and the highest scores (24) in Middle Reach 1 in May and Habitat Channel in August.

TABLE 1. Summary table of taxa richness and abundance for drift and benthic macroinvertebrate samples collected in Chelan River, 2016.

Strata	**Upper Reach 1**				**Middle Reach 1**			
Period	**May**		**Aug**		**May**		**Aug**	
Collection Method[1]	**D**	**BK**	**D**	**BK**	**D**	**BK**	**D**	**BK**
Abundance	4849	1649	583	2349	1516	343	3180	673
Sample Taxa Richness	17	21	30	22	23	20	29	21
Common Taxa[2]	4		9		8		10	
Total Taxa Richness by Period	34		43		35		40	
Total Taxa Richness	50				52			
Distinct Taxa[3]	3				3			

Strata	**Lower Reach 1**				**Habitat Channel**			
Period	**May**		**Aug**		**May**		**Aug**	
Collection Method[1]	**D**	**BK**	**D**	**BK**	**D**	**BK**	**D**	**BK**
Abundance	2746	471	4924	505	131073	1378	1741	294
Sample Taxa Richness	25	27	24	25	11	28	27	24
Common Taxa[2]	10		9		4		11	
Total Taxa Richness by Period	42		40		35		40	
Total Taxa Richness	56				52			
Distinct Taxa[3]	5				2			

Strata	**Tailrace**				**Above Dam**			**Combined Strata**			
Period	**May**		**Aug**		**May**	**July**	**Aug**	**May**		**Aug**	
Collection Method[1]	**D**	**BK**	**D**	**BK**	**BK**	**BD**	**BD**	**D**	**B**	**D**	**B**
Abundance	10080	382	329003	155	11	246	111	150264	4234	339431	4087
Sample Taxa Richness	15	27	3	16	7	28	14	39	49	47	50
Common Taxa[2]	1		1		-	-	-	18		19	
Total Taxa Richness by Period	41		18		-	-	-	70		78	
Total Taxa Richness	45				36			**100**			
Distinct Taxa[3]	3				17			-			

[1]Collection Methods: D=Drift Net, BK=Benthic Kick-Net, BD=Benthic Ekman Dredge; [2]Common Taxa occurred in both drift and benthic samples; [3]Distinct Taxa are not observed in any other strata

TABLE 2. Benthic Index of Biotic Integrity (B-IBI) metrics and scores for the Chelan River, 2016. Metrics calculated by Rhithron Associates, Inc.

	May Sampling Period					
METRICS	R1 Upper	R1 Middle	R1 Lower	Hab Chan	Tailrace	Above Dam[1]
Taxa Richness	21	20	27	28	27	28
E Richness	1	1	2	2	0	0
P Richness	0	0	0	0	0	0
T Richness	3	4	5	3	5	1
Pollution Sensitive Richness	0	0	0	0	0	0
Clinger Richness	6	6	9	7	4	1
Semivoltine Richness	0	0	1	2	1	1
Pollution Tolerant Percent	3.00%	6.12%	9.13%	10.97%	40.58%	46.34%
Predator Percent	10.33%	9.04%	11.25%	15.54%	26.44%	7.32%
Dominant Taxa (3) Percent	74.00%	61.81%	45.44%	45.52%	56.28%	50.00%
METRIC SCORES						
Taxa Richness	3	3	3	3	3	3
E Richness	1	1	1	1	1	1
P Richness	1	1	1	1	1	1
T Richness	1	1	3	1	3	1
Pollution Sensitive Richness	1	1	1	1	1	1
Clinger Richness	1	1	1	1	1	1
Semivoltine Richness	1	1	1	1	1	1
Pollution Tolerant Percent	5	5	5	5	3	3
Predator Percent	3	1	3	3	5	1
Dominant Taxa (3) Percent	3	3	5	5	3	5
MAY SAMPLE SCORE	20	18	24	22	22	18

	August Sampling Period					
METRICS	R1 Upper	R1 Middle	R1 Lower	Hab Chan	Tailrace	Above Dam
Taxa Richness	22	21	25	24	16	14
E Richness	1	1	1	1	0	0
P Richness	0	0	0	0	0	0
T Richness	3	2	3	4	1	0
Pollution Sensitive Richness	2	0	0	1	0	0
Clinger Richness	8	6	8	8	3	0
Semivoltine Richness	0	0	1	1	1	1
Pollution Tolerant Percent	2.57%	1.32%	2.97%	8.16%	10.97%	45.95%
Predator Percent	9.54%	21.55%	10.30%	22.11%	19.35%	1.80%
Dominant Taxa (3) Percent	77.25%	73.35%	60.20%	48.30%	81.29%	64.86%
METRIC SCORES						
Taxa Richness	3	3	3	3	1	1
E Richness	1	1	1	1	1	1
P Richness	1	1	1	1	1	1
T Richness	1	1	1	1	1	1
Pollution Sensitive Richness	1	1	1	1	1	1
Clinger Richness	1	1	1	1	1	1
Semivoltine Richness	1	1	1	1	1	1
Pollution Tolerant Percent	5	5	5	5	5	3
Predator Percent	1	5	3	5	3	1
Dominant Taxa (3) Percent	1	3	3	5	1	3
AUGUST SAMPLE SCORE	16	22	20	24	16	14

[1]Above Dam sample was taken in July. May sample was discarded from analyses.

Benthic Macroinvertebrate Community- Taxonomic Diversity

A diversity of benthic taxa was encountered in the Chelan River. There was strong differentiation of Lake Chelan (above dam) and river assemblage structures (combined periods). The benthic community structures were most similar between the Habitat Channel and Reach 1 (Upper, Middle and Lower) of the Chelan River, with some dissimilarity between these four strata and the Tailrace. The preliminary ordination analysis showed that the community structure above the dam was different to all other strata (Figure 4); however, some convergence issues persisted in our analysis due to the small sample size.

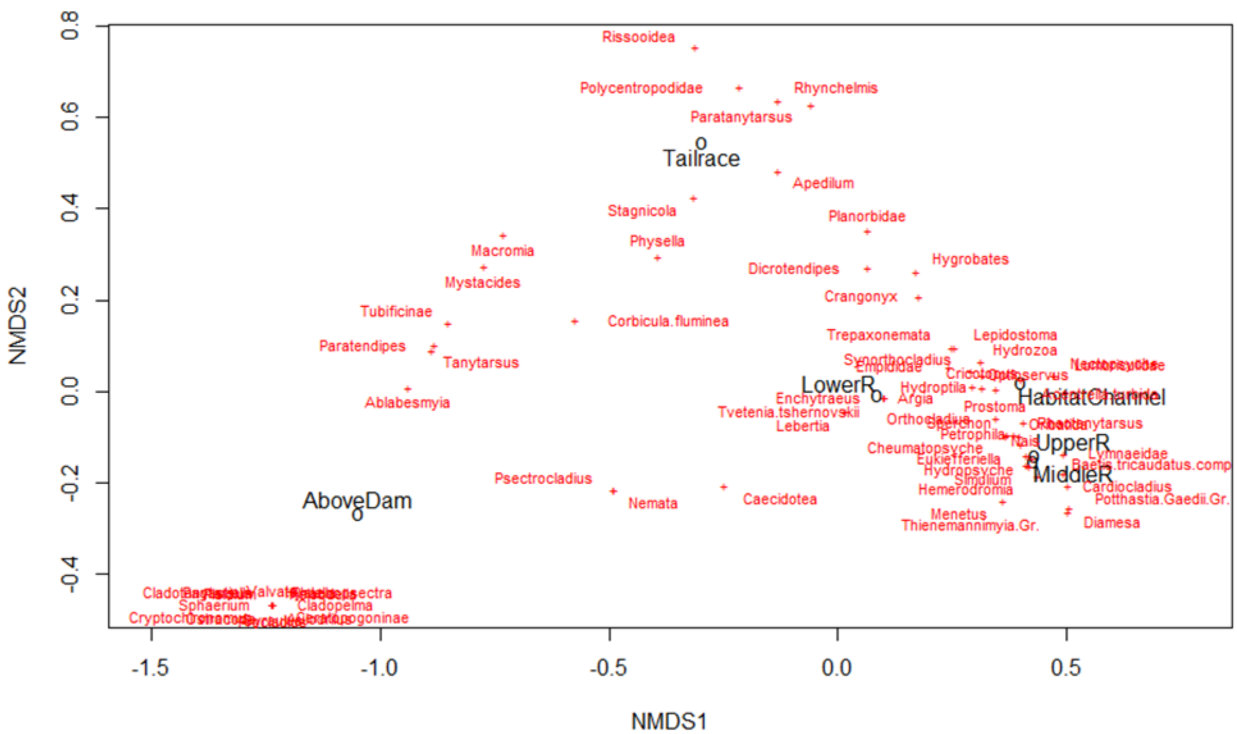

FIGURE 4. Non-metric multidimensional scaling (NMDS) ordination based on benthic taxa abundances of combined sampling periods in six sample strata (Tailrace, Lower Reach 1, Middle Reach 1, Upper Reach 1, Above Dam and Habitat Channel). Red text shows taxa.

Benthic Community Dispersal / Recruitment

The benthic community structure above and below the dam was highly dissimilar for both periods regardless of which analysis method was chosen (Bray-Curtis or Sørenson; Table 3). Using abundance data (Bray-Curtis; Clarke and Warwick 2001) the maximum similarity between community structures was only 7.32% for any strata/period below the dam and the above dam stratum; however, using taxa presence/absence (Sørenson index), similarity was somewhat higher, with a maximum similarity of 17.91% for any strata/period, except for the Tailrace which was 41.27% similar to the Above Dam stratum for combined periods. Community structures were relatively more similar between the Tailrace and all other below dam strata than the Above Dam stratum for all periods. There was a high similarity of community structures between Reach 1 and the Habitat Channel, as high as 82.4% in Reach 1 Middle in May (Sørensen; Chao *et al*. 2005). We could not test statistical significance of these results because these data are limited in only representing a single year with only a single sample for each stratum/period.

TABLE 3. Benthic similarities indices (Bray-Curtis similarities [Clarke and Warwick 2001] and Sørensen similarities indices [Chao *et al*. 2005]) in percentage between sites in the Chelan River for samples collected during May1, August and both periods combined. "HabCh", "R1Low", "R1Mid", "R1Upp" and "Tailrace" represent Habitat Channel, Lower Reach 1, Middle Reach 1, Upper Reach 1, and Tailrace, respectively.

Sites	Bray-Curtis Similarities Index (%)					Sørensen Similarities Index (%)				
	Ab.Dam	HabCh	R1Low	R1Mid	R1Upp	Ab.Dam	HabCh	R1Low	R1Mid	R1Upp
a. May[1] sampling period										
HabCh	1.74					14.04				
R1Low	3.07	48.63				14.29	80.70			
R1Mid	1.36	37.42	63.14			8.33	73.47	70.83		
R1Upp	1.00	45.11	38.02	34.02		11.76	80.77	82.35	88.37	
Tailrace	7.32	30.92	33.76	22.34	15.53	40.00	53.57	61.82	46.81	52.00
b. August sampling period										
HabCh	0.49					5.13				
R1Low	0.32	54.57				5.00	62.75			
R1Mid	1.88	40.67	57.58			11.43	60.87	63.83		
R1Upp	0.35	17.63	30.34	32.77		5.88	71.11	65.22	68.29	
Tailrace	1.50	18.71	11.52	8.45	3.42	13.79	50.00	48.78	33.33	40.00
c. Combined sampling periods										
HabCh	1.59					17.65				
R1Low	2.10	65.36				17.91	73.97			
R1Mid	1.80	46.70	69.89			13.33	78.79	70.77		
R1Upp	0.63	39.01	37.50	33.87		10.17	83.08	75.00	84.21	
Tailrace	6.71	28.93	24.06	19.63	10.11	41.27	60.87	61.76	59.02	56.67

[1]Above Dam samples compare July/August, all other strata compare May/August. Above Dam May sample was discarded for this analysis.

Benthic Community Comparison

The Chelan River B-IBI metric scores were lower than all comparison streams. High temperature and lake-fed sites scored much higher than the Chelan River. The Palouse River scored lower than the other comparison sites, but generally scored better than the Chelan River. The Chelan River and Palouse River both showed low scores in semi-voltine and clinger metrics (Figures 5 and 6).

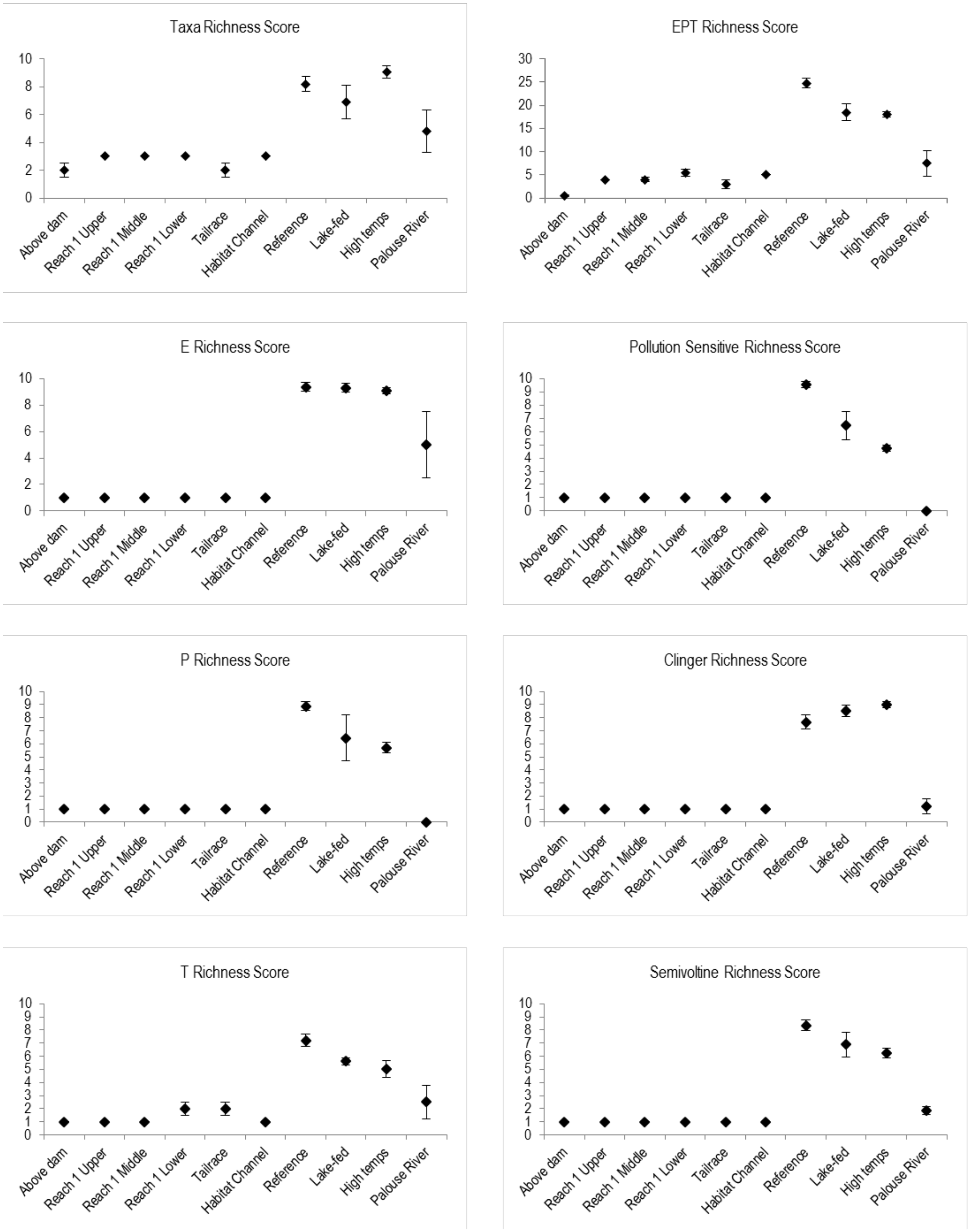

FIGURE 5. Benthic macroinvertebrate taxonomic richness scores compared between six sample reaches of the Chelan River, vs. reference and comparison stream conditions.

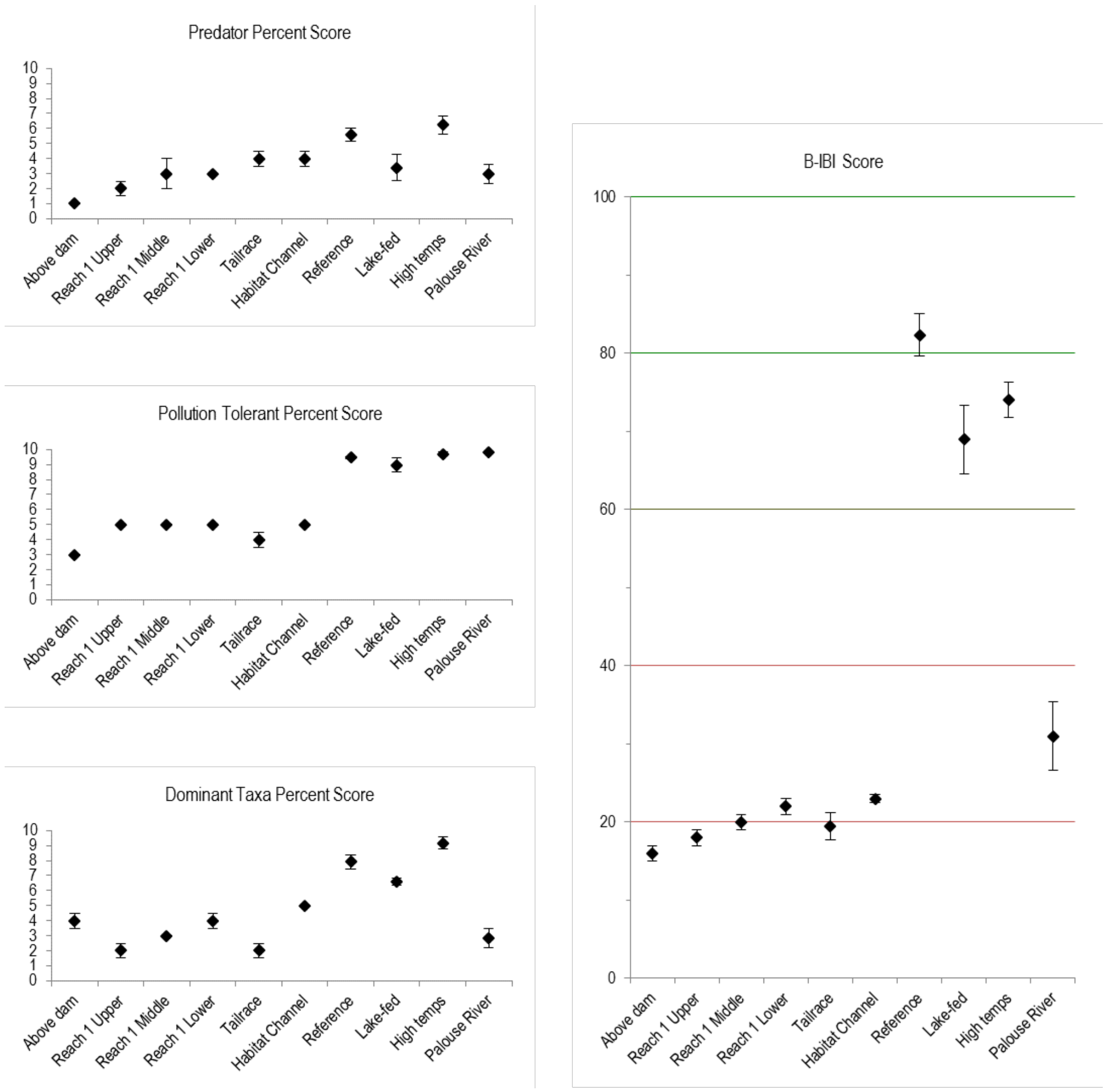

FIGURE 6. Benthic macroinvertebrate taxonomic percent and Benthic Index of Biotic Integrity (B-IBI) scores compared between six sample reaches of the Chelan River, vs. reference and comparison stream conditions. {B-IBI Scores: [0,20] = Very Poor, [20,40] = Poor, [40,60] = Fair, [60,80] = Good, [80,100] = Excellent}.

Drift Macroinvertebrate Community

Drift biomass was calculated for all samples as dry mass of drift organisms collected divided by the volume of water sampled (g/m^3), which was calculated as a function of the average flow through the nets over the time period nets were deployed. In general, biomass was higher within the habitat channel and tailrace strata (Figure 7); however, these metrics were biased high by two samples with very high biomass of a single taxon (Cladocera in Tailrace in August and Copepoda in Habitat Channel in May). When looking only at Reach 1 (Figure 8), biomass generally increased from upstream to downstream, but high variability precluded any statistical analysis of significance.

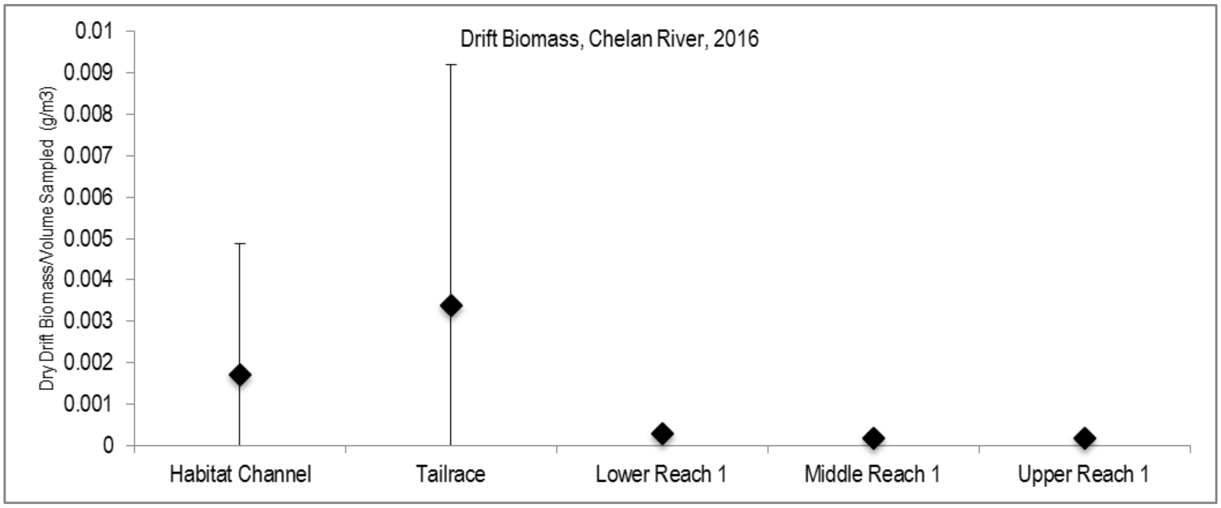

FIGURE 7. Average biomass of drift macroinvertebrate community in the Chelan River, combined periods, calculated as dry sample mass / volume sampled (g/m^3).

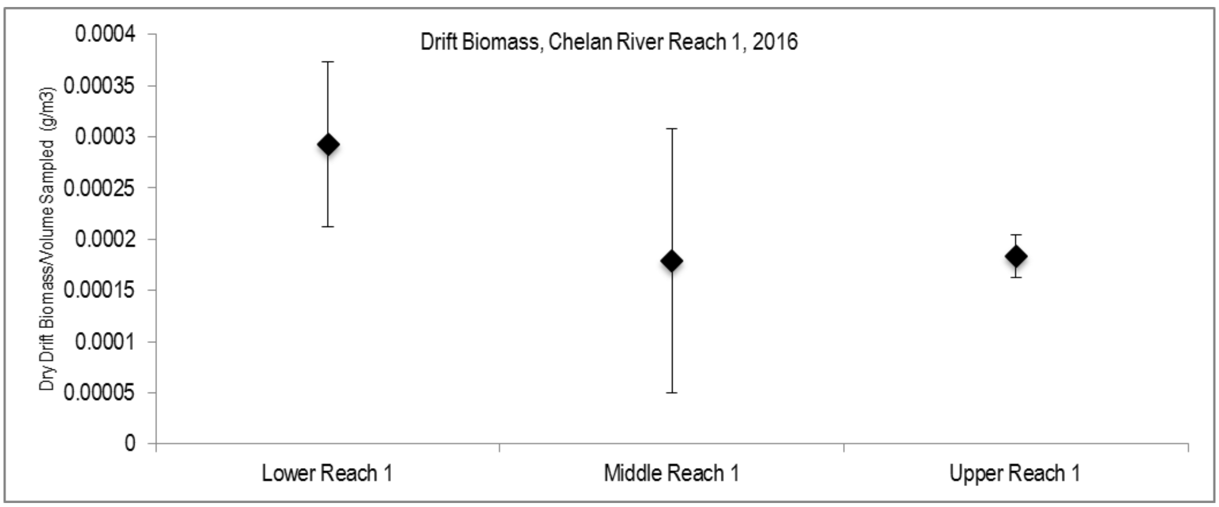

FIGURE 8. Average biomass of drift macroinvertebrate community in Reach 1 of the Chelan River, combined periods, calculated as dry sample mass / volume sampled (g/m^3).

Drift macroinvertebrates were categorized by resource category (group) as aquatic, terrestrial, or aquatic-terrestrial, and presented as proportionate abundance within each strata/period (Figure 9). Aquatic taxa exclusively inhabit aquatic habitats. Terrestrial taxa exclusively inhabit terrestrial environmental habitats and are essentially incidental to drift samples, but offer an important nutrient source for predators and overall water quality. Aquatic-terrestrial taxa are the terrestrial adult life stage of taxa that occupy both aquatic and terrestrial habitats during different life stages. Taxa of this category may be included in both aquatic and aquatic-terrestrial taxonomic groups within the same sample because they occur in varying life stages. In general, abundances of aquatic taxa were higher in the tailrace and habitat channel strata for both periods than in the Reach 1 strata, although again, these groups may be biased high by outlier samples as discussed previously. Within Reach 1, aquatic taxa had higher abundance in August than May, and combined aquatic and aquatic-terrestrial groups had higher abundance in all strata and periods than terrestrial taxa.

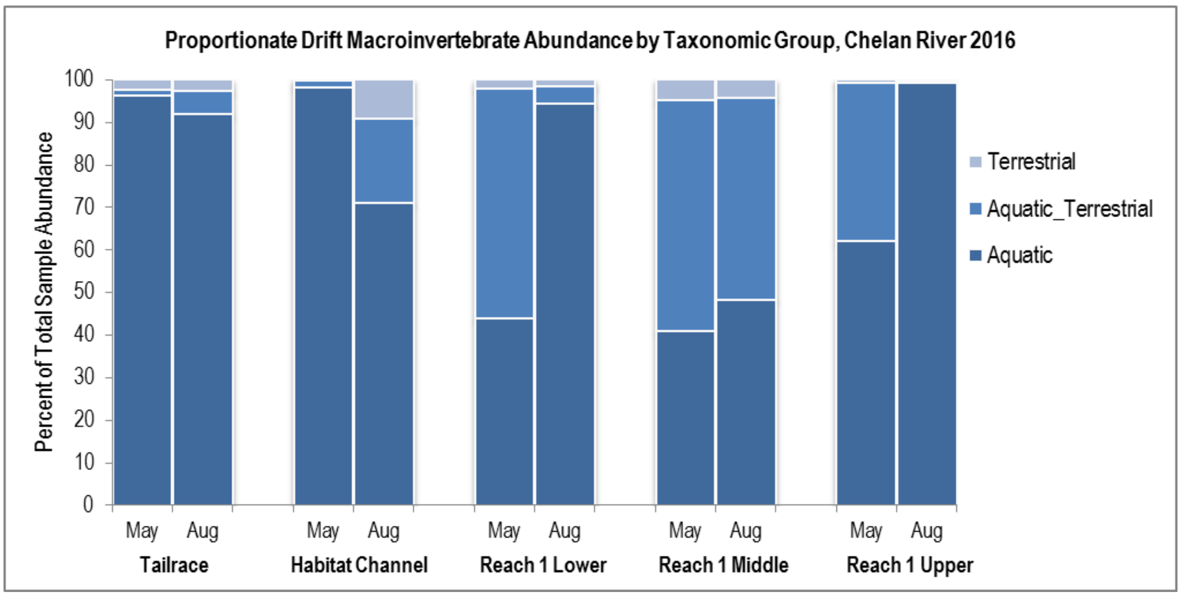

FIGURE 9. Proportionate abundance of drift macroinvertebrate taxa by group (terrestrial, aquatic, aquatic-terrestrial) within the Chelan River by strata and period, 2016.

The drift macroinvertebrate communities had greater similarity between Reach 1 and the Habitat Channel, than the Tailrace and other strata (Figure 10). Taxa shown closer together indicate greater similarity in composition between strata than those further apart. For example, the taxa Trichoptera and Physidae were present only in Upper Reach 1, whereas Leptoceridae and Hydroptidae were found more in the Habitat Channel than other strata. The stress value (goodness of fit) of the analysis was almost zero, similar to the benthic NMDS analysis. This analysis would be improved with additional data.

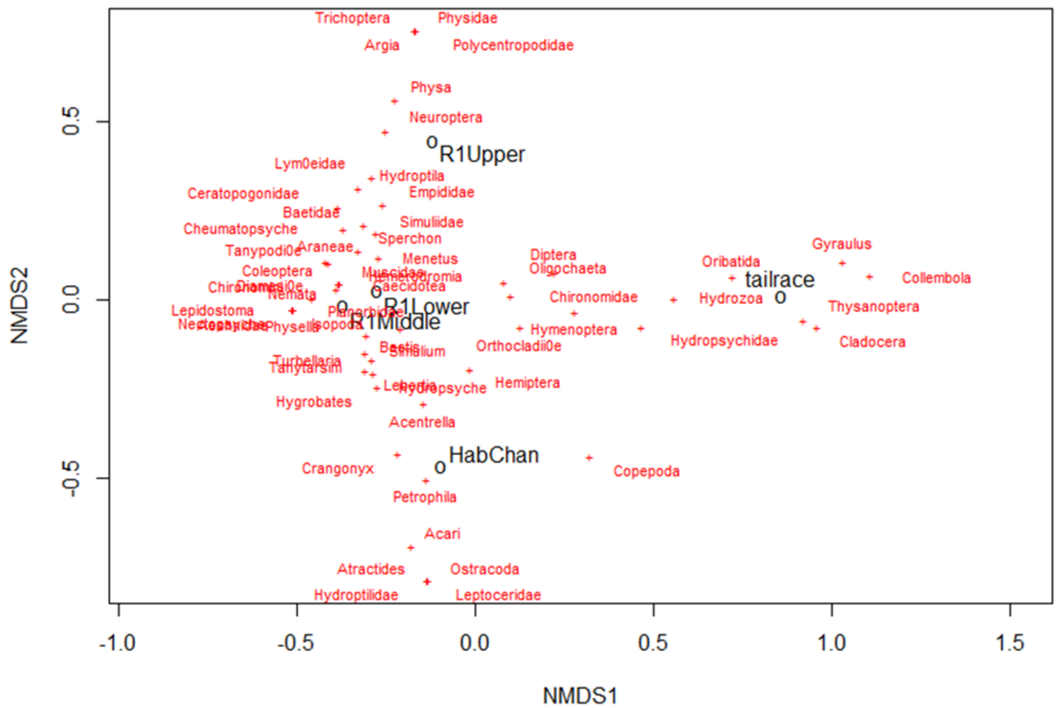

FIGURE 10. Non-metric multidimensional scaling (NMDS) ordination based on species density in 5 sample sites (Tailrace, Lower Reach 1, Middle Reach 1, Upper Reach 1 and Habitat Channel). Taxa are in red text.

Drift Community Dispersal / Recruitment

We found a high level of variability among drift macroinvertebrate community structure between strata, taxonomic groups and periods (Table 4). Generally, there was a greater similarity in both abundance (Bray-Curtis; Clarke and Warwick 2001) and taxa presence/absence (Sørenson; Chao *et al*. 2005) between the three sections of Reach 1 and the habitat channel, particularly for aquatic taxa. The taxonomic composition (without abundance) was as high as 70% for aquatic grouped taxa in May. We did not collect drift samples above the dam, and so cannot compare drift communities above and below the dam.

Using abundance data (Bray-Curtis; Clarke and Warwick 2001) for combined periods and groups, the highest similarity between any strata was between the middle and lower sections of Reach 1 (63.61%). In terms of taxa presence/absence (Sørenson) for combined periods and groups, the highest similarity was between upper and lower Reach 1 (75.68%). However, similarity for this metric exceeded 50% between all strata combinations except lower Reach 1 and the Tailrace (40%). It may not be appropriate to combine strata and groups for drift macroinvertebrate similarity indices considering the high level of variability in these metrics, but increasing the time series of this dataset could reduce noise and allow greater statistical power in analyzing trends. We could not test statistical significance of these results because these data are limited in only representing a single year with only a single sample for each stratum/period.

TABLE 4. Drift similarities indices (Bray-Curtis [Clarke and Warwick 2001] and Sørensen [Chao *et al*. 2005] similarities indices) in percentage between sites in the Chelan River for samples collected during May, August and both periods combined. "HabCh", "R1Low", "R1Mid", "R1Upp" and "Tailrace" represent Habitat Channel, Lower Reach 1, Middle Reach 1, Upper Reach 1, and Tailrace, respectively.

a. May 2016		Bray-Curtis Similarities Index (%)				Sørensen Similarities Index (%)			
Group[1]	Strata	HabCh	Tailrace	R1Low	R1Mid	HabCh	Tailrace	R1Low	R1Mid
Aquatic	Tailrace	13.76				70			
	R1Low	1.58	8.72			41.38	41.38		
	R1Mid	0.84	5.79	65.46		51.85	51.85	72.22	
	R1Upp	4.15	38.13	30.5	26.12	66.67	58.33	54.55	58.06
Aquatic-terrestrial	Tailrace	13.43				100			
	R1Low	86.22	16.67			40	40		
	R1Mid	60.14	28.24	71.21		66.67	66.67	66.67	
	R1Upp	94.44	13.98	90.34	62.74	33.33	33.33	88.89	57.14
Terrestrial	Tailrace	4.87				33.33			
	R1Low	6.06	23.89			33.33	60		
	R1Mid	14.7	21.09	60.32		28.57	72.73	72.73	
	R1Upp	7.25	21.58	48.35	48.65	50	50	50	44.44
Combined	Tailrace	13.72				61.54			
	R1Low	3.72	10.07			36.84	42.86		
	R1Mid	2.1	8.05	68.42		45.71	56.41	70.59	
	R1Upp	6.6	34.7	56.56	41.57	58.06	51.43	59.57	54.55
b. August 2016									
Aquatic	Tailrace	0				8			
	R1Low	54.36	0			65.12	0		
	R1Mid	60.67	0	63.81		59.57	0	77.27	
	R1Upp	26.02	0[2]	12.53	15.85	68.09	7.69	72.73	66.67
Aquatic-terrestrial	Tailrace	23.15				33.33			
	R1Low	17.28	68.12			88.89	40		
	R1Mid	80	26.73	22.26		80	33.33	88.89	
	R1Upp	49.46	24.16	26.46	61.65	80	33.33	88.89	100
Terrestrial	Tailrace	0				0			
	R1Low	15.29	0			66.67	0		
	R1Mid	65.17	0	14.06		88.89	0	60	
	R1Upp	40.58	0	9.62	68.57	66.67	0	60	80
Combined	Tailrace	0.11				12.12			
	R1Low	45.7	0.3			72.41	6.45		
	R1Mid	61.78	0.16	55.73		67.74	5.71	76.67	
	R1Upp	32.53	0.07	15.43	22.54	67.74	11.43	73.33	71.88
c. Combined Periods									
Combined	Tailrace	24.32				51.06			
	R1Low	6.98	0.7			65.67	40		
	R1Mid	5.05	0.68	63.61		66.67	46.15	69.44	
	R1Upp	7.21	1.84	45.7	45.24	67.61	48.15	75.68	68.42

[1]Some taxa such as Chironomidae may be categorized in both aquatic-terrestrial and aquatic groups, as different life stages occupy different habitats. For example, Chironomidae larvae are categorized as aquatic, and Chironomidae adults are categorized as aquatic-terrestrial. Therefore, total taxa richness value may vary slightly between analyses depending on how groups are split or lumped, and total taxa richness of combined groups may be less than the sum of taxa richness within groups.

[2]The tailrace has a large abundance of Cladocera (32,7001), resulting in community dissimilarity. Bray-Curtis similarities take into account species type and abundance, whereas Sørensen only accounts for species.

Drift Community Comparison

We compared community composition using overall abundance of the 20 dominant drift taxa (combined groups and periods) encountered in the Chelan River with six comparison streams in the Wenatchee, Entiat and Methow subbasins, chosen from the CHaMP database for similar discharge and channel width profiles. The Chelan River was largely dominated by Cladocera and Copepoda (Figure 11), which were non-existent or extremely rare in all comparison streams. Further investigation shows that these taxa were encountered in extremely high numbers in only two samples in the Chelan River, with Copepoda found only in the May Habitat Channel sample, and Cladocera found only in the August Tailrace sample. If these outliers are removed from the biodiversity comparison (Figure 12), we see a much greater similarity between taxa found in the Chelan River and comparison streams. The three most dominant taxa in the Chelan River, Chironomidae, Baetis and Orthocladinae, were also found in high abundances in all comparison streams except Chiwaukum, which is higher elevation and more shaded than any of the other comparison streams.

We compared total collected biomass of drift macroinvertebrates with the same CHaMP comparison streams (Figure 13), and found that the Chelan River showed generally higher biomass than the comparison streams, with poor confidence in the estimate. However, considering the same possible bias from high Cladocera and Copepoda presence in two samples of the confluence reaches, we also compared biomass between only Reach 1 strata and the comparison streams (Figure 14). This comparison showed much greater similarity in biomass between Chelan River and the other streams, and a much more precise estimate of average biomass.

We also investigated percentage similarity in taxonomic composition (taxa presence/absence) between the Chelan River and the six comparison streams using Sørenson Similarities Indices (Table 5). We could not compare abundance/dominance of taxa using Bray-Curtis (Clarke and Warwick 2001) because of a high variability in sample size between all streams. We saw a range of similarity in composition between the Chelan River and comparison streams from 27% (Entiat River) to 49% (Lost River, Methow). This was similar to the range in similarities seen amongst the individual comparison streams (24 - 70%). We could not test statistical significance of biomass or taxa richness results because the Chelan River data are limited in only representing a single year with only a single sample for each stratum/period.

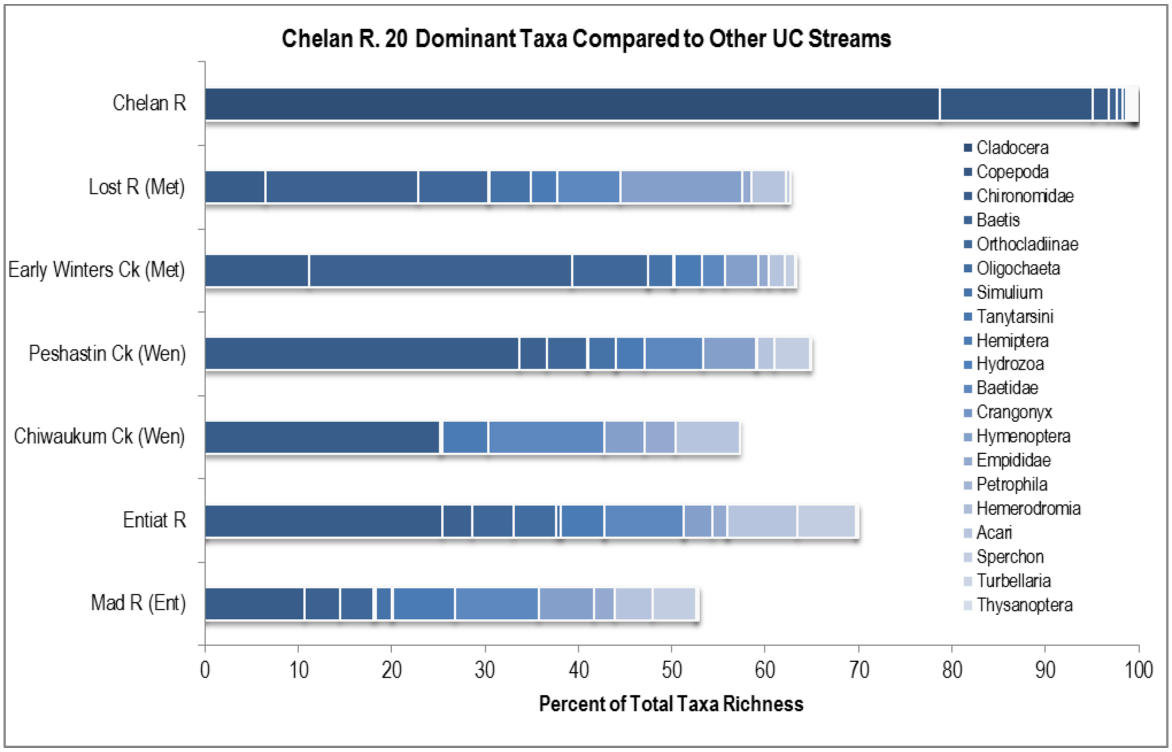

FIGURE 11. Overall abundance of the 20 dominant drift macroinvertebrate taxa encountered in the Chelan River (combined taxonomic groups, periods and strata) in 2016, compared with 6 similar streams in the Upper Columbia region. Comparison streams were chosen from the CHaMP database for similar discharge and channel width profiles, and combine data from many sites and years (2011 - 2015) within each stream.

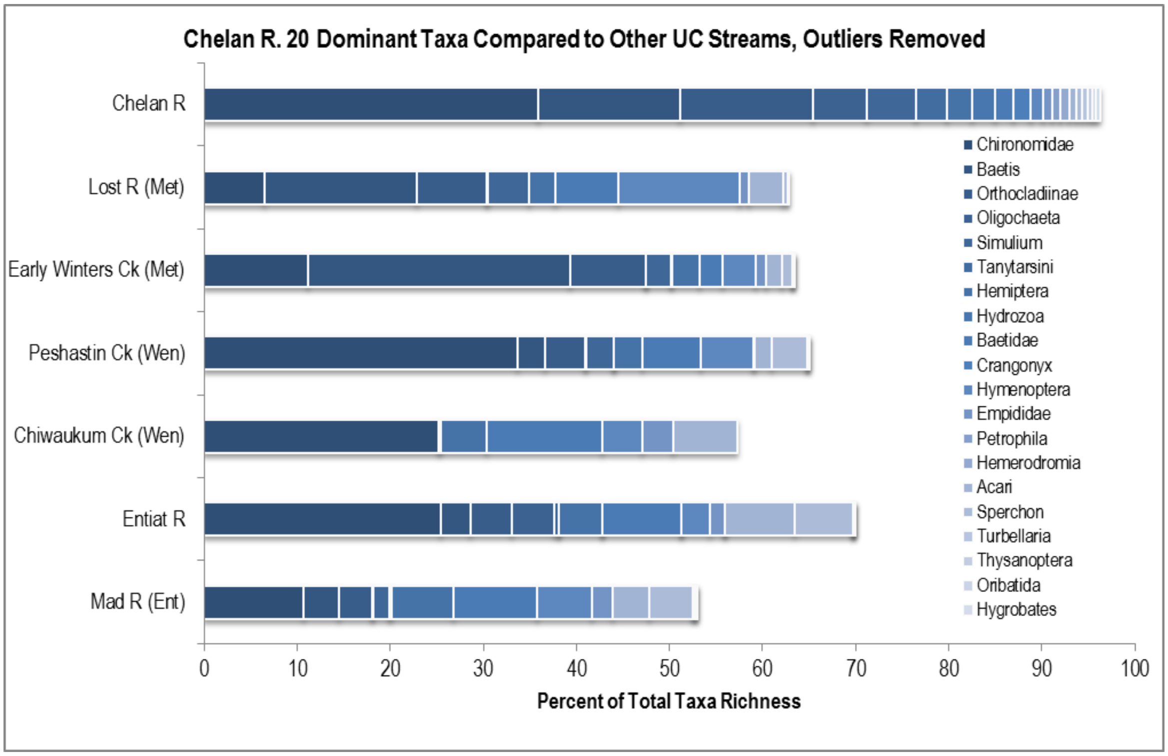

FIGURE 12. Overall abundance of the 20 dominant drift macroinvertebrate taxa, not including Cladocera or Copepoda, encountered in the Chelan River (combined taxonomic groups, periods and strata) in 2016, compared with 6 similar streams in the Upper Columbia region. Comparison streams were chosen from the CHaMP database for similar discharge and channel width profiles, and combine data from many sites and years (2011 - 2015) within each stream.

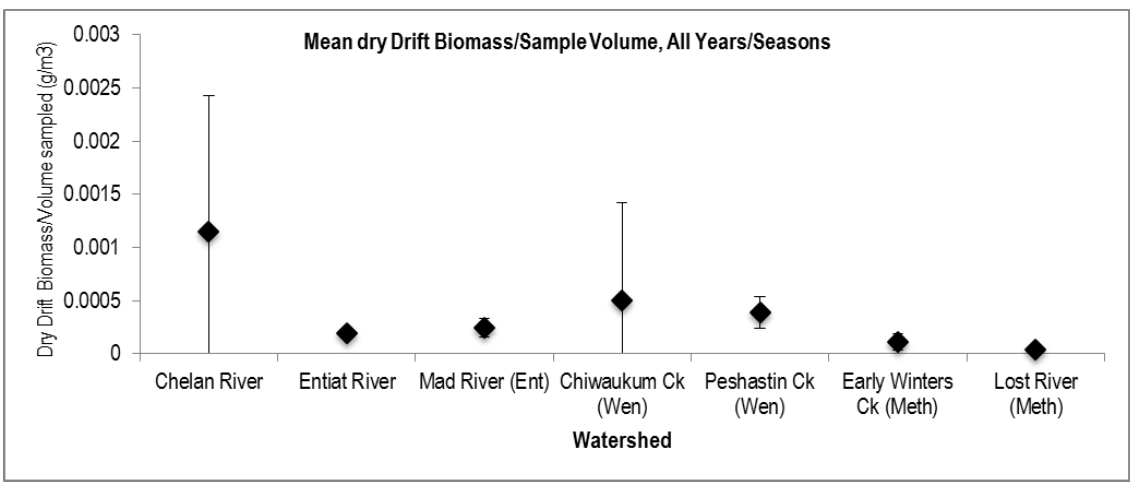

FIGURE 13. Total drift fauna biomass per sampled water volume (g/m^3) collected in the Chelan River (combined taxonomic groups, periods and strata) in 2016, compared with 6 similar streams in the Upper Columbia region. Comparison streams were chosen from the CHaMP database for similar discharge and channel width profiles, and combine data from many sites and years (2011 - 2015) within each stream.

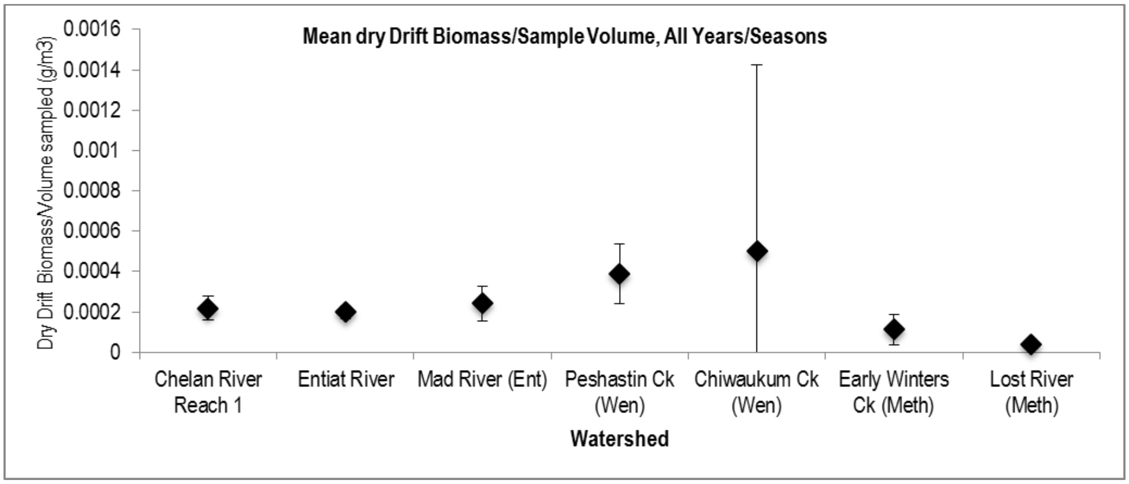

FIGURE 14. Total drift fauna biomass per sampled water volume (g/m^3) collected in Reach 1 of the Chelan River (combined taxonomic groups and periods) in 2016, compared with 6 similar streams in the Upper Columbia region. Comparison streams were chosen from the CHaMP database for similar discharge and channel width profiles, and combine data from many sites and years (2011 - 2015) within each stream.

TABLE 5. Sørensen similarities indices (Chao *et al*. 2005) in percentages between the Chelan River and six comparison streams in the Wenatchee (Chiwaukum, Peshastin), Entiat (Entiat, Mad) and Methow (Lost, Early Winters) River Subbasins. Chelan River data pools all strata/periods from 2016 drift sampling. Comparison streams pool all sites (varies) and years (2011 - 2015) available from the CHaMP database.

Reference_Site	Chelan R	Mad R	Entiat R	Chiwaukum Ck	Early Winters Ck	Lost R
Mad R	27.397					
Entiat R	36.879	70.614				
Chiwaukum Ck	30.435	24.060	25.781			
Early Winters Ck	41.830	52.599	52.997	47.244		
Lost R	49.573	38.488	39.146	37.363	55.263	
Peshastin Ck	37.037	61.708	59.490	36.810	61.607	50.000

Organic Drift Detritus

We analyzed the biomass of organic drift detritus in each strata of the Chelan River, as Ash Free Dry Mass/Weight (AFDW) by volume of water sampled (g/m^3; Figure 15). There was overall a greater amount of drift detritus collected in May than there was in August, except within the upper and middle sections of Reach 1. There was a similar biomass collected in all strata except for the tailrace, where we also saw the greatest seasonal variability.

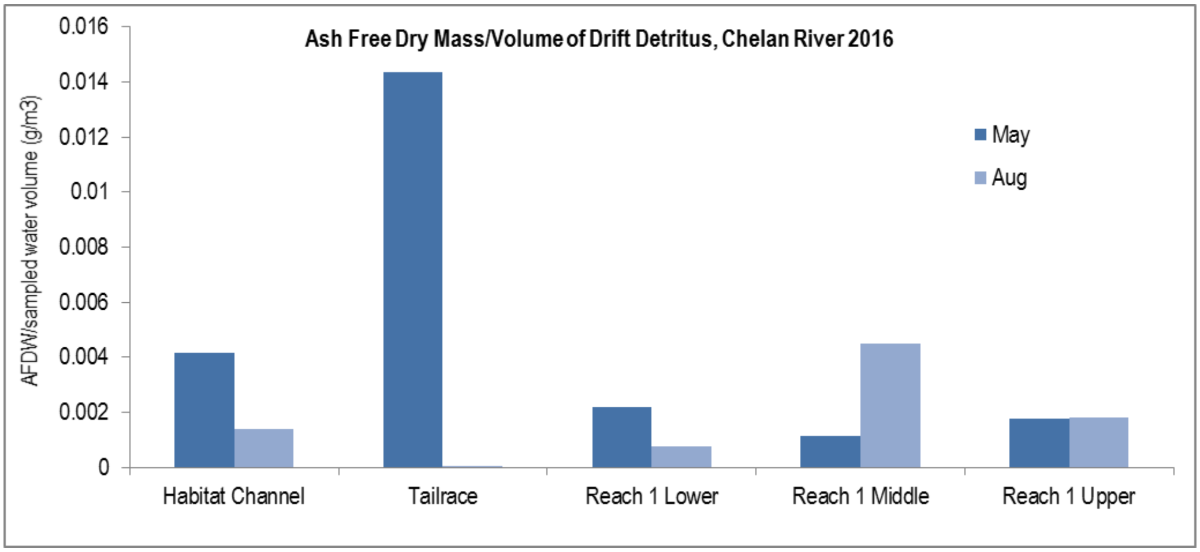

FIGURE 15. Total mass per sampled water volume (g/m^3) of organic drift detritus in the Chelan River, 2016.

DISCUSSION

The field data collection component of this project was completed without any significant protocol modifications, except for a methodology change from modified kick net sampling to dredge sampling in the Above Dam stratum following poor data quality obtained in the May sample. This change yielded much greater quality data than the initially employed approach, in both taxonomic diversity and total abundance of organisms collected, so the revised protocol was permanently changed in the final Quality Assurance Project Plan (QAPP) and recommended for any future sampling efforts under this scope.

The May sampling event was logistically constrained by high flows and a necessary ramp down in dam spill leading up to sampling, which was successfully orchestrated by the PUD and allowed sampling to proceed with no issues. However, macroinvertebrate community composition could have been altered by the high flows prior to sampling, and in fact any bias could have extended into August sampling for long-lived species since flows were high shortly after the May sample period. It is possible that some benthic taxa could have been flushed out of the system by high flows, and that some new drift taxa could have potentially been introduced from the lake, but there is no way to test these hypotheses without extending the time series of sampling, and it is difficult to define baseline conditions without first accounting for natural or introduced variability in the system. We therefore recommend continuing this investigation until inter-annual variability can be adequately described.

Benthic Macroinvertebrate Community- Taxonomic Diversity

The biological diversity of the benthic macroinvertebrate community, as measured by B-IBI, was generally very low compared to reference conditions, and much lower than comparable streams in this ecoregion identified by water temperature, discharge profiles and water source.

However, in absence of pre-dam baseline conditions, it is impossible to say how much benthic community diversity would have existed with natural flows from the hyper-oligotrophic headwater conditions. Furthermore, pre-SA the river was typically dry most of the year, so any pre-dam macroinvertebrates would likely have been entirely extirpated, leaving a "clean slate" by the time the SA was implemented approximately 7 years ago. It is likely that elevated summer temperature is one factor affecting taxa richness, but that is probably not the only factor, and warm water temperatures at the outlet of Lake Chelan are a natural consequence of the shallow basin upstream of the lake outlet. Further study is needed in order to describe temporal variability and trends in the Chelan River benthic community before specific limiting factors can be determined that might be possible to mitigate. It is possible that community diversity will improve as riparian cover is further developed. The SA does not explicitly recommend any other enhancements that would be likely to influence benthic community diversity, and given the high temperature water outflowing Lake Chelan, it would be very difficult to affect a change in summer water temperatures in the river through riparian enhancement alone.

Benthic Community Dispersal / Recruitment

Similarities indices suggest that the Above Dam stratum may contribute more benthic organisms to the Tailrace stratum than to the Reach 1 or Habitat Channel strata. However, this could also be a result of the available habitat being more similar between the Tailrace and Above Dam strata (sandy substrate, low velocity). The Habitat Channel also receives 60-80% of its water pumped directly from the tailrace in the spring and fall, but the high similarity of community structures between Reach 1 and the Habitat Channel, as high as 82.4% in Reach 1 Middle in May (Sørensen; Chao *et al*. 2005) suggest that downstream dispersal from the river is a more important recruitment mechanism than from the lake to the Habitat Channel despite the seasonal direct water source.

The relative contribution of Lake Chelan (Above Dam) to the Chelan River benthic community seems to be low. This stratum also exhibited the lowest diversity of any strata sampled, a reasonable result given that any source colonies in tributaries to the lake would be unlikely to survive the distance or depth of the lake in transport to the outlet. It would therefore be unlikely to expect much colonization to the Chelan River benthic community from downstream dispersal, either via spillway to Reach 1 or powerhouse outflow to the tailrace or habitat channel. The Rocky Reach reservoir has also shown poor benthic diversity of EPT[1] taxa in previous studies (CPUD 2000), and offers a limited source for upstream migration of potential colonizers to the tailrace or habitat channel. Upstream migration would be inhibited between the Habitat Channel and Reach 1 by the Chelan River Gorge, and would be impossible through the spillway or powerhouse outflows to Lake Chelan. This means that any colonization within the Chelan River is likely dominated by aerial (e.g., wind, aerial plankton; see Bilton *et al.* 2001) or passive (e.g., waterfowl) dispersal mechanisms from distant populations, and any level of restoration within the river could be ineffective at improving benthic communities (Brederveld *et al*. 2011). Furthermore, there was a lack of Plecoptera (stoneflies) species in all strata and both

[1] Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), three taxa of aquatic macroinvertebrates that are intolerant to pollution and poor water quality.

seasons. Stoneflies typically occupy areas of substrate similar to the Chelan River, and are generally tolerant of short-term exposure to high water temperatures. We would therefore expect to see this taxa, at least in some numbers, within our samples if a recruitment source were available. Stoneflies are weak fliers, and therefore can only recruit from nearby streams, further supporting the hypothesis that dispersal/recruitment is the key limiting factor to colonization in the Chelan River (Briers *et al.* 2002). It is possible that translocation of EPT taxa from another stream could help establish a population within the Chelan River, but the literature is weak on this method and further study would be needed.

Benthic Community Comparison

Low B-IBI metric scores in the Chelan River, relative to all comparison streams, suggests that high summer temperatures and lake source flows cannot alone explain the low benthic community diversity of the Chelan River. The Palouse River was the closest match to the Chelan River in both discharge and temperature, and experiences similarly wide fluctuations in high to low discharge, although the seasonality of these hydrologic events differs. Of particular interest are the Chelan River and Palouse River's similarly low scores in semi-voltine and clinger metrics. Semi-voltine are long-lived species that take more than a year to complete their life cycle. They are especially sensitive to streams that run dry or have large flooding events, which is characteristic of both the Chelan and Palouse Rivers. Clingers prefer cobble and boulder habitats and are negatively impacted by high embeddedness. The Palouse River has fine sedimentation issues that are probably also affecting clinger populations, but this does not appear to be a limiting factor in the Chelan River. It therefore appears that high discharge variability is the most significant common factor influencing reduced benthic diversity between these systems, but is likely not as significant a limiting factor as biotic recruitment sources. There are many examples of other rivers that experience significant seasonal flood events and still support healthy benthic macroinvertebrate communities. Like temperature, hydrology in the Chelan River would be very difficult to control through any reasonable management actions or habitat enhancements, given its incised channel morphology, lack of sediment source, and complexity in lake level management regimes.

Drift Community Dispersal / Recruitment

Similar to benthic taxa, we showed that a greater similarity between Reach 1 and the Habitat Channel communities suggests downstream dispersal is an important recruitment mechanism, but could not directly compare drift communities above and below the dam to assess whether Lake Chelan provides adequate recruitment stock to colonize the river. Sampling in 2016 was not targeted at drift macroinvertebrates above the dam, because the initial objective was to compare taxonomy of the benthic communities above and below the dam to explore possible recruitment sources for benthic macroinvertebrates in the river. Therefore, the best comparison possible for drift macroinvertebrates above and below the dam was to use the tailrace as a proxy for the above dam environment, as it is a direct outflow, versus the other sample strata that bypass through a variety of habitats and possible recruitment sources. However, because of available habitat within protocol standards, the tailrace sample in May was located below the confluence of the habitat channel, and although flow appeared to be dominated by water from the tailrace, could have been mixed with other sources. We believe that the low similarity in taxa abundances and relatively lower similarity in taxa compositions between the tailrace and other upstream strata suggest that, similar to the benthic community, Lake Chelan likely contributes little to the drift macroinvertebrate community in the Chelan River. However, this could warrant further investigation if organisms found closer to the lake surface are entering Reach 1 of the river via the spillway in greater quantities than are entering the tailrace through the powerhouse outflow, which could also explain some of the dissimilarity in community composition between the tailrace and other strata. This could also help further explain recruitment pathways for benthic taxa entering the river via spillway from Lake Chelan if they are waterborne and not accessible to collection by benthic kicknet in Reach 1. We recommend development and testing of a method such as plankton trawl nets to allow drift macroinvertebrate sampling for comparison above the dam. The developed method must allow measurement of sample volume, and sample a similar volume to nets set in wadeable strata so that biomass and diversity can be directly compared.

Drift Community Comparison

Biomass and taxonomic composition of the drift community were at a similar level to the six Upper Columbia CHaMP comparison streams. Overall taxonomic diversity was somewhat lower, but without other lake-fed streams available for comparison it is difficult to draw any conclusions from this. Although further bioenergetics modeling would be needed, it is likely that drift macroinvertebrates provide an important food source for resident and rearing fish in Reach 1 and the Habitat Channel.

Outlier samples of Cladocera (May Habitat Channel) and Copepoda (August Tailrace) were found in only two samples in the Chelan River and virtually nowhere else in comparison streams. These taxa are also uncommon in the Columbia River, but have been found in previous plankton surveys in Lake Chelan (S. Hays pers. comm.). It is therefore likely these species were entrained at the Chelan Dam penstock intake. Habitat Channel flows in May were supplemented by pumped tailrace water, so the lack of copepods in the May tailrace sample is puzzling; however, it is not uncommon to observe patchy distribution of zooplankton, particularly in deep, slow moving water. The lack of Cladocera in the Habitat Channel in August is not surprising since there was no pumped tailrace water at that time of year. The presence of Copepoda and Cladocera taxa may not accurately represent the biodiversity of the Chelan River, but they could provide an important food source for fish rearing in the tailrace and habitat channel. It is somewhat surprising that neither of these lake-sourced taxa were found in the Reach 1 samples, but perhaps because the low-level outlet draws water only from the bottom 18 inches at the Chelan Dam, there is not as much exchange of pelagic organisms entrained by the low-level outlet as the penstock.

Organic Drift Detritus

Overall, we observed a greater amount of drift detritus in May than in August, which is contrary to expectations since increases of instream algae typically correlate with increased summer temperatures. We also saw a similar biomass in all strata except for the tailrace, where we saw the greatest seasonal variability and highest amount in the May sample. The cause of this is uncertain, but could be a result of settled detritus in Lake Chelan being upwelled and transported through the penstock during activation of the spill overflow channel during the lead up to the May sampling window. Although turbidity was not explicitly measured, visibility seemed slightly poorer in May than August, especially within the tailrace, which could also be a result of this activation. Anecdotally, we observed a greater presence of Didymo in the upper part of Reach 1 than elsewhere, with an increase in August. This could account for some of the increase in detritus in Reach 1 in August, but it is difficult to validate as detritus was only weighed and not identified. It is unlikely that samples were influenced by leaf litter or woody debris as riparian cover is poor throughout middle and upper Reach 1, and water flowing from the lake is generally clean.

Recommendations

1) Repeat this study for an additional 2 years, to account for natural interannual variability in community structures, as well as any potential bias introduced by unusual flow regimes in 2016.

2) Introduce drift macroinvertebrate trawl sampling methods above the dam, to further explore this area as a recruitment source for downstream communities.

3) Increase the total sample size in future collection efforts (i.e., collect more samples within each strata or increased periodicity of sampling) to allow more advanced statistical comparison of samples.

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APPENDIX A: DRIFT TRANSECT MASTER SAMPLE LIST

SiteID	Strata	Lat	Long	Use Order	Evaluation
CRPUD16_76	Habitat Channel	47.80870702	-119.9843489	1	Accept
CRPUD16_70	Habitat Channel	47.80658178	-119.9857635	2	
CRPUD16_69	Habitat Channel	47.8061344	-119.9856961	3	Reject- too close to targeted tailrace sample
CRPUD16_72	Habitat Channel	47.80736273	-119.9854115	4	
CRPUD16_74	Habitat Channel	47.80811289	-119.9850012	5	
CRPUD16_78	Habitat Channel	47.80957276	-119.9845781	6	
CRPUD16_75	Habitat Channel	47.8082989	-119.9844046	7	
CRPUD16_79	Habitat Channel	47.81001609	-119.9846393	8	Reject- overlaps LWD structure
CRPUD16_71	Habitat Channel	47.80694381	-119.985442	9	
CRPUD16_73	Habitat Channel	47.80780206	-119.985429	10	
CRPUD16_77	Habitat Channel	47.80912313	-119.9845803	11	
CRPUD16_68	Habitat Channel	47.80569071	-119.9855889	12	Reject- too close to targeted tailrace sample
CRPUD16_18	Reach 1 Lower	47.82394305	-119.9962547	1	Accept
CRPUD16_21	Reach 1 Lower	47.82446537	-119.998092	2	
CRPUD16_20	Reach 1 Lower	47.82429593	-119.9974814	3	
CRPUD16_09	Reach 1 Lower	47.82254983	-119.9906717	4	
CRPUD16_15	Reach 1 Lower	47.82346597	-119.9943936	5	
CRPUD16_10	Reach 1 Lower	47.82263946	-119.9913255	6	
CRPUD16_01	Reach 1 Lower	47.81959611	-119.9887145	7	
CRPUD16_12	Reach 1 Lower	47.82287537	-119.9925997	8	
CRPUD16_04	Reach 1 Lower	47.82089452	-119.9886463	9	
CRPUD16_22	Reach 1 Lower	47.82475478	-119.9985928	10	
CRPUD16_08	Reach 1 Lower	47.82237125	-119.9900644	11	
CRPUD16_14	Reach 1 Lower	47.82330034	-119.9937734	12	
CRPUD16_16	Reach 1 Lower	47.82365456	-119.9949979	13	
CRPUD16_05	Reach 1 Lower	47.82131948	-119.9888588	14	
CRPUD16_07	Reach 1 Lower	47.82208843	-119.9895468	15	
CRPUD16_19	Reach 1 Lower	47.82412093	-119.9968667	16	
CRPUD16_03	Reach 1 Lower	47.8204676	-119.9884497	17	
CRPUD16_06	Reach 1 Lower	47.82170925	-119.9891906	18	
CRPUD16_17	Reach 1 Lower	47.82378921	-119.9956346	19	
CRPUD16_13	Reach 1 Lower	47.82309888	-119.9931782	20	
CRPUD16_11	Reach 1 Lower	47.82270277	-119.9919863	21	
CRPUD16_02	Reach 1 Lower	47.82002174	-119.9885045	22	
CRPUD16_28	Reach 1 Middle	47.8273328	-119.9984114	1	Accept
CRPUD16_43	Reach 1 Middle	47.83216519	-120.0001326	2	
CRPUD16_29	Reach 1 Middle	47.82775152	-119.9981699	3	
CRPUD16_31	Reach 1 Middle	47.82862035	-119.9978341	4	
CRPUD16_23	Reach 1 Middle	47.82515805	-119.9988705	5	
CRPUD16_26	Reach 1 Middle	47.82649323	-119.9988818	6	
CRPUD16_35	Reach 1 Middle	47.83037736	-119.9972999	7	
CRPUD16_36	Reach 1 Middle	47.83082639	-119.9972741	8	
CRPUD16_25	Reach 1 Middle	47.82604891	-119.998971	9	
CRPUD16_42	Reach 1 Middle	47.83235707	-119.9995334	10	
CRPUD16_44	Reach 1 Middle	47.83193357	-120.0007049	11	
CRPUD16_32	Reach 1 Middle	47.82905871	-119.9976857	12	
CRPUD16_30	Reach 1 Middle	47.82818019	-119.99797	13	
CRPUD16_41	Reach 1 Middle	47.83244431	-119.9988826	14	
CRPUD16_27	Reach 1 Middle	47.82692022	-119.9986763	15	
CRPUD16_40	Reach 1 Middle	47.83235911	-119.9982334	16	
CRPUD16_34	Reach 1 Middle	47.82993417	-119.9973909	17	
CRPUD16_38	Reach 1 Middle	47.83171723	-119.9973497	18	
CRPUD16_33	Reach 1 Middle	47.82949871	-119.9975491	19	
CRPUD16_37	Reach 1 Middle	47.83127585	-119.9972586	20	
CRPUD16_24	Reach 1 Middle	47.82559939	-119.99898	21	
CRPUD16_39	Reach 1 Middle	47.83209356	-119.9977055	22	
CRPUD16_51	Reach 1 Upper	47.83313926	-120.0031799	1	Reject- Field Eval, visible fire retardant prevalent in site
CRPUD16_59	Reach 1 Upper	47.83632567	-120.0052844	2	Accept
CRPUD16_60	Reach 1 Upper	47.83666325	-120.0056976	3	
CRPUD16_49	Reach 1 Upper	47.83224225	-120.0031569	4	
CRPUD16_47	Reach 1 Upper	47.83148244	-120.0025632	5	

SiteID	Strata	Lat	Long	Use Order	Evaluation
CRPUD16_65	Reach 1 Upper	47.83571112	-120.0080095	6	
CRPUD16_45	Reach 1 Upper	47.83171421	-120.001287	7	
CRPUD16_58	Reach 1 Upper	47.83596184	-120.0049004	8	
CRPUD16_62	Reach 1 Upper	47.83678706	-120.0069083	9	
CRPUD16_66	Reach 1 Upper	47.83529514	-120.0082591	10	
CRPUD16_54	Reach 1 Upper	47.83446164	-120.0034543	11	
CRPUD16_67	Reach 1 Upper	47.83486163	-120.008461	12	Reject- too close to top of survey extent
CRPUD16_64	Reach 1 Upper	47.83612871	-120.007763	13	
CRPUD16_46	Reach 1 Upper	47.83155291	-120.0019094	14	
CRPUD16_57	Reach 1 Upper	47.83557471	-120.0045663	15	
CRPUD16_50	Reach 1 Upper	47.8326898	-120.0031948	16	
CRPUD16_48	Reach 1 Upper	47.83181062	-120.0029809	17	
CRPUD16_55	Reach 1 Upper	47.83483914	-120.0038108	18	
CRPUD16_63	Reach 1 Upper	47.83650824	-120.0074289	19	
CRPUD16_53	Reach 1 Upper	47.83403419	-120.0032564	20	
CRPUD16_56	Reach 1 Upper	47.83519426	-120.0042203	21	
CRPUD16_61	Reach 1 Upper	47.83687645	-120.0062787	22	
CRPUD16_52	Reach 1 Upper	47.83358865	-120.0031889	23	

APPENDIX B: BENTHIC REFERENCE AND COMPARISON STREAM DATA

Site ID	Stream Name	Comparison Group	Taxa Richness	Taxa Richness Score	E Richness	E Richness Score	P Richness	P Richness Score	T Richness	T Richness Score	Pollution Sensitive Richness	Pollution Sensitive Richness Score
BIO06600-ROBI77	Robinson Creek	Reference Site	41	4.8	8	10	8	10	7	7.5	9	10
BIO06600-TRCO09	Tributary to Coleman Creek	Reference Site	30	1	4	4.3	7	8.6	2	1.2	4	5.7
SEN06600-TWEN05	Twentyfive Mile Creek	Reference Site	60	10	12	10	10	10	10	10	11	10
SEN06600-TEAN04	Teanaway River Middle Fork	Reference Site	61	10	10	10	4	4.3	7	7.5	7	10
BIO06600-WILS09	Wilson Creek	Reference Site	57	10	10	10	10	10	6	6.2	11	10
BIO06600-FIRS09	First Creek	Reference Site	57	10	9	10	10	10	6	6.2	7	10
BIO06600-SHAD09	Shadow Creek	Reference Site	55	9.7	9	10	8	10	6	6.2	10	10
BIO06600-NTAN09	Taneum Creek, North Fork	Reference Site	57	10	13	10	6	7.1	9	10	12	10
BIO06600-STAN09	Taneum Creek, South Fork	Reference Site	51	8.3	12	10	8	10	12	10	14	10

Site ID	Stream Name	Comparison Group	Taxa Richness	Taxa Richness Score	E Richness	E Richness Score	P Richness	P Richness Score	T Richness	T Richness Score	Pollution Sensitive Richness	Pollution Sensitive Richness Score
WAM06600-008478	Yakima River	Lake-fed	54	9.3	7	8.6	3	2.9	5	5	3	4.3
SEN06600-CLEE12	Cle Elum River	Lake-fed	40	4.5	8	10	8	10	6	6.2	6	8.6
WAM06600-000586	Palouse River	Best Match	32	1.7	1	0	0	0	1	0	0	0
BIO06600-SFCO10	Cowiche River, South Fork	High Temperature	48	7.2	7	8.6	5	5.7	4	3.8	3	4.3
SEN06600-UMTA18	Umtanum Creek	High Temperature	56	10	7	8.6	4	4.3	7	7.5	3	4.3
WAM06600-009134	Teanaway River West Fork	High Temperature	58	10	10	10	6	7.1	4	3.8	4	5.7

Site ID	Clinger Richness	Clinger Richness Score	Semivoltine Richness	Semivoltine Richness Score	Pollution Tolerant Percent	Pollution Tolerant Percent Score	Predator Percent	Predator Percent Score	Dominant Taxa Percent	Dominant Taxa Percent Score	EPT Richness	IBI
BIO06600-ROBI77	17	5.9	5	3.8	0.6	9.9	7.2	3.1	43.4	6.9	23	71.8
BIO06600-TRCO09	6	0	9	8.8	4.4	9	7.4	1.7	62.8	1.7	13	43.5
SEN06600-TWEN05	26	10	9	8.8	4.2	9	9.6	4.3	38.2	8.3	32	90.4
SEN06600-TEAN04	26	10	6	5	3.6	9.2	12.6	5.8	28.8	10	21	81.7
BIO06600-WILS09	20	7.6	11	10	1	9.8	15.4	7.2	31	10	26	90.9
BIO06600-FIRS09	21	8.2	11	10	2.2	9.5	14	6.5	27	10	25	90.5
BIO06600-SHAD09	19	7.1	11	10	0.6	9.9	15.2	7.1	46.4	6.1	23	86
BIO06600-NTAN09	28	10	9	8.8	0	10	10.2	4.6	39	8.1	28	88.6
BIO06600-STAN09	29	10	12	10	4.9	8.9	43.7	10	29.4	10	32	97.1
WAM06600-008478	23	9.4	6	5	8.6	8	4.4	1.7	46.6	6.1	15	60.2
SEN06600-CLEE12	20	7.6	9	8.8	0.6	9.9	11.2	5.1	42.8	7.1	22	77.7
WAM06600-000586	7	0	4	2.5	1.4	9.7	9.4	4.2	53.9	4.1	2	22.2
BIO06600-SFCO10	21	8.2	6	5	0.2	10	10.6	4.8	41.2	7.5	16	65.1
SEN06600-UMTA18	22	8.8	8	7.5	0.4	9.9	18.4	8.7	28.2	10	18	79.6
WAM06600-009134	26	10	7	6.2	3.4	9.2	11.4	5.2	26	10	20	77.3

APPENDIX D: CONSULTATION RECORDS

Chelan PUD, on February 28, 2017, provided a draft of the 2017 Chelan River Biological Objectives Status Report to Ecology and members of the CRFF for 30-day review. The review period was in accordance with the requirements of the May 19, 2010, FERC Order granted a time extension, which set the date for this report to be filed by April 30, 2017. Two consultant prepared reports, that are contained in Appendices B and C, were also provided to Ecology and the CRFF for thirty-day review on February 24, 2017, and March 9, 2017, respectively. In addition, an email was provided to Ecology and the CRFF on March 30, 2017, to remind them that the comment periods were about to end and to offer additional review time upon request.

The following individuals were sent draft copies for a 30-day review periods for the 2017 Chelan River Biological Objectives Status Report and the reports in Appendices B and C. No comments were received on the 2017 Chelan River Biological Objectives Status Report. There was a question received about the Appendix B: Snorkel Surveys In The Chelan Falls Habitat Channel And Tailrace, And Reach 1 Of The Chelan River, Wa – 2016, which was answered but did not result in changes to the report. There was one response of "no comments" to Appendix C: Macroinvertebrate Investigation Chelan River, Washington. The email correspondence is reproduced below.

NAME	***AGENCY***	***Comments***
Zimmrman, Breean	Washington State Department of Ecology	-
Peterschmidt, Mark	Washington State Department of Ecology	-
Bowen, David	Washington State Department of Ecology	-
Pacheco, Jim	Washington State Department of Ecology	-
Korth, Jeffrey	Washington State Department of Fish and Wildlife	-
Simon, Graham	Washington State Department of Fish and Wildlife	-
Maitland, Travis	Washington State Department of Fish and Wildlife	-
Grover Wier, Kari	United States Department of Agriculture – Forest Service	-
Willard, Paul	United States Department of Agriculture – Forest Service	-
Johnson, Emily	United States Department of Agriculture – Forest Service	-
Martinez, Alex	United States Department of Agriculture – Forest Service	-
Rawhouser, Ashley	National Park Service	-
Anthony, Hugh	National Park Service	-
Lewis, Steve	United States Fish and Wildlife Service	-
Yeager, Justin	National Marine Fisheries Services	-
Domingue, Richard	National Marine Fisheries Services	-
Hossack,Bonnie	National Marine Fisheries Services	-
Towey, Bill	Confederated Tribes of the Colville Reservation	-
Rose, Bob	Yakama Indian Nation	-
Merkle, Carl	Confederated Tribes of the Umatilla Indian Reservation	-
Cooney, Mike	City of Chelan	-
Archibald, Phil	Lake Chelan Sportsman Association	-
Elwell, Nick	United States Geological Survey	-
Ernsberger, Tom	Washington State Parks and Recreation Commission	-
Snell, Nona	Washington State Recreation and Conservation Office	-
Uhlhorn, Richard	Lake Chelan Recreation Association	-
O'Keefe, Thomas	American Whitewater	-

From: Hays, Steve
Sent: Friday, February 24, 2017 2:36 PM
To: 'Breean Zimmerman (bzim461@ecy.wa.gov)' <bzim461@ecy.wa.gov>; 'Peterschmidt, Mark F. (ECY) (mape461@ecy.wa.gov)' <MAPE461@ECY.WA.GOV>; 'david.bowen@ecy.wa.gov' <david.bowen@ecy.wa.gov>; 'Jim Pacheco' <jpac461@ecy.wa.gov>; 'Korth, Jeffrey ' <Jeffrey.Korth@dfw.wa.gov>; 'Graham Simon' <Graham.Simon@dfw.wa.gov>; 'travis.maitland@dfw.wa.gov' <travis.maitland@dfw.wa.gov>; 'Kari Grover Wier' <kgroverwier@fs.fed.us>; 'pwillard@fs.fed.us' <pwillard@fs.fed.us>; Emily Johnson (ekjohnson@fs.fed.us) <ekjohnson@fs.fed.us>; 'Alex Martinez (ramartinez@fs.fed.us)' <ramartinez@fs.fed.us>; 'Ashley_Rawhouser@nps.gov' <Ashley_Rawhouser@nps.gov>; 'Hugh_Anthony@nps.gov' <Hugh_Anthony@nps.gov>; 'Steve Lewis (Stephen_Lewis@fws.gov)' <Stephen_Lewis@fws.gov>; 'Rich Domingue (richard.domingue@noaa.gov)' <richard.domingue@noaa.gov>; 'Bonnie.Hossack@noaa.gov' <Bonnie.Hossack@noaa.gov>; 'Justin Yeager (Justin.Yeager@noaa.gov)' <Justin.Yeager@noaa.gov>; 'Bill Towey' <bill.towey@colvilletribes.com>; 'Bob Rose (rosb@yakamafish-nsn.gov)' <rosb@yakamafish-nsn.gov>; 'Carl Merkle (carlmerkle@ctuir.com)' <carlmerkle@ctuir.com>; 'mcooney@cityofchelan.us' <mcooney@cityofchelan.us>; 'Phil Archibald (ndmarkey@gmail.com)' <ndmarkey@gmail.com>; 'Nick Elwell' <'nelwell@usgs.gov'>; 'tom.ernsberger@parks.wa.gov' <tom.ernsberger@parks.wa.gov>; 'nona.snell@rco.wa.gov' <nona.snell@rco.wa.gov>; 'Richard Uhlhorn (richard@richarduhlhorn.com)' <richard@richarduhlhorn.com>; 'Thomas O'Keefe (okeefe@amwhitewater.org)' <okeefe@amwhitewater.org>
Subject: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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To: Chelan River Fishery Forum
- Washington Department of Ecology
- Washington Department of Fish and Wildlife
- United States Forest Service
- National Park Service
- United States Fish and Wildlife Service
- National Marine Fisheries Service
- CCT (Colville)
- YN (Yakama)
- CTUIR (Umatilla tribe)
- City of Chelan
- Lake Chelan Sportsman Association

United States Geological Survey
Washington State Parks and Recreation Commission
Washington State Recreation and Conservation Office
Lake Chelan Recreation Association
American Whitewater

From: Steven Hays, Fish & Wildlife Senior Advisor
Public Utility District No. 1 of Chelan County (Chelan PUD)
steve.hays@chelanpud.org
(509)661-4181

Re: Lake Chelan Hydroelectric Project No. 637 (Project)
30 Day Review and Comment Period – Snorkel Surveys in the Chelan Falls Habitat Channel and Tailrace, and Reach 1 of the Chelan River, WA - 2016

Dear Chelan River Fishery Forum and Other Parties:

Monthly snorkel surveys of the Chelan River Reach 1, Habitat Channel and Tailrace were conducted in 2016. This study is the first of two years of monthly surveys (the second year will be in 2018) that were called for in the Lake Chelan Comprehensive Plan, Chapter 7, Chelan River Biological Evaluation and Implementation Plan. The attached copy is provided for your review.

Please submit your comment letters on or before 5:00 p.m., March 28, 2017, to Steve Hays via email at steve.hays@chelanpud.org. In order to facilitate documentation of your comments and Chelan PUD's responses to comments regarding significant substantive issues, please provide those comments and any supportive rationales or data in a separate document so that it can be incorporated into the record of consultation. I have provided the report in PDF format. However, upon request I will provide a copy in MSWORD if you wish to propose editorial changes using the review features in MSWORD to make your suggested edits.

All comments received will be incorporated into a summary table and appended to the Final Report, Snorkel Surveys in the Chelan Falls Habitat Channel and Tailrace, and Reach 1 of the Chelan River, WA – 2016, with a notation regarding how each comment or recommendation was incorporated in the report, or, if not incorporated, the reasons why the comment was not incorporated.

If you have any questions, please do not hesitate to contact me at (509-661-4181) or by email.

Steven Hays

Fish and Wildlife Senior Advisor
steve.hays@chelanpud.org
(509) 661-4181

One question was received regarding this report. The question and responses to that question are provided below. The report was not changed since the question was not about language in the report.

From: Maitland, Travis W (DFW) [mailto:Travis.Maitland@dfw.wa.gov]
Sent: Friday, February 24, 2017 3:09 PM
To: Hays, Steve
Cc: Osborn, Jeff; Simon, Graham A (DFW)
Subject: RE: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

Chelan County PUD IT Warning:
Please use caution! This is an external email with links or attachments.
One adult Chinook in reach one? Very interesting! I wonder if it spilled over as a juvenile or adult…probably no way of being able to determine that though.

Travis Maitland

Washington Department of Fish and Wildlife Dist. 7 Fish Biologist Wenatchee District Office
3860 Hwy 97a
Wenatchee, WA 98801
(509) 665-3337

From: Hays, Steve
Sent: Friday, February 24, 2017 3:41 PM
To: 'Maitland, Travis W (DFW)'
Cc: Osborn, Jeff; Simon, Graham A (DFW)
Subject: RE: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

The snorkelers said it looked like a "lake fish". It was adult size if I recall. I will ask the snorkel crew if they remember. They saw it on May 1

From: Hays, Steve
Sent: Friday, February 24, 2017 3:46 PM
To: John Stevenson <john.stevenson@bioanalysts.net>; (mark.miller@bioanalysts.net) <mark.miller@bioanalysts.net>; 'Denny Snyder' (denny.snyder@bioanalysts.net) <denny.snyder@bioanalysts.net>
Cc: Maitland, Travis W (DFW) <Travis.Maitland@dfw.wa.gov>; Graham Simon (graham.simon@dfw.wa.gov) <graham.simon@dfw.wa.gov>; Osborn, Jeff <Jeff.Osborn@chelanpud.org>
Subject: FW: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

Hi John, Mark, Denny,

Do you remember more details on the adult Chinook seen in Reach 1 (May 3 survey). See below

Thanks,

Steve

From: Mark Miller [mailto:mark.miller@bioanalysts.net]
Sent: Friday, February 24, 2017 4:03 PM
To: 'Hays, Steve' <steve.hays@chelanpud.org>; 'John Stevenson' <john.stevenson@bioanalysts.net>; "Denny Snyder" <denny.snyder@bioanalysts.net>
Cc: 'Maitland, Travis W (DFW)' <Travis.Maitland@dfw.wa.gov>; 'Graham Simon' <graham.simon@dfw.wa.gov>; 'Osborn, Jeff' <Jeff.Osborn@chelanpud.org>
Subject: RE: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

Steve,

The adult Chinook was in very good condition probably on the smaller size of a typical spring Chinook we see in the Chiwawa every year. We observed the adult Chinook just below the multiple channel habitat. The Chinook showed no signs of turning color or any obvious descaling that I could see. If you look at the fish in this you tube video (very start of video) it about a replica of the size and condition of Chinook I observed in Reach 1. Sorry for the you tube plug but a picture is worth a thousand words.

https://www.youtube.com/watch?v=O-pf7ayH_yw<https://urldefense.proofpoint.com/v2/url?u=https-3A__www.youtube.com_watch-3Fv-3DO-2Dpf7ayH-5Fyw&d=DwMFAg&c=UFACIOAgGpMNe7glHTyWnkdnGv-MOCky1SEhaWd2_pQ&r=ezU4PxVZ39OSTZWDbFxSFrVbVPe0WeCmfe3NvA5sPGA&m=hR_KJuPnjUKrzum_DAwdrWXt2lAkBE-VkRawAdXZhaU&s=1SnchVWDr3VHqrXZ09hn_QXdPY-TPyPUGhz-2lfi0s0&e=>

Mark Miller
BioAnalysts, Inc.
4725 N. Cloverdale Rd.
Boise, ID 83713
Phone: (208) 321-0363
Cell: (208) 890-4038

From: John R. Stevenson [mailto:john.stevenson@bioanalysts.net]
Sent: Friday, February 24, 2017 4:11 PM
To: 'Mark Miller' <mark.miller@bioanalysts.net>; Hays, Steve <steve.hays@chelanpud.org>; "Denny Snyder" <denny.snyder@bioanalysts.net>
Cc: 'Maitland, Travis W (DFW)' <Travis.Maitland@dfw.wa.gov>; 'Graham Simon' <graham.simon@dfw.wa.gov>; Osborn, Jeff <Jeff.Osborn@chelanpud.org>
Subject: RE: 30 Day Review and Comment Period - Chelan River Snorkel Surveys - 2016

Hi Steve,

I was not on that survey, but I just talked to Denny. To add to what Mark said, our notes indicate that the Chinook was estimated to be 23" in length, and was observed by both Mark and Denny. Denny said he got some pictures of it, but they are not very good. Obviously, there is no way of saying for certain, but I'm guessing that fish came down from the lake as an adult. With such good clarity in Reach 1, and the number of experienced bios snorkeling, if it had been in there from a juvenile I'm guessing we would have seen it before May. There is always a chance it resided in either Reach 2 or 3 and just happened to be there on May 3, but I doubt it. Let me know if you need anything else.

Thanks, John

From: Hays, Steve
Sent: Tuesday, February 28, 2017 5:13 PM
To: 'Breean Zimmerman (bzim461@ecy.wa.gov)' <bzim461@ecy.wa.gov>; 'Peterschmidt, Mark F. (ECY) (mape461@ecy.wa.gov)' <MAPE461@ECY.WA.GOV>; 'david.bowen@ecy.wa.gov' <david.bowen@ecy.wa.gov>; 'Jim Pacheco' <jpac461@ecy.wa.gov>; 'Korth, Jeffrey ' <Jeffrey.Korth@dfw.wa.gov>; 'Graham Simon' <Graham.Simon@dfw.wa.gov>; 'travis.maitland@dfw.wa.gov' <travis.maitland@dfw.wa.gov>; 'Kari Grover Wier' <kgroverwier@fs.fed.us>; 'pwillard@fs.fed.us' <pwillard@fs.fed.us>; 'Emily Johnson (ekjohnson@fs.fed.us)' <ekjohnson@fs.fed.us>; 'Alex Martinez (ramartinez@fs.fed.us)' <ramartinez@fs.fed.us>; 'Ashley_Rawhouser@nps.gov' <Ashley_Rawhouser@nps.gov>; 'Hugh_Anthony@nps.gov' <Hugh_Anthony@nps.gov>; 'Steve Lewis (Stephen_Lewis@fws.gov)' <Stephen_Lewis@fws.gov>; 'Rich Domingue (richard.domingue@noaa.gov)' <richard.domingue@noaa.gov>; 'Bonnie.Hossack@noaa.gov' <Bonnie.Hossack@noaa.gov>; 'Justin Yeager (Justin.Yeager@noaa.gov)' <Justin.Yeager@noaa.gov>; 'Bill Towey' <bill.towey@colvilletribes.com>; 'Bob Rose (rosb@yakamafish-nsn.gov)' <rosb@yakamafish-nsn.gov>; 'Carl Merkle (carlmerkle@ctuir.com)' <carlmerkle@ctuir.com>; 'mcooney@cityofchelan.us' <mcooney@cityofchelan.us>; 'Phil Archibald (ndmarkey@gmail.com)' <ndmarkey@gmail.com>; 'Nick Elwell' <'nelwell@usgs.gov'>; 'tom.ernsberger@parks.wa.gov' <tom.ernsberger@parks.wa.gov>; 'nona.snell@rco.wa.gov' <nona.snell@rco.wa.gov>; 'Richard Uhlhorn (richard@richarduhlhorn.com)' <richard@richarduhlhorn.com>; 'Thomas O'Keefe (okeefe@amwhitewater.org)' <okeefe@amwhitewater.org>
Subject: 30 Day Review and Comment Period - Chelan River Biological Objectives 2017 Status Report

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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To: Chelan River Fishery Forum
- Washington Department of Ecology
- Washington Department of Fish and Wildlife
- United States Forest Service
- National Park Service
- United States Fish and Wildlife Service
- National Marine Fisheries Service
- CCT (Colville)
- YN (Yakama)
- CTUIR (Umatilla tribe)
- City of Chelan
- Lake Chelan Sportsman Association

United States Geological Survey
Washington State Parks and Recreation Commission
Washington State Recreation and Conservation Office

Lake Chelan Recreation Association
American Whitewater

From: Steven Hays, Fish & Wildlife Senior Advisor
Public Utility District No. 1 of Chelan County (Chelan PUD)
steve.hays@chelanpud.org
(509)661-4181

Re: Lake Chelan Hydroelectric Project No. 637 (Project)
30 Day Review and Comment Period – Chelan River Biological Objectives 2017 Status Report

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Dear Chelan River Fishery Forum and Other Parties:

The Draft Chelan River Biological Objectives 2017 Status Report is attached for your review and comment. The review period is 30 days.

Please submit your comment letters on or before 5:00 p.m., April 3, 2017, to Steve Hays via email at steve.hays@chelanpud.org. In order to facilitate documentation of your comments and Chelan PUD's responses to comments regarding significant substantive issues, please provide those comments and any supportive rationales or data in a separate document so that it can be incorporated into the record of consultation. I have provided the report in PDF format. However, upon request I will provide a copy in MSWORD if you wish to propose editorial changes using the review features in MSWORD to make your suggested edits.

All comments received will be incorporated into a summary table and appended to the Final Report, Chelan River Biological Objectives 2017 Status Report, with a notation regarding how each comment or recommendation was incorporated in the report, or, if not incorporated, the reasons why the comment was not incorporated.

If you have any questions, please do not hesitate to contact me at (509-661-4181) or by email.

Steven Hays
Fish and Wildlife Senior Advisor
steve.hays@chelanpud.org
(509) 661-4181
From: Hays, Steve
Sent: Thursday, March 09, 2017 4:40 PM
To: 'Breean Zimmerman (bzim461@ecy.wa.gov)' <bzim461@ecy.wa.gov>; 'Peterschmidt, Mark F. (ECY) (mape461@ecy.wa.gov)' <MAPE461@ECY.WA.GOV>; 'david.bowen@ecy.wa.gov' <david.bowen@ecy.wa.gov>; 'Jim Pacheco' <jpac461@ecy.wa.gov>; 'Korth, Jeffrey ' <Jeffrey.Korth@dfw.wa.gov>; 'Graham Simon' <Graham.Simon@dfw.wa.gov>; 'travis.maitland@dfw.wa.gov' <travis.maitland@dfw.wa.gov>; 'Kari Grover Wier' <kgroverwier@fs.fed.us>; 'pwillard@fs.fed.us' <pwillard@fs.fed.us>; 'Emily Johnson (ekjohnson@fs.fed.us)' <ekjohnson@fs.fed.us>; 'Alex Martinez (ramartinez@fs.fed.us)' <ramartinez@fs.fed.us>; 'Ashley_Rawhouser@nps.gov' <Ashley_Rawhouser@nps.gov>; 'Hugh_Anthony@nps.gov' <Hugh_Anthony@nps.gov>; 'Steve Lewis (Stephen_Lewis@fws.gov)' <Stephen_Lewis@fws.gov>; 'Rich Domingue (richard.domingue@noaa.gov)' <richard.domingue@noaa.gov>; 'Bonnie.Hossack@noaa.gov' <Bonnie.Hossack@noaa.gov>; 'Justin Yeager (Justin.Yeager@noaa.gov)' <Justin.Yeager@noaa.gov>; 'Bill Towey' <bill.towey@colvilletribes.com>; 'Bob Rose (rosb@yakamafish-nsn.gov)' <rosb@yakamafish-nsn.gov>; 'Carl Merkle (carlmerkle@ctuir.com)' <carlmerkle@ctuir.com>; 'mcooney@cityofchelan.us' <mcooney@cityofchelan.us>; 'Phil Archibald (ndmarkey@gmail.com)' <ndmarkey@gmail.com>; 'Nick Elwell' <'nelwell@usgs.gov'>; 'tom.ernsberger@parks.wa.gov' <tom.ernsberger@parks.wa.gov>; 'nona.snell@rco.wa.gov' <nona.snell@rco.wa.gov>; 'Richard Uhlhorn (richard@richarduhlhorn.com)' <richard@richarduhlhorn.com>; 'Thomas O'Keefe (okeefe@amwhitewater.org)' <okeefe@amwhitewater.org>
Subject: 30 Day Review and Comment Period - Macroinvertebrate Investigation: Chelan River, WA, Draft Annual Report

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To: Chelan River Fishery Forum
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Washington State Parks and Recreation Commission
Washington State Recreation and Conservation Office

Lake Chelan Recreation Association
American Whitewater

From: Steven Hays, Fish & Wildlife Senior Advisor
Public Utility District No. 1 of Chelan County (Chelan PUD)
steve.hays@chelanpud.org
(509)661-4181

Re: Lake Chelan Hydroelectric Project No. 637 (Project)
30 Day Review and Comment Period – Macroinvertebrate Investigation: Chelan River, WA, Draft Annual Report

----

Dear Chelan River Fishery Forum and Other Parties:

Surveys of the benthic and drift macroinvertebrate community in the Chelan River were conducted in 2016. The attached copy of the report Macroinvertebrate Investigation: Chelan River, WA, Draft Annual Report is provided for your review.

Please submit your comment letters on or before 5:00 p.m., April 10, 2017, to Steve Hays via email at steve.hays@chelanpud.org. In order to facilitate documentation of your comments and Chelan PUD's responses to comments regarding significant substantive issues, please provide those comments and any supportive rationales or data in a separate document so that it can be incorporated into the record of consultation. I have provided the report in PDF format. However, upon request I will provide a copy in MSWORD if you wish to propose editorial changes using the review features in MSWORD to make your suggested edits.

All comments received will be incorporated into a summary table and appended to Macroinvertebrate Investigation: Chelan River, WA, Final Annual Report, with a notation regarding how each comment or recommendation was incorporated in the report, or, if not incorporated, the reasons why the comment was not incorporated.

If you have any questions, please do not hesitate to contact me at (509-661-4181) or by email.

Steven Hays
Fish and Wildlife Senior Advisor
steve.hays@chelanpud.org
(509) 661-4181

From: Pacheco, James (ECY) [mailto:JPAC461@ECY.WA.GOV]
Sent: Monday, March 13, 2017 11:41 AM
To: Hays, Steve <steve.hays@chelanpud.org>
Subject: RE: 30 Day Review and Comment Period - Macroinvertebrate Investigation: Chelan River, WA, Draft Annual Report

Thanks Steve. I have no comments.
Jim

From: Hays, Steve
Sent: Thursday, March 30, 2017 2:30 PM
To: 'Breean Zimmerman (bzim461@ecy.wa.gov)' <bzim461@ecy.wa.gov>; 'Peterschmidt, Mark F. (ECY) (mape461@ecy.wa.gov)' <MAPE461@ECY.WA.GOV>; 'david.bowen@ecy.wa.gov' <david.bowen@ecy.wa.gov>; 'Jim Pacheco' <jpac461@ecy.wa.gov>; 'Korth, Jeffrey ' <Jeffrey.Korth@dfw.wa.gov>; 'Graham Simon' <Graham.Simon@dfw.wa.gov>; 'travis.maitland@dfw.wa.gov' <travis.maitland@dfw.wa.gov>; 'Kari Grover Wier' <kgroverwier@fs.fed.us>; 'pwillard@fs.fed.us' <pwillard@fs.fed.us>; 'Emily Johnson (ekjohnson@fs.fed.us)' <ekjohnson@fs.fed.us>; 'Alex Martinez (ramartinez@fs.fed.us)' <ramartinez@fs.fed.us>; 'Ashley_Rawhouser@nps.gov' <Ashley_Rawhouser@nps.gov>; 'Hugh_Anthony@nps.gov' <Hugh_Anthony@nps.gov>; 'Steve Lewis (Stephen_Lewis@fws.gov)' <Stephen_Lewis@fws.gov>; 'Rich Domingue (richard.domingue@noaa.gov)' <richard.domingue@noaa.gov>; 'Bonnie.Hossack@noaa.gov' <Bonnie.Hossack@noaa.gov>; 'Justin Yeager (Justin.Yeager@noaa.gov)' <Justin.Yeager@noaa.gov>; 'Bill Towey' <bill.towey@colvilletribes.com>; 'Bob Rose (rosb@yakamafish-nsn.gov)' <rosb@yakamafish-nsn.gov>; 'Carl Merkle (carlmerkle@ctuir.com)' <carlmerkle@ctuir.com>; 'mcooney@cityofchelan.us' <mcooney@cityofchelan.us>; 'Phil Archibald (ndmarkey@gmail.com)' <ndmarkey@gmail.com>; 'Nick Elwell' <'nelwell@usgs.gov'>; 'tom.ernsberger@parks.wa.gov' <tom.ernsberger@parks.wa.gov>; 'nona.snell@rco.wa.gov' <nona.snell@rco.wa.gov>; 'Richard Uhlhorn (richard@richarduhlhorn.com)' <richard@richarduhlhorn.com>; 'Thomas O'Keefe (okeefe@amwhitewater.org)' <okeefe@amwhitewater.org>
Subject: 30 Day Review and Comment Periods Ending

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From: Steven Hays, Fish & Wildlife Senior Advisor
Public Utility District No. 1 of Chelan County (Chelan PUD)
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Re: Lake Chelan Hydroelectric Project No. 637 (Project)
30 Day Review and Comment Periods:
Snorkel Surveys in the Chelan Falls Habitat Channel and Tailrace, and Reach 1 of the Chelan River, WA – 2016
Comments Due March 28, 2017
Chelan River Biological Objectives 2017 Status Report
Comments Due April 3, 2017
Macroinvertebrate Investigation: Chelan River, WA, Draft Annual Report
Comments Due April 10, 2017

Dear Chelan River Fishery Forum and Other Parties:

I am taking this opportunity to remind you that there are 30-day review and comment opportunities for three reports that have expired or are about to expire. Thus far, I have not received any comments on these reports, with one response that there will not be any comments from that individual (on the snorkel survey report). I realize that having to review all these reports at once is burdensome and I wish I could space them out for you. However, they all have a FERC filing date of April 30 and each report covers work that was conducted through 2016, thus it was not possible to get them out for review with more time between issuance of each report.

If you intend to provide written comments and missed or expect to miss the comment deadlines, please submit a request for additional time and Chelan PUD will do its best to accommodate your request. Please, if you have reviewed a report, but do not have any comments, it would be very helpful if you could provide a response that acknowledges your receipt of the report and that you will not be providing any comments that would require changes to the report.

Thank you for your time and I hope that you all found the reports informative and useful.

If you have any questions, please do not hesitate to contact me at (509-661-4181) or by email.

Steven Hays
Fish and Wildlife Senior Advisor
steve.hays@chelanpud.org
(509) 661-4181